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Studies on the Physicochemical Properties and Shelf Life of Postharvest Mangifera indica during Storage Environments

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University of Rajshahi

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THESIS SUBMITTED TO THE UNIVERSITY OF RAJSHAHI
IN FULFILMENT OF THE REQURIRMENTS FOR THE DEGREE
OF
DOCTOR OF PHILOSOPHY

IN

BIOCHEMISTRY AND MOLECULAR BIOLOGY

BY

Md. Khairul Islam
B. Sc. Ag. (Hons). M. S. Hort. M.Phil.

May 28, 2008

Protein and Enzyme Laboratory
Dept. of Biochemistry and Molecular Biology
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DEDICATED TO THE DEPARTED SOUL OF MY BELOVED PARENTS

DECLARATION

I do hereby declare that the contents of this thesis entitled "Studies on the Physicochemical Properties and Shelf Life of Postharvest Mangifera indica during Storage Environments" are comprised of my bonafide research works and have at no time, been submitted for any other degree, diploma or other similar title of any university.

Date: May 28, 2008
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CERTIFICATE

This is to certify that Md. Khairul Islam, B. Sc. Ag. (Hons), M. S. Hort., M. Phil., Assistant Professor, Department Crop Science and Technology, University of Rajshahi is the sole author of the dissertation entitled "Studies on the Physicochemical Properties and Shelf Life of Postharvest Mangifera indica during Storage Environments". We have gone through this thesis, and that, in our opinion, it is satisfactory in scope and quality as a thesis for the degree of Doctor of Philosophy in the Department of Biochemistry and Molecular Biology of the University of Rajshahi, Bangladesh.

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The Author

Abstract

An investigation was conducted for obtaining information on the reduction of postharvest losses, pattern of physical, biochemical and mineral content changes, storability as well as shelf life of postharvest mango. The trials included four different experiments involving two factors where variety was a factor comprising of Langra and Khirshapat. These varieties were treated with different postharvest treatments *viz.*, control, paraffin coating, perforated polyethylene cover, unperforated polyethylene cover, hot water (55±1)^{0}C, low temperature in refrigerator (4±1)^{0}C (experiment 1); different doses of Maleic hydrazide solution namely, control, 200, 400 and 600 ppm (experiment 2); different doses of GA3 solution such as, control, 100, 200 and 400 ppm (experiment 3), and different doses of Bavistin DF solution *viz.*, control, 250, 500 and 750 ppm (experiment 4).These experiments were laid out in Randomized Complete Block Design with three replicates. Data obtained from various biochemical analyses in terms of physicochemical properties and shelf life of postharvest mango, were recorded and statistically analyzed for comparison among the mean values using DMRT and LSD.

The results of the experiments exhibited that only the single effect of varieties was found to be significant in most of the parameters studied. Variety Langra performed better in accumulating higher quantity of edible portion, pulp to peel ratio, dry matter, ash, vitamin c, titratable acidity, TSS (after 3rd day in case of experiment 2 and 4 as well as 6th day in case of experiment 3), crude fiber, lipid, water soluble protein, phosphorus, potassium, magnesium, iron and manganese content in all four experiments over Khirshapat. On the other hand, Khirshapat showed better performance in achieving higher quantity of moisture, progressively lost physiological weight, increased pulp pH, TSS (in terms of experiment 1, initial to 3rd day for experiment 2 and 4 as well as initial to 6th day for experiment 3), produced more quantity of sugar (total, reducing and non reducing), calcium, copper and zinc content as well as extended shelf life and delayed skin color changes than Langra at all the storage duration.

Different postharvest treatments subjected to the investigation demonstrated significant variation in most of the physicochemical properties and shelf life of mango at different days after storage. The results explored that some physicochemical properties *viz.*, edible portion, pulp to peel ratio, physiological weight loss, moisture content, pulp pH, TSS, sugar (total, reducing and non reducing), lipid, water soluble protein, phosphorus, potassium, calcium, magnesium, iron and manganese content were rapidly increased as well as skin color, dry matter, ash, vitamin C, titratable acidity, crude fiber, copper and zinc content along with shelf life drastically decreased from untreated mangoes, but, low temperature in refrigerator caused delaying of these changes except physiological weight loss. The unperforated polyethylene cover was found to be the best method for reduction of physiological weight loss. Low temperature in refrigerator was the best inhibitor of ethylene synthesis that delayed ripening and prolongation of shelf life. In case of other experiments, Malic hydrazide, GA3, and Bavistin DF at the doses of 600, 400 and 750 ppm, respectively showed better results in delaying the changes in physicochemical properties and extended shelf life.

The results of the interaction effect of varieties and different post harvest treatments in different experiments were found to be significant in terms of most of the physicochemical properties and shelf life. The combination of Langra and control treatment progressively augmented in edible portion, pulp to peel ratio, lipid, water soluble protein, phosphorus, potassium, magnesium and iron content up to a point of ongoing metabolic cycle and thereafter, these compositions decreased. On the other hand, Khirshapat along with low temperature in refrigerator $(4\pm1)^0$C, Malic hydrazide at 600 ppm, GA3 at 400 ppm and Bavistin DF at 750 ppm acted better in retardation of rapid augmentation of these compositions resulting in prolongation of shelf life in different experiments. Khirshapat using unperforated polyethylene cover also drastically reduced physiological weight loss.

Langra using low temperature in refrigerator$(4\pm1)^0$C, 600 ppm of Maleic hydrazide, 400 ppm of GA3 and 750 ppm of Bavistin DF were found to be excellent in lower diminishing tendency in terms of dry matter, ash, vitamin C, titratable acidity as well as crude fiber followed by other treatment combination in different experiments studied. Khirshapat using no treatment extensively lost physiological weight, absorbed more moisture, increased TSS (up to 6^{th} day then it decreased), accumulated higher sugar (total, reducing and non reducing) and calcium content up to on going metabolic activities but, using low temperature in refrigerator $(4\pm1)^0$C, 600 ppm of Maleic hydrazide, 400 ppm of GA3 and 750 ppm of Bavistin DF solution strongly interrupted these activities. Khirshapat along with low temperature in refrigerator, 600 ppm of Maleic hydrazide, 400 ppm of GA3 and 750 ppm of Bavistin DF solution extended shelf life up to 38.00, 17.00, 18.00 and 17.33 days after storage, respectively. Therefore, low temperature in refrigerator $(4\pm1)^0$C was the best method for preservation and delay ripening of postharvest mango and the second suitable method in another experiment was 400 ppm of GA3 which might be easily adopted by common farmers for mango preservation.

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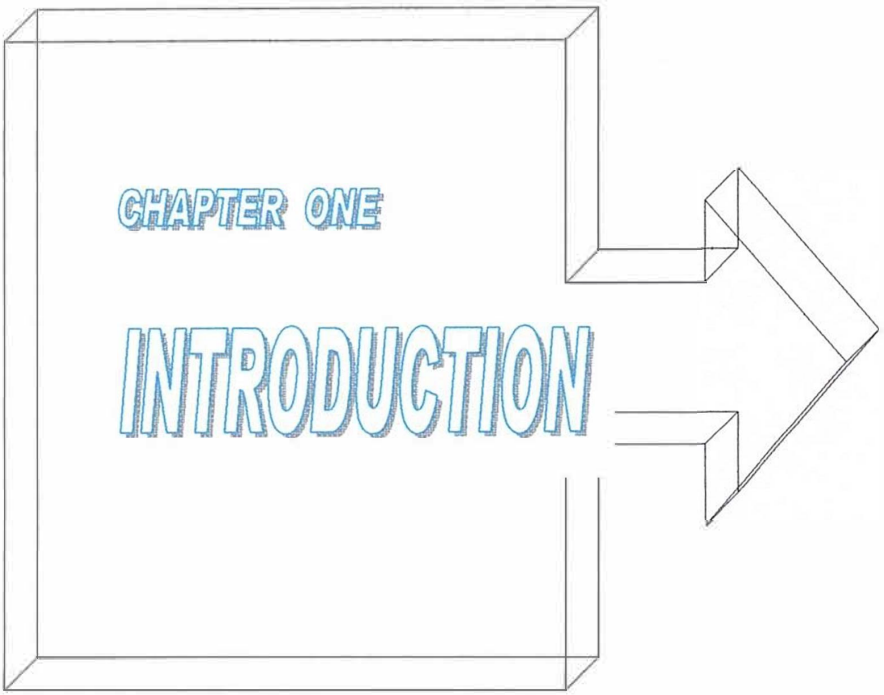

CHAPTER ONE
INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1 Orientation and origin

Mango (*Mangifera indica L.*) is one of the most important fruit crop in tropical and subtropical regions of the world under the family of Anacardiaceae and it was originated in South Asia or Malayan archipelago (Salunkhe and Desai, 1984). It had been cultivated for more than 4000 years (Mukherjee, 1949; Candole, 1984; Bose, 1985). Mukherjee (1949) explored that the genus Mangifera originated in Burma, Indochina and Malayan peninsula; but the mango itself had originated in the Assam – Burma region which also included Bangladesh.

1.2 Production status

The mango is a commercial crop in many countries of the South-East Asia *viz.,* India, Pakistan, the Philippines, Indonesia, Malaysia, Thailand, Burma, Sri Lanka and Java.The main mango producing countries of the world are India, Pakistan, Mexico, Brazil, Haiti and the Philippines, of which India being the largest producer (Salunkhe and Desai, 1984).

Mango ranks third among the tropical fruits grown in the world with a total production of 23.87 million tones (FAO, 2006), to which Bangladesh contributed to only 0.64 million tones (BBS, 2006). It is considered as a fruit crop for home consumption. It is also gaining rapid popularity in the Middle-East, South East Africa, South Africa, Florida, Israel and Australia. Among the fruits, Mango ranks first in terms of area and third in terms of production in Bangladesh (BBS, 1999). Bangladesh produces 184 thousand tons of mangoes per annum from 50.60 thousand hectares of land.

1.3 Uses and importance

Mango is one of the most important, popular and tasteful fruit crop not only in Bangladesh but also in the world owing to its greater utility, characteristics flavor, attractive color, pleasant aroma, delicious taste and nutritional value. It is consumed as fresh ripe and green fruits. Both the green and ripe fruits are also used to make different varieties of processed products like juice, chutney, pickles, jam, jelly etc. For this reason, it is acknowledged as the king of fruits in Bangladesh as well as in other South-East Asian countries (Pursglove, 1972; Shahjahan *et al.,* 1994).

Nutritionally, it contains substantial quantity of appreciable β carotene, vitamin C, and dietary fibre (Pal, 1998) as well as soluble sugars and different minerals which are used for good sources of nutrition and readily available and easily assumable in human body (Singh, 1960) and therefore, is capable to prevent many deficiency diseases (Samad *et al.* 1975, Purohit, 1985, Anon., 1962).

An adult individual needs about 2222 kcal at least of which 2.5% kcal should come from fruits daily as the gross food requirements, but he/she obtains only 1% kcal.(Mondal, 2000). In these circumstances, it is not possible to meet the increasing demand of fruits for growth and development of the human body. About 18, 79,000 metric tons of various types of fruits were produced from the 2, 81,000 hectares of land in the year of 1998-99 whereas our annual demand was about 29,83,875 mt. (BBS, 2000). So, normally there is a shortage of fruit production per year in the country. About 10% of the national income comes from various fruits among the income from agricultural crops, which play a vital role in our national economy (Mondal, 2000). Fruit plants in Bangladesh occupy about 3.91% of the total cultivable land providing only 6.5% of the total foods produced in Bangladesh and they also supply 2.05% of GDP (Mondal, 2000). So, fruit must be economically a very important crop grown in Bangladesh. Mango is a major part of the fruit crops occupied in Bangladesh; but it always decays after harvest.

1.4 Nutritional deficiency

Malnutrition and under nutrition have now become an alarming problem of the people of the third world countries affecting their economic and physical development. Protein–energy malnutrition, vitamin and mineral deficiencies are the most serious nutritional disorder in low income groups. Due to these deficiencies, under–weights and high mortality are prevalent in pre- school children and infants. The minimum dietary requirement of fruit per day per person is 115 g, but our availability is only 30-35 g, which is much lower than the recommended daily allowance (Siddiqui and Scanlan, 1995). The per capita availability of fruits is further reduced sometimes due to high level of postharvest losses (Mondal *et al.*, 1995). Postharvest losses can be considerably reduced by applying improved storage technology and prolonging the shelf life of fruits.

1.5 Quantity of postharvest losses

Postharvest losses and deterioration of nutritional quality of fresh fruit are the most important problems in tropical and sub- tropical regions of the world. A huge quantity of nutritious fruits is being markedly deteriorated due to the lack of proper knowledge on post harvest management practices. As a result, people do not have sufficient nutrition from fruits according to their requirements. A considerable amount of fresh fruits goes waste every year through post-harvest decay. The magnitude of post harvest losses in fresh fruit is estimated to be about 5 to 25% in developed countries and 20 to 50% in developing countries (Khader, 1985). Srinivas *et al.*(1996) reported from India that the total post harvest losses of mango cv. Totapuri and Alphonso to be 17.9% (3.5% orchard/field, 4.9% transportation, 4.10% storage and 5.4 retail level) and 14.4% (1.9% orchard /field, 3.7% transportation, 3.7% storage and 5.3% retail level) ,respectively.

Mushtaq *et al.* (2005) found that total postharvest losses in the marketing Channel's of mango were 11.97% at farm level (Producer/Contractor level), 11.10% at market level (Phariawala and retailer level) and 7.90% at consumer's level.
Quroshi and Meah (1991) found that post harvest losses of mango fruits varied according to variety from 0 to 16.3%, with an average loss of 12.5%. It also depends on transport distance from production site to retail location.

Approximately 30-50% fruits go waste during postharvest handling, storage and ripening (Lashley, 1984). Among the fruits mango manifested high postharvest losses because of its high perishability and climacteric pattern of respiration. The marketability of this perishable fruit is closely linked with the development of suitable technology which reduces the losses at different stages of harvesting and storage condition.

Losses in terms of quality and quantity of fruits occur at all stages in the post harvest system from harvesting to consumption. Reliable statistical data are inadequate especially in Bangladesh to indicate the magnitude of post harvest losses of mango. Singh (1960) reported that the postharvest losses of mango fruit in India due to microbial decay ranged from 20 to 33%. Quality mangoes are produced in north –western part of Bangladesh, of which about 35- 38 % of post harvest losses

are caused due to inefficient handling during its transportation , storage and marketing (Rubbi *et al.*1985). In India, every year 20- 40% of fruits and vegetables are damaged during transportation and storage (Banik, 1995). Hence, the development of technology for reducing postharvest decay is a necessary prerequisite for the promotion of the fruit industry. It is very important not only to produce more but also to save whatever is grown at high production cost.

Lashley (1984) reported the methods of reducing postharvest decay through genetic control of storage life, field and post harvest treatments viz., hot water treatments, wooden crate packaging, corrugated fibre board packaging and plastic films for atmospheric medication. In addition, wax coating, application of fungicide and growth regulators, low temperature storage, oil dipping, use of different chemicals for slowing down the physical activity and ripening process of fruit during the transport and marketing are the commonly used methods to prevent postharvest wastage of mango fruits. Many workers (Dara, *et al*. 1982; Sankat *et al*. 1993; Baez, *et al*. 1993; Feng *et al., 1991;* Inyang and Agbo, 1995) studied the effects of many postharvest treatments with a large number of mango cultivars and observed the extended shelf life.

1.6 Causes of postharvest losses

The postharvest life of any fruit consists of ripening and senescence. After harvest, fruits undergo many physiological and biochemical changes during storage. Apart from those changes, microbial decay also contributes to postharvest losses during ripening and storage. The storage life of a fruit could be prolonged significantly through slowing down the process leading to ripening, and controlling the microbial decay.

The huge amount of important fruit crops are being spoiled due to prevailing temperature, humidity, inappropriate post harvest handling as well as sub- optimal knowledge in the field of postharvest technology after harvesting. This spoilage of fruit is attributed to adverse biochemical changes, namely loss of weight owing to respiration and transpiration, loss of flesh hardness, loss of resistance to different microbial attack and overall devastating deterioration of carbohydrate, protein, lipid, some oxidative enzymes, minerals and nutrient status.

Appropriate production technology, careful harvesting and proper packaging and storage management can contribute to keep the produce quality good. Once a crop is harvested it is impossible to improve its quality. The fruit crops having their high moisture content are inherently more liable to deteriorate especially under tropical conditions. Moreover, they are biologically active and carry out transpiration, respiration, ripening and other biochemical activities, which deteriorate the quality of the produce.

Mango is the staple fruits in Bangladesh being lost from time immemorial should get top priority to reduce markedly and to extend the shelf life by applying different storage treatments. Then, we can use them properly throughout the year round conserving their quality and quantity. As a result, sustainable utility of mango must be increased.

1.7 Postharvest technology

Post harvest loss of fresh mango fruit is one the major problems in the tropic for its high perishability in nature and climacteric pattern in respiration. To extend the postharvest life of mango, its respiration rate should be reduced as per as possible. Ripening of fruits starts after synthesis of ethylene which causes ripening fast. The factors which strongly influence the rate of respiration and to inhibit the synthesis of ethylene are very essential for reduction of losses and extension of shelf life of postharvest mango. Application of different postharvest treatments *viz.*, paraffin coating, perforated polyethylene cover, unperforated polyethylene cover, hot water treatment and low temperature in refrigerator are very much important obstacles to normal respiration of mango fruits. These treatments strongly impede in ethylene synthesis that resulted in low respiration and delay ripening. These materials also reduced the losses and prolonging the shelf life of mango (Tefera *et al.* 2007; Benitez et al. 2006; Fawaz, 2006; Muy *et al.* 2004 and Fonseca *et al.* 2004). In addition, hormonal treatments like Maliec hydrazide (MH) and Gibberellic acid (GA3) and fungicidal treatments like Bavistin DF (BDF) are also excellent ethylene inhibitors. These treatments performed effectively in reduction of postharvest decay, and extension of shelf life of mango (Ranjan *et al.* 2005; Dhemre and Waskar, 2004; Gautam *et al.* 2003; Reddy and Haripriya, 2002 and Ahmed and Singh, 2000). Apparently, these treatments deteriorate the qualities of fruits to some

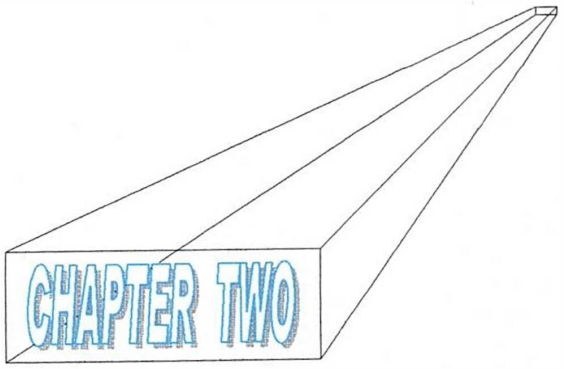
extent, but the reduction of losses and extension of postharvet life of mango will help to increase the market price in the off seasons which play a good role in the economic development.

Postharvest decay causes a huge amount of economic loss that hampers the total GDP in a country. There are no available research findings regarding the controlling of postharvest decay and extending the shelf life of mango in Bangladesh contest. So, therefore, it is very much essential to conduct an investigation for details information in the development of new technology that will help in delay ripening of the commercial mango varietles. Studies also needed for minimizing the postharvest decay and to extend the shelf life of mango. So, the outcome of this work will help solve the persistent problems and minimize the economic loss in this regard.

1.8 Objectives of the study

The present investigation was undertaken with the following objectives.

1. To identify the better one between two mango varieties in terms of nutrient content.
2. To study the behavioral pattern of physicochemical properties of postharvest mango in the storage conditions.
3. To find out a desirable technology for extension of shelf life of mango.
4. To select the best method for reduction of losses and extension of postharvest life of mango.
5. To assess the shelf life of selected fruits as influenced by different physical, chemical and hormonal treatments under different storage conditions.



REVIEW OF LITERATURES

CHAPTER 2

REVIEW OF LITERATURES

Many researchers have studied on physicochemical behavior and shelf life of postharvet *Mangifera indica* L. during storage environments using different kinds of storage treatments. A good number of information's regarding the physicochemical changes and shelf life of mango varieties and storage treatments namely, paraffin coating, perforated and unperforated polyethylene cover, hot water, low temperature in refrigerator, different doses of Maleic hydrazide, Gibberellic acid and Bavistin DF have been accomplished in many parts of the world, but unfortunately, sufficient documents in this connection are not available for our local varieties. Some of research findings relevant to the present investigation, so far as possible to collect, are reviewed and stated in this chapter.

2.1 Effect of paraffin coating

A study was investigated by Muy *et al.* (2004) on storage conditions and waxing affect water status and quality of mango. They exhibited that weight loss increased directly proportional to vapor pressure deficit (VPD). Wax application was effective in reducing by 30% the weight loss, but only at high VPD conditions, empiric model were generated to predict shelf life on control and waxed fruit (r^2 = 0.90) when the fruit reached 89% RWT and psi p = 0 (Cellular Plasmolysis) the commercial quality was unaffected. Fruits with 84% RWC psi-p< 0 and firmness = 20 N, defined the beginning of commercial quality loss. Psi w was reduced during storage from 1.0 to 2.8 MPa, depending on VPD conditions and wax application. This reduction was partially due to solute accumulation (Degrees Brix) that modified Psis. As degrees Brix increased, Psi – s descended in a lineal relation that can also be used for prediction.

Fonseca *et al.* (2004) conducted an experiment in a laboratory to study the pulp and skin pigments in mango 'Haden' applying with fungicide and wax. They showed that the use of wax reduced the synthesis of carotenoid pigments in the pulp of 'Haden' mango. It also reduced chlorophyll breakdown of the skin, mainly chlorophylla, resulting in a lesser development of the yellow background coloration. On the other hand, benomyl and benzalconic chloride did not affect the synthesis or the breakdown of pigments of Haden mango.

Fonseca *et al.* (2001) investigated a trial using of fungicides and wax in storage and postharvest quality of 'Haden' mango in cold storage to study the physicochemical behaviors. They reported that Haden mangoes were dipped in benomyl (1g/litre) or benzalkonium chloride (2g/litre) with or without clean wax (an emulsion containing 18.5 to 20.5% of camauba wax and acrylic resins mixture) and stored (13±1)℃ and 80-90%RH for 21 days. Partial ripening occurred during storage. Waxing increased the general appearance of the fruits, mainly by maintaining them more turgid. Both fungicides controlled anthracnose development during storage. They also showed partial ripening occurred during storage.

An experiment was conducted by Zambrano *et al.* (1997) to study the change during storage of wax coating mango fruit cv. Palmer and Keitt. The fruits were dipped fully in 1% aqueous suspension of Prolong or Primafresh C (original concentration) and stored at 15°C and 85-95% RH. Three fruits were analyzed, at 3 days intervals, for 18 days. Observation shows that there was no significant effect on external color but coating affected internal colour. Wax treated fruits exhibited reduced weight loss as compared with untreated ones.

Yuniarti and Suhardi (1992) observed prolonged ripening period (11 days) and longer over ripe stage (by 9 days) compared to control when mango fruits were dipped in wax emulsion of concentration 6 or 7%. They also found minimum weight loss and low content of soluble solids in the above mentioned treatments.

Chandra and Pathak (1992) claimed that post harvest anthracnose severity of mango fruits could be reduced by pre or post inoculation treatments with waxol, mustard oil, ABC (Attapulgite Based Clay) dust and phytoalexin-84. Viller and Korsten(1994) found that the hot water dip of mango cv. 'Kent' followed by wax + ¼ prochloraz + Bacillus licheniformis treatments were significantly better in reducing anthracnose disease than hot water treatment on the wax + Bacillus subtilis treatment.

Castrillo and Bermudez (1992) carried out an extensive study on postharvest ripening in wax-coated 'Bocado' mango. The results showed that the delayed ripening effects of wax-coated fruits affected fresh weight loss, exocarp chlorophyll degradation and mesocarp pH change; but it did not affect mesocarp chlorophyll, sugar and starch content.

Mohiuddin *et al.* (1991) made an investigation to observe the effects of different coating materials viz. paraffin, soybean and mustard oil on the shelf life of mango cv. 'Ashwina' with or without prior application of Dithane M-45. They observed that the paraffin coating reduced both weight loss and rotting with concomitant enhanced shelf life.

Ilanggantilake *et al.* (1989) conducted an experiment to study the effects of pretreatment and hypoboric storage life of mango. They found that mangoes pre-cooled at 15^{0}C temperature followed by low concentration of 0.5% wax emulsion treatment successfully kept up to 30 days in store without deteriorating fruit quality. Parmar and Chundwat (1989) while working with mango cv. Kesar found that post harvest waxol treatment was most effective in delay ripening along impaired fruit quality when stored at ambient temperature for 10 to 27 days. Joardar (1980) reported that wax coating treatment increased the shelf life and significantly prevented the weight loss of mango.

Krishnamaruthy (1989) conducted a study on the effect of coating material on shelf life of mango and quality attributes. The study consisted on coating unripe mature fruits with Tal-Prolong (a product of sucrose esters, glycerides and cellulose) by dipping fruits for min. in 1 % suspension before storage. This treatment delayed ripening by 4-5 days under ambient condition (28-31^{0}C), for 18 days with reduced weight loss and quality. In another study Huddar *et al.* (1989) found that the dipping in Tal-Prolong at 1 % gave the best retention of fruit colour, flavour and texture over a period of 15 days storage of fruits cv. 'Dashehari' and 'Mallika'.

Chhatpar *et al.* (1972) reported that it was possible to store mangoes for about two and a half months at 5-8^{0}C by coating them with wax emulsion. Ilangantilake and Salokhe (1990) observed that chemical waxing treatment was capable of retaining chlorophyll up to 20 days of storage, but injured the skin after 20 days storage when high concentration of wax was used. It also retarded the ripening process of mango after removal to room temperature conditions. Brown color development on the skin during storage which resulted in an undesirable appearance on the samples. Six percent waxol treated 'Kesar' mango fruits were stored at ambient temperature for 10-27 days, and fruit ripeness, % marketable fruit, weight loss, total soluble solids, sugars and titratable acidity were assessed

(Parmar and Chundawat, 1989). Waxol was the most effective in delaying ripening but it had undesirable effect on fruit quality.

Thangaraj and Irulappan (1988) reported that the weight loss (2.3%) and the longest shelflife (9.7 days) were obtained with 10% frutox+ cool chamber storage. Waxing increased the shelf life and prevented the weight loss of mango significantly (Joarder, 1981).

2.2 Effect of polyethylene cover

Fawaz (2006) conducted an experiment with postharvest mango cv. Bullock's heart to investigate the physico-chemical characters during storage. He observed that 8% wax emulsion resulted in the lowest weight losses and the highest acidity of the fruits, and individual wrapping of fruits in low density polythene film (LDPF) resulted the highest carotenoid content. Postharvest decay was not observed in fruits dipped in 2% calcium chloride or 85 % wax emulsion. Flesh firmness was highest in fruits dipped in 2 % calcium chloride. Among the treatment, dipping in 4 % wax emulsion resulted in the highest total suger content of the fruits, although the values obtained were lower than those of the control fruits.

Illeperuma and Jayasuriya (2002) carried out an investigation to chalk out the physicochemical properties and shelf life prolonged storage of 'Karuthacolomban' mango using modified atmosphere packaging at low temperature. They showed that the fruits packaged with scavengers had lower percent weight loss and minimum changes in physicochemical properties compared with the fruits packaged without scavengers. The modified atmosphere created in low density polythene bags was effective in delaying ripening of Karuthacolomban mango up to 16 days but ripening was further delayed up to 21 days in the presence of scavengers. Physicochemical and sensory properties, visual quality rating and disease index of modified atmosphere stored mango after ripening were similar to those packaged in perforated low density polyethylene bags (LDPE). Therefore packaging of 'Karuthacolomban' mango in 0.05 mm LDPE bags of 1:1 surface area to weight ratio (cm^2g^{-1}) with 50 ml of saturated potassium permanganate absorbed on to suitable porous matrices and 2 gm of activated granular charcoal could be recommended to increase storage life at 13°C.

Fruits of cv. Himsagar were stored in lined wooden boxes for up to 14 days after treatment with tap water, cold water or an aminoethoxyvinyl glycine (10 ppm) solution. For each treatment, half of the fruits were kept in boxes with $KMnO_4$ soaked paper shavings. Physiological weight loss and decay loss were minimal in fruits with the cold water treatment + $KMnO_4$. Fruit quality characteristics were not appreciably affected (Chattapadhyay, 1989). Mondal *et al.* (1995) found a shelf life of mango of 21 days by keeping mango fruits in polybag. Mondal *et al.* (1998) also observed highest shelf life (26.75 days) of mango by polythene wrapping followed by low temperature (12-13°C) storage in another experiment.

Shivarama-Reddy *et al.* (1989) worked with wax coated fruits cv. 'Alphonso' and stored in perforated polyethylene bags (3, 4, 6 or 8% wax emulsion). They demonstrated that the weight loss and the rate of spoilage in storage were reduced over 20 days when the fruits were treated with fungicide (Thiabendazole, Benlate [Benomy] and Bavistin [Carbendazim] at 100, 250 and 500 ppm). The best storage life of mango fruits was found on treatment with thiabendazole (100 ppm) and 6% wax emulsion.

Mature green fruits (cv. Keaw Sawoey) were individually placed in sealed packages in polyethylene film (0.011 mm thick) or pvc film (0.014 mm thick) and stored at 13°C with 78% RH or under ambient conditions (28-33°C, 80% RH). The packaged fruits retained its quality for 6-9 days at ambient temperature and 30-36 days at 13°C, while unpacked fruits rapidly became shrivelled and over ripe (Sornsrivichai *et al.*1989). They noted that pvc film was more effective in delayed ripening than polyethylene film.

Wavhal and Athale (1989) reported that packing in lots of 10 in polyethylene bags (30 × 40 cm, 100 gauge with 0.2% perforation) reduced weight loss, maintained fruit quality and prolonged shelf-life by 4-8 days, compared with non-wrapped fruits. They also reported that inclusion of a bag of vermiculite (30g) saturated with $KMnO_4$ in the polythene bags gave a reduction of weight loss and storage disorders.

Various wrappers such as polythene, cellophane, tissue paper and polio film were tried to prolong the storage life of mangoes (Cheema *et al.*, 1939; Mukherjee,

1956; Singh, 1960). Among these, polythene proved superior to others. It was found that during six weeks storage of mangoes wrapped in polythene bags, the fruits showed lower physiological losses and chilling injury at 7.2°C (Mukherjee, 1956 and Singh, 1960). Similarly, the efficacy of tissue paper in prolonging the storage life of mangoes was demonstrated at 15.6°C (Cheema *et al.* 1939).

Singh *et al.* (1967) found perforated polythene bags in combination with fungicidal wax coating to increase the storage life. Cellophane wrappers caused a greater retention of total soluble solids. Miller *et al.* (1986) reported that total time required for fruit to reach the soft ripe stage was reduced to 16 days by wrapping them with plastic film after the initiation of ground peel colour development, from 20 days required when wrapping mature green fruits.

Working on 'Nam Dok Mai' mango, Koolpluksee *et al.* (1993) found that storage treatments (polyethylene or polypropylene bags, perforated or none perforated, and with or without ethylene absorbent) reduced off odours, off-flavours, chilling injury and delayed ripening compared with control fruits. Longest storage life occurred in fruits kept in perforated polypropylene bags with or without ethylene absorbent (21 and 23 days respectively), while control fruits had a storage life of < 5 days.

2.3 Effect of hot water treatment

Benitez *et al.* (2006) reported that mango cv. Namdokmai fruits at mature-green stage were heat treated by dipping in 50 or 55°C water for 5 minutes and stored at 25°C with 90-95% relative humidity. They found fruits as dipped in ambient water served as the control. Softening slowed down in response to the heat treatment. The effect of the two heat treatments did not considerably differ. Concomitant with softening, the heat-treated fruits exhibited reduced pectin methylesterase [pectinesterase] (PME) and polygalacturonase (PG) activities in both peel and pulp tissues. Heat treatment at 55°C generally resulted in lower PME and PG activities than at 50°C. These result indicated that heat effect of ripening-associated was due to inhibition of pectin-degrading enzymes.

Nair *et al.* (2001) conducted a laboratory experiment on the reduction of chilling injury and quality of mango fruits (cv. Kensington pride) using hot water and

hot air treatments. They found that heat treatment did not result in a substantial reduction in chilling injury development after 21 and 35 days of storage at 5°C. All heat treatments increased respiration rate, but ethylene production, physiological weight loss during storage and total soluble solids were increased only by some heat treatments.

Baez *et al.* (2001) reported an experiment on postharvest performance of mango 'Tommy Atkins' using hot water and wax. They explored that Mexico is the largest mango exporter in the world, producing 40 million ton-pound boxes filled with fruits. They also found that hot water-treated fruits lost more weight than untreated fruits and the use of wax had a positive response in the hot water-treated fruits. Respiratory behavior was normal for all treatments with the climacteric peak at five days, except for hot water and without wax fruit treatments. These fruits lost more weight and did not ripen normally. This general behavior was observed in fruit stored at 12°C for 20 days and after marketing condition.

Nyanjage *et al.* (2001) carried out a laboratory investigation for the determination of postharvest changes in mango fruit cv. Tommy Atkins using hot water treatments and storage temperature. They found that fruit reflectance decreased, whereas chroma and hue algae increased over storage time and also with increase in storage temperature. The yellow colour increased with a rise in storage temperature in hot water treated mango. Soluble solid content of mangoes held at 22°C was highest at 5 days of storage, but decreased subsequently over storage time. Impedance (being a potential non-destructive measure of tissue damage following heat treatment) of all fruits was decreased with Increase In frequency, storage temperature and time In store. The impedance of hot water treatments (hwt) mangoes was lower than that of non-hwt fruits on 8th day after immersion, but recovered almost to control levels on day 4 to 5 or 13°C, but decreased gradually after 5 days at 13°C. Impedance of all mangoes stored at 22°C decreased continuously during storage. Impedance was higher in the inner mesocarp than outer pulp. Impedance of hwt fruits was poorly correlated with soluble solid content and chroma but well correlated with reflectance of fruit pulp at 22°C. Changes in impedance of mangoes were discussed in relation to physiological and biochemical changes that occur during heat treatment and storage.

Jacobi *et al.* (2001) carried out an experiment on loss of heat tolerance in 'Kensington' mango fruits following heat treatments. They observed that the greatest reduction in heat tolerance occurred in fruit placed at 22^{0}C for 16 hrs. compared with the other condition of fruit. These fruit had the highest incidence and severity of skin scalding external cavities starch layer increased F0 values and a lack of recovery in FV/FM ratios after HWT. It was concluded that the loss of heat tolerance in 'Kensington' fruit occurred at a lower rate than the increase in heat tolerance brought about by the 40°C conditioning treatments. Exposure of fruit to 22°C for 24th day or longer accelerated the fruit ripening and induced some protection against heat injury.

There was a finding investigated by Jacobi *et al.* (2000) on the effect of hot air conditioned of 'Kensington' mango fruit on the response to hot water treatment. They showed hot water injuries were reduced and in some cases elimminated by conditioning the fruits at 40°C for 8 h. The conditioning temperature was more important than the duration of the HWT in injury alleviation. Conditioning at 40°C prior to hot water treatment accelerated fruit ripening, increased weight loss, reduced fruit firmness, increased degrees Brix and lowered titratable acidity compared to untreated fruits and fruits receiving other heat treatments. These treated fruits were also more resistant to postharvest diseases.

Gafur *et al.* (1997) conducted a study on extension of postharvest storage life of mango cv. Fazli and Aswina. They reported that hot water treatment (52±2°C) using 1% $CaCl_2$ for 5 min. was the most effective in retarding of fruit ripening (ripening was delayed by 5-8 days) and spoilage was also significantly reduced. The shelf life of control fruit was short; fruit exhibited a rapid rate of ripening as evident by a rapid increase in total soluble solid and by a rapid decreased in acidity and ascorbic acid content. In another experiment, Nyanjage *et al.* (1998) found that hot water treatment at 46.5°C for 45 min and then 2 days of intermittent warming resulted in a significantly low incidence of diseases and severity of external injury, softer fruits, higher brix and better general appearance. Kruger *et al.,* (1997) reported from his investigation of cv. 'Heidi' that hot water treatment at 40°C for 15 min gave best results for storage life.

Bugante *et al.*(1997) reported that hot water dipping (53°C for 5 or 10 min.) significantly decreased incidence of diseases of which 10 min dip providing the most effective control of 'Carabao' mango fruits. Preharvest bagging combined with a 10 min, hot water dip significantly decreased the incidence of disease, anthracnose was reduced by 83% and stem end rot by 100%.

A study was conducted by Jacobi *et al.*(1996) with mango fruits cv. 'Kensington' subjected to conditioning treatments with hot air (38 to 40°C) for 0, 4, 8 or 12 h before hot water treatment (40°C for 30 minutes) and storage at 22°C for 9 days. Fruits conditioned for 8 or 12 h before hot water treatment had minimal injuries. It was reported that conditioning with hot air before hot water treatment had the potential to minimize or eliminate heat injuries associated with hot water disinfestations treatment. In another experiment Jacobi and Giles (1997) treated 'Kensington' fruits following combined vapour heat disinfestations and hot water disease control treatments and found that the HW+VHT treatment combined with continuous storage at 22°C resulted in the highest quality fruits, and is recommended for air freight marketing.

Saucedo et al. (1995) carried out a laboratory trial to study the physiology and shelf life of Manila' mangoes following hot water (46.1°C for 0,80 and 90 min) and stored at 10, 13 and 20°C.They observed the respiration rates, titratable acidity, total soluble solid, weight loss, chilling injury and anthracnose decay. Results showed that these treatments increased the yellow color and weight loss of fruits and reduced chilling injury and anthracnose decay. The best was hot water treatment (46.1°C) for 90 min. In another experiment Carrillo Lopez *et al.* (1995) treated mango fruits cv. 'Haden' with hot water at 46°C for 90 min and then dipped in semperfresh (0.7, 1.4 or 2.1 %). All fruits were than stored at 13°C for a month. All concentration of semperfresh used delayed ripening. Titratable acidity, firmness and green colour were higher in treated 'Haden' fruits than untreated fruits and weight loss, Brix and PH were lower. Vitamin C content was unaffected in the treated and untreated fruits. Saiman (1995) reported that there were no significant differences between infrared treatment (3 minutes exposure to short-wave) and commercially used 5 minutes hot water bath treatment in their effect on fruit quality. The infrared treatment is much cheaper and faster than hot water treatment.

Hermanto and Yuaniarti (1994) showed that hot water treatment at 49°C for 10 min. or 51°C or higher for 5 min. suppressed anthracnose on mangoes inoculated with *C. gloeosporioides*. Hot water treatment at 51 or 53°C for 10 min. was most effective. There was no loss of fruit quality. Hassan *et al.* (1998) found that hot water treatment at 52± 2°C for 5 min. extended shelf life of mango by 5.34 days over control.

Upadhyay *et al.* (1994) conducted an experiment with mature green mangoes cv. 'Red' to evaluate the physicochemical behavior and shelf life indicating dose of 1 KGY after hot water at 55°C for 5 minutes. They reported that irradiation significantly reduced rotting, delayed color development, preserved quality and extended shelf life. A hot water treatment followed by irradiation at 0.3 KGY was found to be the best treatment combination. In an experiment Jacobi and Gowanlock (1995) submerged mature green fruit in hot water at 46°C until the fruit centre reached 45°C, and were than held for 30 minutes. After 7-10 days, the hot water treatment mango fruits were ripe and kept for observation of injury. They reported that the skin injury suggested the disruption of enzyme involved in carbohydrate metabolism.

In Australia, the current recommendation by Johnson *et al.* (1994) for postharvest control of anthracnose (*Colletotrichum gloeosporioides*) in mangoes is a 5- minute heating (52°C) Benomyl dip or 30 second unheated over head spray of Prochloraz. Similar results were also shown by Saaiman and Lonsdale (1994) with combination of prochloraz and imazalil or guazatile. The combination gave improved control of post harvest diseases affecting mango. Hot water (55°C for 2 min.) plus prochloraze (81.0 or 40.5 g **a.i/**100 litre) effectively controlled anthracnose and soft brown rot without being phytotoxic.

Lonsdale *et al.* (1991 a) and Lonsdale (1992 a) conducted a trial with hot water dips and various chemicals. Five minute hot water dip at 55°C plus prochloraze or 5 minute hot water dip followed by ambient temperature (± 25°C) dip in prochloraze were found to be phytotoxic particularly at the higher doses, causing burn on the skin surface. Lonsdale *et al.* (1991 b) and Lonsdale (1992 a) found that a mild irradiation (0.75 KGY) in combination with hot water treatment gave effective control of anthracnose and soft brown rot. Feng *et al.* (1991) reported that hot water

treatment (52-54°C for 8-10 min.) or treatment with thiabendazole (100 ppm) controlled mango anthracnose (*Glomerella cingulata*) effectively.

Esquerra and Lizada (1990) conducted a study with 'Carabao' mango fruits subjected to vapour heat treatment for 10 min. at a pulp temperature of 46°C, and then ripen at 25°C. Vapor heat treatment enhanced peel color quality resulting in a greater portion of treated fruits reaching full yellow color. No adverse effect on the visual quality was observed at the tableripe stage. 'Kensington' mango fruits were treated with hot water or vapour heat for 47°C for 7.5 to 30 minutes (Jacobi and Wong, 1992). The hot water treatment shortened fruit softening time and caused extensive internal and external injury. In another observation, Boonraung *et al.* (1993) found effective control of *Phomopsis mangifera* by dipping mangoes in hot water at 53°C for 10 minutes.

2.4 Effect of low temperature in refrigerator

Tefera *et al.* (2007) conducted an experiment with mangoes for extension of shelf life by maintaining induced temperature between 14.33 and 19.26°C and relative humidity between 70.15% and 82.4° C during storage. They found shelf life of mangoes increased from 3 to 28 days as in the evaporative cooling compared to storage at ambient condition. The storage temperature strongly influenced on all postharvest quality parameter tested in mangoes during storage. Higher temperature rapidly deteriorated the physiological and chemical quality of mangoes. Similarly, modified atmosphere packaging positively affected the physiological and chemical quality of mango during storage. It also reduced the physiological weight loss (PWL) and maintained better quality in terms of pH, ascorbic acid and marketability, compared to control during storage. The benefit of the combined effects of post harvest treatments on mangoes included reduction in PWL maintenance of better chemical quality and improvement in the shelf life of mangoes.

Durigan *et al*. (2004) carried out an investigation on postharvest conservation of 'Tommy Atkins' mango fruit using gamma radiation, wax, hot water and low temperature in refrigeration. They reported shelf life of fruit increased when

temperature in refrigerated storage and improved shelf life after transferring to ambient temperature.

Puttaraju and Reddy (1997) carried out an experiment with mango cv. 'Malika' to chalk out the effect of pre-cooling on the storage life. Their treatments were hydro-cooling (15 or 30 min), running water (15-30 min), room cooling (30 or 60 min.), ice cooling (15 or 30 min), evaporated cooling and control (non-cooling). Cooling under running cold (4-5°C) water for 30 min. retarded ripening significantly, extending the storage life by 3-4 days. In terms of physiological weight loss, delayed ripening and higher fruit firmness ice cooling treatment were most effective but the quality of these fruits were unacceptable due to high rate of spoilage.

Mohammed and Sankat (1995) conducted an experiment with intermittent warning and the cooling cycles of the Julie mango. The fruits were subjected to 2 cyclical cooling and warning regimes for up to 35 days, then kept at ambient temperature (28°C) to ripen. They found that fruits treated to a cycle of 12 h at 5°C followed by 12 h at 16°C showed good ripening quality when stored up to 28 days. Fruits treated to a cycle of 18 h at 5°C followed by 6 h at 16°C have good keeping quality and ripening. They could be stored up to 14 days, but for keeping of longer period reduced shelf life which might be due to chilling injury.

Castrillo and Bermudez (1992) conducted an extensive study, on post harvest ripening in wax coated mango fruits cv. Bocado. The results showed that the delayed ripening of wax coated fruits resulted in fresh weight loss, exocarp chlorophyll degradation and mesocarp pH change, but it did not significantly affect mesocarp chlorophyll, sugar and starch content.

Chattapadhyay (1989) conducted a study on mango fruit cv. 'Himsagar' following treatment with chemicals and cooling; the fruits stored in lined wooden boxes for up to 14 days. He reported that physiological weight loss and decay loss were less in fruits with cold water treatment +$KMnO_4$. In another study Ilangatileke *et al.,* (1989) found that mangoes precooled to 15°C and treated with a low wax concentration (<0.5%) could be kept for up to 30 days of storage without loss of quality after ripening. An experiment of hydro-cooling of mango cv 'Keitt' was conducted by Oothuyse *et al.,* (1995). Hydro-cooling for 30, 60 or 120 min at 20°C or 5°C was compared with air-cooling at 20°C for 30, 60 or 120 min. Incidence and

severity of soft brown rot was reduced by hydro cooling at 5°C for 120 min with extended shelf life of mango accompanied with enhanced taste by hydro cooling at 5°C.

Thangaraj and Irulappan(1988) observed minimum weight loss (2.3%) and the maximum shelf life (9.7 days) of mango fruits, when stored in cool chamber following hot water (52±1)^0 C + wax coating treatments. In an experiment conducted by Wanlapha *et al.* (1980) the mango fruits were treated with hot benomyl solution and wax coated, and then stored in a refrigerator at 10^0 C temperatures with 85% relative humidity. After three weeks of storage the fruits were transferred from the refrigerator and kept at room temperature (30^0 C) for ripening. Maximum storage life of about one month was obtained with acceptable quality of fruit at the end of the storage period.

2.5 Effect of Maleic hydrazide (MH)

Gautam *et al.* (2003) carried out a laboratory trial to investigate the efficiency of postharvest treatments on the shelf life and quality of mango cv. Banganpali using maleic hydrazide (1000 ppm), NAA (500 ppm) hot water at (50±2)°C, $AgNO_3$ (40 ppm) $Ca(NO_3)_2$ 1%, wax emulsion coating (6%) storage in carbonate box containing 10 g permanganate-silica gel at room temperature, storage at 15°C with 0.1% Bavistin (carbendazim) and/or storage in zero energy cool chamber (ZECC). They found the treatments significantly retarded ripening compared to the control. Ripening retardation was maximal in fruit treated with wax emulsion coating + ZECC storage, followed by dipping in calcium nitrate +ZECC storage. Both treatments delayed ripening by more than 6 days over the control. The maximum delay in spoilage was observed in fruits treated with permanganate-silica gel +ZECC storage, followed by $AgNO_3$+ZECC storage. Generally, ZECC storage retarded the time of fruit spoilage irrespective of the treatment combined with it. At the fourth day, the maximum fruit number ripened in the control, while the minimum percent of ripening was observed in calcium nitrate treatment, which was at par with NAA and MH+ ZECC treatments. No ripening was recorded in the following treatments as Bavistin, wax coating both under ambient and ZECC storage. Fruit subjected to various postharvest treatments (Bavistin, wax emulsion coating and NAA) and stored under either ZCC or cold storage conditions recorded lower TSS; TSS: acid ratio; reducing,

non reducing and total sugars; higher total titratable acidity and ascorbic acid content and extended shelf life compared to the control. Hot water treatment did not exhibit any effect on the quality.

Reddy and Haripriya (2002) conducted a laboratory experiment to test the efficiency of certain treatment using fungicides (carbendazim), growth regulators (GA3, maleic hydrazide, and 2,4,5-T) and subsequent storage in polythene bags with ethylene scrubbers, or the wrapped fruits in wooden boxes on the shelf life and quality of mango cultivars Bangalora and Neelum at room temperature. Among the subjected treatments, GA3 (200 ppm) treated fruits stored in ventilated polythene bags with ethylene absorbent signlficantly reduced the physiological weight loss, rate of respiration, delayed color development and ripening and had longer shelf life. Besides, the fruits also exhibited better quality on account of its favourable effect on slower increase in total soluble solids, sugars and retaining more acidity thereby rendering them acceptable up to a period of 18 days in Bangalora and 17 days in Neelum. The other treatments with 1000 ppm 2, 4, 5-T and storage in similar condition as above were the best treatment.

Kumar *et al.* (1992) conducted an experiment where they dipped mature firm mango cv. 'Dashehari' fruits in aqueous solutions of 2, 4, 5-T (500, 1000 and 1500 ppm), maleic hydrazide (500, 1000 and 1500 ppm) and calcium nitrate (1.0, 1.5 and 2.0%) for 10 minutes. Then they noted that the quality of fruits improved during storage as TSS, total sugar and reducing sugar contents were increased but acidity as well as ascorbic acid decreased during storage.

Rashid and Farooqui (1984) carried out an experiment with green hard mangoes (cv. Samar Bahisht) and found that fruits dipped in 1000, 1500 and 2000 ppm solution of maleic hydrazide (MH) for 3 minutes following stored at room temperature (23-30°C) delayed ripening compared with controlled fruits.

Srivastava (1967) reported that the addition of growth regulator maleic hydrazide (MH) with wax emulsion, at the rate of 1000 to 1500 ppm reduced the ripening rate of mango. In the contrary, Joarder (1980) concluded that maleic hydrazide (MH) was useful in ripening but failed to retard spoilage in prolonged storage condition.

2.6 Effect of Gibberellic acid (GA3)

Ranjan *et al.* (2005) carried out an experiment on mangoes storage life. They observed reduced physiological weight loss and spoilage of langra mangofruits influenced by the application of calcium salts and GA3. The highest reduction of weight loss and spoilage were obtained with Ca $(NO_3)_2$ at 1 %. Gradual reduction in specific gravity of langra mango was reduced during storage although the effect of treatments was marginal. Fruits treated with 200 ppm GA3 and 1.0 % Ca $(NO_3)_2$ exhibited maximum marketability and delayed ripening of fruits.

Jain *et al.* (2001) conducted an investigation to find out the influence of postharvest treatments (tap water, air dried, bengound, wax emulsion, cool chamber, Ca $(NO_3)_2$ and GA3) and the storage condition on the quality of mango during storage. They showed that the postharvest application of wax emulsion (8%) and calcium nitrate (1%) in combination with cool chamber storage markedly reduced the rate of ripening and helps to retain the quality characteristics of fruits during storage. At the end of the storage period, minimum total soluble solid, total sugar and reducing sugar contents and maximum acidity were recorded for wax emulsion (8%) + cool chamber storage. Maximum ascorbic acid and highest organoleptic score were obtained with calcium nitrate (1%) + cool chamber storage.

Jain and Mukherjee (2001) carried out an experiment with mango cv. Langra to investigate the delay ripening using growth regulator Gibberellic acid (GA3). They recorded GA3 at the rate of 200 or 300±1 mg significantly delayed ripening of mango fruits cv. ''Langra" when stored at 36.15°C maximum and 27.08°C minimum temperature. GA3 treatment retarded the increase in TSS, total sugars, loss in ascorbic acid content and acidity and reduced the spoilage percentage in mango fruits.

Singh *et al.* (2000) conducted an experiment with postharvest mango cv. Langra to assess the quality and shelf life of mango, using different doses of Gibberellic acid (GA3) and plant extracts. They observed that physiological loss in weight an upward trend irrespective of treatments. Neem oil showed minimum physiological loss in weight (7.77%), closely followed by castor oil (8.35%) and GA3 at 1000ppm (9.87%). Fruits in the control showed maximum physiological weight loss (17.28%) on the 12th day of storage. Spoilage percentage showed an increasing

trend in all the treatments. None of the fruits decayed up to the 6th day of storage at room temperature. Postharvest application of Neem oil showed the minimum decay loss of 9.98% followed by caster oil (13.30%) and GA3 (13.30%). The spoilage organisms associated with decay were *Botryodiplodia theobromae* and *Aspergillus niger.* The infestations of these micro-organisms were prevented by the antiseptic and antifungal action of Neem oil. A sharp fall in firmness in all the treatments was found during the storage period. Yet, edible firmness was retained favorably in fruits treated with neem oil (3.00). Application of GA3 at 500 ppm was recorded the maximum organoleptic rating during storage. Castor oil did not consider due to the obnoxious smell and patchy appearance on the fruits. The total soluble solids increased with increasing period of storage irrespective of treatments. Acidity showed a reverse trend in all the treatments.

Mondal *et al.* (1995) conducted an experiment to study the effect of postharvest treatments on physicochemical changes and shelf life of mango. Seven postharvest treatments *viz.* control, wax coating, keeping mango in cold room and polybag, spraying mango with GA3 and fungicide and keeping mango in poly bag with $KMnO_4$ were used. Among the treatments, the one with wax coating was found to be the best in extending self life of mango (24.4 days) followed by $KMnO_4$ treatments (22.4 days). Mondal *et al.,* (1998) also found 21.00 days extension of self life of mango by wax coating in their experiment.

Singh *et al.* (1995) conducted an experiment with GA3 and Ethrel (ethapon) to enhance the ripening and improved the quality and shelf life of mango cv. 'Amrapali'. They found that ethrel at 500 ppm was very effective In enhancing the ripening and improving the quality in terms of TSS, total sugar, ascorbic acid and β-carotene content. Youlin *et al.* (1997) observed that fruit of mango cv. Zihua dipped with growth regulator, 2, 4-D, GA_3 or NAA, each together with prochloraze prolonged shelf life and improved the acceptability of the fruits.

Mendez (1994) conducted an experiment with GA3 at 250 mg/litre and found that fruit ripening was retarded by GA3 application compared with untreated fruit. Mendez (1995) reported that GA3 application was reduced soluble solids contents and percentage weights loss after storage and resulted in higher colour ratings, when the mango trees were sprayed with GA3 2000 ppm 30 days before harvest and

the harvested fruits were stored at 12 or 25°C for 25 days. While working on mango fruits cv. 'Dashehari', Khader (1989) found maximum delaying in ripening (3 days) over the control and prolonged shelf life with GA_3 (200 mg/L).

Mangoes cv. 'Violet Flower' were treated with gibberellic acid for 10 minutes and then stored at 20-25°C. These delayed ripening and peel colour development. Furthermore, it significantly reduced weight loss during storage as described by Guoqiang *et al.* (1994).

Singh *et al.* (1995) conducted an experiment with GA3 and Ethrel (ethaphon) to enhance the ripening and improved the quality and shelf life of mango cv. 'Amrapali'. They found that ethrel at 500 ppm was very effective in enhancing the ripening and improving the quality in terms of TSS, total sugar, ascorbic acid and β-carotene content. Youlin *et al.* (1997) observed that fruit of mango cv. Zihua dipped with growth regulator, 2, 4-D, GA3 or NAA, each together with prochloraze prolonged shelf life and improved the acceptability of the fruits.

Kumar and Singh (1993) observed that postharvest spray of GA_3 (50 or 75 ppm) or ethrel (500 ppm) was hastened fruit maturity by 8-11 days and ripening significantly improved fruit quality (TSS, sugar, ascorbic acid and β-carotene concentrations) and reduced spoilage loss during storage.

Khumlert (1992) carried out an experiment to study some physico-chemical changes and physiological characteristics of 'Kheaw Sawoey' mango fruit as influenced by GA3 application. Results showed that GA3 (200 ppm) solution delayed ripening of mango via inhibition of some ethylene mediated ripening changes. The colour of peel and pulp, pulp firmness, soluble solids, titratable acidity, conversion of starch to sugar, solubilization of pectic substances was also delayed. Among the fruit characters studied the delayed in peel colour development was the most prominent for the effect of GA3, both in mature and immature fruits.

Khader (1992) conducted an experiment on ripening and quality of fruits cv. 'Mallika' as influenced by GA_3 and vapour Gard (di-l-p-methene). The fruits were treated with 200mg/L GA_3 or 2.5% vapour Gard or both and stored at an ambient temperature (34-37°C) for 16 days or at 15°C for 20 days. He found that GA_3 alone

or with vapour Gard significantly delayed fruit ripening, retarded ascorbic acid degradation in pulp and chlorophyll degradation in the peel, reduced ∞-amylase and peroxidase activities during storage. He further observed that fruits dipping in vapour Gard alone or with GA_3 reduced percentage weight loss during storage at both temperatures. Dipping fruits in vapour Gard alone or with GA_3 markedly delayed ripening in fruits stored at 15^0 C. Finally he concluded that mango could be successfully stored for up to 20 days at 15^0 C after treating with 200 mg/L. GA_3 +2.5% vapour Gard.

Khader (1991) reported that, GA3 application as a foliar spray to the mango variety 'Dashehari' at concentrations of 100, 200, 300 or 400 mg/L after fruit set in 1988 and 1989 retarded the ripening of fruit up to 6 days of storage under ambient temperatures between 36 ± 2°C and 40 ± 3°C. Contrastly, with increasing GA3 concentrations, postharvest ripening during the first 6 days was delayed significantly. Kumar and Dhawan (1995) observed that ethrel (5000 ppm) exhibited a slow rate of ripening compared with controlled fruit.

Feungchan (1992) found that the gibberellic acid (GA3) at 5-200 ppm did not affect the development of chlorophyll in mango fruits. However, 100 ppm of GA retarded fruit ripening by up to 73% Sheikh *et al.* (1992) described that storage life of mango could be extended by postharvest application of cycocel (500 ppm) and 2,4-D (50 ppm) and reduced weight loss, skin and pulp colour development and wrinkling throughout the storage period. However, fruits of these treatments showed less organoleptic values during initial storage period as compared with other treatments.

Mature green 'Kesar' mango fruits were dipped in solutions of gibberellic acid 200 ppm, cycocel 500 ppm and Bavistin 1000 ppm in combination with growth regulators. The fruits were stored at ambient temperature for 10-27 days and fruit ripeness, % marketable fruit, weight loss, total soluble solids, sugar and titratable acidity and vitamin C were assessed. Bavistin (1000 ppm) + GA (150 ppm) delayed ripening by about 2 days and gave the highest % marketable fruit after storage (Parmer and Chundawat, 1989).

Murthy and Rao (1982) reported that the ripening of mango fruits cv. 'Alphonso' can be significantly retarded by postharvest treatments with GA3 (250 mg/L), cycocel, alar and menadione bi-sulphite, as judged by the number of ripe fruits during storage at 28° C. They also observed that cycocel treatment retarded ripening in the early part of storage.

Mango fruits ripening could be controlled through the use of chemical, the value for the Brix/acid ratio was low and firmness was high in fruits treated with gibberellic acid and menadione sulphite. While dipping of mango fruits in GA3 (10^{-6} M), indole-3-acetic acid (IAA) (10^{-6} M) or Kinetin (10^{-5} M) solutions delayed ripening (Majumder *et al.,* 1981).

2.7 Effect of Bavistin DF (BDF)

A research work was conducted by Dhemre and Waskar (2004) for the assessment of postharvest losses, shelf life and quality of Kesar mango fruit. They showed the content of TSS, sugar, (total, reducing and non reducing), physiological weight loss (PWL) and rotting percentage increased with the increase in storage period. Fruits treated with waxol + carbendazim, pre-cooled then subjected to cold storage recorded the longest shelf life (50 days) compared to fruits that were not pre-cooled (46 days), and fruits stored in a cool chamber (26 days) or at room temperature (20 days). The rate of increase in PWL and rotting was also slowest in fruits treated with waxol + carbendazim. The organoleptic rating in terms of color, flavor and texture was highest for fruits treated with waxol + carbendazim than stored at room temperature caused by *Aspergillus niger*

Ahmed and Singh (2000) reported a trial in a laboratory for extension storage life of post harvest mango, using GA3, bavistin (carbendazim) and 200 gauge perforated polyethylene (20% vent) bags. They found that the PWL progressively increased as the storage period advanced on the eleventh day of storage, PWL was maximum (18.53%) under the control and minimum (7.48%) GA3+ polythene bag treatment. Higher percentage of TSS, sugar (total, reducing and non reducing) and reduced level of titratable acidity, vitamin C were recorded in all the treatments up to the last day of storage. Fruits treated with GA3+ perforated polythene bag had

the lowest acidity (39.84%), highest in TSS (22.15%) and pulp pH. The highest TSS/acid ratio was observed in the control (113.67%) where as GA3+ perforated polythene bag showed the lowest ratio (69.46%).

Wasker and Masalkar (1997) conducted an experiment of hydro-cooling and Bavistin dip with mango fruit 'Kesar', 'Totapuri' and 'Vanraj'. The fruits were harvested with stalks (25 cm) hydrocooled at 12°C, given a postharvest dip of Carbendazim (as Bavistin, 1000 ppm) and were then stored at room temperature (23.5-35.1°C, 47.5-80.3% RH) or in lower cool chamber (22.0-26.1°C, 92-95% RH). The shelf life of 'kesar,' 'Totapuri' and 'Vanraj' were 17, 21 and 19 days respectively when stored at room temperature and in cool chamber 25, 36 and 31 days respectively. Percentage weight loss was lower and organoleptic scores were higher in fruits stored in the cool chamber than in fruits stored at room temperature. The fruits which were not dipped in Carbendazim became infected with *Colletotrchum gloeosporioides* and *Diplodia natalensis*. In another experiment Tang *et al.* (1997) reported that dipping the harvested fruits in the growth regulators 2, 4-D, GA3 or NAA each together with prochloraz increased the efficiency of the fungicides against anthracnose and stem end rot, with increasing storage life of the fruits. Gajbhiye *et al.* (2000) also found an effective control against stem end rot and anthracnose diseases when the harvested mango fruits treated with 0.1% Carbendazim up to 10 days.

2.8 Changes in skin color

Morphological features, especially skin color is the most obvious change that occurs in many fruits and is frequent the principal criterion followed by the consumers to identify whether the fruit is ripe or unripe. The most common change in case of mango is the loss of green color (Wills *et al.,* 1989). Hayes (1966) stated that the dark green color of unripe mango gradually changes to light green, and then yellow thereafter, in some cases a deep orange. He also stated that a greenish yellow color might be taken to indicate a stage of maturity that will yield a fruit of satisfactory quality.

2.9 Physical changes during storage

2.9.1 Edible portion

There was no available information's in dealing with edible portion of mango. But, Samson (1986) described the edible portion of mango as 60–75 percent of the total weight. Mondal (2000) also stated that edible portion of Langra and Khirshapat was approximately 73.1% and 67.2%, respectively.

2.9.2 Pulp to peel ratio

Little information is available dealing with the changes in pulp peel ratio during storage and ripening of mango though this is an important physical property of any fruit. However, Tripathi *et al.* (1981) conducted an experiment with banana and observed that, pulp to peel ratio was increased during ripening.

2.9.3 Physiological weight loss

Weight loss reduced when mango fruits were treated with wax as reported by Zambrano *et al.* (1997). Manzano *et al.* (1997) reported that 6.2 percent fresh weight loss of mango fruits occurred when stored at 25° C for 20 days. According to Martinez *et al.* (1997) application of wax coating on postharvest mango fruits significantly reduced weight loss by inhibiting transpiration.

2.9.4 Moisture content

From an observation, Srivastava (1967) found that unripe mango fruit contained higher percentage of moisture. Shahiahan *et al.* (1994) reported that moisture content of mature hard mango pulp was 79.95% which Salunkhe and Desai (1984) observed that mango pulp contained 81% moisture.

2.9.5 Dry matter content

Scientific information about the changes in dry matter content during storage and ripening of mango is not available. However, Paramanik (1995) found that dry matter content in Fazli increased from 17.14 to 28.86% during storage in ambient temperature.

2.9.6 Ash content

Srivastava (1967) reported that ash content of mango fruits ranges from 0.26 to 1.66 percent. It shows the presence of calcium, magnesium, copper, manganese, silicon, iron and phosphorus in the edible part of mango. On the other hand, Singh (1968) observed that ash content of mango fruits depend on varieties and he reported that it was 0.26 to 1.16 percent. Ripe mango is a source of calcium, phosphorus and iron (Salunkhe and Desai, 1984).

2.10 Biochemical changes during storage

2.10.1 Vitamin C content

Mango is a good source of vitamin C at early stages of development, which decreases rapidly 5-7 weeks after fruit set as reported by Gofur *et al.* (1994). They also reported that, at 12 weeks after fruit set ascorbic acid content was 105.2, 65.7 and 17.3 mg/100 g in Langra, Ashwini and Fazli varieties, respectively.

The green fruits stored at 10-12° C for 7 weeks had little change in vitamin C content. Maximum portion of vitamin C was lost when the fruits were stored at room temperature (26-30° C). In addition reduction in vitamin C with progress of fruit maturity and ripening was found in cv. Gopalbhog, Khirshapat, Langra and Fazli as described by Shahjahan *et al.* (1994).

Tripathi (1988) noticed that fruit quality and flavour were best at the 6th day of storage. He noted that the percentage of ascorbic acid was also highest at the same day. During transport and storage (at 10°C for up to 32 days) Joshi and Roy (1988) reported a continuous decrease in vitamin C.

2.10.2 Titratable acidity

Titratable acidity was decreased during storage and ripening as reported by Upadhyay and Tripathi (1985). Leon and Lima (1968) and Medlicott *et al.* (1986) also observed similar results. According to them acidity was reduced during later stage of growth on attainment of maturity and ripening.

Shahjahan *et al.* (1994) revealed that acidity of mango was decreased gradually at the time of storage and ripening. They also found that the percent acidity in green and ripe mango cv. 'Fazli' was 0.32 and 0.10, respectively. Acidity was decreased continuously during storage (Joshi and Roy, 1988). Dhalla and Hanson (1988) conducted an experiment to study the effect of prolong treatments on the storage life of mango and found that decrease of titratable acidity during storage was delayed by the treatments. However, titratable acidity was decreased during post harvest period (Rangavalli *et al.* 1993).

Kumar *et al.* (1993) observed that acid concentration of fruits was fallen in the storage. They also claimed that Kinetin application in mango resulted in a drastic decline in the concentration of all acids.

There were no differences in titratable acidity when fruits stored in cold condition at different temperatures as described by Lam and Wong (1988). In another study, O'Hare (1995) reported that titratable acidity was declined slowly when mango fruits were stored at 13° C.

2.10.3 Pulp pH

Yuniarti (1980) carried out an experiment in an attempt to investigate pH content of mango fruits during storage and reported that the pH content of 'Arumanis' mango remained in an increasing fashion during storage. Joshi and Roy (1988) reported that there was a steady rise in pH of the fruits of 'Alphonso' mango during storage. The pulp pH of ripe Fazli was 4.64 as observed by Kumar *et al.* (1993). They also found that pH of mango pulp was increased during storage. Salles and Tavares (1999) reported that pH of mango pulp increased during storage in a refrigerated room. The pH of hot water treated fruits was higher than non hot water treated fruits (Zhu *et al.*, 2002)

2.10.4 Total soluble solids (Brix %)

Total soluble solids (Brix %) varied from variety to variety (Jagirdar and Maniyar, 1960; Mollah and Siddique, 1973). They recorded that TSS of mango varieties Fazli and Langra were 7.70 to 14.8% and 12.15 to 18.0% respectively. Hossain and Ahmed (1994) reported 18.3% TSS content in cv. Aswina. Shahjahan *et*

al. (1994) reported from their experiment that TSS content was lower in early harvest and higher in later stage (mature stage) of harvesting of ripening fruits in all varieties. Similar result was also obtained by Lakshminarayana (1975) with Florida mangoes. An assessment made by Simao and Gomes (1996) on the Brix in different parts of the fruit (dorsal, ventral and middle parts) of 10 mango varieties indicated that the dorsal part was sweeter than the other parts.

Absar *et al.* (1993) reported that TSS content increased markedly with advances in maturity. They reported that at the ripened stage Langra showed the highest TSS (22.2%) and Fonia the lowest (16.8%). Tripathi (1988) reported highest percentage of TSS in cv. Gourjeet mango fruit on the 6th day of storage. In another observation, Joshi and Roy (1988) reported that TSS increased initially and declined later on during storage. In an experiment conducted by McCollum *et al.* (1993) in order to study the chilling injury and quality attributes as influenced by heat treatment, fruits of cv. 'Keitt' were kept at 38°C temperature for 0, 24 and 48 hrs before storage and cold temperature at 5°C for 11 days. They reported that TSS was higher in the fruits stored at the higher temperature. In an observation, Upadhyay and Tripathi (1985) reported that TSS increased gradually with ripening in cv. Gourjeet. Tripathi (1988), Ashwani and Dhawan (1995) and Mondal *et al.* (1995) also reported similar findings.

2.10.5 Total sugar content

Tandon and Kalra (1983) claimed an increased in total sugar content after 72 days from fruit set. While working with mango fruits Upadhayay and Tripathi (1985) found that total sugar content were increased gradually, when stored for 6 days at room temperature (32-35°C). The total sugar, sucrose and fructose contents of fruits were increased during storage as reported by Tsuda *et al.* (1999). However, maximum sugar content was observed in mango at full ripe stage as reported by Takuji *et al.* (1997).

Shahjahan *et al.* (1994) carried out an experiment with Gopalbhog, Khirshapat, Langra and Fazll. They found that total sugar contents of these fruits were increased at later stage of harvesting and this sugar content was further increased during storage. Tandon *et al.* (1985) reported that total sugar content was

initially decreased in 'Mallika' and it increased until maturity, whereas in 'Langra' total sugar content was increased throughout the growing period. During transport and storage of mango, a rise followed by decline in total sugar content was found by Joshi and Roy (1988). Total sugar content of mango fruits was the highest on the 6th day of storage (Tripathi, 1988).

2.10.6 Reducing sugar content

Kalra and Tandon (1983) conducted an experiment with mango fruit cv. 'Dashehari' harvested after 85, 90 or 95 days of fruit set and then stored at ambient temperature (maximum / minimum, 37.5/31.5°C) with 39-91% relative humidity. The results showed that the reducing sugar content was higher at each successive harvesting stage. However, reducing sugar content of mango was found to be increased markedly up to 5 days after harvest (Lianni *et al.,* 1994). On the other hand, Tandon *et al.* (1985) found increased reducing sugar content of fruits until harvest.

Tripathi (1988) reported that fully mature fruits stored at room temperature for up to 6 days contained highest reducing sugar percentage on the 6th day of storage. Upadhaya and Tripathi (1985) concluded that reducing sugar content was increased gradually with fruit ripening. In an experiment with mango fruit cv. 'Arumanis' harvested 90 days after anthesis and stored at ambient temperature (26°C and high relative humidity) for 14 days, Yuniarti (1980) noticed that there was no significant differences in sucrose or reducing sugar content. On the contrary, Rangavalli *et al.* (1993) observed that reducing sugar content was gradually increased and reached the highest peak of 7.5 percent. Castrillo *et al.* (1992) also observed that reducing sugar was increased slightly during ripening.

2.10.7 Non-reducing sugar content

Post harvest changes in mango were studied by Rangavalli *et al.* (1993), and found a gradual increase in non-reducing sugar content. Sarker and Mushi (1978) conducted an experiment to investigate on non-reducing sugar content at various stages of fruit development and ripening. They noticed that percent of non-reducing sugar was low at the bud stage. But in case of 'Fazli' this amount started to increase

gradually followed by a lag period at the stone formation stage. However, non-reducing sugar content reached at the peak of 17.5 percent at ripening stage. They further observed that at the fully ripe stage, the local variety contained less than one third non-reducing sugars as compared with the Fazli and Gopalbhog. On the other hand, ripe mango contained higher percentage of disaccharide (sucrose) and a smaller amount of aldohexoses (glucose and its isomers).

Non-reducing sugar after attaining a peak remains more or less constant (Joshi and Roy, 1988). Tandon *et al.* (1985) reported that fructose content was increased during ripening. Yuniarti (1980) reported that there were no significant differences in non-reducing sugar content in mango fruit when stored at ambient temperature (+ 26°C and high RH) for 14 days.

2.10.8 Crude fibre content

Crude fibre demonstrated a very slight change during ripening that could be attributable to a decrease in insoluble pectin associated with an increase in soluble pectin in the course of ripening as reported by Mathooko (2000). He also stated that crude fibre was perceived in a small quantity but, it significantly decreased during ripening.

2.10.9 Total lipid content

Biochemical composition as fat of mango variety might be differed with the cultivar and the stage of maturity and ripening as narrated by Anon, 1962. Bandyopadhyay and Nair (1990) stated the changes of fatty acid composition of mango pulp, aroma and flavor of gamma irradiated (0.25kGy) and control mature green Alphonso mangoes during ripening at 25–30°C. Ripening of both control and irradiated mangoes was accompanied by changes in glycerides as well as fatty acids.

Crude fat contents showed a slight increase as ripening progressed. The observed slight increase in fat concentration agreed with the general observation that a link exists between lipid content, color and flavor development of the mango during ripening (Gomez-Lim, 1997). A slow change in fat content on extended storage could be due to decreased citrate level, which is believed to be the

immediate source of acetyl coenzyme A required for biosynthesis of fatty acid and triglyceride (Gomez-Lim, 1997).

2.10.10 Water soluble protein content

Watt and Merril (1963) reported that mature green mango contained 0.7% of protein, but 0.5 to 1.0% of water soluble protein was recorded from Lakshminarayana (1980). Water soluble protein was differed with the cultivar and stage maturity and as well as ripening as described by Anon (1962).

An increase in protein content observed during ripening is in agreement with the findings made in several fruits by Gomez-Lim (1997). He also reported an increase in the amounts of some proteins and enzymes. Mathooko (2000) described a dramatic increase in protein, reflecting the enzyme required for ripening. Peter *et al.* (2007) recommended that protein content increased with the advances of storage duration

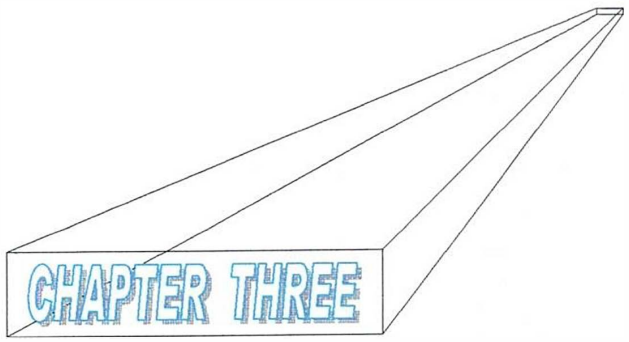
2.11 Mineral changes during storage

Peter *et al.* (2007) showed that light changes increasingly in mineral levels (Mg, K, Na, P, and Fe) were obtained on ripening but, there were no significant variations ($P > 0.05$) in terms of mineral levels among treatments. But, Ca content slightly diminished with the extending of storage period.

Nadkarni (1963) elucidated that iron, calcium and phosphorus contents in 16 cultivars ranged between 0.90 to 3.2 mg, 10 to 20 as well as 10 to 30 mg per 100 g, respectively, but, these minerals components were changed during storage period. Watt and Merrill (1963) reported that ripe mango contained 189 mg per 100 g of fresh pulp.

2.12 Shelf life

The extended shelf life of mango was perceived to be increased during storage period using different postharvest technology as noted by Hossain (1999), Azad (2001) and Barua (2003).



MATERIALS AND METHODS

CHAPTER 3

MATERIALS AND METHODS

Altogether four experiments were conducted to achieve the distinct goals and objectives of the research work. The materials used and methodology employed during the period of this investigation are presented in this section.

3.1 Location and time

The investigation including four different experiments was conducted in Protein and Enzyme laboratory of the Department of Biochemistry and Molecular Biology, Rajshahi University, Rajshahi, Soil Resources Development Institute (SRDI), Rajshahi and Bangladesh Council of Scientific and Industrial Research, BCSIR Laboratory, Rajshahi, Bangladesh during the period from January, 2005 to January, 2008.

3.2 Weather data

The maximum and minimum temperature (^{0}C) both inside and outside of the laboratory experienced and also relative humidity(%) and rainfall (mm) were recorded during the period of investigation (Appendix 1.1)

3.3 Experimental materials

Two mango varieties namely, Langra and Khirshapath were selected as experimental materials. The mango varieties that undertaken for investigation were collected from mango grower of Kansart, Shibgonj Upazila of ChapaiNowabgonj district and Chirghat upazila of Rajshahi district and others material used as postharvest treatments *viz.*, paraffin coating, polyethylene cover, Maleic hydrazide(MH), Gibberellic acid (GA3) and Bavistin DF (BDF) were collected from Rajshahi City market, Rajshahi by requisition. A brief description of above two varieties under study is given in the followings.

Mango varieties

i) Langra

Langra is one of the most popular mango varieties amongst the varieties of the best quality in Bangladesh. The skin color of the variety is light green to light yellow at ripening stage. Mesocarp is yellowish, aromatic, tasteful, sweetest and

fibreless. Peel color is light green and stone is small in size. It is on an average of 9.7 cm in length, 7.3 cm in width and 5.2 cm in high as well as average weight of 314.10 gm. The sweetest of this variety is about 19.7%. Edible portion of this type is approximately 73.1%. It is a seasonal fruit. Ripening stages of this variety is the last of June and available in the market in the month of July. Average yield is good (Plate 1).

ii) Khirshapat

Khirshapat is a popular variety produced early in Bangladesh. It is a medium and oval shaped variety having 8.6 cm long, 7.5 cm wide and 6 cm high on an average. The skin color is light yellow and pulp is yellowish. It is very sweet, succulent, attractive flavor and fibreless. The sweetest of this type is approximate 18.4%. This fruit is somewhat wide and hard like and stone is lighter. Edible portion of this variety is 67.2%. Stage of ripening starts from first week of June. Overall, yield is good but irregular (Plate 2)

Plate 1 Photograph of Langra before using postharvest treatments

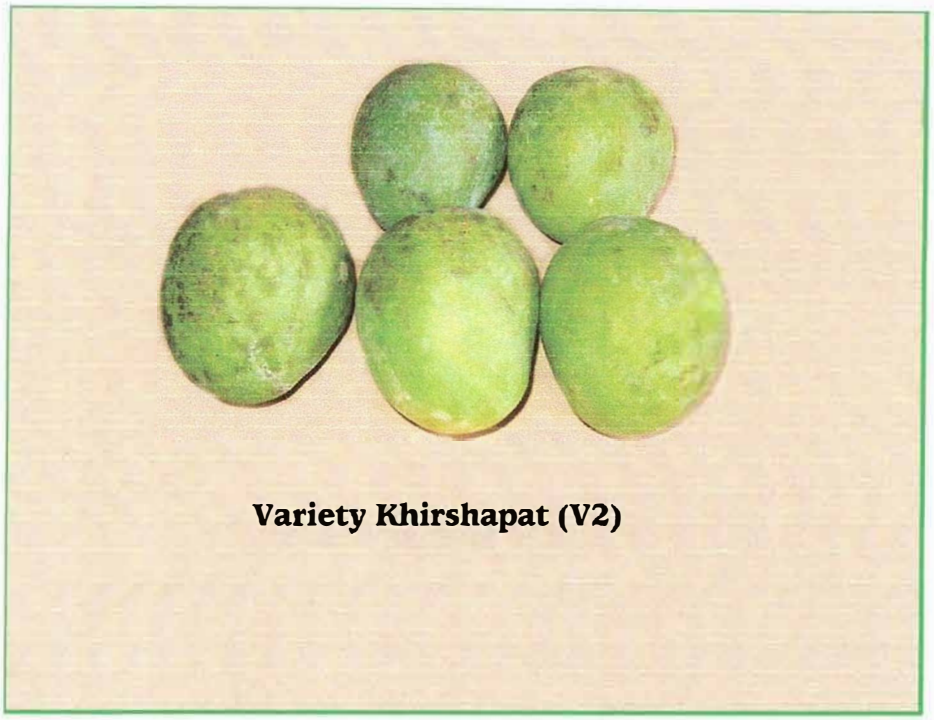


Plate 2 Photograph of Khirshapat before using postharvest treatments

4. Experiments and experimental design

To develop a new approach to increase shelf life, the following experiments on two mango varieties have been adopted in this investigation.

4.1 Experiment 1

Influence of different storage environments on physicochemical changes and shelf life of postharvest mango

4.1.1 Experimental design

The experiment consisted of two factors and was conducted in Randomized Complete Block Design (RCBD) with three replicates.

4.1.2 Treatments

Factor A: Varieties of mango (V) as identified alphabetically below.

Alphabetical symbol	Varieties
V_1	Langra
V_2	Khirshapat

Factor B: Postharvest storage treatments (T) as identified alphabetically below:

Alphabetical symbol	Treatments
T_0	Control
T_1	Paraffin coating
T_2	Perforated polyethylene cover
T_3	Unperforated polyethylene cover
T_4	Hot water treatments (55±2)^0 C
T_5	Low temperature in refrigerator (4±1)^0 C

4.1.3 Experimental layout

There were thirty six treatment combinations including three replications. Each replicate contained twelve treatment combinations.

Varieties	Postharvest storage treatments					
	Control (T_0)	Paraffin coating (T_1)	Perforated polythene cover (T_2)	Unperforated polythene cover (T_3)	Hot water treatment (T_4)	Refrigerated condition (T_5)
Langra (V_1)	V_1T_0	V_1T_1	V_1T_2	V_1T_3	V_1T_4	V_1T_5
Khirshapat (V_2)	V_2T_0	V_2T_1	V_2T_2	V_2T_3	V_2T_4	V_2T_5

Layout

R_1		R_2		R_3	
V_2T_3	V_1T_0	V_1T_5	V_2T_3	V_1T_0	V_1T_3
V_2T_1	V_1T_4	V_2T_0	V_1T_3	V_1T_2	V_2T_3
V_1T_5	V_1T_1	V_2T_2	V_2T_1	V_2T_0	V_1T_4
V_1T_2	V_1T_3	V_2T_4	V_1T_2	V_2T_2	V_2T_4
V_2T_4	V_2T_0	V_1T_4	V_1T_1	V_1T_1	V_1T_5
V_2T_5	V_2T_2	V_1T_0	V_2T_5	V_2T_1	V_2T_5

4.1.4 Data collection

Data were collected at three days interval from the starting day of storage (i.e.; 0, 3, 6, 9, 12, 15 etc.) still over ripening.

4.1.5. Methodology

The experiment was laid out in a Randomized Complete Block Design with three replicates. The post harvest treated fruits were assigned at random in each replication. The required numbers of unblemished physically similar, more or less uniform size, shape and color fruits for the experiment were harvested manually from each plant of the varieties, Langra and Khirshapath. The fruits were carefully selected during harvest. The skin of fruits was cleared with the help of a cloth just after harvesting.

4.1.6 Application of storage treatments

The storage treatments used in the experiment were sequentially assigned to the collected fruits. After the application of treatments, the fruits were kept on a brown paper, which was previously laid out in Randomized Complete Block Design and placed on the laboratory floor at ambient condition. Each of the blocks consisted of the experimental type. For each treatment combination of replication, there were six fruits, of which one was kept to record shelf life, changes in weight, color and other external fruit characteristics. The remaining five fruits were preserved in a deep refrigerator (-85^0 C) at Protein and Enzyme Laboratory in the Department of Biochemistry and Molecular Biology, University of Rajshahi, for recording the data periodically at five different dates (at 3 days interval). Five fruits from each treatment combination of every replicate were chemically analyzed for the determination of the changes in edible portion, juice content of fruits, vitamin C content, total titratable acidity, pulp pH, total soluble solid (TSS), sugar content, crude fibre, total lipid, protein, different minerals etc. To ensure the application of the different storage treatment of the fruits for each variety, the following procedure was accomplished.

4.1.7 Preparation of postharvest storage treatments

4.1.7.1 Control (T_0)

Eighteen mangoes of each variety were selected at random from a mango basket and the fruits were kept on a brown paper at ambient condition arranging at random by application.

4.1.7.2 Paraffin coating (T_1)

Solid paraffin wax was made liquid by heating it with the help of an electric heater in a large aluminum pot. Eighteen fruits from both the varieties were taken for wax coating individually. The fruits were treated as per treatment and dipped in it quickly. Care was taken to ensure a uniform coating on all the fruits and kept on brown paper for observation (Plate 4).

4.1.7.3 Perforated polyethylene covers (T_2)

The 19 cm x 15 cm sized polyethylene cover was taken at laboratory room and these were perforated with a scissor in nine equal positions of the bags. Individual fruit was taken into polyethylene cover and the open portion of the bag was sealed with burning. Eighteen fruits of each variety were bagged in this system and then placed on brown paper for next observation.

4.1.7.4 Unperforated polythene covers (T_3)

Unperforated 19 cm x 15 cm sized polyethylene cover was used for this treatment. An individual fruit was taken into polyethylene cover. Eighteen fruits of each variety were kept into it, and the top of the bag was tied by burning and then placed on brown paper for observation.

4.1.7.5 Hot water treatment (T_4)

Tap water was heated in a hot water bath at (55 ± 2)^0 C. Fruits were individually dipped into hot water for a period of 5 minutes and then stored at ambient condition on brown paper (Plate 4).

4.1.7.6 Low temperature in refrigerator (T_5)

Fruits were stored in a refrigerated incubator at (4±1) $^\circ$C. The temperature of the refrigerated incubator was maintained by adjusting the button on the incubator.

4.2 Experiment 2

Influence of different doses of Maleic hydrazide on physicochemical changes and shelf life of mango during storage

Plate 3 Photograph of Langra ang Khirshapat in basket after collection from farmer's orchard

Plate 4 Photograph of the application of different postharvest treatments especially, paraffin coating and hot water treatment on mangoes

4.2.1 Experimental design

Two factors experiment was conducted in Randomized Complete Block Design (RCBD) with three replicates

4.2.2 Treatments

Factor A: Varieties of mango (V) as in experiment 1

Factor B: Maleic hydrazide used as postharvest hormonal treatment (MH)

Alphabetical symbol	Treatments (ppm)
M_0	Control
M_1	200
M_2	400
M_3	600

4.2.3 Experimental layout

There were twenty four treatment combinations including three replications. Each replicate contained eight treatment combinations

Varieties	Maleic hydrazide (MH) solution			
	Control (M_0)	200 ppm (M_1)	400 ppm (M_2)	600 ppm (M_3)
Langra (V_1)	V_1M_0	V_1M_1	V_1M_2	V_1M_3
Khirshapat (V_2)	V_2M_0	M_1V_2	V_2M_2	V_2M_3

Layout

R_1		R_2		R_3	
V_1M_0	V_2M_1	V_1M_0	V_2M_3	V_2M_1	V_2M_2
V_2M_3	V_2M_0	V_1M_3	V_2M_0	V_1M_2	V_1M_0
V_2M_2	V_1M_2	V_2M_1	V_1M_1	V_2M_3	V_1M_3
V_1M_1	V_1M_3	V_2M_2	V_1M_2	V_2M_0	V_1M_1

4.2.4 Data collection as in experiment 1

4.2.5 Methodology as in experiment 1

4.2.6 Application of storage treatment as in experiment 1

4.2.7 Preparation of Maleic hydrazide (MH) solution

The solution of Maleic hydrazide (MH) of 200, 400 and 600 ppm were prepared by dissolving 200, 400 and 600 mg of MH in 1 litre of distilled water. For successfully dissolvent of MH, 10 ml of ethanol was taken in a conical flask and thereafter, the required amount of MH was added and mixed with it thoroughly by shaking. Finally, the volume of the solution was made upto 1 litre. The fruits of both varieties were dipped into the solution for a period of 5 minutes. Care was taken to ensure sufficient absorption of MH by the fruits and then they were stored at room temperature on brown paper.

4.3 Experiment 3

Effect of different doses of Gibberellic acid on physicochemical behavior and shelf life of postharvest mango

4.3.1 Experimental design

Two factors experiment was carried out in Randomized Complete Block Design (RCBD) with three replications

4.3.2 Treatments

Factor A: Varieties of mango (V) as in experiment 1

Factor B: Gibberrelic acid used as a postharvest hormonal treatment (GA3)

Alphabetical symbol	Treatments (ppm)
G_0	Control
G_1	100
G_2	200
G_3	400

4.3.3 Experimental layout

There were twenty four treatment combinations including three replications. Each replicate contained eight treatment combinations

Varieties	Postharvest hormonal treatment (GA3)			
	Control (G_0)	100 ppm(G_1)	200 ppm(G_2)	400 ppm (G_3)
Langra (V_1)	V_1G_0	V_1G_1	V_1G_2	V_1G_3
Khirshapat (V_2)	V_2G_0	V_2G_1	V_2G_2	V_2G_3

Layout R_1 R_2 R_3

V_1G_3	V_2G_3		V_2G_3	V_1G_3		V_1G_o	V_2G_3
V_2G_o	V_2G_1		V_2G_2	V_1G_2		V_1G_1	V_2G_2
V_1G_2	V_2G_2		V_2G_1	V_1G_o		V_1G_2	V_2G_1
V_1G_1	V_1G_o		V_1G_1	V_2G_o		V_1G_3	V_2G_o

4.3.4 Data collection as in Experiment 1

4.3.5 Methodology as in Experiment 1

4.3.6 Application of storage treatments as in experiment 1

4.3.7 Preparation of Gibberellic acid (GA3) solution

The solution of GA3 of 100, 200, and 400 ppm was prepared by dissolving 100, 200, and 400 mg of GA3 in one litre of distilled water. The fruits of both varieties were dipped into the solution for a period of 5 minutes. Care was taken to ensure sufficient absorption of GA3 by the fruits and then they were stored at room temperature on brown paper.

4.4 Experiment 4

Influence of different doses of Bavistin DF on physiochemical properties and shelf life of mango varieties during storage

4.4.1 Experimental design

The experiment consisted of two factors and was conducted in Randomized Complete Block Design (RCBD) with three replicates

4.4.2 Treatments

Factor A: Varieties of mango (V) as in experiment 1

Factor B: Bavistin DF used as a postharvest fungicidal treatment (BDF)

Alphabetical symbol	Treatments (ppm)
B_0	Control
B_1	250
B_2	500
B_3	750

4.4.3 Experimental layout

There were twenty four treatment combinations including three replications. Each replicate contained eight treatment combinations

Varieties	Bavistin DF as a postharvest fungicidal treatment			
	Control (B_0)	250 (B_1)	500 (B_2)	750 (B_3)
Langra (V_1)	V_1B_o	V_1B_1	V_1B_2	V_1B_3
Khirshapat (V_2)	V_2B_o	V_2B_1	V_2B_2	V_2B_3

Layout R_1 R_2 R_3

V_1B_o	V_1B_2		V_2B_2	V_1B_3		V_1B_1	V_1B_2
V_1B_1	V_2B_o		V_1B_1	V_2B_1		V_2B_o	V_2B_2
V_2B_3	V_1B_3		V_1B_2	V_1B_o		V_1B_3	V_1B_o
V_2B_1	V_2B_2		V_2B_3	V_2B_o		V_2B_3	V_2B_1

4.4.4 Data collection as in experiment 1

4.4.5 Methodology as in experiment 1

4.4.6 Application of storage treatment as in experiment 1

4.4.7 Preparation of Bavistin DF (BDF) solution

The solution of BDF of 250, 500, and 750 ppm were prepared by dissolving 250, 500 and 750 mg of BDF in one litre of distilled water. The fruit of both the varieties were dipped into the BDF solution for a period of 5 minutes. Care was taken to ensure enough quantity of BDF being absorbed by the fruits and stored at ambient condition on brown paper.

4.5 Organoleptic evaluation

Organoleptic evaluation of fresh mango pulp at full ripe stage during storage was made by a taste panel with a group of 10 male and female undergraduate and post graduate students at third year B.Sc.(Hons), M.Sc and M.Phil. levels. The opinion of all students was collected on taste and quality in a predesigned format questionnaire. Then the results have been presented both in percentage and in acceptable scores.

5.0 Parameters studied

The following parameters were studied for investigation of the experiments:

5.1. External fruit features

External fruit character such as skin color was recorded visually. Changes in skin color of the fruits were also observed by using a standard color chart.

5.2 Physicochemical parameters

Mango fruits from each treatment combination were selected at random from both the varieties and replications at an interval of three days such as 0, 3, 6, 9, and 12 of storage for physicochemical analysis. Care was taken while collecting the fruits from storage. Biochemical analysis was accomplished mostly in Protein & Enzyme Lab, of the Department of Biochemistry and Molecular Biology, University of Rajshahi, Soil Resources Development Institute (SRDI) Shyampur, Rajshahi and Bangladesh Council of Scientific and Industrial Research Laboratory, BCSIR, Rajshahi, Bangladesh.

The physicochemical parameters were estimated through the methods adopted from the manual of analysis of fruit and vegetable products by Rangana (1979), Analytical methods: soil, water, plant material, fertilizer by Leif Peterson (2002) and Biochemical Methods for Agricultural Sciences by Sadasivan and Manickhan (1992).

5.2.1 Edible portion of mango

At first, the weight of fruit was taken with an electric balance. Then, the fruit was peeled with a sharp knife and the inner stone was removed. The remaining fruit pulp (edible portion) was weighed. Finally, the percentage of edible portion was measured with the following formula.

$$\text{Edible portion} = \frac{WP}{TW} \times 100$$

Where,

WP = Weight of mango pulp

TW= Total weight of fruit

5.2.2 Determination of pulp to peel ratio

Pulp was removed from the fruits at an interval of three days during ripening. After separation, the weight of peel and pulp was taken by using an electrical

balance and the pulp to peel ratio was calculated. The pulp was then used for another chemical analysis.

5.2.3 Physiological weight loss of mango fruit

A specific fruit from each treatment combination of each block was taken and individually weighed using electrical balance and sometimes rough balance and then kept for ripening. The process was continued still ripening at three days interval. Percent total weight loss was calculated by using the following formula:

$$\% \text{ Weight loss (WL)} = \frac{IW-FW}{IW} \times 100$$

Where,

% WL = Physiological weight loss

IW = Initial fruit weight and

FW = Final fruit weight

5.2.4 Percent moisture content of pulp

Ten g of fruit pulp from each treatment combination of each replication was taken in a porcelain crucible (which was previously cleaned, heated at 100^0 C, cooled and weighed). The crucible was then placed in an electrical oven at 80^0 C for 72 hours until the weight became constant. It was then cooled in a desiccator and weighed again.

Calculation

$$\% \text{ Moisture} = \frac{IW-FW}{IW} \times 100$$

Where,

IW = Initial weight of pulp

FW = Final weight of oven dried pulp

5.2.5 Percent dry matter content of pulp

Percent dry matter content was calculated by using the data obtained during moisture estimation using the following formula

%Dry matter = 100 - % moisture content

5.2.6 Percent ash content of pulp

The oven-dried sample from 5.2.4 above was ashed in a muffle furnace at 600^0 C for six hours after initial pre-ashing at 200^0 C and percent ash was calculated as follows

$$\% \text{ Ash} = \frac{A}{I} \times 100$$

Where,

A= Weight of ash and

I = Initial weight of pulp

5.2.7 Estimation of vitamin C content of mango pulp

Vitamin C of mango pulp was estimated by the titrimetric method as stated by Bessey and King (1933)

1. Reagents

The following reagents were used for estimation of vitamin C

i) 3% Metaphosphoric acid (HPO_3)

Three g of metaphosphoric acid was dissolved in 80 ml of acetic acid and made volume up to 100 ml with distilled water.

ii) Standard vitamin C solution (0.1 mg/ml)

Ten mg of pure vitamin C was dissolved in 3% metaphosphoric acid and made volume up to 100 ml with this acid.

iii) Dye solution

Two hundred mg of 2, 6-dichlorophenol indophenols and 210 mg of sodium bicarbonate were dissolved in distilled water and made volume up to 100 ml .The solution was then filtered.

2. Procedure

The following steps were followed.

Ten ml of standard vitamin C solution was taken in a conical flask and titrated it with the dye solution.

Five g of mango pulp were cut into small pieces and homogenized well with the 3% metaphosphoric acid (approximately 20 ml) and filtered it through double layer of muslin cloth. The filtrate was centrifuged at 3,000 rpm for 10 min. and the clear supernatant was titrated with 2, 6-dichlorophenol indophenols solution. The amount of vitamin C present in the extract was determined by comparing with the titration result of standard vitamin C solution.

Calculation

Quantity of vitamin C content (mg/ 100 g) of fresh mango pulp

$$= \frac{\text{Quantity of vitamin C obtained}}{\text{Weight of mango pulp}} \times 100$$

5.2.8 Titrable acidity in mango pulp

Titratable acidity of mango pulp was determined by the method of Ranganna (1979)

1. Reagents

The following reagents were used for determination of titrable acidity.

i) Standard NaOH solution (0.1 N)

ii) 1% Methyl red

2. Extraction of mango juice

Ten g of mango pulp were taken in a 100 ml beaker and then it was homogenized with distilled water in a blender. The blended materials was then filtered and transferred to a 100 ml volumetric flask and the volume was made up to the mark with distilled water.

3. Titration Procedure

Ten ml of pulp solution was taken in conical flask. Two to three drops of Phenolphthalein indicator was added and then the conical flask was shaken vigorously. It was then filtrated immediately with 0.1 N NaOH solutions from a burette till a permanent pink color will be appeared. The volume of NaOH solution required for titration was recorded. Percent titratable acidity was calculated by using the following formula:

$$\% \text{ Titratable acidity} = \frac{T \times N \times V1 \times E}{V2 \times W \times 1000} \times 100$$

Where,

T = Titre

N = Normality of NaOH

V1 = Volume made up

E = Equivalent weight of acid

V2 = Volume of extract

W = Weight of sample

5.2.9 Pulp pH of mango

1. Preparation of standard buffer solution

pH 7 and pH 4 buffer tablets (BDH chemicals Ltd., Poole, England) were dissolved in water and made up to the mark of 100 ml with distilled water.

2. Extraction of fruit juice

For the determination of pulp pH, 1 g of fresh pulp was taken in a mortar with pestle. Then, the pulp was crushed thoroughly and homogenized well with 10 ml of distilled water. Finally, the extract was filtrated through two layers of muslin cloths.

3. Procedure

The electrode assembly of pH meter was dipped into the standard buffer solution of pH 7 taken in a clean and dry beaker. The temperature correction knob was set to 28°C and the fine adjustment was made by asymmetry potentially knob to pH 7. After washing with distilled water the electrode assembly was dipped into a solution of standard pH 4 and adjusted to the required pH by fine asymmetry potential knob. The electrode assembly was raised, washed twice with distilled water, and then rinsed with mango juice and finally it was dipped into the juice of mango for recording the pH of the extract.

5.2.10 Total soluble solids (% Brix) of mango pulp

Total soluble solid content of mango pulp was estimated by using Abbe Refractometer. A drop of mango juice squeezed from the fruit pulp on the prism of the Refractometer. Percent TSS was obtained from the direct reading of the instrument. Temperature correction was done using the methods as described by Ranganna (1979).

5.2.11 Determination of total sugar content of mango pulp

Total sugar content of mango pulp was determined calorimetrically by the Anthrone method (Jayaraman, 1981).

1. Reagents

Following reagents were used for determination of total sugar:

A. Anthrone reagent: The reagent was prepared by dissolving 2 g of anthrone in one litre of concentrated H_2SO_4.

B. Standard glucose solution: A standard solution of glucose was prepared by dissolving 10 mg of glucose in 100 ml of distilled water.

2. Extraction of sugar from mango pulp

Extraction of sugar from mango pulp was done by the following method (Loomis and Shull, 1937). Four g of mango pulp was cut into small pieces and immediately plunged into boiling ethyl alcohol and was allowed to boil 5 to 10 minutes (5 to 10 ml of alcohol was used per gram of pulp). The extract was cooled and crushed thoroughly in a mortar with pestle. Then the extract was filtered through two layers of muslin cloths and the ground tissue was re-extracted for three minutes in hot 80% alcohol, using 2 to 3 ml of alcohol per gram of tissue. The second extraction was ensured complete removal of alcohol suluble substances. The extract was cooled and passed through two layers of muslin cloth. Both of the extracts were filtered through Whatmann No. 41 filter paper.

The volume of the extract was evaporated to about 25 %(1/4) of the volume over a steam bath and cooled. This reduced volume of the extract was transferred to a 100 ml volumetric flask and it was made up to the mark with distilled water.

3. Procedure

Aliquot of 1 ml of pulp extract was pipetted into test tubes and 4 ml of the anthrone reagent was added to each of this solution and mixed well. Glass marbles were placed on top of each test tube to prevent loss of water through evaporation. Then the tubes were placed in a boiling water bath for 10 minutes and then cooled. A reagent blank was prepared by taking 1 ml of water and 4 ml of anthrone reagent in a tube and treated similarly. The absorbance of blue green solution was measured at 680 nm in a colorimeter.

A standard curve of glucose was prepared by taking 0.0, 0.1, 0.2, 0.4, 0.6, 0.8 and 1.0 ml of standard glucose solution in different test tubes containing 0.0, 10, 20, 40, 60, 80, and 100 µg of glucose respectively, and the volume was made up to 1 ml with distilled water. Then 4 ml of anthrone reagent was added to each test tube and mixed well. All these solutions were treated similarly as described above. The absorbance was measured at 680 nm using the blank containing 1 ml of water and 4 ml of another reagent.

The amount of total sugar present in the extract was calculated from the standard curve of glucose (Fig. 1). Finally, the percentage of total sugar was determined by using the following formula.

$$\% \text{ Total sugar (g/ 100g of mango)} = \frac{\text{Quantity of sugar obtained}}{\text{Weight of sample}} \times 100$$

5.2.12 Determination of reducing sugar of mango pulp

Reducing sugar content of mango was determined by Dinitrosalicylic acid method (Miller, 1972).

1. Reagents

i) Dinitrosalicylic acid (DNS) solution: Simultaneously, 1.0 g of DNS, 200 mg of crystalline phenol and 50 mg of sodium sulphite were placed in a beaker and mixed with 100 ml of 1% NaOH by stirring. When it was needed to store, sodium sulphite was added just before use.

ii) 40 % solution of Rochelle salt

It was prepared by dissolving 40 g of sodium potassium tartarate with distilled water and made up to the mark in 100 ml of volumetric flask.

2. Extraction of sugar from mango pulp

The same procedure for extraction of sugar from mango pulp was followed as described in 5.2.11.

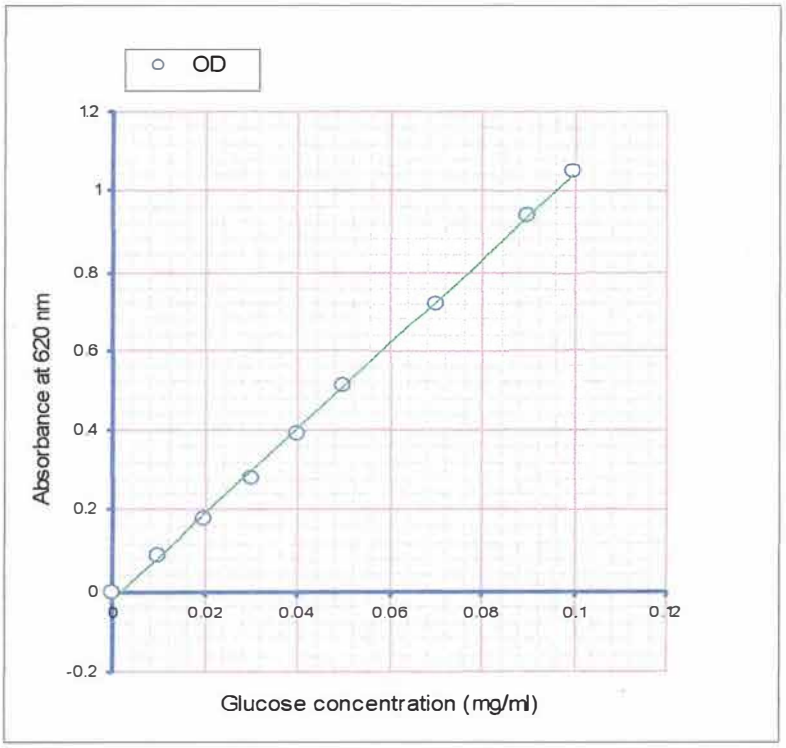


Fig. 1 Standard curve of glucose for estimation of total sugar

3. Procedure

Aliquot of 3 ml of the extract was pipetted into a test tube and 3 ml of DNS regent was added to each of this solution and mixed well. The test tubes were heated for 5 minutes in a boiling water bath. After the color has developed, 1 ml of 40 % Rochelle salt was added when the contents of the tubes were still warm. The test tubes were then cooled under a running tap water. A reagent blank prepared by taking 3 ml of distilled water and 3 ml of DNS reagent in a tube and treated similarly. The absorbance of the solution was measured at 575 mm in a colorimeter. The amount of reducing sugar was calculated from the standard curve of glucose (Fig. 2). The percentage of reducing sugar present in the mango pulp was determined by using the following formulae:

% Reducing sugar (g/100 g of sample)

$$= \frac{\text{Amount of reducing sugar obtained}}{\text{Weight of sample}} \times 100$$

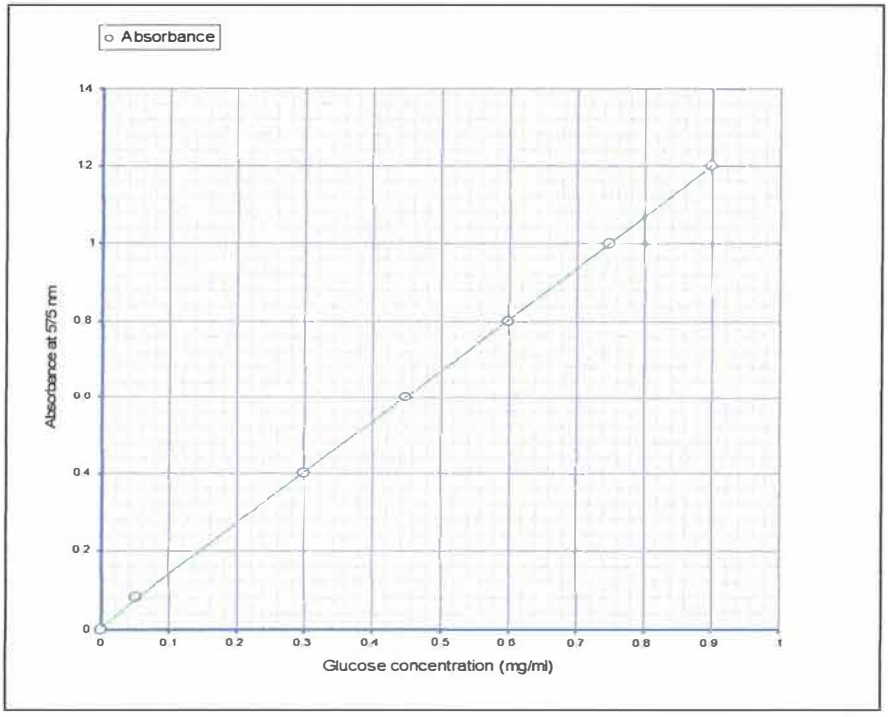


Fig. 2 Standard curve of glucose for estimation of reducing sugar

5.2.13 Estimation of non-reducing sugar

Non-reducing sugar content of mango pulp was calculated by using the following formulae:

% Non-reducing sugar = % total sugar - % reducing sugar.

5.2.14 Estimation of crude fibre of mango pulp

Crude fibre of mango pulp was estimated following the procedure as given in the Biochemical Methods for Agricultural Sciences by Sadasivam and Manickam (1992)

Reagents

A. H_2SO_4 solution (0.255 N): 1.25 g of concentrated sulphuric acid was dilluted to 100 ml of distilled water.

B. NaOH solution (0.313 N): 1.25 g of sodium hydroxide was diluted to 100 ml of distilled water.

C. Alcohol.

Procedure

1. Two g of oven dried ground material of fruit pulp which was less than 1% of fat content previously estimated was taken in a beaker. The beaker was made up to the mark of 200 ml with 1.25% H_2SO_4 solution. The mixture was boiled for 30 minutes having bumping chips for smooth boiling keeping the volume constant by addition of distilled water at frequent interval.
2. After boiling, the mixture was filtered through muslin cloth and the residue was washed with boiling water until washings were no longer acidic.
3. The material/residue was transferred to the same beaker and 200 ml of 1.25% NaOH solution was added in it carefully and boiled for 30 minutes.
4. Again, the solution was filtered through muslin cloth and was washed with 25 ml of 1.25% H_2SO_4 solution, three times of 50 ml portion of distilled water and 25 ml of alcohol.
5. The residue after filtration was again transferred to pre weighed porcelain crucible (W_c) and was dried at $130^0 \pm 2^0$C for 2 hrs. in an oven and the dried material was cooled in a desiccators and it was weighed in a electrical balance(W_d)
6. Finally, the crucible was then ignited for 30 minutes at $600^0 \pm 15^0$ C in a muffle furnace for ashing and it was cooled in desiccators and reweighed (W_a).

Calculation

% crude fibre in ground sample

$$= \frac{\text{Loss in weight on ignition } (Wd-Wc)-(Wa-Wc)}{\text{Weight of the sample}} \times 100$$

5.2.15 Determination of total lipid content of mango pulp

Total lipid content of fruit pulp was determined by the method of Bligh and Dyer (1959).

Reagents

A mixture of chloroform and ethanol was prepared at the ratio of 2:1 V/V.

Procedure:

About 2 gm of fruit pulp was taken in a mortar and grinded it properly adding there 20 ml of distilled water. The grinded juice was transferred to a separating funnel and 60 ml of chloroform and ethanol mixture was added. The mixture was mixed thoroughly. It was then kept overnight at room temperature in the dark. At the end of this period, 40 ml of chloroform and 40 ml of water were further added and mixed. Generally, three layers were found at this time. A clear lower layer of chloroform containing the entire lipid, a colored aqueous layer of ethanol with all water soluble materials and a thick pasty interphase were seen.

The chloroform layer was carefully collected in a pre-weighed beaker and then placed on a steam bath for evaporation. After evaporation of the chloroform, the weight of beaker was determined again. The difference in between the weights gave the amount of the lipid.

Calculation:

Percent of lipid content (g/100 g of fruit pulp)

$$= \frac{\text{Amount of lipid obtained}}{\text{Weight of fruit pulp}} \times 100$$

5.2.16 Estimation of water soluble protein content of mango pulp

Water soluble protein content of mango pulp was determined following the method of Lowry *et al*. (1951)

1. Required reagents

Following reagents were used for the estimation of protein

A. 2% Na_2CO_3 solution in o.1N NaOH.

B. 0.5% copper sulphate in 1% sodium potassium tartarate.

C. Folin Ciocalteau Reagent (FCR): (FCR: H_2O=1:1).

D. Protein standard: 100µg/ml in distilled water. A standard solution of egg albumin was prepared by dissolving 100 µg of egg albumin in 1 ml of distilled water

2. Extraction of mango juice

Five g of mango pulp was taken in a mortar with a pestle and it was grinded and homogenized with distilled water. The blended and homogenized materials was then filtered with double layer muslin cloth to a 100 ml beaker and then it was transferred to a 100 ml volumetric flask and the volume was made up to the mark with distilled water.

3. Procedure

1. Reagent A and B were mixed in a ratio of 50:1 and diluted reagent C were prepared carefully and FCR solution was used just before taking spectrophotometric reading.

2. Aliquot of 1 ml was taken in test tube duplicately. Five ml of A and B mixture was added to each of the test tube. After ten minutes, 0.5ml of FCR solution was added to each test tube. Finally, the reading was taken in a spectrophotometer at 650 nm after 30 minutes. A graph was drawn by plotting conc. against absorbance and from the graph the amount of protein was calculated in the supplied sample (Fig. 3).

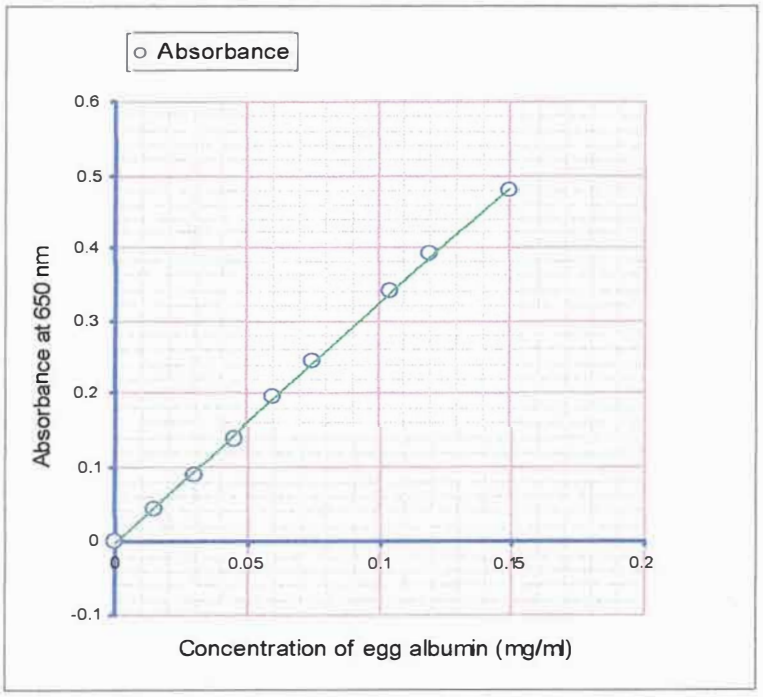


Fig. 3 Standard curve of protein for estimation of water soluble protein

5.2.17 Determination of different minerals

Different important minerals of mango pulps were determined following the procedure as described in Analytical Methods (Petersen, 2002).

Preparation of plant sample

Procedure of drying

The cleaned porcelain crucibles were placed in an oven at 105^0 C for overnight. The crucibles were allowed to cool in a desiccator's and these were weighed. The mango pulps were collected with spatula and put into crucible and again weighed. The crucibles were placed in the oven at 105^0 C for 24 hours. Then, the crucibles were allowed to cool in a desiccator and weighed. The crucibles were again placed in the oven at 105^0 for 2 hours. These were cooled in a desiccator and weighed again. Drying, cooling and weighing were accomplished repeatedly until the weight became constant. The dried pulps were stored in airtight plastic container. The moisture content was calculated in the sample.

Procedure of grinding

The dried plant material was ground in a mortar with pestle. These were further kept in an oven at 105^0 C for overnight due to absorption of moisture in the time of grinding for keeping the weight constant.

5.2.17.1 Determination of phosphorus content

Ground mango pulp was digested and P was released by digestion with nitric acid and it was determined by spectrophotometry.

Reagents

A. HNO_3 (68%)

B. Ammonium molybdate ascorbic acid

C. Diluted HNO_3 1: 100

Twenty ml of 68% HNO_3 was transferred to 2000 ml volumetric flask and made the volume with distilled water and mixed well.

Digestion procedure

1. Ground pulp material (0.3 g) was taken into digestion tube. The two remaining tubes were blanks. Five ml of 68% nitric acid was added to each of all the 40 tubes. The content was mixed in each tube and was kept the tubes overnight. The tubes were placed in the digester and the tubes were covered with the exhaust

manifold. The temperature was set at 125° C. The digester was turned on and the digestion was continued for 4 hours after boiling started. It was observed that no tubes became dry.

2. After cooling, the digestion mixture was transferred with distilled water to a 200 ml volumetric flask. The flask was made up to the mark with distilled water and mixed well. It was filtered on a dry filter into a dry bottle which could be closed with a screw cap. The filtrate was kept in the closed bottle and used for estimation of Phosphorus.

Measurement of phosphorus

Five ml of diluted filtrate was transferred to a 50 ml volumetric flask. Water was added to approx. 30 ml and was mixed well and then, 10 ml of ammonium molybdate- ascorbic acid solution was added and made volume with water and was mixed well. After 15 minutes, the absorbance was measured on a spectrophotometer at 890 nm. Sometimes, the procedure was done repeatedly due to higher absorbance of the highest standard solution using a smaller amount of filtrate. In this case, 1:100 diluted HNO_3 was added to the volumetric flask to make the total volume of 1: 100 diluted HNO_3 and filtrate equal to 5 ml.

When the content of P was very high, the filtrate was diluted further before transfer to the 50 ml flask. The dilution was made up to the mark. After transfer of 5 ml diluted filtrate to the 50 ml volumetric flask, 5 ml 1:100 diluted HNO_3 and water to aprox. 30 ml were added. Then 10 ml ammonium molybdate ascorbic acid was added, the 50 ml volumetric flask was made to volume with water and the absorbance was measured at 890 nm after 15 minutes.

Calculation

Amount of P was determined by the following formula:-

$$\text{mg per kg mango pulp} = \frac{a \times 25000}{b \times c}$$

Where,

a = mg P per litre.

b = ml diluted filtrate transferred into the 50 ml volumetric flask for determination of P

c = g of plant material taken into the digestion tube.

5.2.17.2 Determination of potassium content

Powder form of mango pulp was digested and K was released by digestion with nitric acid and it was determined by flame photometry.

Reagents

A. HNO_3 (68%)

B. Diluted HNO_3 1: 100

Twenty ml of 68% HNO_3 was transferred to 2000 ml volumetric flask and made the volume with distilled water and mixed well.

Digestion procedure

Same as phosphorus

Measurement of potassium

The diluted filtrate (10 ml) was transferred into a 50 ml volumetric flask using a pipette. The flask was made up to the volume with water and mixed well. The content of K was measured by flame photometry. When the reading was found to be higher than the reading of the highest standard solution, further dilution was made. In this case, 1:100 diluted HNO_3 was added to the volumetric flask to make the total volume of 1:100 diluted HNO_3 and filtrate was equal to 10 ml.

Calculation

Amount of K was determined by the following formula:-

$$\text{mg per kg mango pulp} = \frac{a \times 25000}{b \times c}$$

Where,

a = mg of K per litre.

b = ml diluted filtrate transferred into the 50 ml volumetric flask for determination of K

c = g of plant material taken into the digestion tube.

5.2.17.3 Determination of calcium content

Ground mango pulp was digested and Ca was released by digestion with nitric acid and it was determined by atomic absorption spectrophotometer.

Reagents

A. HNO_3 (68%)

B. Diluted HNO_3 1: 100

Twenty ml of 68% HNO_3 was transferred to 2000 ml volumetric flask and made the volume with distilled water and mixed well.

iii) $LaCl_3$ solution

The 435 g of $LaCl_3$ $7H_2O$ was weighed into a beaker. One hundred ml of 5 M HNO_3 and 400 ml water were added in it. The salt was heated gently until it was dissolved. After cooling, 300 ml of more 5 M HNO_3 was added and the solution was transferred to 5 l volumetric flasks. It was made to volume with water and mixed. The solution contained 3.25% of La.

Digestion procedure

Same as phosphorus

Measurement of calcium

Twenty ml of diluted filtrate was transferred into a 50 ml volumetric flask using a pipette. The $LaCl_3$ solution (5 ml) was added to make a volume with water and mixed well. The content of Ca was measured by atomic absorption spectrometer. When the reading was found to be higher than the reading of the highest standard solution, a larger dilution was made. In this case, 1:100 diluted HNO_3 was added to the volumetric flask to make the total volume of 1:100 HNO_3 and filtrates was equal to 20 ml.

Calculation

Amount of Ca was determined by the following formula:-

$$\text{mg per kg mango pulp} = \frac{a \times 25000}{b \times c}$$

Where,

a = mg of Ca per litre.

b = Amount of filtrate transferred into the 50 ml volumetric flask for determination of Ca

c = g of plant material taken into the digestion tube

5.2.17.4 Determination of magnesium content

Ground material of mango pulp was digested and Mg was released by digestion with nitric acid and it was determined by atomic absorption spectrophotometer.

Reagents

Same as calcium

Digestion procedure

Same as phosphorus

Measurement of Magnesium

Diluted filtrate (5 ml) was transferred into a 50 ml volumetric flask using a pipette. The $LaCl_3$ solution (5 ml) was added to make a volume with water and mixed well. The content of Mg was measured by atomic absorption spectrometer. When the reading was found to be higher than the reading of the highest standard solution, a larger dilution was made. In this case, 1:100 diluted HNO_3 was added to the volumetric flask to make the total volume of 1:100 diluted HNO_3 and filtrate was equal to 5 ml.

Calculation

Amount of Mg was determined by the following formula:

$$\text{mg per kg mango pulp} = \frac{a \times 25000}{b \times c}$$

Where,

a = mg of Mg per litre.

b = ml of diluted filtrate transferred into the 50 ml volumetric flask for determination of Mg

c = g of plant material taken into the digestion tube.

5.2.17.5 Determination of copper content

Powder form of mango pulp was digested and Cu was released by digestion with nitric acid and it was determined by atomic absorption spectrophotometer.

Digestion procedure

Same as phosphorus

Measurement of copper

The content of Cu was measured by atomic absorption spectrometer (AAS) directly in the undiluted filtrate.

Calculation

Amount of Cu was determined by the following formula:

$$\text{mg per kg mango pulp} = \frac{d \times 200}{c}$$

Where,

d = mg of Cu per litre.

c = g of ground pulp material taken into the digestion tube.

5.2.17.6 Determination of iron content

Ground mango pulp material was digested and Fe was released by digestion with nitric acid and it was determined by atomic absorption spectrophotometry.

Digestion procedure

Same as phosphorus

Measurement of iron

The content of Fe was measured by atomic absorption spectrometer (AAS) directly in the undiluted filtrate.

Calculation

Amount of Fe was determined by the following formula:

$$\text{mg per kg mango pulp} = \frac{d \times 200}{c}$$

Where,

d = mg of Fe per litre.

c = g of ground pulp material taken into the digestion tube.

5.2.17.7 Determination of manganese content

Ground material of mango pulp was digested and Mn was released by digestion with nitric acid and it was determined by atomic absorption spectrophotometry.

Digestion procedure

Same as phosphorus

Measurement of manganese

The content of Mn was measured by atomic absorption spectrometer directly in the undiluted filtrate.

Calculation

Amount of Mn was determined by the following formula:

$$\text{mg per kg mango pulp} = \frac{d \times 200}{c}$$

Where,

d = mg of Mn per litre.

c = g of ground pulp material taken into the digestion tube.

5.2.17.8 Determination of zinc content

Ground mango pulp material was digested and Zn was released by digestion with nitric acid and it was determined by atomic absorption spectrophotometry.

Digestion procedure

Same as phosphorus

Measurement of zinc

The content of Zn was measured by atomic absorption spectrometer directly in the undiluted filtrate.

Calculation

Amount of Zn was determined by the following formula:

$$\text{mg per kg mango pulp} = \frac{d \times 200}{c}$$

Where,

d = mg of Zn per litre.

c = g of ground pulp material taken into the digestion tube.

5.3 Shelf life of mango

Shelf life (days) of mango as influenced by different post harvest treatments and varieties was calculated by counting the days required to ripen fully with retaining optimum marketing and eating qualities.

6.0 Statistical analysis

The collected data was statistically analyzed by analysis of variance method. The means of different parameters was compared using DMRT as described by Gomez and Gomez (1984).

CHAPTER FOUR

RESULTS AND DISCUSSION

CHAPTER 4

RESULTS AND DISCUSSION

This chapter deals with the observation of four experiments with graphical representation and discussion of the results obtained from different experiments. The results of all the experiments on external feature, physicochemical parameters and shelf life of two mango varieties influenced by different treatments as in experiment 1:different storage treatments, experiment 2: different doses of Maleic hydrazide (MH) solution, experiment 3: different doses of Gibberellic acid (GA3) solution and experiment 4: different levels of Bavistin DF (BDF) solution as well as their combined effects are presented in the following Tables 1.1–1.15, 2.1-2.19, 3.1- 3.25 and 4.1-4.25 and in the Figures 1.1–1.46, 2.1-2.33, 3.1-3.22 and 4.1-4.22, respectively, for clear interpretation and good understanding. The brief analysis of variance of data in respect of various parameters studied are shown in Appendices 1.1-1.14, 2.1-2.12, 3.1-3.12 and 4.1- 4.12.

7.0 Experiment 1

Influence of different storage environments on physicochemical changes and shelf life of postharvest mango

7.1 Changes in skin color

Morphological features, especially skin color is the most obvious change that occurs in many fruits and is frequent the principal criterion followed by the consumers to identify whether the fruit is ripe or unripe. The most common change in case of mango is the loss of green color (Wills *et al.,* 1989).

Postharvest treatments strongly influenced the skin color of both the fruits *viz.,* Langra and Khirshapat (Table 1.1). Both varieties demonstrated the original green color at the initial stage of harvesting. At 3rd day, Langra and Khirshapat developed a trace in yellow at control (T_0) but, they retained green color at T_1, T_3, andT_5 treatments. Langra also exhibited trace in yellow at T_2 and light green at T_4 treatments while Khirshapat developed light green at T_2 and T_4 treatments.

At 6th day, Langra was found to be greenish yellow at T_0 while, light green was noticed from T_1 and T_3 treatments. But it developed yellowish green color at T_2

and T_4 treatment and remained green at T_5 treatment. On the other hand, Khirshapat showed yellowish green at T_0, but, it developed greenish yellow at T_2 and T_4, and light green at T_1 and T_3 treatments. It also remained green at T_5 treatments.

After 9 days of storage, Langra was found to be deep yellow and yellowish green at T_0, T_1 and T_3 as well as greenish yellow at T_2 and T_4 treatments, respectively but, it still retained its original green color at T_5 treatments having slightly shrinkage. On the other hand, Khirshapat showed yellow at T_0 and T_2 treatments, yellowish green at T_1 and T_4 treatments and yellowish green at T_3 treatments. Further, it also retained its original green color with slightly shrinkage at T_5.

After 12 days of storage, Langra was found to be yellow with black spot at T_0, yellowish green at T_1, T_3 and T_4, deep yellow at T_2 treatment, but, it retained green color at T_5 treatment showing shrinkkage. On the other hand, Khirshapat was also found yellow with light spot at T_0, and T_2; greenish yellow and yellowish green at T_1, T_3 and T_4 but, it still retained its original green color having shrinkage condition at T_5 treatment.

After 15 days of storage, Langra showed no existence of T_0, T_2 and T_4 and retained yellow color at T_1 and T_3 treatment while, it developed light green color at T_5 treatment having heavy shrinkage condition. On the other hand, Khirshapat showed completely rotten condition at T_0, T_2 and T_4 treatment but, it modified into yellow color at T_1 and still retained its original green color at T_5 treatment having heavy shrinkage condition. Regarding the skin color development, harvest of mango at due time was found to be desirable. Changes in skin color are partially supported by the findings of Azad (2001) and Hossain (1999).

7.2 Changes in physical characters during storage environments

Various parameters regarding to the physical changes of mango are presented and discussed in the following sub-headings.

7.2.1 Edible portion of mango

Edible portion is one of the most important considerations of mango for the consumers as well as for the researchers. This portion is called pulp in case of mango. Varieties of mango were found to be significant in relation to edible portion

at different days after storage (Appendix 1.2). The edible portion of mango was recorded to be increased gradually with the passing of time of storage (Fig. 1.1). At 12th day the highest edible portion (72.65%) of mango was obtained from Langra and lowest (71.60) was reported from Khirshapat. Present investigation was supported by the findings of Azad (2001).

Different storage treatments in respect of edible portion were also found to be highly significant at different days after storage (Appendix 1.2). Edible portion of mango among the means of storage treatments increased gradually with different days after storage (Fig. 1.3). At 9th day, control (T_o) exhibited the highest percentage of edible portion (76.34%), whereas at this time the lowest percentage (67.50%) was obtained from low temperature in refrigerated condition (4±1)°C. At 12th day, edible portion decreased slightly due to its rotten situation at T_o, at the same time another treatments showed increased level of edible portion of mango (Fig. 1.3). These results are also supported by the findings of Hossain (1999).

Combined effects of varieties and storage treatments on edible portion were not significant at various days after storage (Appendix 1.2). But, edible portion was increasing at all the days after storage. At each day, the increasing trend was high with the combination of Langra (V_1) and control (T_o). After 9th day, edible portion was decreased at V_1T_o and V_2T_o combinations, but other treatment combination showed augmented situation in this time. At 12th day, the maximum edible portion (75.82%) was obtained from the treatment combination of V_1T_o followed by others. The lowest (68.12%) was recorded from the treatment combination of Khirshapat and low temperature in refrigerator (Table 1.2). This situation occurred by the treatments combination was possibly due to inhibition of ethylene synthesis at low temperature in refrigerator but no obstacle in ethylene synthesis in control situation.

7.2.2 Pulp to peel ratio

Variation in pulp to peel ratio between two varieties was found to be highly significant in all days of storage (Appendix 1.2). The ratio was increased for the time being at different days in both the varieties. In all the days, Langra exhibited better performance in pulp to peel ratio compared to Khirshapat (Fig. 1.2). At 12th day,

Langra produced higher ratio (8.21) whereas Khirshapat produced lower (8.00). These results are in conformity with the findings of Azad (2001). This happened possibly due to genetically dissimilarities between varieties.

Differences between storage treatments were also found highly significant in case of pulp to peel ratio in all the storage period (Appendix 1.2). In all the cases, control treatments showed more ratio followed by others. The increasing trend of this ratio was the same up to 6th day at T_o treatment, thereafter, this trend slightly decreased due to rotten situation. On the other hand, the other treatments showed more or less similar increasing trend of the ratios. At 12th day, T_o treatment produced the highest ratio (10.69) followed by hot water treatment (10.07), perforated polyethylene cover (9.05), unperforated polyethylene cover (6.98), paraffin coating (6.53) and low temperature in refrigerator (5.3). The lowest ratio was observed from refrigerator due to suspension of ethylene synthesis at low temperature but, control treatment produced maximum ratio due to higher synthesis of ethylene. So, the preservative value of refrigerator was much better than the other treatment. But in this system, ripening did not occur after taking to normal environments from refrigerator.

Combined effects of varieties and different storage treatments were found to be significant in terms of pulp to peel ratio at different days after storage except at initial stage (Appendix 1.2 and Table 1.2). Pulp to peel ratio was increased at the space of time in all days of storage. But, it was found that the treatment combination of V_1T_o produced wider ratio compared to the other treatment combination. The highest ratio (10.95) was recorded from the treatment combination of V_1T_o at 12th day and the lowest (5.15) was recorded from the combination of V_2T_5 at 12 DAS. These results are in partial agreements with the findings of Hossain (1999) and Azad (2001).

7.2.3 Physiological weight loss

Varieties exhibited highly significant physiological weight loss (PWL) at different days after storage (Appendix 1.3 and Table 1.4). At each day of storage, Khirshapat (V_2) gradually lost comparatively more PW as compared to Langra with advancing of storage time (Fig. 1.5). The highest (12.88%) and lowest (12.00%) of

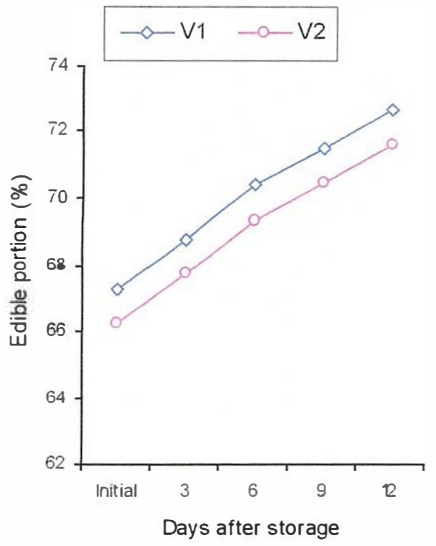


Fig. 1.1 Edible portion of mango pulp in varieties at different days after storage

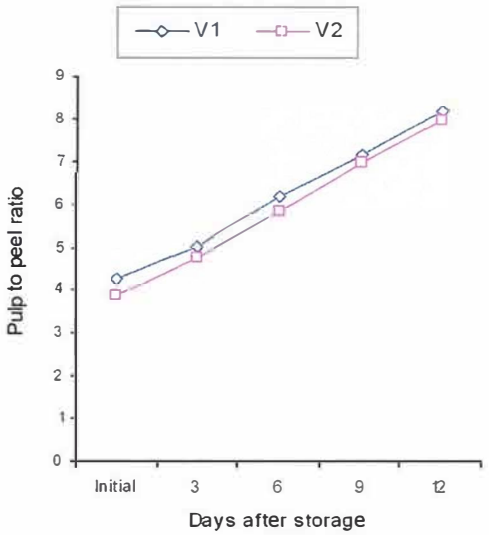


Fig. 1.2 Pulp to peel ratio of mango in varieties at different days after storage

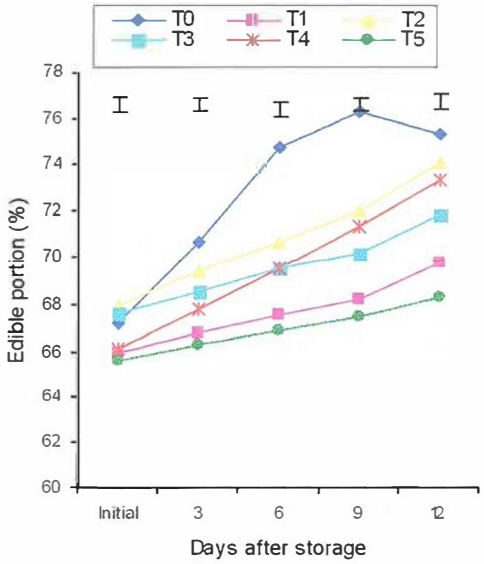


Fig. 1.3 Edible portion of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

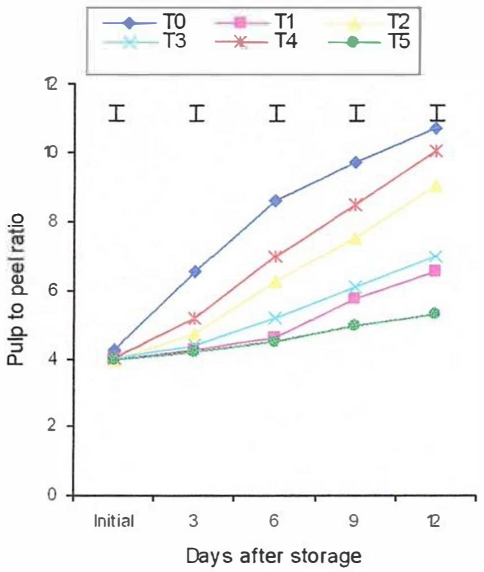


Fig. 1.4 Pulp to peel ratio of mango as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

Figures represent

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2)^{0}C
T_5= Low temperature in refrigerator (4±1)^0 C

Table: 1.1 Changes in skin color of two mango varieties (*viz.*,Langra and Khirshapat) as influenced by different postharvest treatments during storage at ambient condition

Varieties	Treatments	Days after storage					
		Initial	3	6	9	12	15
V_1	T_0	Green	Trace in yellow	Greenish yellow	Deep yellow	Black spotted yellow	_
	T_1	Green	Green	Light green	Greenish Yellowish	Greenish yellow	_
	T_2	Green	Trace in yellow	Yellowish green	Greenish yellow	Deep Yellow	_
	T_3	Green	Green	Light green	Yellowish green	Yellow	Yellow
	T_4	Green	Light green	Yellowish green	Greenish yellow	Yellow	_
	T_5	Green	Green	Green	Green (slight shrinkage)	Green (shrinkage)	Light green (deep shrinkage)
V_2	T_0	Green	Trace in yellow	Yellowish green	Yellow	Light spotted yellow	_
	T_1	Green	Green	Light green	Greenish yellow	Greenish yellow	_
	T_2	Green	Light Green	Greenish yellow	Yellow	yellow	_
	T_3	Green	Green	Light green	Yellowish green	Greenish yellow	Yellow
	T_4	Green	Light Green	Greenish yellow	Greenish yellow	Yellowish green	_
	T_5	Green	Green	Green	Green (slight shrinkage)	Green (shrinkage)	Green (deep shrinkage)

Treatments

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2) ^{0} C and
T_5= Low temperature in refrigerator (4±1)^0 C

Table 1.2 Combined effects of varieties and different storage treatments on edible portion and pulp to peel ratio of postharvest mango

Treatments combination	Edible portion (%)at different days					Pulp to peel ratio at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1T_0	67.64 ab	71.22 a	75.25 a	76.85 a	75.82 a	4.42 a	6.85 a	8.85 a	9.95 a	10.95 a
V_1T_1	66.15 bc	66.95 c-e	67.78 ef	68.48 d	70.12 de	4.25 a-c	4.42 f	4.92 h	5.52 i	6.32 i
V_1T_2	68.52 a	70.02 ab	71.35 b	72.65 b	74.68 a-c	4.30 a-c	4.89 d	6.35 e	7.65 e	9.15 e
V_1T_3	68.60 a	69.52 ab	70.68 bc	71.15 b	72.87 c	4.20 bc	4.48 ef	5.22 g	6.22 g	7.13 g
V_1T_4	66.78 a-c	68.38 b-d	70.18 b-d	71.98 b	73.95 a-c	4.28 a-c	5.25 c	7.13 c	8.62 c	10.23 c
V_1T_5	65.85 bc	66.45 de	67.05 f	67.68 d	68.48 ef	4.35 ab	4.32 f	4.75 h	5.12 j	5.45 j
V_2T_0	66.74 a-c	70.24 ab	74.24 a	75.83 a	74.84 ab	4.12 c	6.23 b	8.35 b	9.45 b	10.43 b
V_2T_1	65.83 bc	66.62 de	67.32 ef	68.02 d	69.52 d-f	3.83 de	4.12 g	4.32 i	5.94 h	6.74 h
V_2T_2	67.33 a-c	68.83 bc	70.13 b-d	71.43 b	73.43 bc	3.78 de	4.65 e	6.15 f	7.45 f	8.95 f
V_2T_3	66.68 a-c	67.59 c-e	68.38 d-f	69.22 cd	70.92 d	3.89 de	4.33 f	5.13 g	5.92 h	6.82 h
V_2T_4	65.56 c	67.16 c-e	68.96 c-e	70.76 bc	72.76 c	3.92 d	5.08 c	6.82 d	8.32 d	9.92 d
V_2T_5	65.52 c	66.13 e	66.72 f	67.32 d	68.12 f	3.72 e	4.12 g	4.25 i	4.82 k	5.15 k
Level of significance	NS	NS	NS	NS	NS	NS	**	**	***	***
CV%	1.56	1.51	1.43	1.45	1.46	2.55	2.13	1.73	1.47	1.28

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2 ^{0} C
T_5= Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

PWL were recorded from Khirshapat and Langra at 12th day, respectively. The results also revealed that total PWL progressively increased with the increase in storage period. The findings also indicated that Langra showed better performance in respect of PWL as compared to Khirshapat. Water loss through lenticels seems to be the probable cause of physiological weight loss in the fruits during storage. Lower lenticels density in Langra facilitated lesser water loss leading to minimum total weight loss (Azad, 2001). Singh *et al.* (2000) also reported more or less the similar findings.

Variation was also found highly significant among the means of postharvest storage treatments on PWL (Appendix 1.3). At different days after storage, it revealed that control (T_o) treatment was faster in PWL followed by other treatments (T_4, T_2, T_5 and T_1) and the mangoes treated with T_3 treatment were slower in PWL. It was also indicated that T_o, T_4 and T_2 treatments showed PWL more or less in the same rate whereas, T_5 , T_1 and T_3 treatment, followed more or less same rate of losses (Fig. 1.7). At 12th day, the maximum PWL (19.88%) was obtained in T_o and minimum (8.20%) in T_3. These phenomena happened seems to be protected by polyethylene cover around the fruits which hindered in PWL. These results are in partial coincided with the findings of Hossain (1999) while, these result are strongly supported by the findings of Fawaz (2006) and Illeperuma and Jayasuriya (2002)

The combined effect of varieties and different storage treatments exhibited highly significant on PWL at different days of storage (Appendix 1.3). At different days of storage, it showed that different treatment combination showed PWL gradually with advancing of storage time. At 12th day, there was found the maximum PWL (20.50%) at V_2T_o and the minimum (4.20%) at V_1T_3 (Table 1.3). It also revealed that Langra lost minimum amount of water owing to using polythene cover followed by the other treatment combination. These results are in partial supported by the findings of Azad (2001) and Hossain (1999).

7.2.4 Moisture content

Varieties showed highly significant moisture content at different days after storage (Appendix 1.3). At different days, the results indicated that moisture content increased with the passing of time of storage (Fig. 1.6). This increasing rate was

more or less similar from 3 to 9 days and thereafter, it decreased slightly due to starting rotten. Figure 1.6 denoted that each day of storage, Khirshapat produced more moisture as compared to Langra, the maximum (85.99%) and minimum (83.89%) was recorded from V_2 and V_1 at 12th day. Shajahan *et al,* (1994) observed different results in this regard and the moisture content increased in Langra than Khirsapat. These results are in agreement with the findings of Azad (2001). This variation might be due to genetical, location, weather effect, soil quality or maturity of the fruit.

Variation among the means of storage treatments on moisture content was highly significant at different days after storage (Appendix 1.3). At different days, moisture content increased gradually with space of time but, this increasing point was the maximum in control treatment at 6th day, in T_4 at 9th day and in T_1, T_2, and T_3 at 12th day (Fig. 1.8). T_o treatment produced the highest moisture content (85.88%) at 9th day, and thereafter, it decreased up to 12th day and the lowest (82.73%) was recorded from T_5 at 9th day. The increasing trend of moisture content from initial to 9 days might be due to a metabolic activities and osmotic pressure inside the mango fruit as well as this decrease might be due to suspending metabolic activities resulting in rotten and drying.

The combined effect of varieties and different storage treatments in respect of moisture content was found to be significant at initial and 3rd day but, non significant from 6th days to onward (Appendix 1.3). At different days, moisture content increased with the augmentation of storage time. The treatment combination of V_2T_o, V_2T_4 and V_2T_3 produced the highest moisture content (86.92%, 86.86% and 86.87%) at 6, 9 and 12th day, respectively. In this storage period, the lowest values (81.75%, 81.94% and 81.75%) were observed from the treatment combination of V_1T_5 (Table 1.3). These treatment combinations provided slightly lesser amount of moisture content from 6 and 9 days. The moisture content increasing from initial to other days might be due to metabolic activities and osmotic principles and decreasing in a certain days might be due to suspending metabolic activities resulting in drying,

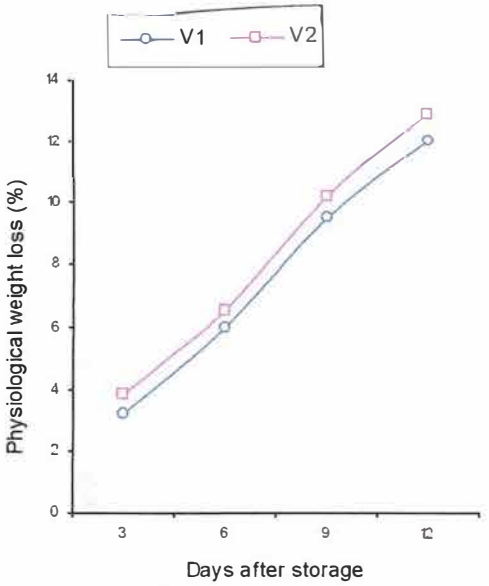


Fig. 1.5 Physiological weight loss of mango between varieties at different days after storage

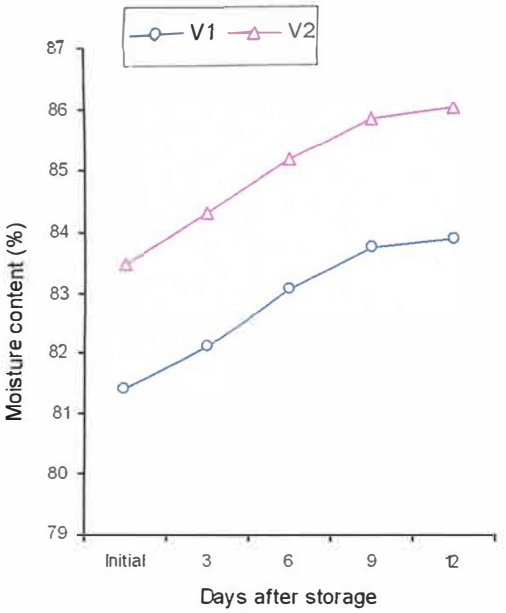


Fig. 1.6 Moisture content of mango pulp between varieties at different days after storage

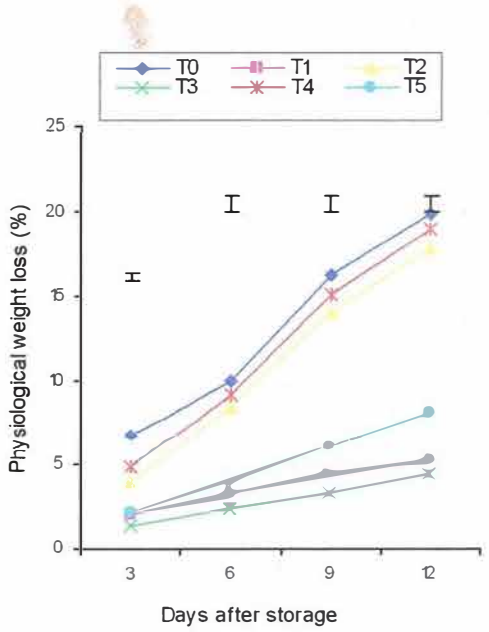


Fig. 1.7 Physiological weight loss of mango as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

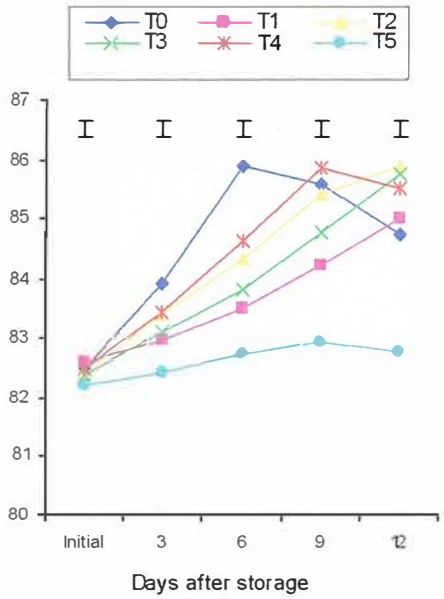


Fig.1.8 Moisture content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

Figures represent

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2)^0 C
T_5= Low temperature in refrigerator (4±1)^0 C

Table1.3 Combined effects of variety and different storage treatments on physiological weight loss and moisture content of postharvest mango

Treatments combination	Physiological weight loss (%) at different days				Moisture content (%) at different days				
Varieties × Treatments	3	6	9	12	Initial	3	6	9	12
V_1T_0	6.35 b	9.50 b	15.65 b	19.25 b	81.23 e	82.65 e	84.85 d	84.53 f	83.68 g
V_1T_1	1.75 i	3.20 h	4.25 h	4.85 h	81.56 d	81.85 g	82.38 i	83.11 i	83.86 g
V_1T_2	3.50 f	8.30 d	13.75 d	17.30 d	81.55 d	82.36 f	83.27 g	84.38 f	84.84 e
V_1T_3	1.20 k	2.20 j	3.15 j	4.20 i	81.35 e	81.98 g	82.72 h	83.65 h	84.65 f
V_1T_4	4.60 d	8.85 c	14.55 c	18.60 c	81.65 d	82.45 f	83.63 f	84.87 e	84.52 f
V_1T_5	1.80 i	3.75 f	5.85 f	7.80 f	81.22 e	81.42 h	81.75 j	81.94 j	81.75 h
V_2T_0	7.25 a	10.60 a	16.80 a	20.50 a	83.75 a	85.17 a	86.92 a	86.62 b	85.76 d
V_2T_1	2.30 h	3.40 g	4.50 g	5.65 g	83.65 a	84.07 c	84.64 e	85.37 d	86.12 c
V_2T_2	4.45 e	8.75 c	14.50 c	18.45 c	83.28 bc	84.45 b	85.36 c	86.46 b	86.92 a
V_2T_3	1.50 j	2.60 i	3.45 i	4.75 h	83.45 b	84.22 c	84.94 d	85.87 c	86.87 a
V_2T_4	5.20 c	9.50 b	15.65 b	19.30 b	83.35 bc	84.46 b	85.64 b	86.86 a	86.52 b
V_2T_5	2.50 g	4.30 e	6.50 e	8.60 e	83.25 c	83.45 d	83.72 f	83.94 g	83.76 g
Level of significance	***	***	***	***	***	**	NS	NS	NS
CV%	1.48	1.67	1.05	0.84	1.05	0.13	0.12	0.12	0.12

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2 ^{0} C
T_5= Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

transpiration and evaporation. Moisture content increased in the present study is in partial agreement with the findings of El-Mahmoudi and Eisawi (1968) in banana.

7.2.5 Dry matter content

The variation in varieties means on dry matter content of mango pulp demonstrated highly significant at different days after storage (Appendix 1.4). At different days of storage, dry matter content decreased gradually with the advancement towards storage time (Fig. 1.9). It showed that Langra gave comparatively more dry matter content comparing to Khirshapat. At initial stage, Langra provided the maximum (18.56%) while Khirshapat provided the minimum (16.55%) but at 12th day, Langra provided minimum (16.12%) while Khirshapat gave 14.00 % of dry matter. These results are in partial agreement with the findings of Hassain (1991).

Different storage treatment adopted in this study on dry matter content of mango exhibited significant effect at different days after storage (Appendix 1.4). At different days, dry matter content decreased gradually with the passing of time of storage (Fig. 1.11). It was also noticed that control treatment produced the lowest dry matter (14.11%) at 6th day whereas, the highest dry matter (17.27%) was observed in mangos that kept in the refrigerator at this period and thereafter, it increased to onward. At 12th day, dry matter content has found to be 17.24% and 14.12% for storage at refrigeration and perforated polyethylene cover, respectively (Fig. 1.11).

The combined effect of varieties and different storage treatments on dry matter content of mango pulp was significant at initial and 3rd day but, non-significant at 6, 9 and 12th day (Appendix 1.4). At different days, dry matter content decreased gradually up to 9th day and then, it increased slightly from control at 12th day. At initial day, the highest dry matter content (18.78%) was noticed from the treatment combination of V_1T_5 which was statistically similar with the combination of V_1T_3 and V_1T_0. In this level, the lowest value (16.25%) was observed from the treatment combination of V_2T_0 which was also statistically similar with the combination of V_2T_1. At 12th day, the highest value (18.25%) was recorded from the combination of V_1T_5 and the lowest value (13.08%) was recorded from V_2T_0 (Table

1.4). The decrease in dry matter content with increasing storage period may be due to breaking down of the complex carbohydrates into simple molecules and H_2O as well as adding water through osmotic process and metabolic activities. The decrease in dry matter content of mango pulp is not in agreement with the findings of Hossain (1999).

7.2.6 Ash content

Variation in varieties means on ash content of mango pulp was highly significant at different days after storage (Appendix 1.4). At different days, values of ash content reduced gradually with the passing of storage time (Fig. 1.10). It also revealed that Langra accumulated comparatively more ash than Khirshapat at all the days. Higher (1.07%) ash content was accumulated from Langra at initial level whereas Khirshapat accumulated lower quantity (0.95%).

Different storage treatments exhibited significant variation in ash content of mango at different days except at initial level (Appendix 1.5). It was demonstrated from the Fig. 1.12 that ash content was affected by different storage treatments and increased slightly than control at 3rd day in all the treatments, except at T_2 treatment but, it decreased after this stage. At 6th day, T_5 treatment produced highest (0.99%) where as the lowest ash (0.81%) was found in T_0 treatment. At 12th day, the maximum (0.99%) ash content was gathered from T_5 and minimum (0.81%) was accumulated from perforated polythene cover storage.

The combined effect of varieties and different storage treatments was found to be non significant on ash content of mango at various days after storage (Appendix 1.4 and Table 1.4). It may suggest from the present data that ash content showed good correlation with the dry matter content.

7.3 Changes in biochemical properties of mango during storage environments

Various changes relating to biochemical properties of mango fruits are presented and discussed under the following sub-headings.

7.3.1 Vitamin C content

Variation in between varieties means on vitamin C content of mango pulp was noticed to be highly significant at different days after storage (Appendix 1.5). At various days after storage, it was observed that Langra showed better performance

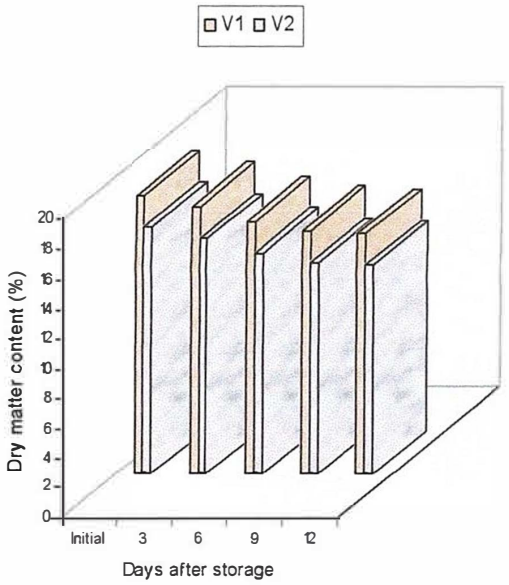


Fig. 1.9 Effect of varieties on dry matter content of mango pulp at different days after storage

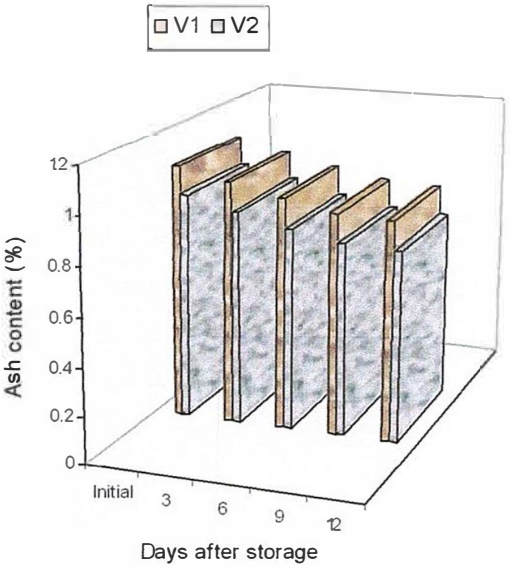


Fig. 1.10 Effect of varieties on ash content of mango pulp at different days after storage

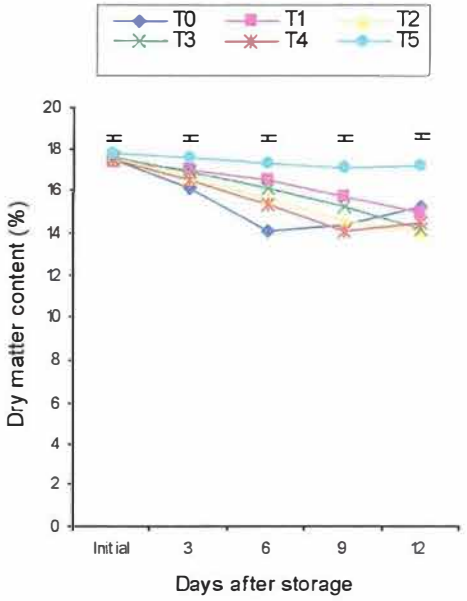


Fig. 1.11 Dry matter content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

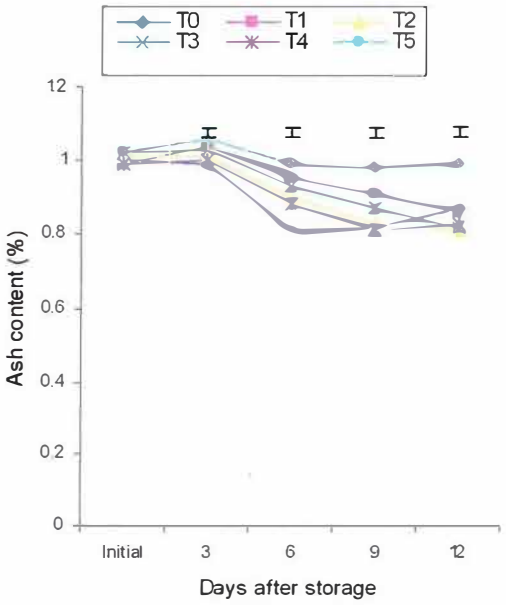


Fig. 1.12 Ash content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

Figures represent

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2)^{0}C
T_5= Low temperature in refrigerator (4±1)^0 C

Table 1.4 Combined effects of varieties and different storage treatments on dry matter and ash content of postharvest mango

Treatments combination	Dry matter content (%) at different days					Ash content(%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1T_0	18.77 a	17.35 d	15.15 g	15.47 e	16.32 b	1.07 a	0.99 d	0.87 de	0.88 d	0.93 b
V_1T_1	18.38 b	18.15 b	17.62 b	16.89 b	16.14 b	1.05 a	1.04 ab	1.01 b	0.97 b	0.92 b
V_1T_2	18.45 b	17.64 c	16.73 d	15.62 e	15.16 d	1.06 a	1.01 b-d	0.96 c	0.89 d	0.87 c
V_1T_3	18.65 a	18.02 b	17.28 c	16.35 c	15.35 c	1.08 a	1.03 a-c	0.99 b	0.93 c	0.88 c
V_1T_4	18.35 b	17.55 c	16.37 e	15.13 f	15.48 c	1.05 a	1.00 cd	0.94 c	0.86 de	0.89 c
V_1T_5	18.78 a	18.58 a	18.27 a	18.06 a	18.25 a	1.08 a	1.06 a	1.04 a	1.03 a	1.04 a
V_2T_0	16.25 e	14.83 h	13.08 j	13.38 i	14.21 e	0.93 b	0.85 g	0.75 g	0.76 g	0.81 d
V_2T_1	16.35 e	15.93 f	15.36 f	14.63 g	13.88 f	0.94 b	0.91 f	0.88 d	0.84 e	0.79 de
V_2T_2	16.72 cd	15.55 g	14.64 h	13.54 i	13.08 h	0.96 b	0.89 f	0.84 ef	0.77 g	0.75 f
V_2T_3	16.55 d	15.78 f	15.06 g	14.13 h	13.13 h	0.95 b	0.90 f	0.86 de	0.81 f	0.76 ef
V_2T_4	16.65 cd	15.54 g	14.36 i	13.14 j	13.48 g	0.94 b	0.89 f	0.82 f	0.75 g	0.77 ef
V_2T_5	16.75 c	16.55 e	16.28 e	16.06 d	16.24 b	0.96 b	0.95 e	0.93 c	0.92 c	0.93 b
Level of significance	***	**	NS	NS	NS	NS	NS	NS	NS	NS
CV%	0.59	0.62	0.66	0.68	0.73	2.07	2.17	2.29	2.40	2.42

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2 ^{0} C
T_5= Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

in accumulating vitamin C as compared to Khirshapat (Fig. 1.13). It also indicated that quantity of vitamin C decreased with advancing of storage period. The decreasing trend was higher from initial to 6th day, and thereafter it was slightly slower.At the initial stage, Langra produced higher amount (151.23 mg/100 g) of vitamin C whereas Khirshapat showed lower amount (56.00 mg/100 g). At 12th day, Langra also showed wider amount of vitamin C (23.84 mg/100 g) and Khirshapat gave the lower amount (17.35 mg/100 g) (Fig. 1.13). These results also elucidated that vitamin C content gradually reduced with the advancement of storage period in case of both the varieties. It might be due to augmentation of ethylene synthesis resulting breaking down of ascorbic acid. The results of the present study are in agreement with the findings of Azad (2001), Shyamalamma (1995), Gofur *et al.* (1994) and Absar *et al.* (1993).

Variation among the treatments means on vitamin C content was highly significant at different days after storage (Appendix 1.5). At initial day, green mango treated with low temperature in refrigerator (4±1)^0 C produced the highest amount (105.50 mg/100 g) of vitamin C which was statistical similar with the fruit treated with unperforated polyethylene cover (T_3) and untreated mango (T_o). After initial level, it decreased gradually with the passing of storage time (Fig. 1.14). It was found that decreasing trend was faster with untreated fruit but, it showed slower with the fruit in low temperature at refrigerated condition. At 12th day, it ranged between 12.97 to 30.87 mg per 100 g of pulp obtained from control (T_o) and treated with low temperature in refrigerator. The decreasing trend in vitamin C content from both the treated and untreated mangoes at different storage period might be due to oxidation of ascorbic acid and low temperature in refrigerator might be possibly due to causing delay ripening resulting in lower oxidation of vitamin C. These results are supported by the findings of Hossain (1999).

The combined effect of varieties and different storage treatments exhibited significant variation in respect of vitamin C content at different days after storage (Appendix 1.5 and Table 1.5). At various days of storage, it was found that vitamin C content decreased with the advancement of storage period. The quantity of vitamin C ranged between 52.50 to 155.30 mg per 100 g of fresh mango pulp at initial day

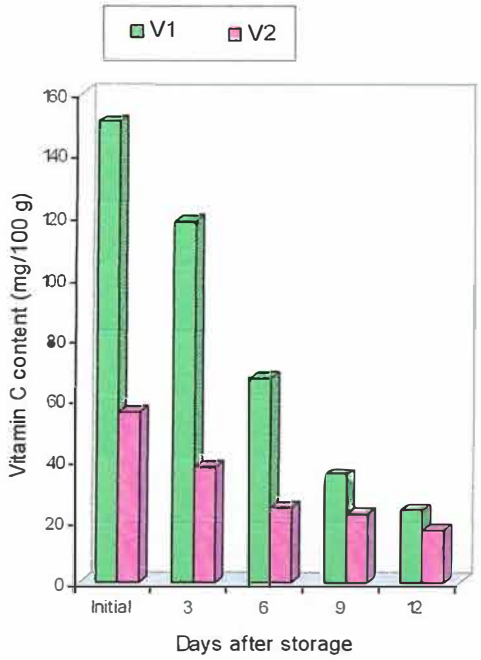


Fig. 1.13 Effect of varieties on vitamin C content of mango pulp at different days after storage

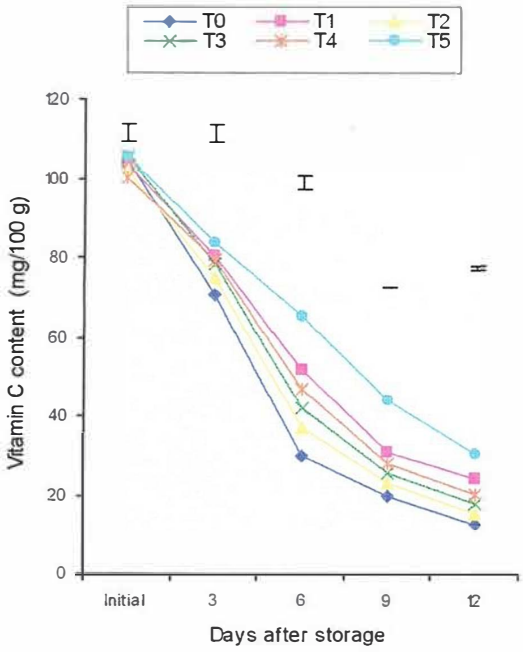


Fig. 1.14 Vitamin C content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

Figures represent

V_1 = Langra	T_1=Paraffin coating	T_4=Hot water treatments (55±2)^{0}C
V_2 = Khirshapat	T_2=Perforated polyethylene cover	T_5= Low temperature in refrigerator (4±1)^0 C
T_0 =Control	T_3=Unperforated polyethylene cover	

of storage with the combination of V_2T_4 and V_1T_5. These quantities reduced gradually after initial day. At 12th day, it also ranged between 10.33 to 35.80 mg per 100 g, with the treatment combination of V_2T_0 and V_1T_5. The maximum (35.80 mg/100 g) was obtained from the treatment combination of V_1T_5 whereas the lowest (10.33 mg/100 g) was recorded from the treatment combination of V_2T_0.

7.3.2 Titratable acidity

Variation in between varieties in relation to titratable acidity was noticed to be highly significant at different days after storage (Appendix 1.6). At various days of storage, Langra showed higher titratable acidity as compared to Khirshapat (Fig. 1.15). Titratable acidity decreased with the passing of storage period. The decreasing trend was very faster from initial to 6th day, and thereafter, this trend was slightly slower from 6 to 12th day. At initial day, the highest (4.31%) was recorded in Langra

Table 1.5 Combined effects of varieties and different storage treatments on vitamin C content of postharvest mango

Treatments combination	Vitamin C content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12
V_1T_0	150.60 bc	110.70 e	45.60 f	24.80 g	15.60 b
V_1T_1	152.30 b	120.40 b	75.50 b	36.50 b	27.35 b
V_1T_2	149.60 cd	114.60 d	55.30 e	28.60 e	19.20 f
V_1T_3	151.40 bc	118.30 c	62.40 d	30.70 d	21.60 e
V_1T_4	148.20 d	119.70 bc	68.60 c	33.80 c	23.50 d
V_1T_5	155.30 a	125.80 a	95.60 a	58.20 a	35.80 a
V_2T_0	58.60 e	30.60 i	15.60 l	15.60 k	10.33 j
V_2T_1	55.20 f	40.50 fg	28.80 h	26.30 f	21.65 e
V_2T_2	54.70 f	35.80 h	20.30 k	18.60 j	12.83 i
V_2T_3	59.40 e	38.75 g	22.45 j	21.30 i	15.50 h
V_2T_4	52.50 g	39.40 g	25.60 i	23.40 h	17.85 g
V_2T_5	55.61 f	42.20 f	35.55 g	30.85 d	25.93 c
Level of significance	***	*	***	***	***
CV%	1.01	1.34	1.62	0.36	1.06

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4 =Hot water treatments (55±2 ^{0} C
T_5 = Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

whereas the lowest (3.55%) was recorded from Khirshapat. At 12th day, the highest (0.53%) was obtained from Langra while Khirshapat produced the lowest amount (0.45%). The decreasing trend of titratable acidity at storage period was also reported by Upadhyay and Tripathi (1985), Leon and Lima (1968) and Medlicott *et al.* (1986). According to them, acidity reduced during storage growth on attainment of maturity and ripening. It also might be due to genetical dissimilarities between the varieties.

Different storage treatments used in this investigation on titratable acidity demonstrated significant variation among the means at various days after storage (Appendix 1.6). At various days of storage, titratable acid content declined very sharply from initial to 6th day, and then, it declined steadily from 9th day to onward (Fig. 1.17). In all the cases of storage period, the wider titratable acidity (4.01%, 2.59%, 1.43%, 1.15% and 0.96%) was recorded at low temperature in refrigerator from initial to 12th day, followed by 3.90%, 1.23%, 0.53%, 0.30% and 0.17% in untreated (T_o) mangoes, respectively. These results are partially supported by the findings of Tefera *et al.* (2007).

The combined effect of varieties and storage treatments on titratable acidity of mango pulp was observed to be significant at different days after storage except at 3rd and 6th days (Appendix 1.6). At different days after storage, there was found decreasing trend of titratable acidity with the advancement of storage period (Table 1.6). At initial day, the highest concentration (4.42%) was noticed from the treatment combination of V_1T_5 which was statistically identical with the combination of V_1T_3 and the lowest acid content (3.48%) was reported from the treatment combination of V_2T_4. At 12th day, titratable acid concentration ranged between 0.15 to 1.10%. In this stage, the highest (1.10%) amount was recorded from the treatment combination of V_1T_5, whereas the lowest (0.15%) was recorded from the treatment combination of V_2T_o. This occurrence might be possible due to inhibition of acid oxidation at low temperature in refrigerator and genetical variation in between varieties.

7.3.3 Pulp pH

Variation in between the means of varieties was highly significant on pulp pH of mango at different days after storage (Appendix 1.6). At various days of storage, there was found an increasing trend of pulp pH with the passing of storage period (Fig. 1.16). In all the storage period, pulp pH showed more amount in Khirshapat as compared to Langra. Higher pH (3.72) was obtained from green Khirshapat at initial day whereas lower (3.60) was reported from green Langra. At 12th day, the highest pulp pH (5.83) was recorded from Khirshapat and the lowest value (5.67) was noticed from Langra, respectively. Increasing trend of pulp pH was also observed by Yuniarti (1980), Kumar *et al.* (1993) and Shahjahan *et al.* (1994). This phenomenon might be due to oxidation of acid during storage resulting in higher pulp pH and genetical dissimilarities between the varieties.

The postharvest treatments imposed to the mango fruits exhibited significant variation in pulp pH at different days after storage (Appendix 1.6). An increasing trend of pulp pH was noticed from different treated and untreated fruits from initial to onwards (Fig. 1.18). Pulp pH was wider in control at all stages of storage followed by the other treatments; especially fruits treated with low temperature in refrigerator gave the lowest trend of augmentation of pulp pH. pH value of mango pulp was the maximum (6.95) from control whereas the fruits treated with low temperature in refrigerator gave the lowest (4.45) value at 12th day (Fig. 1.18). These results are strongly supported by the findings of Tefera *et al.* (2007).

The combined influence of varieties and imposed storage treatments regarding pulp pH was found to be significant at different days of storage except, initial and 3rd day. There was showing an increasing trend of pulp pH from various treatment combinations at different days of storage (Table 1.6). At different days of storage, the treatment combination of V_2T_0 denoted the highest pH value (7.00) which was statistical similar with the combination of V_1T_0 and the lowest pH value(4.40) was recorded from the treatment combination of V_1T_5. It was also statistically identical with the combination V_2T_5. This phenomenon might be possible due to low temperature in refrigerator which hindered in acid oxidation that caused delay ripening. Further, low temperature in refrigerator may cause delay ripening

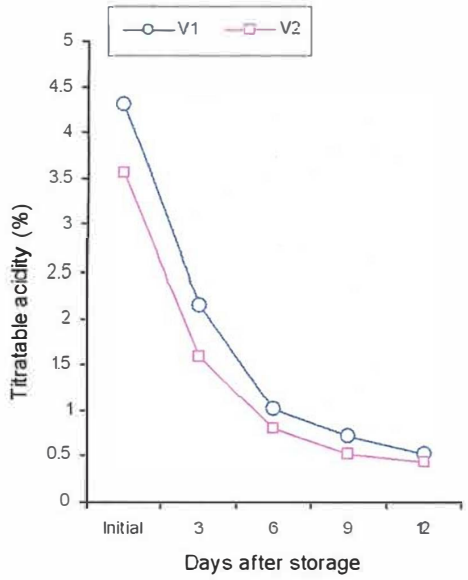


Fig. 1.15 Effect of varieties on titratable acidity of mango pulp at different days after storage

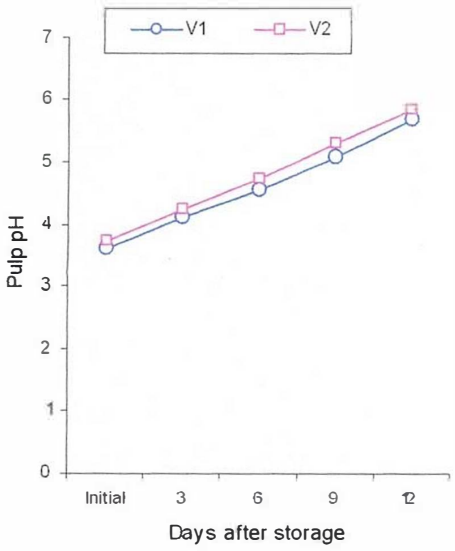


Fig. 1.16 Effect of varieties on pH of mango pulp at different days after storage

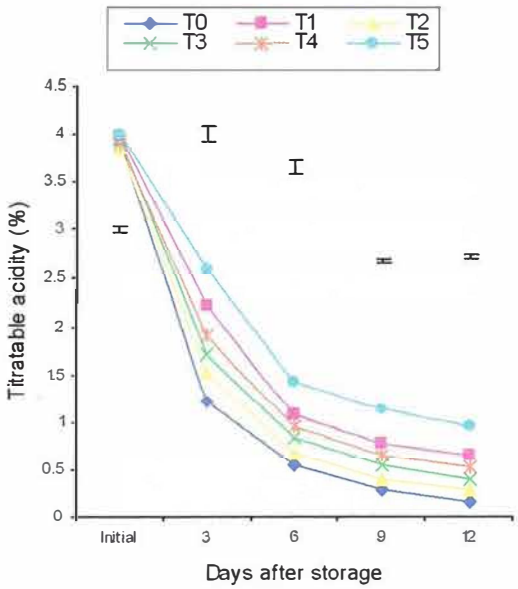


Fig. 1.17 Titratable acidity of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

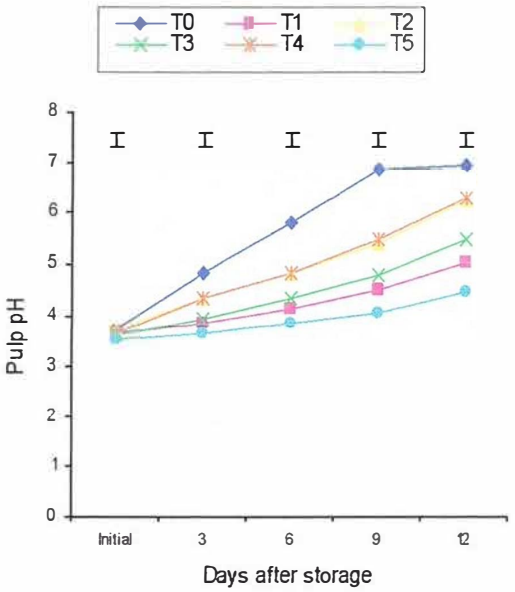


Fig. 1.18 Pulp pH of mango as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

Figures represent

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2)^{0}C
T_5= Low temperature in refrigerator (4±1)^0 C

Table 1.6 Combined effects of varieties and different storage treatments on titratable acidity and pulp pH of postharvest mango

Treatments combination	Titratable acidity (%) at different days					Pulp pH at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1T_0	4.25 bc	1.50 d	0.60 hi	0.35 h	0.18 g	3.70 ab	4.80 a	5.70 b	6.80 a	6.90 a
V_1T_1	4.30 b	2.45 b	1.20 bc	0.87 c	0.65 c	3.60 ab	3.80 fg	4.10 h	4.40 g	5.10 g
V_1T_2	4.20 c	1.82 c	0.75 f-h	0.45 g	0.29 f	3.70 ab	4.30 cd	4.80 d	5.30 d	6.20 c
V_1T_3	4.35 ab	2.02 c	0.92 d-f	0.62 e	0.42 e	3.60 ab	3.90 ef	4.30 fg	4.70 f	5.40 f
V_1T_4	4.32 b	2.30 b	1.05 cd	0.75 d	0.53 d	3.50 b	4.20 d	4.60 e	5.20 d	6.00 d
V_1T_5	4.42 a	2.83 a	1.60 a	1.35 a	1.10 a	3.50 b	3.60 h	3.80 i	4.00 h	4.40 h
V_2T_0	3.55 ef	0.95 f	0.45 i	0.24 i	0.15 g	3.80 a	4.90 a	5.90 a	6.90 a	7.00 a
V_2T_1	3.65 d	1.99 c	0.95 de	0.67 e	0.62 c	3.70 ab	3.90 ef	4.20 gh	4.60 f	5.00g
V_2T_2	3.50 ef	1.25 e	0.57 hi	0.34 h	0.26 f	3.80 a	4.40 bc	4.90 d	5.50 c	6.30 c
V_2T_3	3.52 ef	1.45 de	0.72 gh	0.44 g	0.37 e	3.60 ab	4.00 e	4.40 f	4.90 e	5.60 e
V_2T_4	3.48 f	1.49 d	0.84 e-g	0.55 f	0.49 d	3.80 a	4.50 b	5.10 c	5.80 b	6.60 b
V_2T_5	3.60 de	2.35 b	1.25 b	0.95 b	0.82 b	3.60 ab	3.70 gh	3.90 i	4.10 h	4.50 h
Level of significance	*	NS	NS	***	***	NS	NS	*	**	***
CV%	1.33	6.89	11.46	4.10	2.38	2.85	2.50	2.24	2.01	1.81

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 = Control
T_1 = Paraffin coating
T_2 = Perforated polyethylene cover
T_3 = Unperforated polyethylene cover
T_4 = Hot water treatments (55±2 ^{0} C
T_5 = Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

resulting in low acid degradation achieving low pulp pH, but, Khirshapat without treatment showed highest pulp pH due to none inhibition of acid degradation.

7.3.4 Total soluble solid (Brix %) content

Statistically highly significant variation was observed in total soluble solid content between two varieties at different days after storage (Appendix 1.7). The results indicated that TSS content of mango pulp augmented gradually with the passing of storage period. The augmenting trend was more or less similar and it increased faster from initial to 6th day thereafter, it increased slower from 6th day to onward (Fig. 1.19). At every stage of storage period, Khirshapat gave better performance in TSS accumulation than Langra. The highest TSS value (18.00%) was recorded from Khirshapat and the lowest (17.04%) was recorded from Langra at 12th day. The increase of TSS during storage in mango was reported by Singh (1968). Absar *et al.* (1993) reported that TSS was increased with maturity of mango fruit. But, they found highest TSS in Langra. Mollah and Siddique (1973) reported that TSS value varied from cultivar to cultivar. These might be possible due to genetically differences between varieties.

Different storage treatments induced with the postharvest mangoes in this study demonstrated significant variation in respect of TSS content at different days after storag (Appendix 1.7). At different days after storage, it was noticed that TSS accumulation increased with the advancement of storage time. It also indicated that TSS content sharply increased from untreated mangoes at initial to 6th day and then, it decreased markedly at 6 to 12th day (Fig. 1.21). Another storage treatments *viz.*, hot water treatment also increasingly produced TSS from initial to 9th day and thereafter, it decreased sharply. The mangoes treated with perforated polyethylene cover also gave more or less increasing trend from initial to onward. But, the fruits treated with low temperature in refrigerator produced TSS very steady motion at various days of storage. The highest (20.67, 19.68 and 20.67%) TSS accumulation was obtained from control, hot water and perforated polyethylene cover at 6, 9 and 12th day whereas, the lowest (7.99, 9.59 and 11.09%) was obtained from control. These results are in partially supported by the findings of Jacobi *et al.* (2000). Lianni

et al. (1994) showed that TSS content increased markedly up to 5 days after harvest without using any treatment. These happened possibly due to ripening condition resulting in maximizing TSS gathering in control and low temperature in refrigerator retardated in ethylene synthesis that caused delay ripening and ultimately in lower TSS accumulation. It also elucidated that TSS gathering is strongly related to ripening and it caused decrease owing to becoming rotten.

The combined effect of varieties and implied storage treatments on TSS exhibited non significant at initial, 3 and 6th days but, significant at 9 and 12th days (Appendix 1.7 and Table 1.7). There was found an increasing behavior of TSS at different days (Table 1.7). The highest accumulation (21.13, 20.12 and 21.12%) was recorded from the treatment combination of V_2T_0, V_2T_4 and V_2T_2 at 6, 9 and 12th days of storage, whereas the lowest value (7.56, 9.25 and 10.75%) was recorded from the treatment combination of V_1T_5, respectively.

7.3.5 Total sugar content

Variation in between both the varieties means on total sugar content was found to be significant at different days after storage (Appendix 1.7). It was noted that total sugar content increased markedly with the passing of time at different days after storage (Fig. 1.20). This increasing tendency was markedly from initial to 9 days at both the varieties and then, it increased steadily. At all days of storage Khirshapat produced comparatively more quantity than that of Langra. At initial day, Khirshapat produced the highest (6.19%) whereas, Langra gave the lowest (5.78%). At 12 days after storage Khirshapat produced the highest quantity (17.62%) and the lowest (17.17%) was recorded from Langra. Upadhyay and Tripathi (1985) reported that total sugar content increased gradually during storage for 6 days at room temperature. Sugar content increased during ripening (Srivastava, 1967). These results are in conformity with the findings of Shahjahan *et al.* (1994). Tsuda *et al.* (1999) also found the similar result. The increase in total sugar might be due to conversion of complex starch or carbohydrate into simple compound like sucrose, fructose, galactose etc.

Different storage treatments applied to this experiment on total sugar content of mango pulp showed significant variation at different days after storage except at initial day (Appendix 1.7 and Table 1.7). At different days after storage, it indicated that total sugar content increased markedly with the advancement of storage period (Fig. 1.22). The increasing tendency was very fast in untreated mango followed by other treatments. It also showed excellent performance in sugar formation as compared to T_4, T_2, T_3, T_1 and T_5 treatments at 6th day. The maximum quantity of total sugar (11.06, 17.43 and 20.43%) was recorded from control at 3, 6 and 9th days and in which 20.70% was recorded from hot water treatment at 12th day, but the minimum (6.91, 8.06, 9.67 and 11.94%) was recorded from low temperature in refrigerator. Puttaraju and Reddy (1997) stated in their findings that low temperature in most effective in delay ripening but the quality of these fruits were unacceptable due to high rate of spoilage. Mondal *et al.* (1995) also reported the increasing trend of total sugar content at the later stage of storage. The increasing trend of total sugar at untreated mangos might be due to breaking down of complex carbohydrate into simple compound but, low temperature in refrigerator made delay ripening at storage period resulting in lower conversion of complex compound into simple molecules.

The combined effect of varieties and adopted storage treatments in this study in terms of total sugar content of mango pulp exhibited non significant variation at different days after storage. It indicated that total sugar content increased with the passing of storage time at different days after storage. The maximum quantity of total sugar (20.78 and 20.84%) was received from the treatment combination of V_2T_o and V_2T_4 at 9 and 12th day, whereas the minimum (9.47% and 11.57%) was received from the treatment combination of V_1T_5.

7.3.6 Reducing sugar content

Analysis of variance showed that varieties had significant effect on reducing sugar content of mango pulp at different days after storage (Appendix 1.8). There was found an increasing trend of reducing sugar with the passing of storage time Table 1.8). It was also noticed that Khirshapat produced comparatively more reducing sugar than Langra at different days after storage. (The highest (6.51%) quantity of this sugar was achieved from Khirshapat while, the lowest (6.33%) was

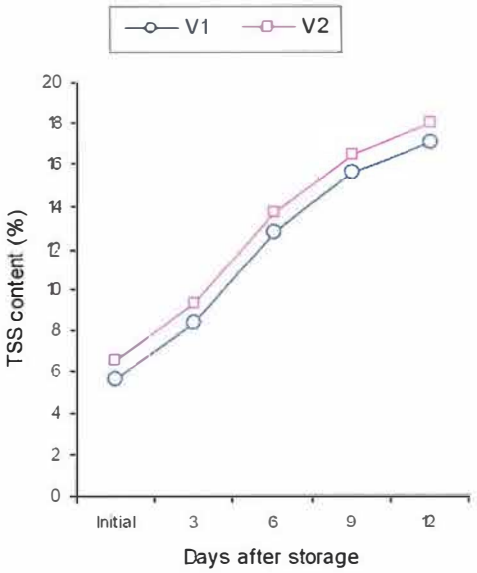


Fig. 1.19 Effect of varieties on TSS of mango pulp at different days after storage

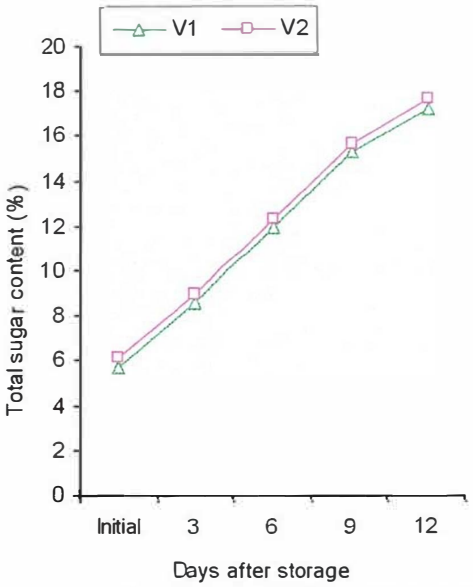


Fig. 1.20 Effect of varieties on total sugar content of mango pulp at different days after storage

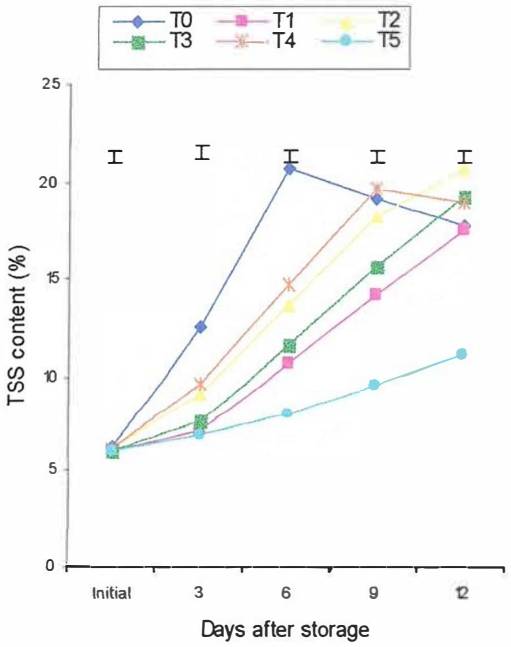


Fig. 1.21 TSS of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

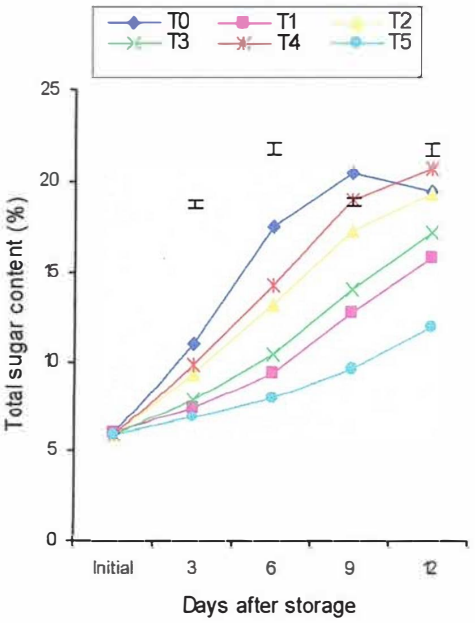


Fig. 1.22 Total sugar content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

Figures represent

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2)^{0}C
T_5= Low temperature in refrigerator (4±1)^0 C

Table 1.7 Combined effects of varieties and different storage treatments on total soluble solid and total sugar content of postharvest mango

Treatments combination	TSS content (%) at different days					Total sugar content (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1T_0	5.82 b	12.13 b	20.22 b	18.75 d	17.25 h	5.85 b	10.86 b	17.27 b	20.12 b	19.15 c
V_1T_1	5.63 bc	6.62 j	10.12 h	13.63 i	16.83 i	5.82 b	7.32 h	9.33 j	12.55 j	15.55 f
V_1T_2	5.74 b	8.74 f	13.21 e	17.72 e	20.22 b	5.75 b	9.25 e	13.05 f	17.12 f	19.12 c
V_1T_3	5.51 c	7.05 i	11.12 g	15.13 g	18.72 e	5.78 b	7.82 g	10.32 h	13.85 h	17.05 d
V_1T_4	5.73 b	9.24 e	14.24 d	19.24 c	18.45 f	5.72 b	9.78 d	14.07 d	18.79 d	20.56 a
V_1T_5	5.65 bc	6.43 k	7.56 j	9.25 k	10.75 k	5.77 b	6.67 i	7.87 l	9.47 l	11.57 h
V_2T_0	6.72 a	13.05 a	21.13 a	19.62 b	18.13 g	6.25 a	11.25 a	17.58 a	20.78 a	19.77 b
V_2T_1	6.56 a	7.52 h	11.23 g	14.73 h	18.23 g	6.22 a	7.72 g	9.72 i	12.94 i	15.93 e
V_2T_2	6.62 a	9.62 d	14.11 d	18.62 d	21.12 a	6.18 a	9.67 d	13.48 e	17.42 e	19.57 b
V_2T_3	6.53 a	8.12 g	12.15 f	16.15 f	19.75 c	6.12 a	8.12 f	10.62 g	14.13 g	17.32 d
V_2T_4	6.64 a	10.13 c	15.12 c	20.12 a	19.32 d	6.21 a	10.13 c	14.48 c	19.15 c	20.84 a
V_2T_5	6.53 a	7.35 h	8.42 i	9.92 j	11.42 j	6.15 a	7.14 h	8.25 k	9.86 k	12.31 g
Level of significance	NS	NS	NS	*	***	NS	NS	NS	NS	NS
CV%	1.70	1.24	0.79	0.65	0.59	1.74	1.18	1.46	0.67	1.00

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4 =Hot water treatments (55±2 ^{0} C
T_5 = Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

achieved from Langra at 12th day of storage (Table 1.8). These results are in agreement with the report of Upadhyay and Tripathi (1985). Casttrillo *et al.* (1992) elucidated that reducing sugar increased during storage period. Khirshapat producing comparatively more reducing sugar might be due to genetical variation in both the varieties.

Storage treatments imposed to this study exhibited significant variation in terms of reducing sugar content of mango pulp at different storage period (Appendix 1.8). The results showed that reducing sugar of mango pulp was augmented gradually at different days after storage. It also denoted that untreated mangoes showed better performance in producing reducing sugar as compared to other treatments. Again, it was found from control that reducing sugar content increased gradually up to 9th days of storage and then, it decreased due to starting decomposition. At 12th day, the maximum (7.13%) amount of reducing sugar was attained from hot water treatment and the lowest (4.91%) was attained from the fruit treated with low temperature in refrigerator. Increase in reducing sugar during storage was stated by Tripati (1988). Lower increasing trend of reducing sugar content treated with low temperature in refrigerator might be probably due to delay ripening resulting in lower conversion of carbohydrates into simples molecules.

The combined effect of varieties and implied storage treatments of mango pulp demonstrated significant variation in respect of reducing sugar content of mango pulp at 9 and 12 days of storage and non significant at initial, 3 and 6th days of storage (Appendix 1.8). It denoted that reducing sugar content increased gradually at three days interval up to 9th days of storage thereafter, it decreased. At 9 and 12th days, the maximum (7.43 and 7.22%) quantity was recorded from the treatment combination of V_2T_0 and V_2T_4 whereas, the lowest (3.38 and 4.88%) was reported from the treatment combination of V_2T_5, respectively (Table 1.8).

7.3.7 Non reducing sugar content

The variation in between the varieties means was highly significant in terms of non-reducing sugar content at different storage days (Appendix 1.8). There exhibited an increasing trend of non reducing sugar content at different days of storage. At all days after storage, it was noticed that Khirshapat showed better

performance in achieving of non reducing sugar content as compared to Langra (Table 1.9). At 12th day the highest (11.06%) amount of non reducing sugar was obtained from Khirshapat and the lowest amount (10.84%) was obtained from Langra. These results are in conformity with the findings of Ali and Mazhar (1960). They reported that non reducing sugar content of ripe fruits was 11.20%. The result obtained from this experiment might be due to varietal differences.

Different storage treatments adopted in this trial had the profound significant variation on non reducing sugar content of mango at different days after storage except at initial day (Appendix 1.8). It was observed that non reducing sugar content of mango pulp increased sharply at various days. It also indicated that untreated fruits showed better performance in achieving comparatively more non reducing sugar followed by the other treatments. This increasing trend decreased at 9th day due to rotten situation. Lower increasing trend was observed from the fruits treated with low temperature in refrigerator. Hot water treatment showed better performance in accumulation of non reducing sugar content at 12th day. The highest value (13.15%) was recorded from hot water treatment which was statistically at par with control and the lowest value (6.27%) was recorded from low temperature in refrigerator at 12th day. These events might be possibly due to low temperature in refrigerator that inhibited fruit ripening resulting in smaller accumulation of non reducing sugar. These results are in agreement with the reports of Singh (1968), Joshi and Roy (1988) and Rangavalli *et al.* (1993). They found a gradual increase in non reducing sugar content of untreated fruit.

The analysis of variance of the combined effect of varieties and induced storage treatments had non significant effect on non reducing sugar content of mango at different days after storage except at 9th day (Appendix 1.8). It was noticed that an increasing trend of non reducing sugar was found from different treatment combination at various days of storage (Table 1.9). At 9th day, the highest (13.35%) quantity of non reducing sugar was recorded from the treatment combination of V_2T_0 which was statistically at par with V_2T_4 whereas; the lowest (6.09%) was recorded from the treatment combination of V_1T_5.

Table 1.8 Changes of reducing and non reducing sugar content between mango varieties and influenced by different storage treatments

Treatments	Reducing sugar (%) at different days					Non-reducing sugar (%) at different days				
Variety	Initial	3	6	9	12	Initial	3	6	9	12
V_1	1.61 b	2.19 b	3.65 b	4.94 b	6.33 b	4.18 b	6.43 b	8.28 b	10.38 b	10.84 b
V_2	1.78 a	2.37 a	3.83 a	5.09 a	6.51 a	4.41 a	6.62 a	8.52 a	10.63 a	11.06 a
Level of significance	***	***	***	***	***	***	***	***	***	***
Treatments										
T_0	1.77 a	3.37 a	6.56 a	7.35 a	6.71 c	4.29	7.69 a	10.70 a	13.10 a	12.75 b
T_1	1.65 bc	1.85 e	2.76 e	4.02 e	6.15 e	4.37	5.67 e	6.77 e	8.73 d	9.60 e
T_2	1.72 ab	2.22 c	3.42 c	5.04 c	7.03 b	4.24	7.24 c	9.85 c	12.23 b	12.32 c
T_3	1.68 bc	1.98 d	3.07 d	4.43 d	6.59 d	4.28	5.99 d	7.41 d	9.56 c	10.60 d
T_4	1.71 a-c	2.51 b	4.11 b	5.83 b	7.13 a	4.26	7.45 b	10.18 b	13.15 a	13.57 a
T_5	1.64 c	1.75 f	2.56 f	3.40 f	4.91 f	4.32	5.11 f	5.51 f	6.27 e	6.87 f
Level of significance	**	***	***	***	***	NS	***	***	***	***

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2 ^{0} C
T_5= Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

Table 1.9 Combined effects of varieties and different storage treatments on reducing and non reducing sugar content of postharvest mango

Treatments combination	Reducing sugar (%) at different days					Non-reducing sugar (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1T_0	1.65 d-g	3.25 b	6.46 b	7.26 b	6.57 de	4.21 b-d	7.61 ab	10.48 b	12.86 b	12.58 c
V_1T_1	1.55 g	1.75 hi	2.65 h	3.92 i	6.02 g	4.27 a-c	5.57 g	6.68 g	8.63 f	9.53 f
V_1T_2	1.62 e-g	2.12 e	3.32 e	4.95 e	6.93 c	4.11 cd	7.13 d	9.73 d	12.17 c	12.19 d
V_1T_3	1.58 fg	1.88 fg	2.95 g	4.32 g	6.53 e	4.22 b-d	5.94 ef	7.37 e	9.53 d	10.52 e
V_1T_4	1.66 d-f	2.46 c	4.06 c	5.78 c	7.03 b	4.06 d	7.32 c	10.03 c	13.01 b	13.53 a
V_1T_5	1.58 fg	1.68 i	2.48 i	3.38 j	4.88 h	4.19 b-d	4.99 i	5.39 i	6.09 h	6.69 h
V_2T_0	1.88 a	3.48 a	6.65 a	7.43 a	6.85 c	4.37 ab	7.77 a	10.93 a	13.35 a	12.92 b
V_2T_1	1.75 b-d	1.95 f	2.86 g	4.12 h	6.27 f	4.47 a	5.77 f	6.86 f	8.82 e	9.66 f
V_2T_2	1.82 ab	2.32 d	3.52 d	5.13 d	7.12 b	4.36 ab	7.35 c	9.96 c	12.29 c	12.45 c
V_2T_3	1.78 bc	2.08 e	3.18 f	4.54 f	6.65 d	4.34 ab	6.04 e	7.44 e	9.59 d	10.67 e
V_2T_4	1.75 b-d	2.55 c	4.15 c	5.87 c	7.22 a	4.46 a	7.58 b	10.33 b	13.28 a	13.62 a
V_2T_5	1.70 c-e	1.82 gh	2.63 h	3.42 j	4.93 h	4.45 a	5.23 h	5.62 h	6.44 g	7.05 g
Level of significance	NS	NS	NS	*	**	NS	NS	NS	*	NS
CV%	3.07	2.28	1.39	1.04	0.81	2.39	1.60	1.24	0.99	0.95

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4 =Hot water treatments (55±2 ^{0} C
T_5 = Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

7.3.8 Crude fibre content

Crude fibre is very important for man and animals. It contains very little amount in mango, but it protects the human body from catastrophic diseases like colon cancer. It is not assimilated by human body but, it strongly help in digestion of food and making stool in the intestine.

The analysis of variance of mango varieties used in this experiment showed significant variation on crude fiber content of mango pulp at different storage period (Appendix 1.9). There was found a decreasing trend of crude fiber from both the varieties at different days of storage (Fig. 1.23). It also denoted that Langra showed better performance in accumulation of crude fiber. At initial day, Langra gave the highest (1.30%) quantity of crude fiber as compared to Khirshapat (1.18%). The amount of crude fiber decreased gradually from initial to onward at both the varieties. At 12^{th} day, the highest (0.75%) was noted from Langra whereas; the lowest (0.65%) was noted from Khirshapat. There were no available research findings regarding crude fiber content of mango in the scientific literature. The decrease in crude fiber content with the advancement of storage period might be due to breaking down of cellulose and lignin into smaller compound.

Various storage treatments applied to this trial had significant effect on crude fiber content of mango pulp at different days after storage (Appendix 1.9). There exhibited that crude fiber content decreased gradually with the passing of storage period (Fig. 1.25). At all days, it was found that crude fiber content was comparatively higher at the fruit treated with low temperature in refrigerator followed by other treatments. At initial day, the maximum amount of crude fiber (1.28%) was reported from T_o treatment which was statistically identical with T_2 and T5 treatment and the lowest (1.22%) was reported from T_1 treatment which was also statistical identical with T_3, and T_4 treatment. At 12^{th} day, the maximum (0.90%) was recorded from T_5 treatment where as the lowest (0.42%) recorded from T_0 treatment. Crude fiber decreased in mango pulp at the advancement of storage period was reported by Mathooko (2000).

The combined effect of varieties and different storage treatments demonstrated the significant variation in respect of crude fiber content of mango at

different days of storage period (Appendix 1.9). It was observed that the crude fiber content of mango pulp decreased gradually towards time of storage period (Table 1.10). It indicated that the treatment combination of V_1T_5 gave better performance in achieving comparatively more crude fiber content at all storage time except at initial day. At 12th day, the highest (0.96%) quantity of crude fiber was gathered from the treatment combination of V_1T_5 and the lowest (0.36%) was gathered from the treatment combination of V_2T_0.

7.3.9 Total lipid content

The analysis of variance of varieties had significant effect on lipid content in mango at different days after storage (Appendix 1.9).The results denoted that an increasing trend of lipid content was noted in mango pulp at different days (Fig. 1.24). In all the days, it indicated that Langra produced higher amount of lipid content as compared to Khirshapat. At 12th day, the highest (0.72%) amount of lipid was noticed from Langra and the lowest (0.65%) was noticed from Khirshapat (Table 1.16). This event might be due to the genetically dissimilarities between two varieties.

The difference between postharvest storage treatments used in this study in terms of lipid content was highly significant at different days after storage (Appendix 1.9). There was found an increasing trend of lipid content with the passing of storage period at various days (Fig. 1.26). It was also noticed that control treatment produced comparatively higher amount of lipid followed by T_1, T_2, T_3, T_4 and T_5 treatment, from initial to 9 days; and then, it decreased due to becoming rotten situation. At 9th day, the highest (0.80%) amount of lipid was obtained from control whereas; the lowest (0.38%) was obtained from the fruits treated with low temperature in refrigerator. At 12th day, perforated polyethylene cover treated fruits gave the highest (0.78%) amount of lipid which was statistically similar with the fruits treated with hot water treatment and the lowest (0.48%) was produced from the fruits treated with low temperature in refrigerator. These occurrences might be due to the low temperature in refrigerator which caused delay ripening resulting in lower production of lipid content.

The interaction effects of varieties and induced storage treatment in this trial were highly significant in respect of lipid content of mango pulp at different days

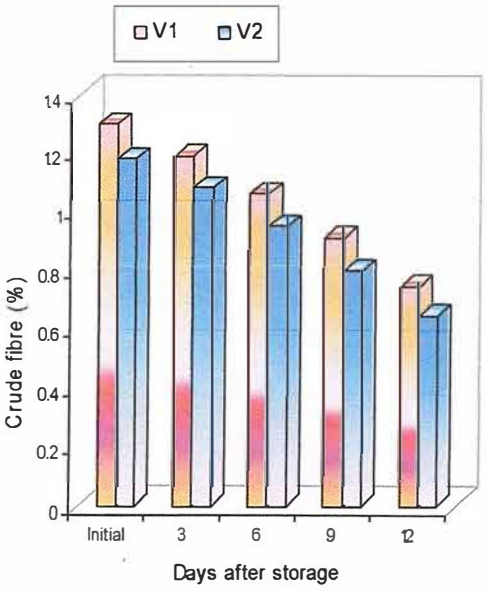


Fig. 1.23 Effect of varieties on crude fibre of mango pulp at different days after storage

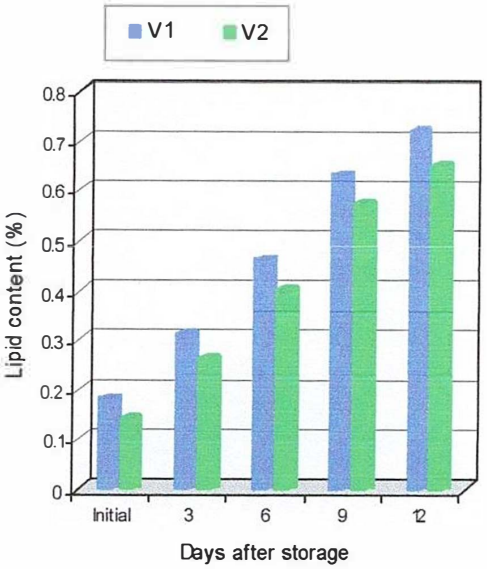


Fig. 1.24 Effect of varieties on total lipid content of mango pulp at different days after storage

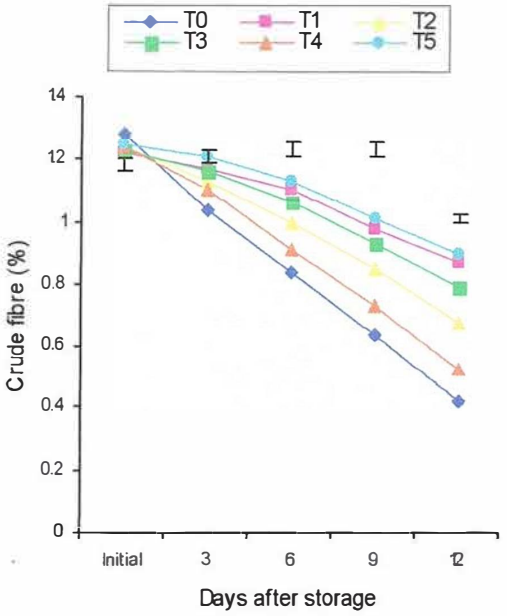


Fig. 1.25 Crude fibre of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

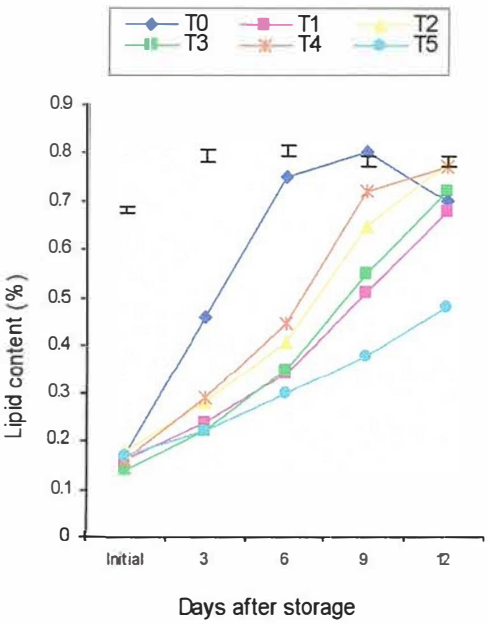


Fig. 1.26 Total lipid content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

Figures represent

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2)^{0}C
T_5= Low temperature in refrigerator (4±1)^0 C

Table 1.10 Combined effects of varieties and different storage treatments on crude fibre and lipid content of postharvest mango

Treatments combination	Crude fibre (%) at different days					Lipid content (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1T_0	1.34 a	1.13 de	0.93 f	0.72 g	0.48 h	0.18 a-c	0.47 a	0.77 a	0.83 a	0.72 cd
V_1T_1	1.25 cd	1.23 ab	1.15 ab	1.03 ab	0.92 b	0.17 b-d	0.25 cd	0.35 d-f	0.53 de	0.71 cd
V_1T_2	1.28 bc	1.17 b-d	1.04 d	0.88 de	0.71 e	0.19 a-c	0.29 bc	0.42 c	0.67 c	0.80 ab
V_1T_3	1.30 a-c	1.21 bc	1.11 bc	0.98 bc	0.84 c	0.15 d-f	0.24 c-e	0.36 c-f	0.56 d	0.74 c
V_1T_4	1.32 ab	1.15 c-e	0.96 ef	0.78 f	0.58 g	0.20 ab	0.33 b	0.49 b	0.76 b	0.81 a
V_1T_5	1.33 ab	1.28 a	1.18 a	1.06 a	0.96 a	0.21 a	0.26 cd	0.34 d-f	0.42 f	0.52 f
V_2T_0	1.21 de	0.96 g	0.76 h	0.56 h	0.36 i	0.15 d-f	0.45 a	0.72 a	0.77 b	0.67 de
V_2T_1	1.18 e	1.10 ef	1.05 cd	0.93 cd	0.81 c	0.14 d-g	0.22 de	0.32 f	0.49 e	0.64 e
V_2T_2	1.19 e	1.09 ef	0.96 ef	0.82 ef	0.65 f	0.16 c-e	0.26 cd	0.39 c-e	0.63 c	0.75 bc
V_2T_3	1.16 e	1.11 d-f	1.01 de	0.88 de	0.74 d	0.13 e-g	0.20 de	0.33 ef	0.53 de	0.69 c-e
V_2T_4	1.15 e	1.05 f	0.85 g	0.67 g	0.47 h	0.11 g	0.24 c-e	0.40 cd	0.67 c	0.72 cd
V_2T_5	1.16 e	1.14 de	1.07 cd	0.96 c	0.84 c	0.12 fg	0.18 e	0.25 g	0.33 g	0.43 g
Level of significance	**	*	*	***	***	***	***	***	***	**
CV%	1.87	1.84	2.07	1.33	1.50	6.90	3.71	2.40	1.76	1.42

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4 =Hot water treatments (55±2 ^{0} C
T_5 = Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

after storage (Appendix 1.9). There was found an increasing trend of lipid content in mango pulp with the advancement of time of storage (Table 1.10). It also denoted that lipid content was produced comparatively more quantity from the treatment combination of V_1T_0 at initial to 9th day and then, it decreased due to becoming rotten situation. At this time, lower quantity was reported from the treatment combination of V_2T_5. At 12th day, the highest (0.81%) quantity of lipid was recorded from the treatment combination of V_1T_4 whereas; the lowest (0.43%) was recorded from the treatment combination of V_2T_5.

7.3.10 Water soluble protein content

The analysis of variance of mango varieties demonstrated highly significant variation in respect of water soluble protein content (WSPC) in mango at different days after storage (Appendix 1.10). It was found an increasing trend of WSPC at time being passed (Fig. 1.27). It also exhibited that Langra was better in WSPC accumulation as compared to Khirshapat at all stages of storage. At 12th day, the highest (1.20%) accumulation of WSPC was reported from Langra whereas the lowest (1.08%) was reported from Khirshapat. This might be possible due to the seed protein of mango extended to pulp areas during ripening stage.

Various storage treatments imposed to this investigation in terms of WSPC exhibited significant variation at different days after storage (Appendix 1.10). Various results obtained from biochemical analysis showed an increasing trend of WSPC in mango pulp with the advancement of storage period (Fig. 1.29). It was also denoted that WSPC was synthesized comparatively more amount in untreated fruits followed by the fruits treated with T_4, T_2, T_3, T_1 and T_5 treatment, respectively. The increasing trend of WSPC in control was sharp from initial to 6 days, thereafter, its increasing trend declined up to 9th day and then, it totally decreased due to becoming rotten condition. At the same time, the increasing trend of WSPC from the fruit treated with low temperature in refrigerator was very slower due to delay ripening. At 9th day, the highest (1.37%) quantity of WSPC was obtained from control whereas; the lowest (0.76%) was noted from low temperature in refrigerator.

The results of the present investigation were supported by the findings of Gomez-lim (1997) and Anon (1962).

The combined effect of varieties and implied storage treatments in this experiment were found to be significant in respect of WSPC at different days after storage (Appendix 1.10). The results obtained from the investigation demonstrated that WSPC increased markedly in the treatment combination of V_1T_0 from initial to 9 days and then, it decreased due to beginning rotten situation whereas; the lower increasing trend was found from the treatment combination of V_2T_5, respectively. At 12th day, the highest (1.40%) quantity of WSPC was noticed from the treatment combination of V_1T_4 whereas; the lowest (0.87%) was noticed from the treatment combination of V_2T_5 (Table 1.11).

7.4 Changes in minerals of mango during storage environments

Different changes regarding minerals of mango fruits are presented and discussed in the following sub-headings.

7.4.1 Phosphorus content

Variation between varieties means in terms of P content was found to be highly significant at different days after storage (Appendix 1.10). There exhibited a steadily increasing trend of P content in both the varieties with the advancement of storage period (Fig. 1.28). It also indicated that Langra produced comparatively more quantity of P as compared to Khirshapat. The increasing trend of P in Langra was more or less similar up to 9 days thereafter, its trend declined due to becoming rotten condition. At 12th day, higher (23.08 mg/100 g) quantity of P content was recorded from Langra and lower (20.30 mg/100 g) was recorded from Khirshapat. Better performance in increased level of P content from Langra might be due to genetical dissimilarities. It also elucidated that the increase of P content in mango pulp was intimately related to ripening during storage. These results are in partially supported by the findings of Nadkarni (1963) worked with 16 cultivars. He found the range between 10-30 mg/100 g.

Difference between various storage treatments adopted to this trial in relation to P content were highly significant at different days after storage (Appendix 1.10).

It was observed that P content increased steadily at various days after storage. It also indicated that P content from control was increased at slower rate from initial to 6 days and then; it increased more slowly rate than its previous trend. After 9th day, it declined possibly due to becoming decay (Fig. 1.30). At 12th day, the highest (23.43 mg/100 g) quantity of P content was reported from the fruit treated with hot water treatment and the lowest value (19.65 mg/100 g) was obtained from the fruit treated with low temperature in refrigerator. Lower amount of P content from the fruits treated with low temperature in refrigerator might be due to the delay ripening which resulted in lower accumulation of P content and keeping the quality best. The results of the present investigation were strongly supported by the reports of Peter *et al.* (2007).

The combined effect of varieties and imposed storage treatments exhibited significant variation on P content of mango pulp at different days after storage except at initial day (Appendix 1.10). There was found an increasing trend of P content with the passing of storage period (Table 1.11). It also indicated that P content increased gradually from initial to 9 days with the treatment combination of V_1T_0 and then, it decreased due to becoming spoilage. In this time, P content showed lower increasing trend from the treatment combination of V_2T_5. At 12th day, the highest (24.49 mg/100 g) quantity was recorded from the treatment combination of V_1T_4 whereas; the lowest (18.25 mg/100 g) was recorded from the treatment combination of V_2T_5. It also denoted that Langra with low temperature in refrigerator was found to be the best in keeping the quality preservation followed by the other treatment combinations.

7.4.2 Potassium content

The analysis of variance of mango varieties in terms of potassium (K) content was found to be highly significant at different days after storage (Appendix 1.11). There was found an increasing trend of K content in both the varieties with the passing of storage period at different days after storage (Fig. 1.31). In all the storage period, Langra was noticed as a more producer of K as compared to Khirshapat. It was also observed that increasing trend of K stopped at 9th day. At this period, the highest (0.30%) K was recorded from Langra and the lowest (0.27%) was recorded from Khirshapat. These phenomena might be probably due to rotten

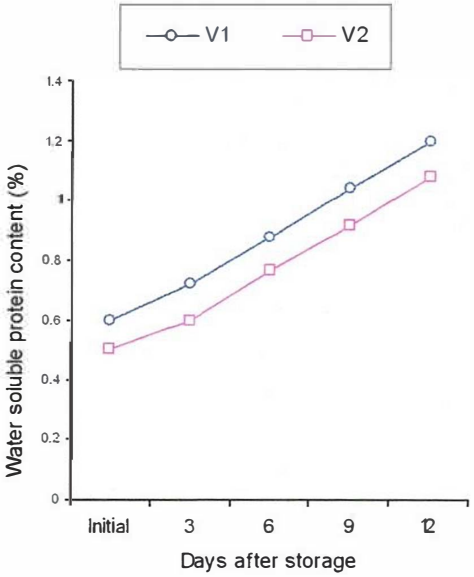


Fig. 1.27 Effect of varieties on water soluble protein content of mango pulp at different days after storage

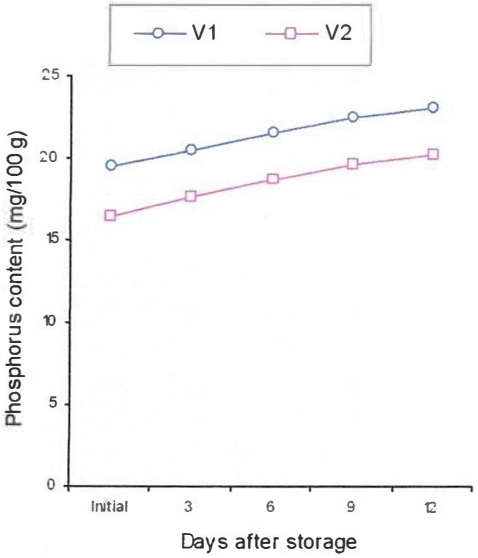


Fig. 1.28 Effect of varieties on phosphorus content of mango pulp at different days after storage

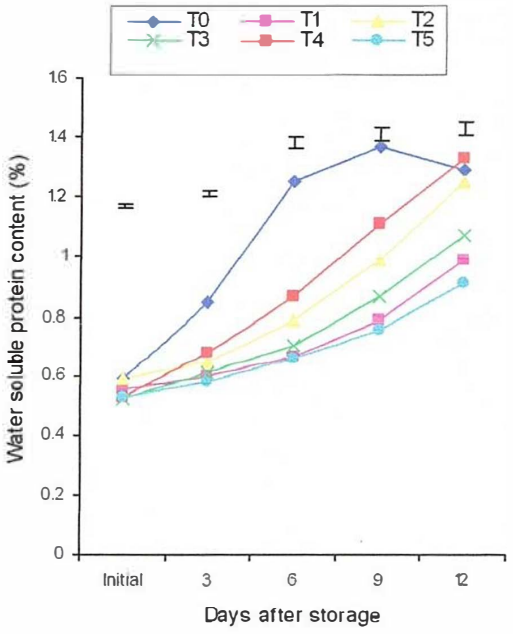


Fig. 1.29 Water soluble protein content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

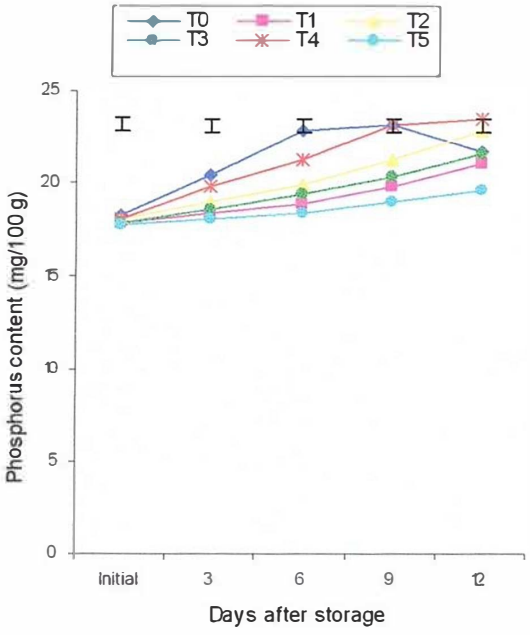


Fig. 1.30 Phosphorus content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

Figures represent

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2)^{0}C
T_5= Low temperature in refrigerator (4±1)^0 C

Table 1.11 Combined effects of varieties and different storage treatments on water soluble protein and phosphorus content of postharvest mango

Treatments combination	Water soluble protein content (%) at different days					Phosphorus (mg/100 g) different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1T_0	0.65 a	0.92 a	1.31 a	1.45 a	1.36 ab	19.75 a	21.87 a	24.29 a	24.62 a	23.13 c
V_1T_1	0.62 ab	0.65 de	0.72 ef	0.84 f	1.04 g	19.45 cd	19.98 d	20.52 e	21.36 f	22.62 d
V_1T_2	0.66 a	0.72 c	0.85 d	1.05 d	1.32 bc	19.55 bc	20.46 c	21.43 c	22.66 c	24.22 b
V_1T_3	0.55 cd	0.66 d	0.76 e	0.92 e	1.12 f	19.35 de	20.08 d	20.84 d	21.83 e	22.98 c
V_1T_4	0.58 bc	0.74 c	0.92 c	1.17 c	1.40 a	19.65 ab	20.85 b	22.38 b	24.23 b	24.49 a
V_1T_5	0.55 cd	0.62 f	0.69 fg	0.79 fg	0.94 h	19.25 e	19.58 e	19.92 g	20.44 g	21.06 g
V_2T_0	0.52 c-e	0.78 b	1.18 b	1.28 b	1.22 de	16.85 f	18.95 f	21.38 c	21.72 e	20.21 h
V_2T_1	0.48 e	0.54 h	0.62 h	0.74 gh	0.94 h	16.35 ij	16.86 j	17.39 j	18.22 j	19.47 i
V_2T_2	0.52 c-e	0.58 g	0.73 ef	0.93 e	1.18 ef	16.65 g	17.55 h	18.52 h	19.79 h	21.35 f
V_2T_3	0.49 de	0.56 gh	0.66 gh	0.82 f	1.02 g	16.45 hi	17.18 i	17.94 i	18.89 i	20.12 h
V_2T_4	0.48 e	0.62 ef	0.82 d	1.05 d	1.26 cd	16.58 gh	18.75 g	20.28 f	22.13 d	22.38 e
V_2T_5	0.51 de	0.53 h	0.62 h	0.72 h	0.87 i	16.22 j	16.62 k	16.96 k	17.48 k	18.25 j
Level of significance	***	**	*	***	*	NS	***	***	***	***
CV%	1.83	1.58	1.70	1.19	1.83	0.58	0.55	0.52	0.49	0.48

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2 ^{0} C
T_5= Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

situation whichresulted in metabolic activities suspension. Langra was the better producer possibly due to genetical dissimilarities between the two varieties. At storage period, increase of K content might be probably due to transmission of K from stone and peel to pulp of mango.

Storage treatments applied to this experiment in respect of K content of mango had highly significant at different days after storage (Appendix 1.11). It indicated that K content increased gradually with the advancement of storage time. But, K content from the untreated fruits decreased after 9th day whereas, other treatments namely, T_4, T_2, T_3, T_1 and T_5 retained its increasing with days (Fig. 1.33). In this period there was found a very lower trend of K increasing at the fruit treated with low temperature in refrigerator. At 9th day, the maximum (0.32%) of K content was noticed from the untreated fruits whereas; the lowest (0.24%) was noticed from the fruits treated with low temperature in refrigerator. Lower dissemination of K content in the fruits treated with low temperature in refrigerator might be possible due to delay ripened causing lower transmission of K.

The combined effect of implied varieties and induced storage treatments in relation to K content of mango pulp was found to be non significant at different days of storage (Appendix 1.11). It denoted that K content of mango pulp from different treatment combination increased gradually with passing of storage time (Table 1.12). But, only the treatment combination of V_1T_0 gave the highest decreasing trend after 9 days. At 9th day, the highest (0.33%) quantity of K was recorded from the treatment combination of V_1T_0 whereas; the lowest (0.23%) was recorded from the treatment combination of V_2T_5.

7.4.3 Calcium content

The analysis of variance of imposed varieties to this experiment in terms of Ca content demonstrated highly significant variation at different days after storage (Appendix 1.11). There was found an increasing trend of Ca with the passing of storage time from both the varieties (Fig. 1.32). It also denoted that Khirshapat showed better performance in achieving of Ca content over Langra. At 12th day the highest (21.71%) quantity of Ca was obtained from Khirshapat and the lowest (19.97%) was recorded from Langra. This might be due to genetical variation

between two varieties. These results are in partially supported by the report of Nadkarni (1963), when he worked with different varieties of mango.

Different storage treatments on Ca of mango pulp exhibited significant variation at different days after storage (Appendix 1.11). At various days, Ca content increased gradually with the passing of storage time (Fig. 1.34). It also elucidated that Ca content in control increased sharply from initial to 6th day and then, it increased smoothly and thereafter, it decreased due to becoming rotten. At the same time, Ca content from the fruits treated with low temperature in refrigerator increased very smoothly with the passing of time. At 9th day, the highest (24.40 mg/100 g) quantity of Ca was obtained from untreated fruits whereas; the lowest (14.50 mg/100 g) was obtained from the fruits treated with low temperature in refrigerator. These events might be possible due to delay ripening caused in lower transmission of Ca content from peel and stone to pulp of mango, but, these results are not supported by the findings of Peter *et al.* (2007).

The combined effect of varieties and imposed storage treatments in terms of Ca content of mango pulp showed non significant variation at different storage treatments (Appendix 1.11). There was found a light increasing trend of Ca content of mango pulp from various treatment combinations (Table 1.12). After 9th day, the maximum (25.27 mg/100 g) quantity of Ca was recorded from the treatment combination of V_2T_0 and the minimum (13.64 mg/100 g) was recorded from the treatment combination of V_1T_5.

7.4.4 Magnesium content

Significant variation was observed in mg content between the varieties at different days after storage (Appendix 1.12). It was noticed that Mg content increased gradually with the passing of storage period (Fig. 1.35). It also indicated that Mg content increased steadily from initial to 9th day, thereafter, it decreased slightly due to rotten situation. At 9th day, the highest (17.85 mg/100 g) was recorded in Langra and the lowest (16.66 mg/100 g) was recorded in Khirshapat. This occurrence might be possible due to genetical dissimilarities between two varieties. There were no available research articles relating to Mg content in the scientific literature.

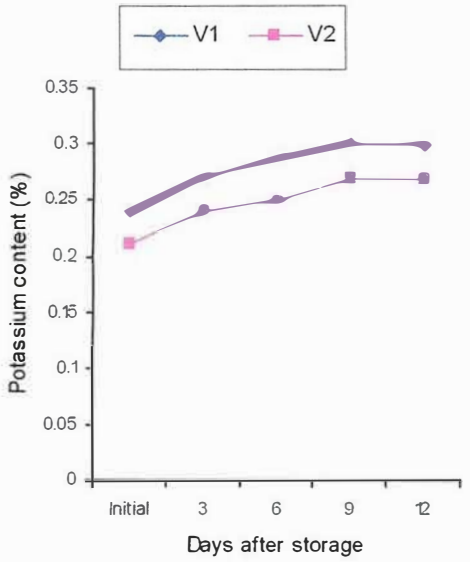


Fig. 1.31 Effect of varieties on potassium content of mango pulp at different days after storage

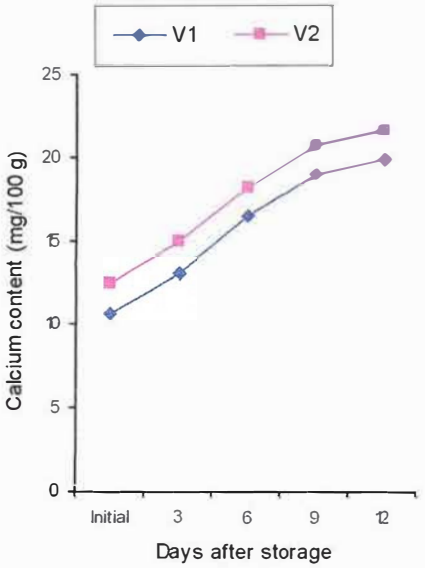


Fig. 1.32 Effect of varieties on calcium content of mango pulp at different days after storage

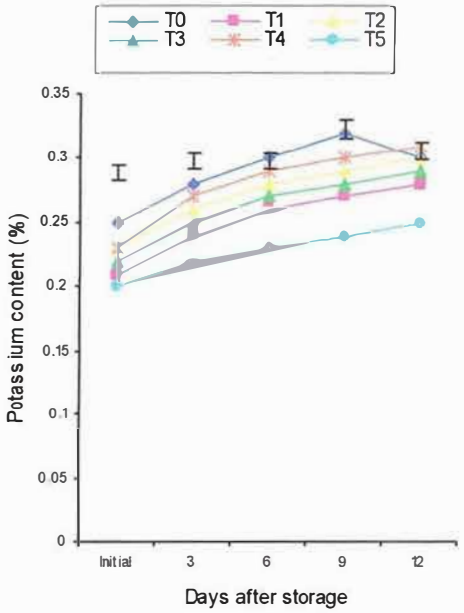


Fig. 1.33 Potassium content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

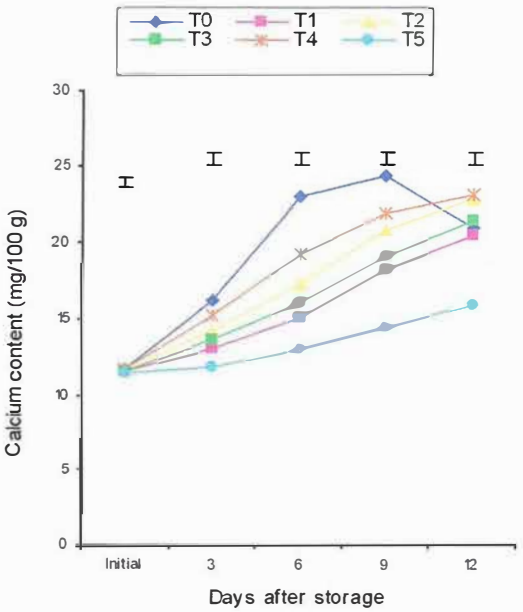


Fig. 1.34 Calcium content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

Figures represent

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2)^{0}C
T_5= Low temperature in refrigerator (4±1)^0 C

Table 1.12 Combined effects of varieties and different storage treatments on potassium and calcium content of postharvest mango

Treatments combination	Potassium content (%) at different days					Calcium content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6 D	9	12
V_1T_0	0.27 a	0.30 a	0.32 a	0.33 a	0.31 ab	10.75 d-f	15.32 c	22.12 b	23.52 b	20.13 h
V_1T_1	0.23 b-d	0.25 d-f	0.27 d-f	0.28 cd	0.29 bc	10.65 ef	12.16 i	14.28 j	17.39 i	19.62 i
V_1T_2	0.24 bc	0.28 a-c	0.30 a-c	0.31 ab	0.32 a	10.82 de	13.34 g	16.45 g	19.92 f	22.05 d
V_1T_3	0.22 cd	0.27 b-d	0.29 b-d	0.30 bc	0.31 ab	10.72 d-f	12.75 h	15.25 i	18.34 h	20.63 g
V_1T_4	0.25 b	0.29 ab	0.31 ab	0.32 ab	0.33 a	10.85 d	14.34 e	18.45 d	21.15 e	22.23 c
V_1T_5	0.22 cd	0.23 f-h	0.24 gh	0.25 ef	0.26 de	10.62 f	10.92 j	12.13 l	13.64 k	15.16 k
V_2T_0	0.23 cd	0.26 c-e	0.28 c-e	0.30 bc	0.28 cd	12.58 ab	17.14 a	23.86 a	25.27 a	21.78 e
V_2T_1	0.19 e	0.22 gh	0.24 gh	0.25 ef	0.26 de	12.45 a-c	13.95 f	16.07 h	19.18 g	21.29 f
V_2T_2	0.22 cd	0.24 e-g	0.26 e-g	0.27 de	0.28 cd	12.62 a	15.12 d	18.24 e	21.73 d	23.86 b
V_2T_3	0.21 d	0.23 f-h	0.25 fg	0.26 de	0.27 cd	12.42 bc	14.45 e	16.95 f	20.05 f	22.36 c
V_2T_4	0.21 d	0.25 d-f	0.27 d-f	0.28 cd	0.28 cd	12.53 a-c	16.08 b	20.18 c	22.87 c	24.11 a
V_2T_5	0.18 e	0.21 h	0.22 h	0.23 f	0.24 e	12.36 c	12.65 h	13.85 k	15.36 j	16.86 j
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	4.72	4.12	3.84	3.70	3.64	0.90	0.74	0.60	0.52	0.50

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2 ^{0} C
T_5= Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

Different storage treatments induced in this trial had highly significant variation on Mg content of mango pulp at different days after storage (Appendix 1.12). There was found an increasing trend of Mg content of mango pulp with the advancement of storage period (Fig. 1.37). It also showed that Mg content from untreated and hot water treated fruit augmented very markedly from initial to 6 days and from initial to 9 days respectively and then, it decreased very sharply. The highest (18.28, 18.15 and 17.93 mg/100 g) quantity of Mg content was obtained from control, hot water treatment and perforated polyethylene cover at 6, 9 and 12 days of storage whereas, the lowest (16.24, 16.55 and 16.94 mg/100 g) was obtained from fruit treated with low temperature in refrigerator, respectively. There might have a relation of augmentation of Mg content of mango pulp to ripening event. The results of the present experiment are inconformity with the findings of Peter *et al.* (2007).

Different varieties used and storage treatments imposed in this experiment in terms of Mg content of mango pulp exhibited significant variation at various days after storage except at 9 and 12th days (Appendix 1.12). There was found an increasing trend of Mg content of mango pulp with the passing of storage time (Table 1.13). At 6th day, the highest (18.92 mg/100 g) quantity of Mg was observed from the treatment combination V_1T_0 whereas; the lowest (15.53 mg/100 g) was recorded from the treatment combination of V_2T_5.

7.4.5 Copper content

Variation between varieties in relation to Cu content of mango pulp was highly significant at different days after storage (Appendix 1.12). It revealed that Cu content of mango pulp decreased gradually with the passing of storage period (Fig. 1.36). It also denoted that Cu content of Khirshapat was comparatively more as compared to Langra. At initial day higher (0.36 mg/100 g) amount was recorded from Khirshapat and lesser amount (0.33 mg/100 g) was recorded from Langra. At 12th day, Khirshapat gave the highest (0.20 mg/100 g) amount of Cu content and the lowest (0.18 mg/100 g) was obtained from Langra. These phenomena might be possible due to genetical dissimilarities between the varieties. There were no available research reports regarding Cu content of mango at the scientific literature,

but, the results of the present study revealed that Cu content diminished during storage.

The postharvest treatments used in the present study in relation to Cu content of mango pulp were observed to be highly significant at different days after storage (Appendix 1.12). It explored that Cu content decreased gradually with the advancement of storage period at various days of storage. The decreasing trend of untreated fruits was much higher than the treated fruits with T_4, T_2, T_3, T_1 and T_5. At 12th day, the highest quantity of Cu (0.26 mg/100 g) was recorded from the fruits treated with low temperature in refrigerator whereas; the lowest (0.14 mg/100 g) was recorded from control (Fig. 1.38). This means low temperature in refrigerator was much better treatment followed by the others. Its preservative quality was also found to be the best.

The combined effect of used varieties and imposed storage treatments in terms of Cu content of mango exhibited non significant variation at various days after storage except at initial day (Appendix 1.12). It indicated that Cu content from different treatment combination decreased with the advancement of storage duration. At 12th day, the highest (0.27 mg/100 g) was obtained from the treatment combination of V_2T_5, and the lowest (0.13 mg/100 g) was obtained from the treatment combination of V_1T_0 (Table 1.13).

7.4.6 Iron content

The analysis of variance of varieties on iron (Fe) content of mango pulp showed highly significant at different days after storage (Appendix 1.13). There was found an increasing trend of Fe content with the passing of storage duration. The increasing trend was more or less similar from initial to 9th day and thereafter, it increased very smoothly. At 12th day, the highest (4.24 mg/100 g) quantity was noticed from Langra and the lowest (3.18 mg/100 g) was noticed from Khirshapat (Fig. 1.39). These results are in partially supported by the findings of Nadkarni (1963), when he worked with different varieties of mango fruits.

There was found significant variation due to the effect of storage treatments on Fe content of mango pulp at various days after storage (Appendix 1.13).

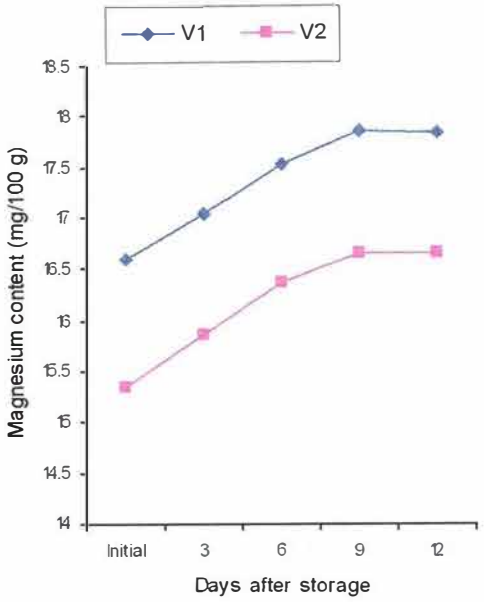


Fig. 1.35 Effect of varieties on magnesium content of mango pulp at different days after storage

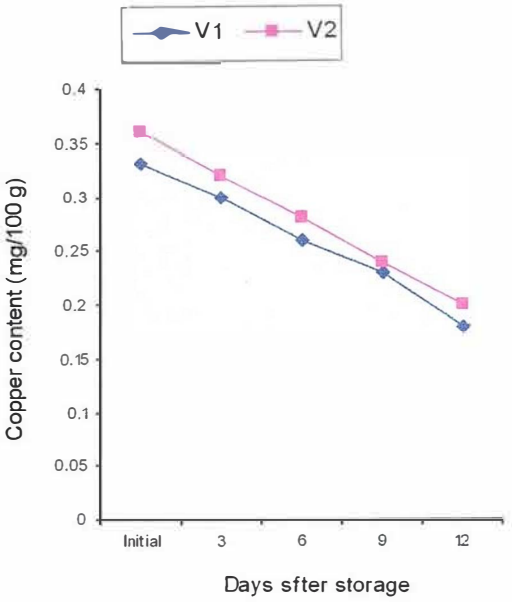


Fig. 1.36 Effect of varieties on copper content of mango pulp at different days after storage

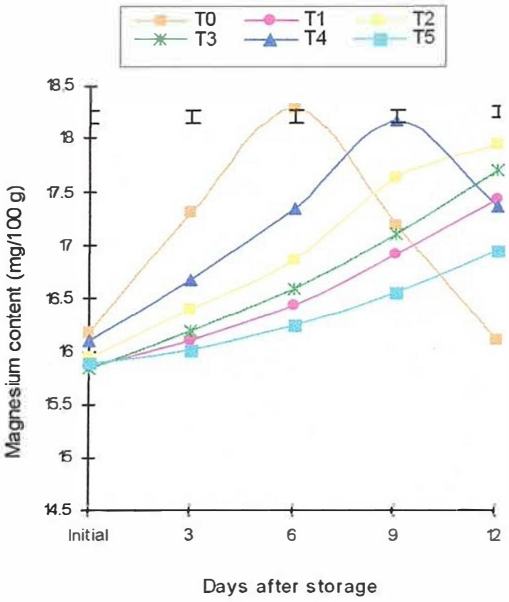


Fig. 1.37 Magnesium content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

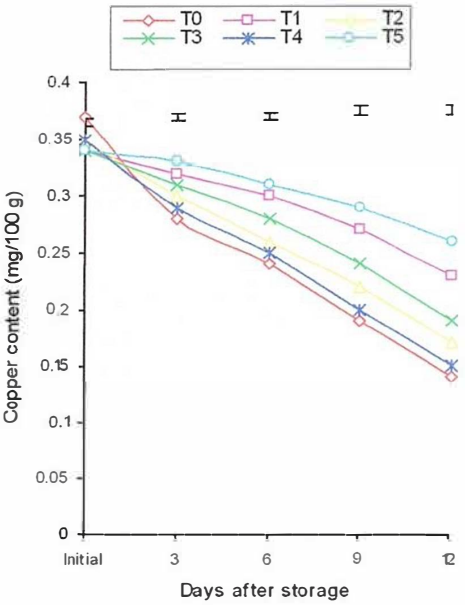


Fig. 1.38 Copper content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

Figures represent

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2)^0 C
T_5= Low temperature in refrigerator (4±1)^0 C

Table 1.13 Combined effects of varieties and different storage treatments on magnesium and copper content of postharvest mango

Treatments combination	Magnesium content (mg/100 g) at different days					Copper content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1T_0	16.85 a	17.95 a	18.92 a	17.82 c	16.72 h	0.35 b-d	0.27 f	0.23 f	0.18 h	0.13 h
V_1T_1	16.35 e	16.62 d	16.95 f	17.43 e	17.94 c	0.32 e	0.31 b-d	0.29 bc	0.26 bc	0.22 bc
V_1T_2	16.45 de	16.88 c	17.35 d	18.21 b	18.52 a	0.33 de	0.29 d-f	0.25 d-f	0.21 e-g	0.16 e-f
V_1T_3	16.55 cd	16.75 cd	17.14 e	17.65 cd	18.24 b	0.32 e	0.30 c-e	0.27 cd	0.23 de	0.18 de
V_1T_4	16.75 ab	17.25 b	17.92 b	18.73 a	17.94 c	0.34 c-e	0.28 ef	0.24 ef	0.19 gh	0.14 gh
V_1T_5	16.65 bc	16.72 cd	16.94 f	17.25 f	17.65 d	0.33 de	0.32a-c	0.30 ab	0.28 ab	0.24 b
V_2T_0	15.52 f	16.64 d	17.65 c	16.55 h	15.49 j	0.38 a	0.29 d-f	0.25 d-f	0.20 f-h	0.14 gh
V_2T_1	15.36 f	15.58 g	15.92 i	16.39 h	16.92 g	0.36 bc	0.33 ab	0.31 ab	0.28 ab	0.24 b
V_2T_2	15.45 f	15.89 f	16.38 h	17.03 g	17.34 e	0.37 ab	0.31 b-d	0.27 cd	0.22 ef	0.17 ef
V_2T_3	15.15 g	15.65 g	16.04 i	16.55 h	17.15 f	0.35 b-d	0.32 a-c	0.29 bc	0.25 cd	0.20 cd
V_2T_4	15.45 f	1 6.08e	16.75 g	17.58 de	16.79 gh	0.36 a-c	0.30 c-e	0.26 de	0.21 e-g	0.15 f-h
V_2T_5	15.15 g	15.32 h	15.53 j	15.84 i	16.23 i	0.35 b-d	0.34 a	0.32 a	0.30 a	0.27 a
Level of significance	***	*	*	NS	NS	NS	NS	NS	NS	NS
CV%	0.65	0.63	0.61	0.60	0.63	3.00	3.41	3.18	4.44	5.58

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2 ^{0} C
T_5= Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

It denoted that Fe content increased very sharply from initial to 6 days and then, it decreased markedly at control. But, Fe content of fruit from the other treatments such as T_1, T_2, T_3, T_4 and T_5 increased gradually whereas, T_5 treatment showed least increasing tendency at all storage duration (Fig. 1.41). At 12th day, the highest (4.71 mg/100 g) quantity of Fe was noticed from the fruits treated with hot water treatment whereas; the lowest (2.28 mg/100 g) was noticed from the untreated mangoes. The low increasing trend of the fruits treated with low temperature in refrigerator was possibly due to the delay ripening which resulted in lower increasing trend. These results are in partially agreement with the findings of Peter *et al.* (2007).

There was non significant variation in respect of Fe content of mango pulp at different days after storage as influenced by the treatment combination of varieties and implied storage treatments (Appendix 1.13). An increasing trend of Fe content was also noticed from initial to 6 days thereafter, it decreased rapidly with the treatment combination of V_1T_0 whereas; the lowest increasing trend was observed with the treatment combination of V_2T_5 (Table 1.14). At 6th day, the highest (5.24 mg/100 g) quantity of Fe was reported from the treatment combination of V_1T_0 and the lowest (1.48 mg/100 g) was reported from the treatment combination of V_2T_5 (Table 1.14).

7.4.7 Manganese content

The manganese (Mn) content of mango pulp was observed to differ significantly in both the varieties at different days after storage (Appendix 1.13). It was found that Mn content increased gradually with the increase of storage period (Fig. 1.40). It also revealed that Langra was better in the performance of Mn accumulation as compared to Khirshapat. At 12th day, the highest (1.21 mg/100 g) quantity of Mn was recorded from Langra whereas; the lowest (1.06 mg/ 100 g) was recorded from Khirshapat. There were no available research reports relating to Mn content in the scientific literature.

Different storage treatments had also highly significant effect on Mn content of mango pulp at different days after storage (Appendix 1.13). It was found that Mn content increased gradually from initial to 6 days, and then, it decreased markedly in control. On the other hand, it increased from initial to 6 days thereafter, it decreased

in control. At the same time, very lower increasing trend of Mn was noticed from the fruit treated with low temperature in refrigerator (Fig. 1.42). At 12th day, Mn content ranged from 0.89 to 1.31 mg per 100 g of fresh pulp of mango. The maximum (1.31 mg/100 g) was recorded from perforated polyethylene cover treated fruits which was statistical identical with the fruits treated with unperforated polythene cover. The minimum (0.89 mg/100 g) was found from untreated fruits.

The combined effects of varieties and used different storage treatments in terms of Mn content of mango pulp were found to be significant at various days after storage except at 6, 9 and 12th days (Appendix 1.13). There was found an increasing trend of Mn content in different treatment combination with the increase of storage duration (Table 1.14). At 12th day, the highest (1.38 mg/100 g) was reported from the treatment combination of V_1T_2, and the lowest (0.92 mg/100 g) was obtained from the treatment combination of V_2T_5.

7.4.8 Zinc content

Variation in respects of zinc (Zn) content of mango pulp due to the effect of varieties showed highly significant at different days after storage (Appendix 1.14). It was observed that Zn content decreased markedly with the increasing of storage duration from both the varieties (Fig. 1.43). It also revealed that Khirshapat noticed the signal of better performance in achieving comparatively more Zn content over Langra. Zn content ranged between 1.31 to 1.49 mg per 100 g of mango pulp at initial day and 0.79 to 0.97 mg per 100 g at 12th day. The highest (1.49 and 1.31 mg/100 g) was recorded in Khirshapat and the lowest (0.97 and 0.79 mg/100 g) was recorded from Langra at initial and 12th days. These events might be possible due to genetical dissimilarities.

Different postharvest storage treatments caused significant differences in Zn content of mango pulp at different days after storage except at 3rd day (Appendix 1.14). There was found a decreasing trend of Zn content with the increase of storage period from the fruits treated with different storage treatment. It also explored that the decreasing trend was very high in control and very low in the fruits treated with low temperature in refrigerator (Fig. 1.45). At 12th day, the maximum (1.06 mg/100 g) was noticed from the fruits treated with low temperature in refrigerator which was 1.38 mg per 100 g of fresh mango pulp at initial level and the lowest (0.61 mg/100 g) was noticed from control which was 1.45 mg per 100 g of mango pulp at initial

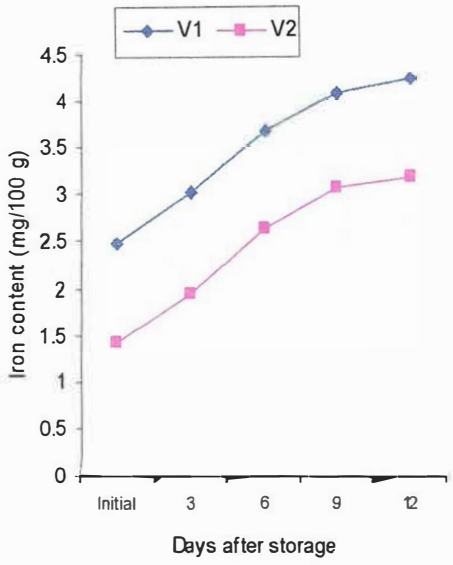


Fig. 1.39 Effect of varieties on iron content of mango pulp at different days after storage

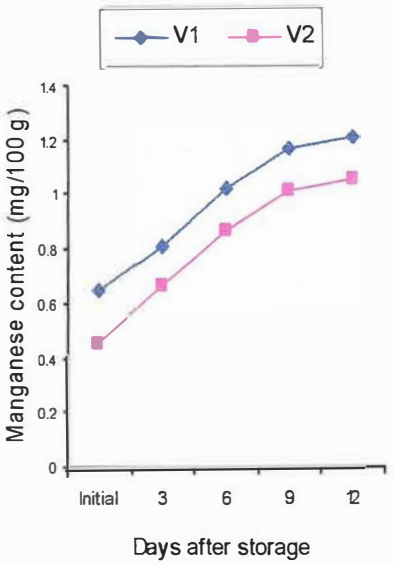


Fig. 1.40 Effect of varieties on manganese content of mango pulp at different days after storage

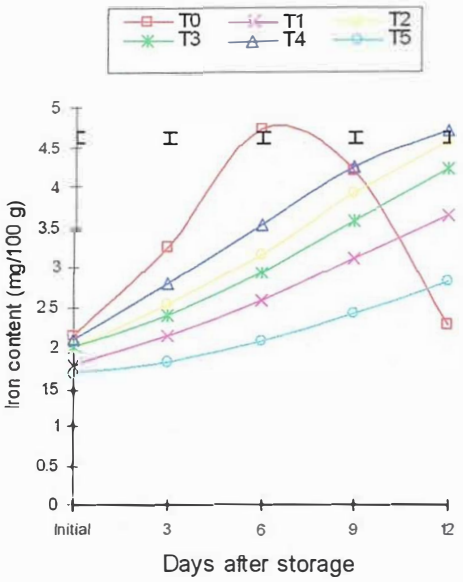


Fig. 1.41 Iron content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

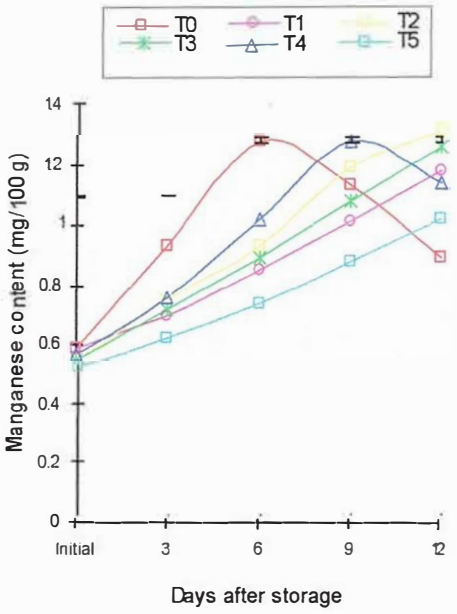


Fig. 1.42 Manganese content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

Figures represent

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2)^{0}C
T_5= Low temperature in refrigerator (4±1)^0 C

Table 1.14 Combined effects of varieties and different storage treatments on iron and manganese content of postharvest mango

Treatments combination	Iron content (mg/100 g) at different days					Manganese content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1T_0	2.65 a	3.74 a	5.24 a	4.69 a	2.74 g	0.68 a	1.02 a	1.37 a	1.22 bc	0.98 f
V_1T_1	2.35 bc	2.68 e	3.11 f	3.66 d	4.18 c	0.66 bc	0.77 d	0.92 ef	1.08 d-f	1.25 bc
V_1T_2	2.55 a	3.08 c	3.72 d	4.48 b	5.12 a	0.64 d	0.82 b	1.03 cd	1.25 ab	1.38 a
V_1T_3	2.49 ab	2.92 cd	3.44 e	4.09 c	4.72 b	0.65 cd	0.79 c	0.96 de	1.14 cd	1.32 ab
V_1T_4	2.59 a	3.32 b	3.94 c	4.66 a	5.25 a	0.67 ab	0.82 b	1.08 c	1.33 a	1.19 cd
V_1T_5	2.25 c	2.38 f	2.63 g	2.98 f	3.42 e	0.62 e	0.72 e	0.84 fg	0.98 fg	1.12 de
V_2T_0	1.65 d	2.75 de	4.25 b	3.72 d	1.82 i	0.49 g	0.83 b	1.18 b	1.03 e-g	0.79 g
V_2T_1	1.25 f	1.58 h	2.02 i	2.57 g	3.09 f	0.52 f	0.63 h	0.78 g	0.94 g	1.11 de
V_2T_2	1.45 e	1.97 g	2.62 g	3.38 e	4.02 c	0.45 hi	0.68 f	0.82 fg	1.12 c-e	1.24 bc
V_2T_3	1.52 de	1.88 g	2.42 h	3.07 f	3.74 d	0.44 i	0.65 g	0.82 fg	1.01 fg	1.19 cd
V_2T_4	1.59 de	2.28 f	3.12 f	3.84 d	4.16 c	0.46 h	0.69 f	0.95 de	1.22 bc	1.08 e
V_2T_5	1.12 f	1.26 i	1.48 j	1.83 h	2.22 h	0.42 j	0.52 i	0.64 h	0.77 h	0.92 f
Level of significance	NS	NS	NS	NS	NS	***	***	NS	NS	NS
CV%	5.32	4.19	3.26	2.91	2.81	1.86	1.55	5.72	4.77	4.60

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2 ^{0} C
T_5= Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

day. Zn content decreased in the storage period was possibly due to transmission from pulp to stone and metabolic activities of stored mango may be depressed or suppressed to the presence of Zn content. There was no available research articles regarding Zn content of mango pulp in the scientific literature, but, the present results elucidated that Zn content decreased with the advancement of storage duration.

The combined effect of varieties and imposed storage treatments in terms of Zn content of mango demonstrated non significant variation at different days after storage (Appendix 1.14). There was also found the decreasing trend of Zn content of mango pulp from various treatment combinations (Table 1.15).

7.5 Shelf life

Highly significant difference was found from varieties on shelf life of mango (Appendix 1.14). The results revealed that shelf life ranged between 15.22 to 16.44 days (Fig. 1.44). Longer shelf life (16.44 days) was obtained in Khirshapat and the slightly shorter (15.22 days) was obtained in Langra (Fig. 1.44). Variation in shelf life between varieties might be possible due to genetical. These results indicated that Khirshapat was better in preservation of mango.

Difference between imposed storage treatments in this experiment in terms of shelf life of mango exhibited highly significant (Appendix 1.14). The shelf life of mango ranged between 7.83 to 36.50 days in different storage treatments (Fig. 1.46). The longest shelf life (36.50 days) was recorded from the fruits treated with low temperature in refrigerator followed by the shelf life of the fruits treated with paraffin coating (14.17 days), hot water treatment (12.00 days), perforated polyethylene cover (11.00 days) whereas the shortest shelf life (7.17 days) was recorded from untreated fruit (Fig. 1.46). The longest shelf life obtained from the fruits treated with low temperature in refrigerator might be possible due to suppression or inhibition of physiological and biochemical activities in responding for slower senescence of harvested fruits and consequently led to the longest shelf life, but, mangoes were found deeply shrinkage condition. The results are inconformity with the findings of Tefera *et al.* (2007), Durigan *et al.* (2004) also found the similar results. Wanlapha *et al.* (1980) observed the longest shelf life of mango where they worked with mango under preservation at low temperature in refrigerator.

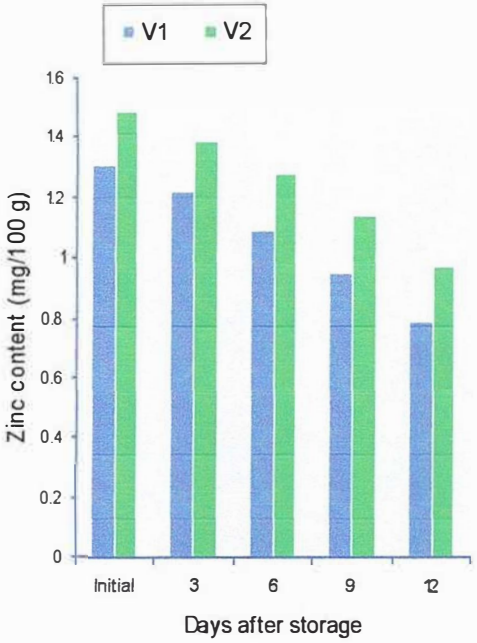


Fig.1.43 Effect of varieties on zinc content of mango pulp at different days after storage

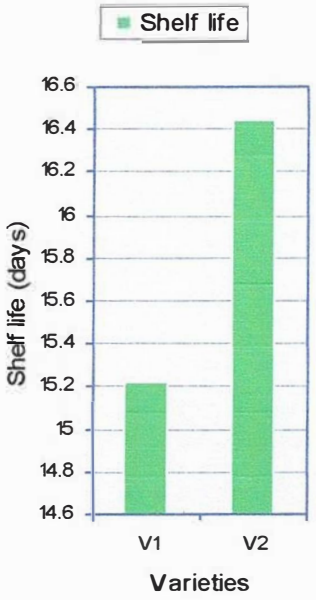


Fig. 1.44 Effect of varieties on shelf life of mango

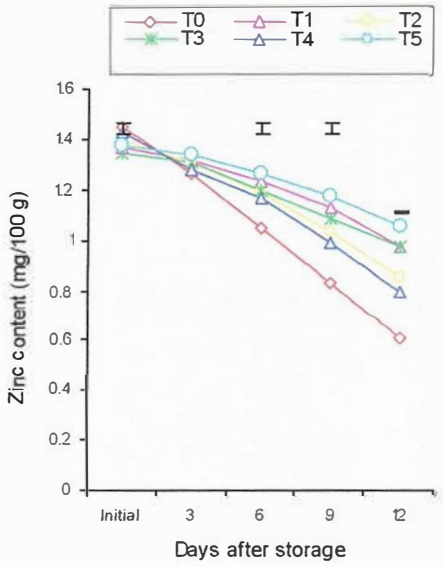


Fig. 1.45 Zinc content of mango pulp as influenced by storage treatments at different days after storage. Vertical bars represent LSD at 0.05 level

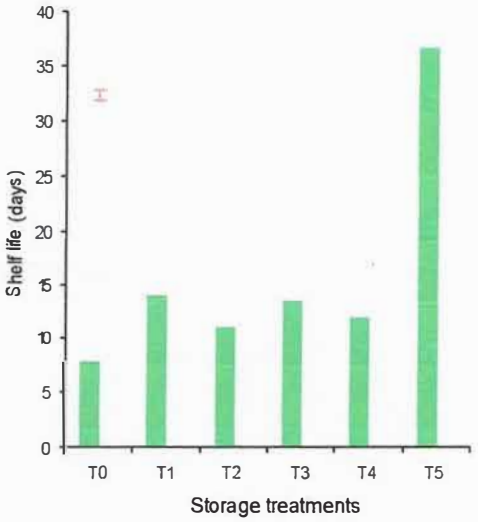


Fig. 1.46 Shelf life of mango as influenced by storage treatments. Vertical bars represent LSD at 0.05 level

Figures represent

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2)^{0}C
T_5= Low temperature in refrigerator (4±1)^0 C

The combined effect of varieties and induced storage treatments on shelf life of mango was found to be highly significant (Appendix 1.14). The shelf life ranged between 7.33 to 38.00 days from various treatment combinations. The longest shelf life (38.00 days) was noticed from the treatment combination of V_2T_5, whereas the shortest (7.33 days) was noticed from V_1T_0 (table 1.15), but, mangos treated with low temperature in refrigerator were noticed deeply shrinkage condition.

Table 1.15 Combined effects of varieties and different storage treatments on zinc content and shelf life of postharvest mango

Treatments combination	Zinc content (mg/100 g) at different days					Shelf life
Varieties × Treatments	Initial	3	6	9	12	Total days
V_1T_0	1.35 cd	1.19 b	0.97 e	0.75 i	0.52 j	7.33 f
V_1T_1	1.28 d	1.21 b	1.14 cd	1.04 d-f	0.88 g	13.67 cd
V_1T_2	1.32 d	1.23 b	1.11 cd	0.96 fg	0.78 h	10.67 e
V_1T_3	1.27 d	1.22 b	1.12 cd	1.01 e-g	0.91 f	13.33 d
V_1T_4	1.33 d	1.20 b	1.04 de	0.86 h	0.67 i	11.33 e
V_1T_5	1.28 d	1.25 b	1.18 bc	1.09 c-e	0.98 d	35.00 b
V_2T_0	1.55 a	1.35 a	1.13 cd	0.92 gh	0.69 i	8.33 f
V_2T_1	1.45 ab	1.42 a	1.34 a	1.22 ab	1.08 b	14.67 c
V_2T_2	1.48 ab	1.38 a	1.26 ab	1.12 b-d	0.94 e	11.33 e
V_2T_3	1.43 bc	1.39 a	1.28 a	1.17 a-c	1.04 c	13.67 cd
V_2T_4	1.52 ab	1.36 a	1.30 a	1.12 cd	0.92 ef	12.67 d
V_2T_5	1.48 ab	1.43 a	1.36 a	1.26 a	1.14 a	38.00 a
Level of significance	NS	NS	NS	NS	**	*
CV%	3.73	4.00	4.39	4.99	2.37	4.36

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
T_0 =Control
T_1=Paraffin coating
T_2=Perforated polyethylene cover
T_3=Unperforated polyethylene cover
T_4=Hot water treatments (55±2 ^{0} C
T_5= Low temperature in Refrigerator (4±1)^0 C
* indicates at 5% level
** indicate at 1% level
***indicates at 0.1%
NS non significant

8.0 Experiment 2

Influence of different doses of Maleic hydrazide on physicochemical changes and shelf life of mango during storage

8.1 Changes in skin color

External features, especially peel color is the most distinct change that occurs in many fruits and is frequent the major criterion followed by the consumers to identify whether the fruit is ripe or unripe. The most common change in case of mango is the loss of green color (Wills *et al.* 1989).

Different doses of Maleic hydrazide (MH) solution strongly affected the skin color of both the fruits namely, Langra and Khirshapat (Table 2.1). Both the varieties showed the original green color at the initial stage of harvesting. At 3rd day, Langra turned in to a light green color at all doses except M_3 treatment, but Khirshapat retained its original green color.

At 6th day, Langra was noticed to be yellowish green at control (M_0), 200 ppm (M_1) and 400 ppm (M_2) treatment and it held its original green color at 600 ppm (M_3) of MH solution. On the other hand, Khirshapat developed a trace in yellow color at M_0, but it retained its original green color at M_1, M_2 and M_3 treatments.

At 9th day, Langra gave yellow color at control, yellowish green at M_1 and M_2 as well as light green at M_3 treatment, respectively. Khirshapat demonstrated greenish yellow at control treatment, trace in yellow at M_1 and M_2 treatments. But, it also retained its original green color at M_3 treatment.

At 12th day of storage, Langra was reported as blackish yellow at control and yellow, greenish yellow and trace in yellow at M_1, M_2 and M_3 treatments, respectively. On the other hand, Khirshapat was also noticed as deep yellow color at M_0, greenish yellow, yellowish green and trace in yellow at M_1, M_2 and M_3 treatments. After 15 days of storage, Langra exhibited no existence at control, blackish yellow, yellow and greenish yellow at M_1, M_2 and M_3 treatments, respectively. Khirshapat showed completely rotten condition at M_0 but showed yellow, greenish yellow and yellowish green at M_1, M_2 and M_3 treatments, respectively.

8.2 Changes in physical characters during storage environments

Different parameters relating to the physical changes of mango are presented and elucidated in the following sub-headings.

8.2.1 Physiological weight loss

Varieties showed highly significant in terms of PWL at different days after storage (Appendix 2.1). At each day, Khirshapat gradually showed comparatively more PWL as compared to Langra with the passing of storage duration (Fig. 2.1). The maximum (10.67%) and the minimum (9.78%) PWL were observed from Khirshapat and Langra at 12th day, respectively. The results also revealed that total PWL progressively increased with the increase of storage duration. The findings also indicated that Langra showed better performance in respect of PWL as compared to Khirshapat. Water loss through lenticel seems to be the probable cause of physiological weight loss in the fruits during storage. Lower lenticel density in Langra facilitated lesser water loss leading to minimum total weight loss (Azad, 2001). Singh *et al.* (2000) also reported more or less the identical findings.

Variation of the means as influenced by different doses of Maleic hydrazide (MH) showed highly significant on PWL (Appendix 2.1). At different days after storage, it revealed that the untreated fruit was very fast in PWL compared to M_1, M_2 and M_3 treatments. It also denoted that untreated fruit showed in PWL sharply as compared to M_3 treatment (Fig. 2.3). At 12th day, the maximum PWL (11.65%) was recorded M_0 and minimum (9.19%) in M_3 treatment. These phenomena happened seems to be inhibited by 600 ppm of MH solution retarded the fruit ripening. These results are in partial coincided with the findings of Reddy and Haripriya (2002).

The combined effect of varieties and different doses of MH showed highly statistical significant on PWL at different days after storage (Appendix 2.1). At different days, it revealed that various treatment combinations showed in PWL gradually with the increase of storage duration. At 12th day, there exhibited the maximum PWL (12.00%) at V_2M_0 and the minimum (8.75%) at V_1M_3 treatment combination. It also explored that Langra lost the minimum amount of water with 600 ppm (M_3) treatment followed by the other treatment combinations.

8.2.2 Moisture content

The analysis of variance of imposed varieties showed highly significant on moisture content at different days (Appendix 2.1). At different days after storage, the results denoted that moisture content increased with the passing of storage duration (Fig. 2.2). The increasing trend was more or less similar from initial to 9 days and thereafter, the decrease in increasing tendency might be due to rotten. Figure 2.2 also revealed that on all the experimental days, Khirshapat showed more moisture comparing to Langra. Higher (88.63%) and the minimum (85.86%) were obtained from V_2 and V_1 at 12^{th} day. Shajahan *et al.,* (1994) observed different results in this regard and the moisture content increased in Langra than Khirsapat. But, these results are in agreement with the findings of Azad (2001). This variation might be possible due to genetical, location, weather effect, soil quality or maturity of the fruit.

Variation among the means of different doses of MH solution on moisture content was observed to be highly significant at different days after storage except at initial day (Appendix 2.1). At different day, moisture content was increased gradually with the extension of storage duration (Fig. 2.4). Untreated fruit produced the highest moisture content (87.88%) at 9^{th} day and thereafter; it decreased, whereas the lowest (85.82%) was recorded from M_3 treatment.

The combined effect of varieties and different doses of MH solution in terms of moisture content exhibited significant variation at different days (Appendix 2.1). At different days, moisture content increased with the passing of storage period. The treatment combination of V_2M_0, V_2M_1 and V_2T_2 produced the maximum moisture content (*viz.,* 89.10, 89.25 and 89.70%) at 6, 9 and 12 days, respectively. In these storage periods, the lowest values (83.60, 84.40 and 85.20%) were observed from the treatment combination of V_1M_3 (Table 2.2). These treatment combinations provided slightly lesser amount of moisture content from 6 and 9^{th} days. The increase of moisture content from initial to consequent days might be possible due to metabolic activities and osmotic principles and decreasing in a certain day might be due to suspending metabolic activities resulting in drying, transpiration and evaporation. Moisture content increased in the present study is in partial agreement with the findings of El-Mahmoudi and Eisawi (1968) in banana.

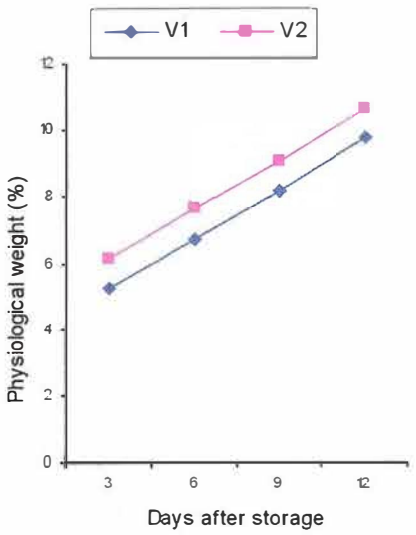


Fig. 2.1 Effect of varieties on physiological weight loss of mango at different days after storage

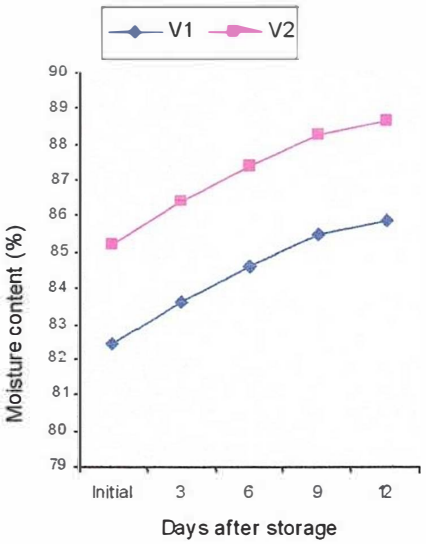


Fig. 2.2 Effect of varieties on moisture content of mango pulp at different days after storage

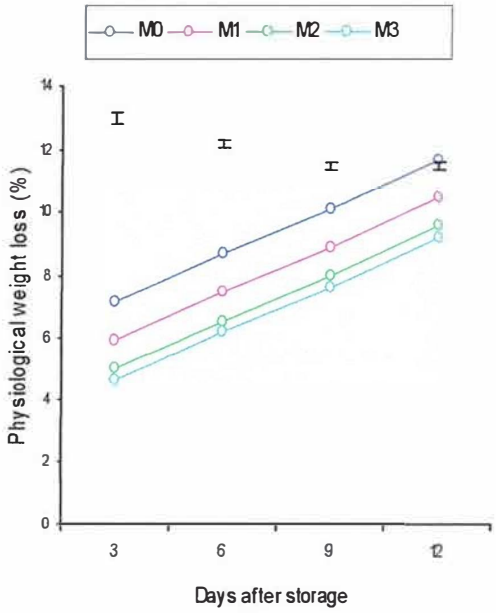


Fig. 2.3 Physiological weight loss of mango as influenced by different doses of Maleic hydrazide (MH) solution at different days after storage. Vertical bars represent LSD at 0.05 level

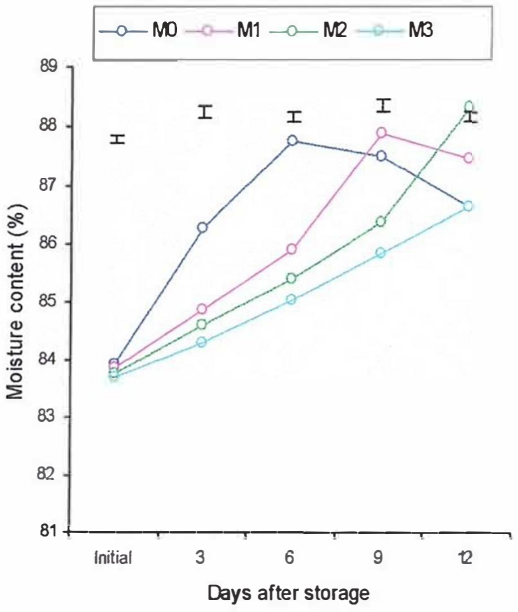


Fig. 2.4 Moisture content of mango pulp as influenced by different doses of Maleic hydrazide (MH) solution at different days after storage. Vertical bars represent LSD at 0.05 level

Graph represents

V_1 = Langra	M_1=200 ppm of MH solution
V_2 = Khirshapat	M_2=400 ppm of MH solution
M_0 = Control	M_3 =600 ppm of MH solution

Table 2.1 Changes in skin color of two mango varieties as influenced by different doses of Maleic hydrazide solution during storage at ambient condition

Varieties	Treatments	Days after storage					
		Initial	3	6	9	12	15
V_1	M_0	Green	Light green	Yellowish green	Yellow	Blackish yellow	_
	M_1	Green	Light green	Yellowish green	Yellowish green	Yellow	Blackish yellow
	M_2	Green	Light green	Yellowish green	Yellowish green	Greenish yellow	Yellow
	M_3	Green	Green	Green	Light green	Trace in yellow	Greenish yellow
V_2	M_0	Green	Green	Trace in yellow	Greenish yellow	Deep yellow	_
	M_1	Green	Green	Green	Trace in yellow	Greenish yellow	Yellow
	M_2	Green	Green	Green	Trace in yellow	Yellowish green	Greenish yellow
	M_3	Green	Green	Green	Green	Trace in yellow	Yellowish green

Table 2.2 Combined effects of varieties and different doses of Maleic hydrazide solution on physiological weight loss of mango and moisture content of mango pulp during storage at ambient condition

Treatments combination	Physiological weight loss (%) at different days				Moisture content (%) at different days				
Varieties × Treatments	3	6	9	12	Initial	3	6	9	12
V_1M_0	6.80 b	8.30 b	9.70 b	11.30 b	82.60 b	84.90 d	86.40 d	86.12 e	85.26 f
V_1M_1	5.50 d	7.00 d	8.40 e	10.00 e	82.50 b	83.50 e	84.50 e	86.50 e	86.08 e
V_1M_2	4.50 f	6.00 f	7.45 g	9.05 g	82.40 b	83.20 ef	84.00 f	84.90 f	86.90 d
V_1M_3	4.25 g	5.75 g	7.15 h	8.75 h	82.30 b	82.90 f	83.60 g	84.40 g	85.20 f
V_2M_0	7.50 a	9.00 a	10.40 a	12.00 a	85.30 a	87.60 a	89.10 a	88.82 b	87.96 c
V_2M_1	6.45 c	7.95 c	9.35 c	10.95 c	85.23 a	86.25 b	87.25 b	89.25 a	88.82 b
V_2M_2	5.60 d	7.00 d	8.50 d	10.10 d	85.17 a	86.00 bc	86.80 c	87.80 c	89.70 a
V_2M_3	5.12 e	6.62 e	8.02 f	9.62 f	85.10 a	85.75 c	86.45 cd	87.25 d	88.05 c
Level of significance	*	*	***	***	NS	NS	NS	NS	NS
CV%	1.57	0.99	0.61	0.56	0.38	0.25	0.24	0.26	0.23

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
M_0 =Control
M_1=200 ppm of MH solution
M_2=400 ppm of MH solution
M_3=600 ppm of MH solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

8.2.3 Dry matter content

The variation in varieties means in respect of dry matter content demonstrated highly significant at different days (Appendix 2.2). At different days, dry matter decreased gradually with the advancement of storage duration (Fig. 2.5). The results indicated that Langra produced comparatively more dry matter comparing to Khirshapat. At initial day, Langra gave higher (17.55%) dry matter whereas; Khirshapat produced lesser (14.78%) and at 12^{th} day, Langra contributed the highest (14.13%) whereas, Khirshapat gave the highest (11.37%). These results are in partially supported by the findings of Hossain (1991).

Different doses of MH imposed in this study on dry matter content of mango had highly significant at different days after storage (Appendix 2.2). At different days of storage, dry matter content decreased gradually with the passing of storage duration (Fig. 2.7). It also noticed that M_3 treatment gave the highest dry matter (14.98%) at 6^{th} day whereas; the lowest dry matter (12.25%) was recorded from control.

The combined effect of varieties and different doses of MH solution on dry matter content of mango showed non significant at different days after storage (Appendix 2.2). At different days, dry matter content decreased gradually up to 9^{th} day and then, it increased slightly from control at 12^{th} day. At initial day, the highest dry matter content (17.70%) was noticed from the treatment combination of V_1M_3 which was statistically identical with the combination of V_1M_2 whereas; the lowest (14.70%) was recorded from the combination of V_2M_0 which was also statistically similar with the combination of V_2M_1, V_2M_2 and V_2M_3. At 12^{th} day, the highest value (14.80%) was reported from the treatment combination of V_1M_3 and the lowest value (10.30%) was recorded from V_2M_2 (Table 2.3). The decrease in dry matter with the increasing storage period might be possible due to breaking down the complex carbohydrates into simple molecules and H_2O as well as adding water through osmotic process and metabolic activities. The decreasing of dry matter content of mango pulp was not supported by the findings of Hossain (1999).

8.2.4 Ash content

Variation in varieties means in respect of ash content of mango pulp demonstrated significant at different days after storage (Appendix 2.2). At different days, values of ash content reduced gradually with the passing of storage duration (Fig. 2.6). The results denoted that Langra gave comparatively more ash than Khirshapat at all days. Higher (0.98%) ash was achieved from Langra at initial day where Khirshapat achieved (0.85%) and again, the maximum achievement was 0.78% from Langra at 12th day whereas, the minimum achievement (0.65%) from Khirshapat.

Different doses of MH had non significant variation on ash content of mango at different days (Appendix 2.2). The results demonstrated from the figure 2.8 that ash content influenced by different doses of MH decreased slightly from M_3 and markedly from control.

The combined effect of varieties and different doses of MH were found non-significant variation in terms of ash content of mango at various days after storage (Appendix 2.2 and Table 2.3).There was no available research findings relating to ash content of mango. It also denoted that ash content was more related to dry matter content. The results of the present study revealed that ash content depended upon the quantity of dry matter achieved.

8.3 Changes in biochemical properties of mango during storage environments

Various changes regarding biochemical properties of mango pulp are presented and discussed under the following sub-headings.

8.3.1 Vitamin C content

Variation between varieties means in respect of vitamin C content of mango pulp was found to be highly statistically significant at different days after storage (Appendix 2.3). At various days, the results denoted that Langra showed better performance in accumulation of vitamin C as compared to Khirshapat (Fig. 2.9). It also revealed that quantity of vitamin C decreased with the increase of storage period. The decreasing trend was observed higher from initial to 6th days and thereafter, it was slightly slower. At the initial day, Langra gave the highest (132.13 mg/100 g) amount of vitamin C whereas; Khirshapat contributed the lowest amount

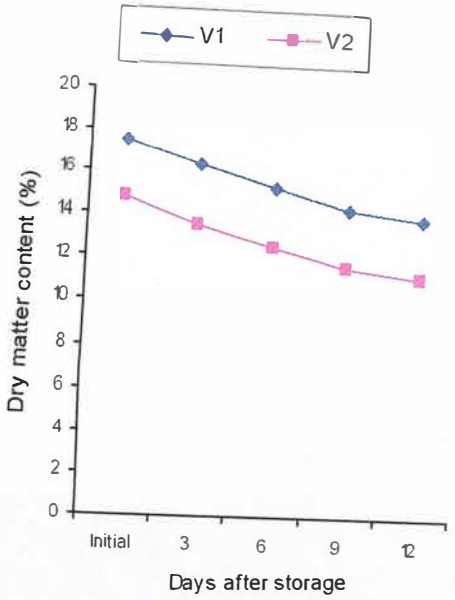


Fig. 2.5 Effect of varieties on dry matter content of mango pulp at different days after storage

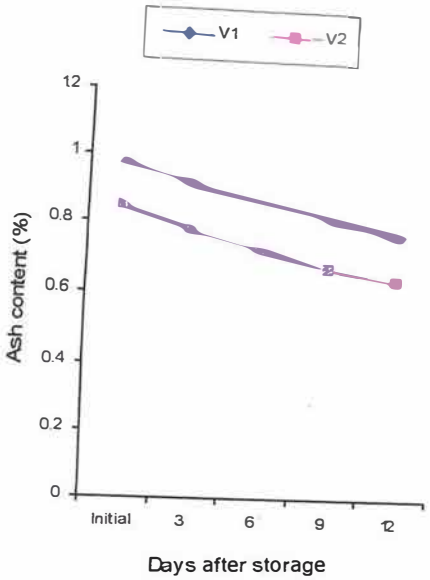


Fig. 2.6 Effect of varieties on ash content of mango pulp at different days after storage

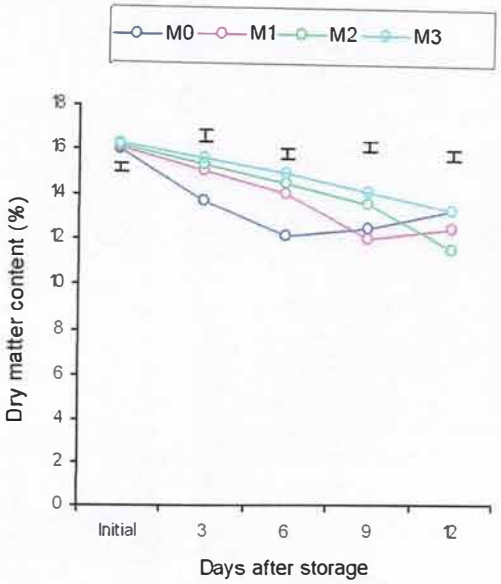


Fig. 2.7 Dry matter content of mango pulp as influenced by different doses of MH solution at different days after storage. Vertical bars represent LSD at 0.05 level

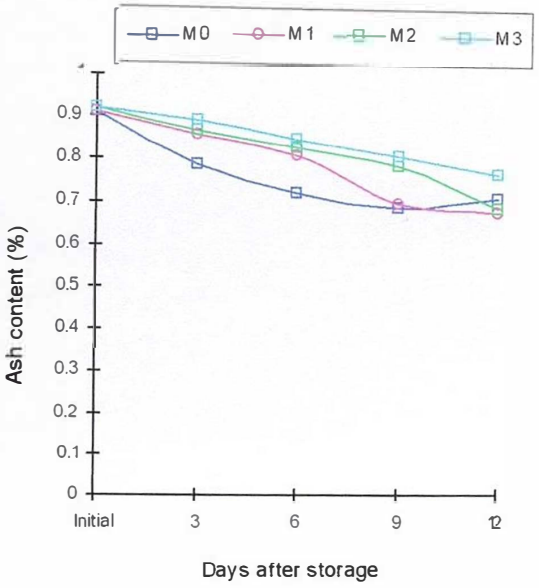


Fig. 2.8 Ash content of mango pulp as influenced by different doses of MH solution at different days after storage. Vertical bars represent LSD at 0.05 level

Graph represents

V_1 = Langra	M_1=200 ppm of MH solution
V_2 = Khirshapat	M_2=400 ppm of MH solution
M_0 = Control	M_3 =600 ppm of MH solution

(42.98 mg/100 g). At 12th day, Langra again exhibited higher (16.03 mg/100 g) amount of vitamin C and Khirshapat produced the lesser (8.55 mg/100 g) amount (Fig. 2.9). These results explored that vitamin C content gradually reduced with the increase of storage duration in both the varieties. It might be possible due to augmentation of ethylene synthesis resulting in oxidation of ascorbic acid. The results of the present study are in agreement with the findings of Azad (2001), Shyamalamma (1995), Gafur *et al.* (1994) and Absar et al. (1993).

Variation among the means of different doses of MH in terms of vitamin C content showed highly statistical significant at different days after storage (Appendix 2.3). At initial day, green mangoes treated with 600 ppm (M_3) gave the highest (89.35 mg/100 g) amount of vitamin C while, the lowest (85.56 mg/100 g) was recorded from M_1 treatment. After initial day, it decreased gradually with the passing of storage time (Fig. 2.10). It also indicated that decreasing trend was faster in control, and slower in M_3 treated fruit. At 12th day, vitamin C content ranged between 8.10 to 16.60 mg per 100 g of mango pulp was obtained from control and M_3 treated fruit, respectively. The decrease in vitamin C content in both treated and untreated mangoes at different storage period might be possible due to oxidation of ascorbic acid and M_3 dose was possibly causing delay ripening resulting in lower oxidation in vitamin C. These results are in supported by the findings of Hossain (1999). Gautam *et al.* (2003) also found the similar findings.

The combined effect of varieties and different doses of MH solution demonstrated significant variation in respect of vitamin C at different days after storage (Appendix 2.3 and Table 2.4). At various days during storage, the results were observed that vitamin C content decreased with the advancement of storage period. The quantity of vitamin C ranged between 40.92 to 133.60 mg per 100 g of fresh mango pulp at initial stage was noticed from the combination of V_2M_1 and V_1M_2 and in which V_1M_2 was statistically at par with V_1M_0 and V_1M_3. These quantities were reduced gradually after initial day. It denoted at 12th day that vitamin C content ranged between 4.30 to 20.40 mg per 100 g of fresh mango pulp was achieved from the treatment combination of V_2M_0 and V_1M_3 (Table 2.4).

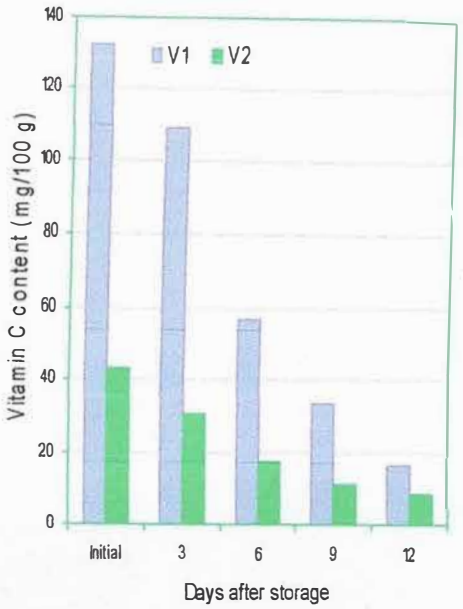


Fig. 2.9 Effect of varieties on vitamin C content of mango pulp at different days after storage

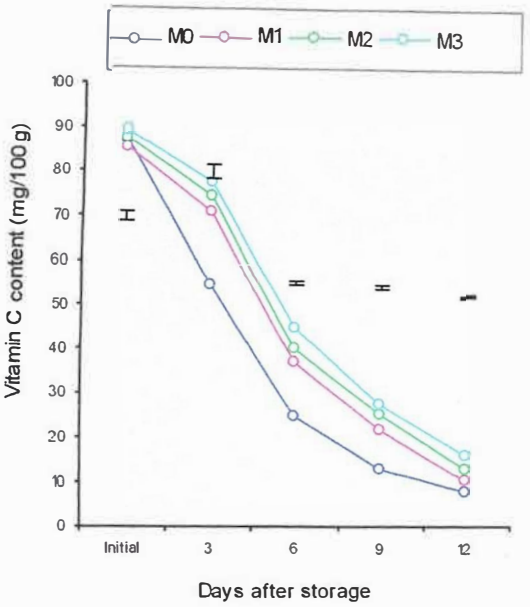


Fig. 2.10 Vitamin C content of mango pulp as influenced by different doses of MH solution at different days after storage. Vertical bars represent LSD at 0.05 level

Graph represents

V_1 = Langra	M_1=200 ppm of MH solution
V_2 = Khirshapat	M_2=400 ppm of MH solution
M_0 = Control	M_3 =600 ppm of MH solution

8.3.2 Titratable acidity

Variation between varieties means on titratable acidity was statistically highly significant at different days after storage (Appendix 2.4). At various days, Langra exhibited higher titratable acidity as compared to Khirshapat (Fig. 2.11). Titratable acidity decreased with the increase of storage period. The decreasing trend was very fast from initial to 3rd day and thereafter, its trend was slightly slower. At initial level the highest (3.79%) was noticed from Langra whereas the lowest (2.53%) was noticed from Khirshapat. At 12th day, the highest (0.33%) was recorded from Langra whereas Khirshapat gave the lowest amount (0.26%). The decreasing trend of titratable acidity at storage period was reported by Upadhyay and Tripathi (1988) and Leon and Lima (1968) and Medlicott *et al.* (1986) also found the similar results. According to them, acidity was reduced during storage growth on attainment of maturity and ripening. It also might be due to genetical dissimilarities between the varieties.

Table 2.3 Combined effects of varieties and different doses of Maleic hydrazide solution on dry matter and ash content of postharvest mango during storage at ambient condition

Treatments combination	Dry matter content (%) at different days					Ash content(%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1M_0	17.40 c	15.10 d	13.60 d	13.88 c	14.74 a	0.97	0.87 ab	0.78 ab	0.76 ab	0.77 ab
V_1M_1	17.50 bc	16.50 c	15.50 c	13.50 d	13.92 b	0.98	0.93 a	0.88 a	0.76 ab	0.75 ab
V_1M_2	17.60 ab	16.80 b	16.00 b	15.10 b	13.07 c	0.99	0.94 a	0.90 a	0.86 a	0.76 ab
V_1M_3	17.70 a	17.10 a	16.40 a	15.60 a	14.80 a	0.99	0.96 a	0.92 a	0.88 a	0.84 a
V_2M_0	14.70 d	12.40 g	10.90 g	11.18 g	12.04 d	0.84	0.72 b	0.65 b	0.62 b	0.65 ab
V_2M_1	14.75 d	13.75 f	12.75 f	10.75 h	11.18 e	0.84	0.79 ab	0.74 ab	0.63 b	0.61 b
V_2M_2	14.80 d	14.00 ef	13.20 e	12.20 f	10.30 f	0.85	0.80 ab	0.76 ab	0.71 ab	0.62 b
V_2M_3	14.85 d	14.25 e	13.55 d	12.75 e	11.95 d	0.85	0.82 ab	0.78 ab	0.74 ab	0.70 ab
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	0.65	1.01	0.90	1.06	0.99	11.61	12.01	12.59	13.79	13.89

Table 2.4 Combined effects of varieties and different doses of Maleic hydrazide solution on vitamin C content of postharvest mango during storage at ambient condition

Treatments combination	Vitamin C content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12
V_1M_0	132.50 a	85.53 d	38.20 d	19.30 d	11.90 e
V_1M_1	130.20 b	112.30 c	58.60 c	34.50 c	14.30 c
V_1M_2	133.60 a	116.60 b	63.20 b	39.20 b	17.50 b
V_1M_3	132.20 a	120.30 a	68.80 a	42.30 a	20.40 a
V_2M_0	42.30 d	24.35 h	12.55 h	7.80 h	4.30 h
V_2M_1	40.92 d	30.20 g	16.30 g	9.70 g	7.20 g
V_2M_2	42.20 d	32.55 f	18.40 f	12.50 f	9.90 f
V_2M_3	46.50 c	35.50 e	21.60 e	13.60 e	12.80 d
Level of significance	**	***	***	***	*
CV%	1.21	1.16	0.57	0.86	1.08

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
M_0 =Control
M_1=200 ppm of MH solution
M_2=400 ppm of MH solution
M_3 =600 ppm of MH solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Different doses of MH solution used in this investigation on titratable acidity showed significant variation among the means at various days after storage except initial day (Appendix 2.4). At various days, titratable acid content declined very sharply from initial to 3rd day and then, it declined steadily (Fig. 2.13). In all storage period, the higher titratable acidity (1.26, 0.96, 0.76, and 0.45%) was noted from M_3 treatment from initial to 12th day, followed by 0.70%, 0.43%, 0.24% and 0.12% in untreated mangoes, respectively (Fig. 2.13). These results are in partially supported by the findings of Tefera *et al.* (2007), but, these results are in agreement with the findings of Kumar *et al.* (1992).

The combined effect of varieties and different doses of MH in relation to titratable acidity of mango pulp were found to be non significant at different days after storage except 3rd day (Appendix 2.4 and Table 2.5). At different days, there was observed a decreasing trend of titratable acid content with the advancement of storage period (Table 2.5). At 3rd day, the highest (1.32%) concentration was recorded from the treatment combination of V_1M_3 which was statistically similar with the combination of V_1M_2, V_1M_1 and V_2M_3 and the lowest acid concentration (0.50%) was recorded from the treatment combination of V_2M_0 (Table 2.5). These occurrences might be possible due to retardation of acid oxidation at V_1M_3 treatment combination and showed genetical variation in between varieties.

8.3.3 Pulp pH

The analysis of variance in between the varieties demonstrated statistical highly significant on pulp pH of mango at different days after storage (Appendix 2.4). At various days, there exhibited an increasing trend of pulp pH with the passing of storage period (Fig. 2.12). In each storage period, pulp pH indicated more acedic quantity more from Khirshapat compared with Langra. The highest pulp pH (3.55) was noticed from green Khirshapat at initial day whereas; the lowest (3.47) was noticed from green Langra. At 12th day, the highest pH (6.20) was obtained from Khirshapat and the lowest value (6.10) was obtained from Langra. Increasing trend of pulp pH was also observed by Yunlartl (1980), Kumar *et al.* (1993) and Shahjahan *et al.* (1994). This phenomenon might be perhaps due to oxidation of acid during

storage resulting in higher pulp pH and also exhibiting genetical dissimilarities between varieties.

Different doses of MH adopted to this trial showed significant variation in pulp pH at different days after storage (Appendix 2.4). An increasing trend of pulp pH was observed from different treated and untreated fruits at various days of storage (Fig. 2.14). Pulp pH was higher in control at all stages of storage over the fruits treated with M_1, M_2 and M_3 treatments. pH value of mango pulp was the highest (6.95) in the control whereas the fruits treated with M_3 treatment produced the lowest (5.65) value at 12th day (Fig. 2.14). The results of the present investigation are in partially supported by the findings of Reddy and Hariprya (2002).

The combined effect of varieties and different doses of MH subjected to this study regarding pulp pH were found to be non significant at different days after storage (Appendix 2.4 and Table 2.5). There was showing an increasing trend of pulp pH from various treatment combinations at different days (Table 2.5). At 12th day, the highest (7.0) pH value was recorded from the treatment combination of V_2M_0 and the lowest (5.60) was recorded from the treatment combination of V_1M_3, respectively.

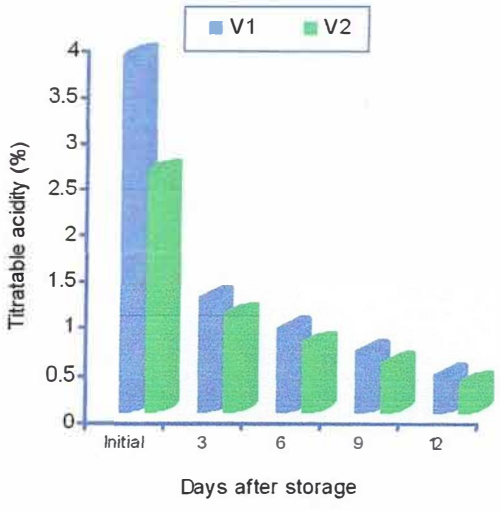


Fig. 2.11 Effect of varieties on titratable acidity of mango pulp at different days after storage

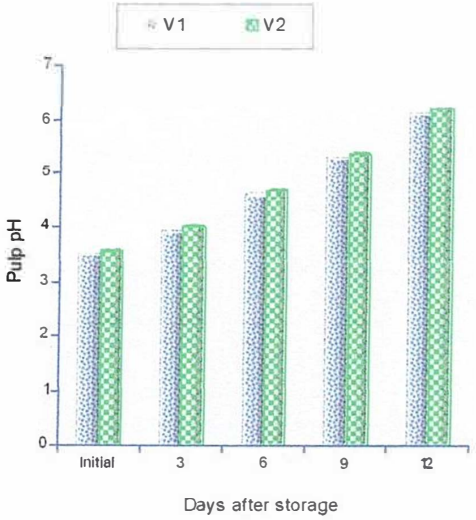


Fig. 2.12 Effect of varieties on pulp pH of mango at different days after storage

Figures represent
V1 = Langra V2 = Khirshapat

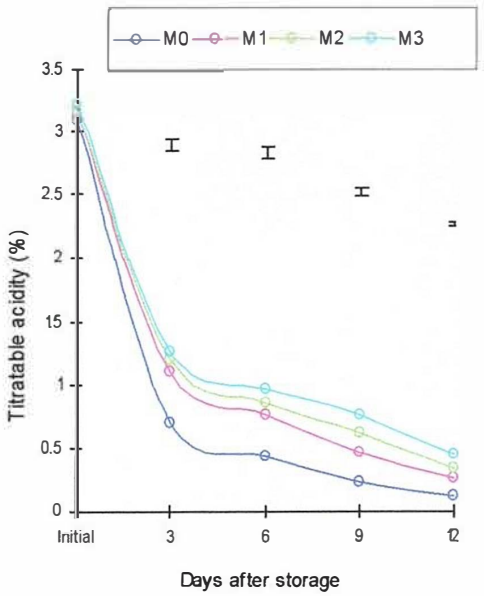


Fig. 2.13 Titratable acidity of mango pulp as influenced by different doses of MH solution at different days after storage. Vertical bars represent LSD at 0.05 level

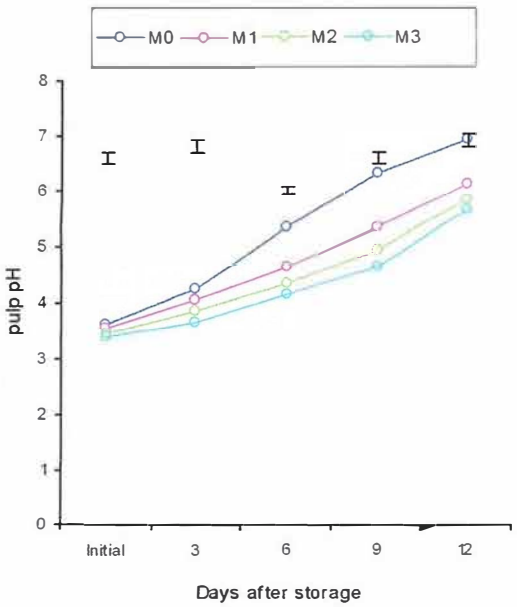


Fig. 2.14 Pulp pH of mango as influenced by different doses of MH solution at different days after storage. Vertical bars represent LSD at 0.05 level

Graph represents

V_1 = Langra	M_1=200 ppm of MH solution
V_2 = Khirshapat	M_2=400 ppm of MH solution
M_0 = Control	M_3=600 ppm of MH solution

8.3.4 Total soluble solid (Brix %) content

Statistically highly significant variation was noticed in connection with TSS content between two varieties at different days after storage (Appendix 2.5). The results denoted that TSS content of mango pulp increased gradually with the advancement of storage period. The increasing trend was faster from initial to 6th day thereafter; it increased slower (Fig. 2.15). At initial to 6th day, Khirshapat exhibited better performance in TSS accumulation than Langra. But, after 6 days, Langra showed better than Khirshapat and it again, lower than Khirshapat at 12th day (Fig. 2.15). At 12th day, the highest (16.63%) TSS quantity was obtained from Khirshapat and the lowest (16.43%) was obtained from Langra. Increased in the percentage of TSS during storage of mango was reported by Singh (1968). Absar *et al*. (1993) reported that TSS was increased with maturity of mango fruit. But, they

found highest TSS in Langra. Mollah and Siddique (1973) reported that TSS value varied from cultivar to cultivar. These might be possible due to genetical differences between varieties.

Different doses of MH subjected to the postharvest mangoes in this study were observed significant variation in respect of TSS content at different days after storage (Appendix 2.5). At different days of storage, it was noticed that TSS accumulation increased with the advancement of storage time. It also denoted that TSS content was markedly increased in untreated mangoes from initial to 6th day and then, it decreased significantly (Fig. 2.17). Another treatment *viz.*, M_1 also gave increased TSS from initial to 9th day and thereafter, it decreased sharply. The mangoes treated with M_2 treatment also showed more or less similar increasing trend from initial to 12th day. But, the fruits treated with M_3 produced TSS changes very steady motion at various days after storage. The highest (19.65, 18.90 and 19.15%) TSS accumulation was obtained from M_0, M_1 and M_2 at 6, 9 and 12th day respectively, whereas, the lowest (8.65, 12.15 and 16.15%) was obtained from M_3 treatments. These results are in partially supported by the findings of Jacobi *et al.* (2000). Lianni *et al.* (1994) showed TSS content was increased markedly up to 5 days after harvest without using any treatment. This happened possibly due to ripening condition resulting in maximize the TSS gathering in control and 600 ppm of MH (M_3) hindered in ethylene synthesis that caused delay ripening and ultimately in lower TSS accumulation. It also elucidated that TSS gathering is strongly related to ripening and it caused decrease owing to rotten.

The combined effect of varieties and induced different doses of MH on TSS content demonstrated significant at different days after storage except initial and 3rd day (Appendix 2.5 and Table 2.6). There was found an augmentig behavior of TSS content at different days of storage (Table 2.6). The highest accumulation (20.00, 19.10 and 19.70%) was noticed from the treatment combination of V_1M_o, V_1M_1 and V_1M_2 at 6, 9 and 12th days, whereas; the lowest value (8.40, 11.90 and 15.90%) was noticed from the treatment combination of V_1M_3 and V_2M_3, respectively.

8.3.5 Total sugar content

Variation in between both the varieties means in respect of total sugar content of mango pulp was observed to be significant at different days after storage (Appendix 2.5). The results indicated that total sugar content (TSC) increased markedly with the passing of storage duration (Fig. 1.16). This increasing trend was more or less sharp from initial to 9th days in both the varieties, thereafter; it increased steadily. At all days of storage Khirshapat gave comparatively more quantity of TSC than Langra. At initial day, Khirshapat had the highest (5.98%) whereas Langra had the lowest (5.50%). At 12th day, Khirshapat accumulated the highest quantity (19.27%) and the lowest (18.80%) was recorded from Langra. Upadhyay and Tripathi (1985) reported that total sugar content was augmented gradually, when stored for 6 days at room temperature. Sugar content increased during ripening (Srivastava, 1967). These results are in conformity with the findings of Shahjahan *et al.* (1994). Tsuda *et al.* (1999) also found the similar results. The increase in TSC might be due to conversion of complex starch or carbohydrate into simple compound like sucrose, Fructose, galactose etc.

Different storage treatments applied to the investigation on total sugar content of mango pulp demonstrated significant variation at different days after storage except initial level (Appendix 2.5). At different days, it denoted that TSC increased markedly with the advancement of storage period (Fig. 2.18). The increasing trend was very fast in untreated mango followed by other treatments namely M_1, M_2 and M_3, respectively. The maximum quantity of TSC (10.60, 19.00 and 21.00%) was reported from untreated mangoes at 3, 6 and 9 days, whereas; the minimum (7.38, 9.38 and 11.88%) was recorded from M_3 treatment. Mondal *et al.* (1995) reported the increasing trend of total sugar content at the later stage of storage. Total sugar content of mango pulp was the highest on the 6th day of storage (Tripathi, 1988). The results of the present study are in agreement with the findings of Reddy and Haripriya (2002) and Kumar *et al.* (1992). The increasing trend of total sugar at untreated might be possible due to breaking down of complex carbohydrate into simple compound (sucrose, fructose etc.) but, M_3 treatment made delay ripening at storage period resulting in lower conversion of complex compound into simple molecules.

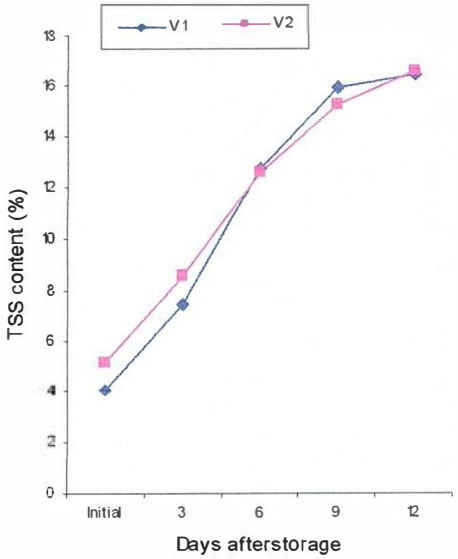


Fig. 2.15 Effect of varieties on total soluble solid of mango pulp at different days after storage

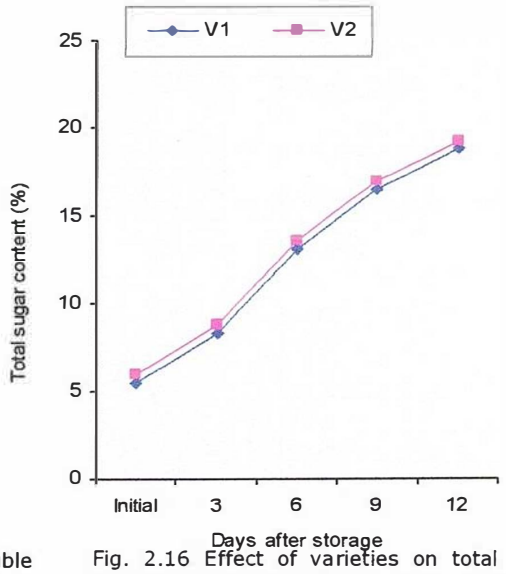


Fig. 2.16 Effect of varieties on total sugar content of mango pulp at different days after storage

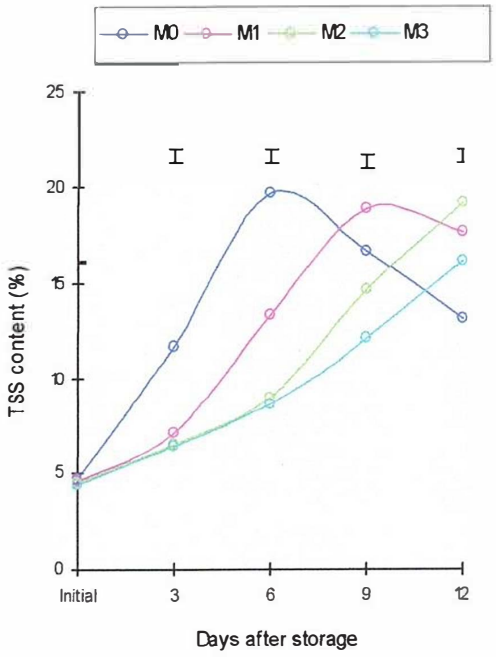


Fig. 2.17 Total soluble solid of mango pulp as influenced by different doses of MH solution at different days after storage. Vertical bars represent LSD at 0.05 level

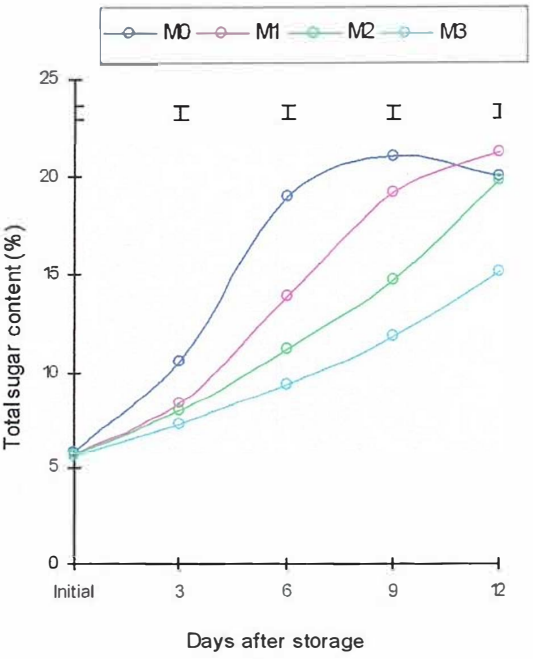


Fig. 2.18 Total sugar content of mango pulp as influenced by different doses of MH solution at different days after storage. Vertical bars represent LSD at 0.05 level

Graph represents

V_1 = Langra	M_1=200 ppm of MH solution
V_2 = Khirshapat	M_2=400 ppm of MH solution
M_0 = Control	M_3=600 ppm of MH solution

Table 2.5 Combined effects of varieties and different doses of Maleic hydrazide solution on titratable acidity and pulp pH of postharvest mango during storage at ambient condition

Treatments combination	Titratable acidity (%) at different days					pulp pH at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1M_0	3.75 a	0.90 d	0.52 d	0.28 e	0.13 e	3.57 a-c	4.20 ab	5.30 a	6.30 a	6.90 a
V_1M_1	3.80 a	1.15 a-c	0.80 bc	0.53 c	0.30 c	3.50 bc	4.00 cd	4.60 b	5.30 b	6.10 b
V_1M_2	3.78 a	1.25 ab	0.92 ab	0.68 b	0.38 b	3.40 c	3.80 ef	4.30 cd	4.90 c	5.80 cd
V_1M_3	3.83 a	1.32 a	1.05 a	0.82 a	0.50 a	3.40 c	3.60 g	4.10 e	4.60 d	5.60 e
V_2M_0	2.45 b	0.50 e	0.33 e	0.20 e	0.10 e	3.70 a	4.30 a	5.40 a	6.40 a	7.00 a
V_2M_1	2.52 b	1.05 cd	0.71 c	0.39 d	0.23 d	3.60 ab	4.10 bc	4.70 b	5.40 b	6.20 b
V_2M_2	2.55 b	1.15 bc	0.80 bc	0.55 c	0.32 c	3.50 bc	3.90 de	4.40 c	5.00 c	5.90 c
V_2M_3	2.60 b	1.20 a-c	0.87 b	0.70 b	0.40 b	3.40 c	3.70 fg	4.20 de	4.70 d	5.70 de
Level of significance	NS	*	NS	NS	NS	NS	NS	NS	NS	NS
CV%	3.18	8.49	10.75	10.30	10.05	2.56	2.56	1.33	1.69	1.72

Table 2.6 Combined effects of varieties and different doses of Maleic hydrazide solution on total soluble solid and total sugar content of postharvest mango during storage at ambient condition

Treatments combination	TSS content (%)at different days					Total sugar content (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1M_0	4.20 d	11.20 b	20.00 a	17.00 c	13.50 g	5.60 c	10.35 b	18.75 b	20.75 b	19.76 e
V_1M_1	4.10 de	6.60 e	13.60 c	19.10 a	16.10 e	5.50 cd	8.07 d	13.67 d	18.97 d	20.98 b
V_1M_2	4.00 ef	6.00 f	9.00 ef	15.20 e	19.70 a	5.50 cd	7.70 e	10.90 f	14.50 f	19.60 e
V_1M_3	3.90 f	5.90 f	8.40 g	12.40 g	16.40 d	5.40 d	7.05 g	9.15 h	11.65 h	14.85 g
V_2M_0	5.30 a	12.30 a	19.30 b	16.30 d	12.80 h	6.10 a	10.85 a	19.25 a	21.25 a	20.26 c
V_2M_1	5.20 ab	7.70 c	13.20 d	18.70 b	19.20 b	6.00 a	8.57 c	14.17 c	19.47 c	21.48 a
V_2M_2	5.10 bc	7.10 d	9.10 e	14.10 f	18.60 c	6.00 a	8.25 d	11.45 e	14.95 e	20.05 d
V_2M_3	5.00 c	7.00 d	8.90 f	11.90 h	15.90 f	5.80 b	7.50 f	9.60 g	12.10 g	15.30 f
Level of significance	NS	NS	***	***	***	NS	NS	NS	NS	NS
CV%	2.31	1.31	0.84	0.65	0.63	1.85	1.24	0.79	0.62	0.56

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
M_0 =Control
M_1=200 ppm of MH solution
M_2=400 ppm of MH solution
M_3 =600 ppm of MH solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

The combined effect of varieties and imposed different doses of MH solution in this study in terms of total sugar content of mango pulp demonstrated non significant variation at different days after storage (Appendix 2.5 and Table 2.6). The results indicated that total sugar content was increased with the passing of storage time (Table 1.13). At 12th day the maximum (21.48%) quantity of TSC was achieved from the treatment combination of V_2M_1 whereas, the minimum (14.85%) was achieved from the treatment combination of V_1M_3.

8.3.6 Reducing sugar Content

Analysis of variance exhibited that varieties had significant effect on reducing sugar content of mango pulp at different days after storage (Appendix 2.6). There was observed an increasing trend of reducing sugar with the passing of storage period (Table 2.7). It also noticed that Khirshapat gave comparatively more reducing sugar than Langra at different days of storage. The highest (5.38%) quantity of this sugar was received from Khirshapat whereas; the lowest (5.08%) was achieved from Langra at 12th day of storage (Table 1.7). These results are in agreement with the report of Upadhyay and Tripathi (1985). Casttrillo *et al.* (1992) elucidated that reducing sugar was increased during storage period. Khirshapat producing comparatively more reducing sugar might be possible due to genetlcal variation in both the varieties.

Different doses of MH solution imposed to this study showed significant variation in respect of reducing sugar content of mango pulp at different storage period (Appendix 2.6). It was found that reducing sugar of mango pulp was augmented gradually at different days after storage. It also denoted that untreated mangoes were noticed better in producing of reducing sugar as compared to other treatments. There was found from control that reducing sugar content increased gradually up to 9 days and then, it might be affected due to decomposition. At 12th day, the maximum (6.35%) amount of reducing sugar was attained from M_1 treatment and the lowest (4.80%) was attained from the fruit treated with M_3 treatment. Increase in reducing sugar during storage was stated by Tripati (1988) and Kumar et al. (1992). Lower increasing trend of reducing sugar content treated

with M_3 treatment might be possible due to delay ripening resulting in lower conversion of carbohydrates into simple's molecules.

The combined effect of varieties and implied different doses MH solution of mango pulp showed non significant variation in relation to reducing sugar content of mango pulp at different days (Appendix 2.6). It denoted reducing sugar content increased gradually at three days interval up to 9th day thereafter, it decreased from the treatment combination of V_2M_0 (Table 2.8). At 12th day, the highest (6.5%) quantity was noticed from the treatment combination of V_2M_1 and the lowest (3.90%) was noticed from V_1M_3.

8.3.7 Non reducing sugar content

The variation in between the varieties means had highly significant in respect of non-reducing sugar content at different days after storage (Appendix 2.6). There showed an increasing trend of non reducing sugar content at different days. At all days, it was observed that Khirshapat was better in achieving of non reducing sugar content as compared to Langra (Table 2.8). At 12th day, the highest (13.90%) amount of non reducing sugar was attained from Khirshapat and the lowest (13.72%) amount was attained from Langra. These results are in conformity with the report of Ali and Mazhar (1960). They reported that non reducing sugar content of ripe fruits was 11.20%. The result obtained from the investigation might be possible due to varietals dissimilarities.

Different doses of MH solution subjected to this trial gave the profound variation on non reducing sugar content of mango at different days after storage except initial level (Appendix 2.6). It was noticed that non reducing sugar content of mango pulp increased markedly at various days. It also denoted that untreated mango exhibited better performance in accumulation of more quantity of non reducing sugar followed by other treatment. This increasing trend decreased at 9th day due to putrified situation. Lower increasing trend was found from the fruit treated with M_3 treatment. At 12th day the highest result (15.21%) was recorded from control and lowest value (11.02%) was recorded from M_3 treatment. These events might be possible due to the M_3 treatment impeded ethylene synthesis of

mango resulting in delay ripening and little amount of non reducing sugar achievement. These results are in agreement with the reports of Singh (1968), Joshi and Roy (1988) and Rangavalli *et al.* (1993). They found a gradual increase in non reducing sugar content of untreated fruit.

The analysis of variance of the combined effect of varieties and applied different doses of MH solution were found to be non significant in terms of non reducing sugar content of mango pulp at different days (Appendix 2.6). It revealed that an increasing trend of non reducing sugar was noticed from different treatment combination at various days (Table 2.8). At 12th day, the highest (15.31%) quantity of non reducing sugar was recorded from the treatment combination of V_2M_0 whereas; the lowest (10.95%) was recorded from the treatment combination of V_1M_3, respectively.

8.3.8 Crude fibre content

The analysis of variance of mango varieties imposed in this investigation exhibited significant variation on crude fibre content of mango pulp at different days after storage (Appendix 2.7). There was found a decreasing trend of crude fibre from both the varieties at different days after storage (Fig. 2.19). It also indicated that Langra demonstrated better performance in accumulation of crude fibre. At initial day, Langra produced the highest (1.29%) quantity of crude fibre as compared to Khirshapat (1.16%). The amount of crude fibre decreased gradually with the increase of storage period from both the varieties. At 12th day, the highest (0.54%) quantity of crude fiber was noticed from Langra whereas; the lowest (0.41%) was noticed from Khirshapat. There were no available research findings regarding crude fiber content of mango in the scientific literature but, the present study revealed that crude fibre decreased with the advance of storage duration. The decrease in crude fiber content with the advancement of storage period might be possible due to breaking down of cellulose and lignin into smaller compound.

Various doses of MH solution used to this trial was found to be significant effect on crude fiber content of mango pulp at different days after storage except initial day (Appendix 2.7). The results explored that crude fibre content decreased

Table 2.7 Changes of reducing and non reducing sugar content in mango varieties and influenced by different doses of Maleic hydrazide solution at ambient condition during storage

Treatments	Reducing sugar (%) at different days					Non-reducing sugar (%) at different days				
Variety	Initial	3	6	9	12	Initial	3	6	9	12
V_1	1.33 b	2.05 b	3.63 b	4.95 b	5.08 b	4.17 b	6.24 b	9.49 b	11.52 b	13.72 b
V_2	1.60 a	2.35 a	3.93 a	5.25 a	5.38 a	4.39 a	6.44 a	9.69 a	11.69 a	13.90 a
Level of significance	***	***	***	***	***	***	***	***	**	**
Treatments										
M_0	1.58 a	3.10 a	6.10 a	6.30 a	4.80 c	4.30	7.50 a	12.90 a	14.70 a	15.21 a
M_1	1.44 ab	2.05 b	3.65 b	6.05 b	6.35 a	4.31	6.27 b	10.27 b	13.17 b	14.88 b
M_2	1.47 ab	1.90 c	3.00 c	4.60 c	5.70 b	4.28	6.08 c	8.18 c	10.13 c	14.13 c
M_3	1.38 b	1.75 d	2.35 d	3.45 d	4.05 d	4.23	5.53 d	7.03 d	8.43 d	11.02 d
Level of significance	*	***	***	***	***	NS	***	***	***	***

Table 2.8 Combined effects of varieties and different doses of Maleic hydrazide solution on reducing and non reducing sugar content of postharvest mango during storage at ambient condition

Treatments combination	Reducing sugar (%) at different days					Non-reducing sugar (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1M_0	1.45 b-d	2.95 b	5.95 b	6.15 b	4.65 f	4.15 c	7.40 b	12.80 b	14.60 b	15.11 b
V_1M_1	1.30 de	1.90 d	3.50 d	5.90 c	6.20 b	4.20 bc	6.17 d	10.17 d	13.07 d	14.78 c
V_1M_2	1.32 c-e	1.75 ef	2.85 f	4.45 e	5.55 d	4.18 c	5.95 e	8.05 f	10.05 e	14.05 d
V_1M_3	1.25 e	1.60 f	2.20 h	3.30 g	3.90 h	4.15 c	5.45 f	6.95 g	8.35 f	10.95 e
V_2M_0	1.70 a	3.25 a	6.25 a	6.45 a	4.95 e	4.44 a	7.60 a	13.00 a	14.80 a	15.31 a
V_2M_1	1.58 ab	2.20 c	3.80 c	6.20 b	6.50 a	4.42 a	6.37 c	10.37 c	13.27 c	14.98 b
V_2M_2	1.62 ab	2.05 cd	3.15 e	4.75 d	5.85 c	4.38 ab	6.20 cd	8.30 e	10.20 e	14.20 d
V_2M_3	1.50 bc	1.90 de	2.50 g	3.60 f	4.20 g	4.30 a-c	5.60 f	7.10 g	8.50 f	11.10 e
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	7.24	4.82	2.81	2.08	2.03	2.48	1.67	1.11	0.91	0.77

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
M_0 =Control
M_1=200 ppm of MH solution
M_2=400 ppm of MH solution
M_3 =600 ppm of MH solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

gradually with the passing of storage period (Fig. 2.21). At all days, it was found that crude fiber content was comparatively higher at the fruit treated with M_3 treatment followed by other treatments. At 3rd day, the maximum (1.15%) amount of crude fiber was obtained from M_3 treatment and the lowest (0.79%) was noticed from M_0 treatment. At 12th day, the maximum (0.65%) was mentioned from M_3 treatment whereas the lowest (0.39%) was mentioned from M_o treatment (Fig. 2.21). Crude fibre exhibited a very slight change during ripening as stated by Mathoko (2000).

The combined effect of varieties and different doses of MH solution were observed the non significant variation in terms of crude fiber content of mango pulp at different days after storage (Appendix 2.7). It indicated that crude fibre decreased gradually with the increase of storage period (Table 2.9). It also indicated that the treatment combination of V_1M_3 was better in achieving crude fibre content at all storage times. At 9th day, the highest (0.90%) quantity of crude fiber was obtained from the treatment combination of V_1M_3 and the lowest (0.37%) was gathered from the treatment combination of V_2M_o, which was statistically at par with V_2M_1 and V_1M_o respectively.

8.3.9 Total lipid content

The analysis of variance of varieties was significant on lipid content in mango pulp at different days after storage (Appendix 2.7). An increasing trend of lipid content was obtained in mango pulp at different days (Fig. 2.20). At all days of storage, it denoted that Langra gave higher amount of lipid as compared to Khirshapat. At 12th day, the highest (0.67%) amount of lipid was recorded from Langra and the lowest (0.63%) was recorded from Khirshapat. These events might be possible due to the genetically dissimilarities between two varieties.

Different doses of MH solution used in this study in terms of lipid content exhibited highly significant at different days after storage (Appendix 2.7). It was found an increasing trend of lipid content with the passing of storage period at various days after storage (Fig. 2.22). It also indicated that control treatment produced comparatively higher amount of lipid followed by M_1, M_2 and M_3 treatments from initial to 9 days; and then, it decreased due to becoming decayed situation. At 9th day, the highest (0.75%) amount of lipid content was reported from control whereas; the lowest (0.45%) was reported from the fruit treated with M_3 treatment.

At 12th day, M_1 treated fruit had the highest (0.73%) amount of lipid and the lowest (0.55%) was noticed from the fruit treated with M3 treatment, respectively. These occurrences might be possible due to M_3 treatment caused delay ripening resulting in lower production of lipid content.

The interaction effects of varieties and induced various doses of MH solution in this trial were found to be non significant in respect of lipid content of mango pulp at different days after storage (Appendix 2.7). It was observed an increasing trend of lipid content in mango pulp with the advancement of storage duration (Table 2.9). It also denoted that lipid content was obtained comparatively more quantity from the treatment combination of V_1M_0 at initial to 9th day and then, it decreased due to starting of decomposition. At this time, lower quantity was noticed from the treatment combination of V_2M_3. At 12th day, the highest (0.76%) quantity of lipid was reported from the treatment combination of V_1M_1 whereas; the lowest (0.54%) was reported from the treatment combination of V_2M_3, respectively.

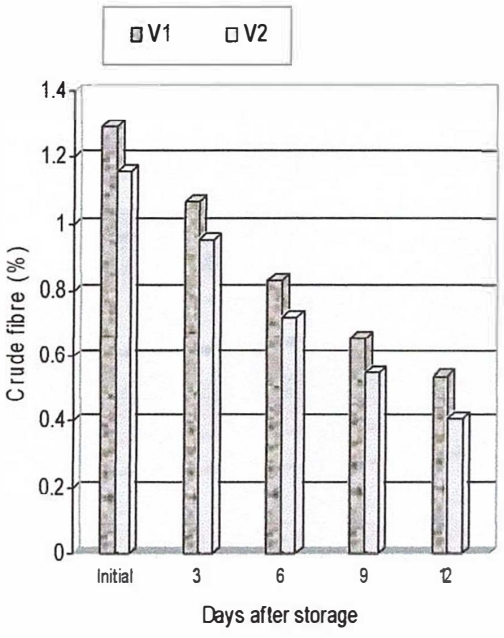


Fig. 2.19 Effect of varieties on crude fibre of mango pulp at different days after storage

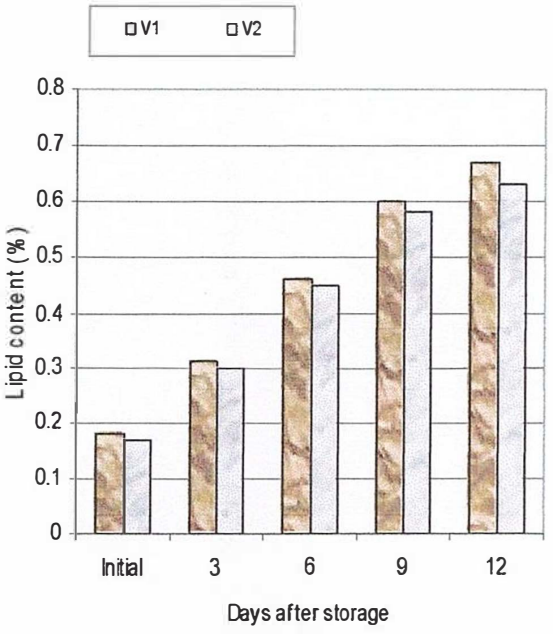


Fig. 2.20 Effect of varieties on lipid content of mango pulp at different days after storage

Graph represents
V_1 = Langra
V_2 = Khirshapat

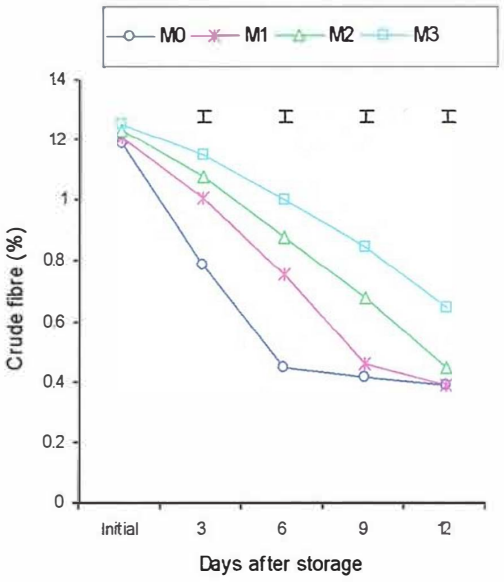


Fig. 2.21 Crude fibre of mango pulp as influenced by different doses of MH solution at different days after storage. Vertical bars represent LSD at 0.05 level

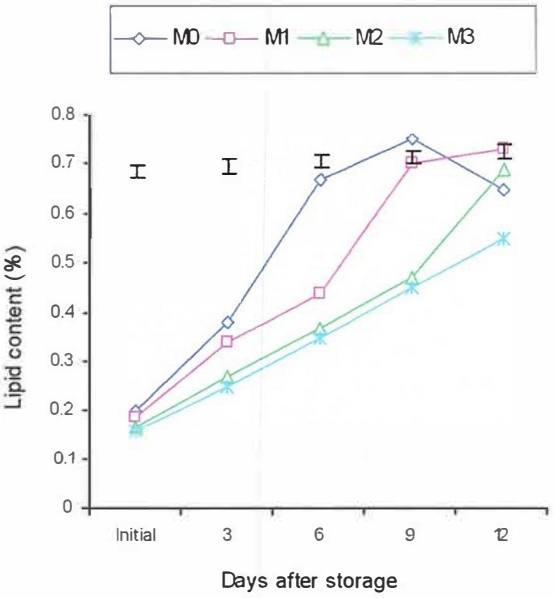


Fig. 2.22 Lipid content of mango pulp as influenced by different doses of MH solution at different days after storage. Vertical bars represent LSD at 0.05 level

Graph represents

V_1 = Langra	M_1=200 ppm of MH solution
V_2 = Khirshapat	M_2=400 ppm of MH solution
M_0 = Control	M_3 =600 ppm of MH solution

8.3.10 Water soluble protein content

The analysis of variance of mango varieties exhibited significant variation in respect of water soluble protein content (WSPC) in mango pulp at different days after storage except initial, 3rd and 12th days (Appendix 2.8). It was found an increasing trend of WSPC with becoming extended time of storage duration. It also explored that Langra was better in WSPC accumulation as compared to Khirshapat at all stages of storage. At 9th day, the highest (1.01%) accumulation of WSPC was reported from Langra whereas the lowest (0.92%) was reported from Khirshapat (Table 2.10). These might be possible due to the seed protein of mango disseminated to pulp areas during ripening stages and it also might have genetical variation in between two varieties.

Different doses of MH solution imposed to this investigation in terms of WSPC showed significant variation at different days except initial and 12th day (Appendix 2.8). Various results obtained from biochemical analysis was noticed an increasing

Table 2.9 Combined effects of varieties and different doses of Maleic hydrazide solution on crude fibre and lipid content of postharvest mango during storage at ambient condition

Treatments combination	Crude fibre (%) at different days					Lipid content (%) at different days				
Varieties x Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1M_0	1.25 ab	0.85 e	0.50 e	0.47 de	0.47 cd	0.20 a	0.39 a	0.68 a	0.77 a	0.67 b
V_1M_1	1.27 ab	1.07 bc	0.82 c	0.52 d	0.47 cd	0.19 ab	0.34 c	0.44 b	0.70 bc	0.76 a
V_1M_2	1.29 a	1.14 ab	0.94 b	0.74 b	0.51 bc	0.17 b-d	0.27 d	0.37 c	0.47 d	0.69 b
V_1M_3	1.30 a	1.20 a	1.05 a	0.90 a	0.70 a	0.16 cd	0.25 de	0.35 cd	0.45 de	0.55 d
V_2M_0	1.12 c	0.72 f	0.40 f	0.37 e	0.32 e	0.19 ab	0.37 b	0.66 a	0.72 b	0.62 c
V_2M_1	1.14 c	0.94 de	0.69 d	0.39 e	0.31 e	0.18 a-c	0.33 c	0.43 b	0.69 c	0.69 b
V_2M_2	1.17 bc	1.02 cd	0.82 c	0.62 c	0.39 de	0.16 cd	0.26 de	0.36 cd	0.46 de	0.68 b
V_2M_3	1.20 a-c	1.10 a-c	0.95 b	0.80 b	0.60 b	0.15 d	0.24 e	0.34 d	0.44 e	0.54 d
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	**	***
CV%	4.36	5.28	6.88	8.82	12.15	6.06	3.38	2.34	1.72	1.63

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
M_0 =Control
M_1=200 ppm of MH solution
M_2=400 ppm of MH solution
M_3 =600 ppm of MH solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

trend of WSPC in mango pulp with the advancement of storage period (Fig. 2.23). It also revealed that WSPC was accumulated more in untreated fruit followed by the fruit treated with M_1, M_2 and M_3, treatments, respectively. The increasing trend of WSPC in control was very distinct from initial to 6 days thereafter, its increasing trend declined due to spoilage. At the same time, the increasing trend of WSPC from the fruit treated with M_3 treatment was very slower due to delay ripening. At 9th day, the highest (1.21%) accumulating of WSPC was recorded from control which was statistically identical with M_1 and the lowest (0.72%) was recorded from M_3 treatment, respectively. It elucidated that extension of WSPC synthesis was strongly depended upon fruit ripening. An increase in protein content observed during ripening is in agreement with the findings of Gomez-Lim (1997).

The combined effect of varieties and imposed different doses of MH solution in this experiment demonstrated non significant variation in respect of WSPC at different days after storage (Appendix 2.8). The results obtained from the investigation indicated that WSPC increased markedly in the treatment combination of V_1M_0 from initial to 9th day and then, it decreased due to becoming putrefied condition whereas, the lower increasing trend was noticed from the treatment combination of V_2M_3. At 9th day, the highest (1.24%) quantity of WSPC was counted from the treatment combination of V_1M_0 whereas; the lowest (0.68%) was counted from the treatment combination of V_2M_3.

8.4 Changes in minerals of mango during storage environments

Different changes regarding minerals of mango fruits are presented and discussed in the following sub-headings.

8.4.1 Phosphorus content

Variation in between varieties means in respect of P contents showed highly significant at different days after storage (Appendix 2.8). It was noticed a steadily increasing trend of P contents in both the varieties with the increase of storage period (Table 2.16). It also indicated that Langra gave comparatively more quantity of P as compared to Khirshapat. The Increasing trend of P In Langra was more or less similar up to 9 days thereafter, its trend declined due to becoming spoilage of fruits.

At 12th day, the highest (23.52 mg/100 g) quantity of P was obtained from Langra and the lowest (21.65 mg/100 g) was obtained from Khirshapat. Better performance of increasing trend of P content in Langra might be due to genetical dissimilarities. It also elucidated that the increase of P content in mango was intimately related to ripening during storage. These results are in partially supported by the findings of Nadkarni (1963) when he worked with 16 cultivars. He found the ranged between 10-30 mg/100 g among cultivars. Peter *et al.* (2007) also showed the similar findings.

Different doses of MH solution adopted to this trial in terms of P content exhibited highly significant at different days after storage (Appendix 2.8). The results were noticed that P content augmented steadily at various days after storage. It also revealed that P content in control increased at slow motion from initial to 6th day thereafter; it increased at very slow rate than its previous trend. After 9th day, it declined possibly due to becoming hackneyed situation of fruit (Fig. 2.24). At 12th day, the highest (23.64 mg/100 g) quantity of P content was noticed from the fruit treated with M_1 treatment and the lowest value (21.67 mg/100 g) was noticed from the fruit treated with M3 treatment. Lower amount of P content from the fruit treated with M3 treatment might be possible due to delay ripening resulting in lower accumulation of P content and keeping the quality best for preservation. There were no available research articles regarding P changes as influenced by MH solution in the scientific literature but, the results of the present research revealed that P content was changed during storage.

The combined effect of varieties and imposed various doses of MH solution showed significant variation on P content of mango pulp at different Phosphorus (Appendix 2.8). It was found an increasing trend of P content with the increasing of storage period (Table 2.11). It also denoted that P content increased gradually from initial to 9th day with the treatment combination of V_1M_0 and then, it decreased due to starting of fruit bad situation. In this time, P content demonstrated lower increasing trend from the fruit treated with the treatment combination of V_2M_3. At 12th day, the highest (24.62 mg/100 g) quantity of P was recorded from the treatment combination of V_1M_1 whereas; the lowest (20.35 mg/100 g) was recorded from the treatment combination of V_2M_3. It also revealed that Langra along with M_3

treatment was found the best combination in keeping the quality good in preservation followed by other treatment combinations. These treatment combinations strictly impeded the ripening of mango fruits during storage.

8.4.2 Potassium content

Analysis of variance of mango varieties in terms of K content showed highly significant at different days after storage (Appendix 2.9). It was observed an increasing trend of K content in both the varieties with the increase of storage period at different days during storage (Table 2.12). In all the storage period, Langra was found as more producer of K content as compared to Khirshapat. It was also noticed that the increasing trend of K content was suspended at 9^{th} day of storage. At this period, the highest (0.28%) of K was obtained from Langra and the lowest (0.25%) was recorded from Khirshapat (Table 2.12). These events might be possible due to becoming spoilage of mango fruit resulting in lower metabolic activities. Langra was better producer of K content possibly due to genetical dissimilarities between varieties. At different storage period, K content increased might be possible due to transmission of K from stone and peel to pulp of mango.

Different doses of MH solution applied to this experiment in respect of K content of mango were highly significant at different days after storage (Appendix 2.9). The results indicated that K content augmented gradually with the passing of storage time. But, K content from the untreated fruit decreased at 9^{th} day, whereas other treatments *viz.*, M_1, M_2 and M_3 retained their increasing trends (Fig. 2.25). In this period, there was found a very lower increasing trend of K in the fruit treated with M_3 treatment. At 9^{th} day, the maximum (0.29%) of K content was recorded from the untreated fruit whereas, the lowest (0.25%) was recorded from the fruit treated with M_3 treatment which was statistical similar with M_2 treatment. Lower dissemination of K content in the fruit treated with M_3 treatment might be possible due to delay ripening causing lower transmission of K resulting in keeping quality good.

The combined effect of varieties and induced different doses of MH solution in relation to K content of mango pulp demonstrated non significant at different days after storage (Appendix 2.9). It indicated that K content of mango pulp from different treatment combination increased gradually with the passing of storage time

(Table 2.13). But, only the treatment combination of V_1M_0 gave the highest decreasing trend at 9th day. In this period the highest (0.30%) quantity of K was reported from the treatment combination of V_1M_0 which was statistical identically with V_1M_1 whereas, the lowest (0.23%) was reported from the treatment combination of V_2M_3.

8.4.3 Calcium content

Analysis of variance of imposed varieties to this investigation in terms of Ca content showed highly significant at different days after storage (Appendix 2.9). The results were observed an increasing trend of Ca content with the advancement of storage time from both the varieties (Table 2.12). It also indicated that Khirshapat was better in achieving of Ca content followed by Langra. At 12th day, the highest (22.70 mg/100 g) quantity of Ca was recorded from Khirshapat and the lowest (20.75 mg/100 g) was recorded from Langra. These events might be possible due to genetical variation in between two varieties. These results are in partially supported by the report of Nadkarni (1963).

Different doses of MH solution in respect of Ca content of mango pulp demonstrated significant variation at different days after storage (Appendix 2.9). At various days during storage, Ca content augmented gradually with the advancement of storage time (Fig. 2.26). It also elucidated that Ca content from control increased markedly from initial to 6th day and then, it increased smoothly thereafter, it decreased due to starting decay. At the same time, Ca content from the fruit treated with M_3 treatment increased very smoothly. At 9th day, the highest (24.53 mg/100 g) quantity of Ca was recorded from untreated fruit whereas; the lowest (16.30 mg/100 g) was recorded from the fruit treated with M_3 treatment. These phenomena might be possible due to delay of ripening caused in lower transmission of Ca content from peel and stone to pulp of mango. The results of the present investigation are not supported by the findings of Petter *et al.* (2007).

The combined effect of varieties and imposed different doses of MH solution in terms of Ca content of mango pulp exhibited significant variation at different storage duration (Appendix 2.9). The results was noticed an increasing trend of Ca content of mango pulp from various treatment combinations (Table 2.13). At 9th day, the highest (25.39 mg/100 g) quantity of Ca was obtained from the treatment

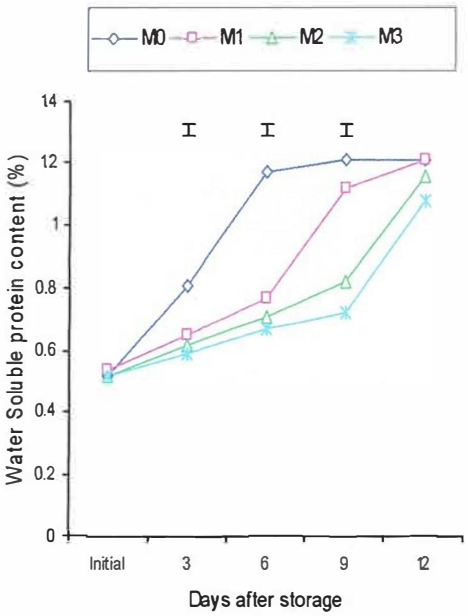


Fig. 2.23 Effect of different doses of MH solution on water soluble protein content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

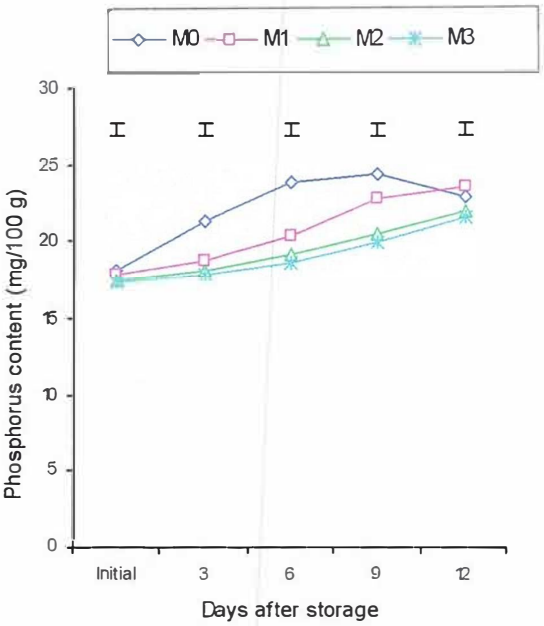


Fig. 2.24 Effect of different doses of MH solution on phosphorus content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

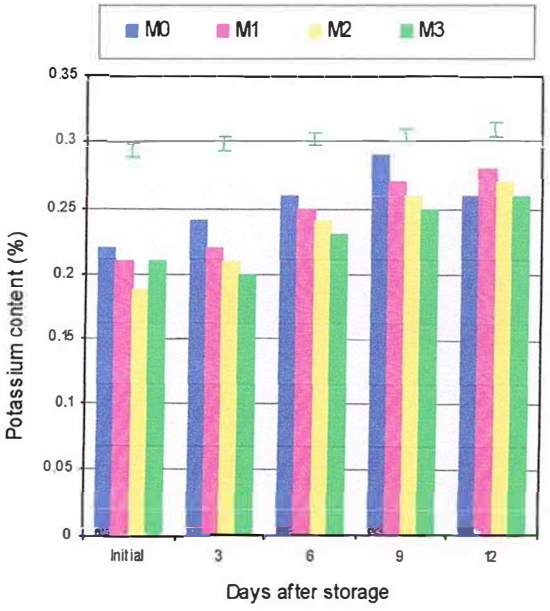


Fig. 2.25 Potassium content of mango pulp as influenced by different doses of MH solution at different days after storage. Vertical bars represent LSD at 0.05 level

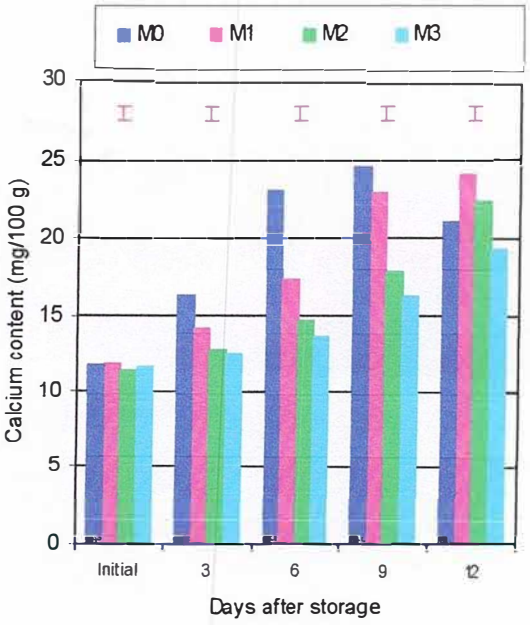


Fig. 2.26 Calcium content of mango pulp as influenced by different doses of MH solution at different days after storage. Vertical bars represent LSD at 0.05 level

Graph represents

M_0 =Control

M_1=200 ppm of MH solution

M_2=400 ppm of MH solution

M_3 =600 ppm of MH solution

Table 2.10 Changes of water soluble protein and phosphorus content in postharvest mango varieties during storage at ambient condition

Treatments	Water soluble protein content (%) at different days					Phosphorus (mg/100 g) at different days				
Variety	Initial	3	6	9	12	Initial	3	6	9	12
V_1	0.56 a	0.71 a	0.89 a	1.01 a	1.19 a	19.42 a	20.43 a	21.89 a	23.20 a	23.52 a
V_2	0.49 b	0.62 b	0.77 b	0.92 b	1.13 b	16.15 b	17.83 b	19.30 b	20.72 b	21.65 b
Level of significance	NS	NS	*	*	NS	***	***	***	***	***

Table 2.11 Combined effects of varieties and different doses of Maleic hydrazide solution on water soluble protein and phosphorus content of postharvest mango during storage at ambient condition

Treatments combination	Water soluble protein content (%) at different days					Phosphorus (mg/100 g) different days				
Varieties x Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1M_0	0.54	0.85 a	1.21 a	1.24 a	1.22	19.86 a	21.88 a	24.38 a	24.78 a	23.38 b
V_1M_1	0.57	0.69 a-c	0.83 b	1.18 a	1.24	19.66 b	20.46 c	21.96 c	24.42 b	24.62 a
V_1M_2	0.55	0.67 a-c	0.78 bc	0.88 bc	1.20	19.25 c	19.95 d	20.98 d	22.12 d	23.08 c
V_1M_3	0.58	0.62 bc	0.73 bc	0.75 cd	1.10	18.92 d	19.43 e	20.24 e	21.48 e	22.98 c
V_2M_0	0.50	0.77 ab	1.12 a	1.18 a	1.19	16.55 e	20.95 b	23.45 b	23.95 c	22.45 e
V_2M_1	0.51	0.60 bc	0.70 bc	1.05 ab	1.17	16.25 f	17.36 f	18.88 f	21.32 e	22.65 d
V_2M_2	0.48	0.57 bc	0.64 bc	0.75 cd	1.12	15.84 g	16.54 g	17.55 g	19.05 f	21.13 f
V_2M_3	0.45	0.55 c	0.60 c	0.68 d	1.05	15.94 g	16.48 g	17.32 h	18.55 g	20.35 g
Level of significance	NS	NS	NS	NS	NS	*	***	***	***	***
CV%	17.65	15.95	12.63	11.01	9.26	0.60	0.55	0.52	0.48	.47

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
M_0 =Control
M_1=200 ppm of MH solution
M_2=400 ppm of MH solution
M_3 =600 ppm of MH solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Table 2.12 Changes of potassium and calcium content between postharvest mangoes during storage at ambient condition

Treatments	Potassium (%) at different days					Calcium (mg/100 g) at different days				
Variety	Initial	3	6	9	12	Initial	3	6	9	12
V_1	0.23 a	0.25 a	0.27 a	0.28 a	0.28 a	10.65 b	13.02 b	16.26 b	19.45 b	20.75 b
V_2	0.18 b	0.19 b	0.22 b	0.25 b	0.25 b	12.47 a	14.95 a	18.19 a	21.39 a	22.70 a
Level of significance	***	***	***	***	***	***	***	***	***	***

Table 2.13 Combined effects of varieties and different doses of Maleic hydrazide solution on potassium and calcium content of postharvest mango during storage at ambient condition

Treatments combination	Potassium content (%) at different days					Calcium content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1M_0	0.24 a	0.26 a	0.28 a	0.30 a	0.27 a-c	10.85 e	15.45 b	22.18 b	23.68 c	20.18 f
V_1M_1	0.23 ab	0.25 ab	0.27 ab	0.28 ab	0.29 a	10.65 f	13.15 e	16.25 d	21.82 d	22.88 c
V_1M_2	0.21 c	0.24 a-c	0.26 a-c	0.27 bc	0.28 ab	10.35 g	11.82 f	13.67 g	16.88 g	21.42 e
V_1M_3	0.22 bc	0.23 bc	0.25 b-d	0.26 b-d	0.27 a-c	10.75 ef	11.65 f	12.92 h	15.42 h	18.53 g
V_2M_0	0.19 d	0.22 c	0.24 c-e	0.27 bc	0.25 cd	12.55 b	17.16 a	23.89 a	25.39 a	21.89 d
V_2M_1	0.18 de	0.19 d	0.23 de	0.25 c-e	0.26 b-d	12.82 a	15.42 b	18.53 c	24.09 b	25.15 a
V_2M_2	0.17 e	0.18 d	0.22 e	0.24 de	0.25 cd	12.35 c	13.86 c	15.72 e	18.92 e	23.45 b
V_2M_3	0.19 d	0.17 d	0.20 f	0.23 e	0.24 d	12.15 d	13.35 d	14.62 f	17.17 f	20.29 f
Level of significance	NS	NS	NS	NS	NS	***	***	***	**	**
CV%	5.21	4.88	4.35	4.04	4.02	0.92	0.76	0.62	0.52	0.49

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
M_0 =Control

M_1=200 ppm of MH solution
M_2=400 ppm of MH solution
M_3 =600 ppm of MH solution

* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level

NS means non significant

combination of V_2M_0 and the lowest (15.42 mg/100 g) was obtained from the treatment combination of V_1M_3, respectively.

8.4.4 Magnesium content

Highly significant variation was found in Mg content between the varieties means at different days after storage (Appendix 2.10). The results were observed that Mg content increased gradually with the passing of storage period (Table 2.14). It also reveled that Mg content increased steadily from initial to 9th days thereafter, it decreased slightly due to becoming gone bad of the fruit situation. At 9th day, the highest (17.61 mg/100 g) was reported from Langra and the lowest (16.98 mg/100 g) was recorded from Khirshapat. This phenomenon might be due to genetical dissimilarities between the varieties. There were no available research findings relating to Mg content during storage in the scientific literature. The results of the present study revealed that Langra was batter in Mg accumulation over Khirshapat but, it has also increased during storage.

Different doses of MH solution induced in this trial exhibited highly significant variation in relation to Mg content of mango pulp at different days after storage (Appendix 2.10). It was noticed a smooth increasing trend of Mg content of mango pulp with the advancement of storage period (Fig. 2.27). It also explored that Mg content from control increased gradually from initial to 6th day and then, it decreased very sharply. The highest (17.90, 17.74 and 18.28 mg/100 g) quantity of Mg was recorded from control, M_1 and M_2 treatment at 6, 9 and 12th day whereas, the lowest (16.30, 17.04 and 17.77 mg/100 g) was recorded from the fruit treated with M_3 treatment, respectively. The augmentation of Mg content in mango pulp might be related to starting of ripening.

The combined effect of varieties used and various doses of MH solution imposed in this experiment in terms of Mg content of mango pulp showed significant variation at various days except 3 and 9 (Appendix 2.10). The results noticed an increasing trend of Mg content of mango pulp with the increase of storage time (Table 2.15). At 6th day, the highest (18.25 mg/100 g) quantity of Mg was attained

from the treatment combination of V_1M_0 whereas; the lowest (15.75 mg/100 g) was recorded from the treatment combination of V_2M_3, respectively.

8.4.5 Copper content

Variation in between varieties in terms of Cu content of mango pulp showed highly significant at different days after storage (Appendix 2.10). The results revealed that Cu content of mango pulp decreased gradually with the advancement of storage period (Table 2.14). It also denoted that Cu content of Khirshapat was more as compared to Langra. At initial day, higher (0.35 mg/100 g) content of Cu was recorded in Khirshapat and lower (0.32mg/100 g) was recorded in Langra. At 12^{th} day, Khirshapat produced the highest (0.20 mg/100 g) amount of Cu and the lowest (0.18 mg/100 g) was recorded from Langra (Table 2.14). These events might be possible due to genetical dissimilarities between the varieties. There were no available research reports regarding Cu content of mango at the scientific literature but, the present research findings revealed that Cu content reduced gradually with the advance of storage duration.

Different doses of MH solution used in the present study in relation to Cu content of mango pulp exhibited highly significant variation at different days after storage except initial day (Appendix 2.10). The results indicated that Cu content decreased gradually with the increase of storage period at various days. The decreasing trend from control had higher than the fruit treated with M_1, M_2 and M_3 treatment respectively. At 12^{th} day, higher quantity of Cu (0.24 mg/100 g) was obtained from the fruit treated with M_3 whereas, lower (0.12 mg/100 g) was obtained from control (Fig. 2.28). It meant M_3 treatment was much better than the other treatments in conservation of Cu content. So, the present findings elucidated that M_3 treatment was the best treatment in preservation of mango.

The combined effect of varieties and imposed different doses of MH solution in terms of Cu content of mango were found to be non significant variation at various days after storage except initial and 12^{th} day (Appendix 2.10). The results denoted that Cu content in different treatment combination decreased with the increase of storage duration. At 12^{th} day, the highest (0.26 mg/100 g) was recorded from the

treatment combination of V_2M_3, and the lowest (0.11 mg/100 g) was recorded from the treatment of V_1M_0 (Table 2.15).

8.4.6 Iron content

The analysis of variance of varieties in relation to Fe content of mango pulp was found to be highly significant at different days after storage (Appendix 2.11). The results were observed an increasing trend of Fe content with the advancement of storage duration. The increasing trend of Fe content showed more or less similar from initial to 9th day thereafter, it decreased slightly. At 9th day, the highest (4.62 mg/100 g) quantity of Fe was recorded from Langra and the lowest (3.81 mg/100 g) was recorded from Khirshapat. These results are in partially supported by the findings of Nadkarni (1963). These events might be possible due to genetical dissimilarities between the varieties.

Highly significant variation was found due to the effect of different doses of MH solution on Fe content of mango pulp at various days after storage (Appendix 2.11). The results indicated that Fe content increased markedly from initial to 6th day and then, it decreased markedly at control and similarly M_1 treated fruits decreased of Fe after 9th days. But, Fe content obtained from the other fruits treated with M_2 and M_3 treatment increased gradually up to 12th day (Fig. 2.29). At 12th day, the highest (5.03 mg/100 g) quantity of Fe was recorded from the fruit treated with M_2 treatment whereas; the lowest (3.07 mg/100 g) was recorded from the untreated fruit. A smaller quantity of Fe obtained from untreated fruits was possibly due to decaying resulted in lower amount. On the other hand Fe content gradually augmented in M_3 treatment containing their good quality. These results are partially supported by the findings of Peter *et al.* (2007).

There was non significant variation in respect of Fe content of mango pulp at different days after storage as influenced by the combined effect of varieties and implied different doses of MH solution (Appendix 2.11). These results indicated that an increasing trend of Fe content was found from initial to 6th day thereafter, it decreased very fast from the treatment combination of V_1M_0 whereas the lowest increasing trend was noticed in the treatment combination of V_2M_3, respectively (Table 2.17). At 6th day, the highest (5.75 mg/100 g) quantity of Fe was recorded

from the treatment combination of V_1M_0 and the lowest (1.88 mg/100 g) was recorded from the treatment combination of V_2M_3.

8.4.7 Manganese content

Manganese Mn content of mango pulp was found to be differed significantly in both the varieties mean at different days after storage (Appendix 2.11). The results noticed that Mn content increased gradually with the advancement of storage period (Table 2.16). It also explored that Langra showed better in the accumulation of Mn content as compared to Khirshapat. At 9th day, the highest (1.16 mg/100 g) quantity of Mn was reported from Langra whereas; the lowest (0.96 mg/100 g) was reported from Khirshapat, respectively (Table 2.16). It also explored that Mn content did not increase after 9th day. There were no available research reports relating to Mn content in the scientific literature. The present research findings revealed that Langra was better than Khirshapat in Mn content accumulation.

Different doses of MH solution were highly significant on Mn content of mango pulp at different days after storage (Appendix 2.11). The results noticed that Mn content augmented gradually from initial to 6th day, and then it reduced markedly in control. On the other hand, it increased from initial to 9th day thereafter; it reduced in the fruit treated with M_1 treatment. At the same time, very lower increasing trend of Mn content was recorded from the fruit treated with M_3 treatment (Fig. 2.30). At 12th day, Mn content ranged between 0.89 to 1.21 mg per 100 g of fresh pulp of mango. The maximum (1.21 mg/100 g) was noticed from M_2 treated fruits and the minimum (0.89 mg/100 g) was recorded from control.

The combined effect of varieties and used different doses of MH solution in respect of Mn content of mango pulp were found to be non significant at various days after storage (Appendix 2.11). The results observed an increasing trend of Mn content in different treatment combination with the increase of storage duration (Table 2.17) At 6th day, the highest (1.32 mg/100 g) was obtained from the treatment combination of V_1M_0, and the lowest (0.62 mg/100 g) was obtained from the treatment combination of V_2M_3, (Table 2.17). At 12th day, the highest (1.32 mg/100 g) was noticed from the treatment combination of V_1M_2 and the minimum (0.92 mg/100 g) was noticed from the treatment combination of V_2M_3, respectively.

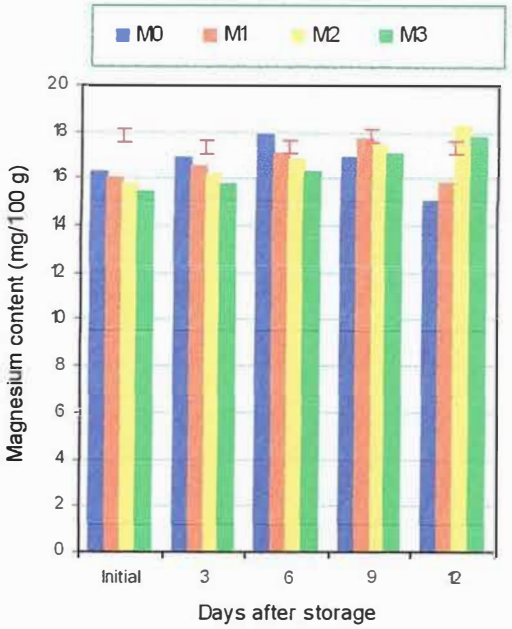


Fig. 2.27 Effect of different doses of MH solution on magnesium content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

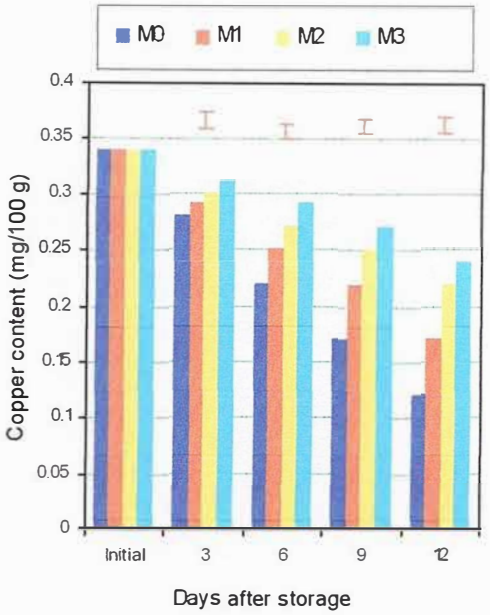


Fig. 2.28 Effect of different doses of MH solution on copper content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

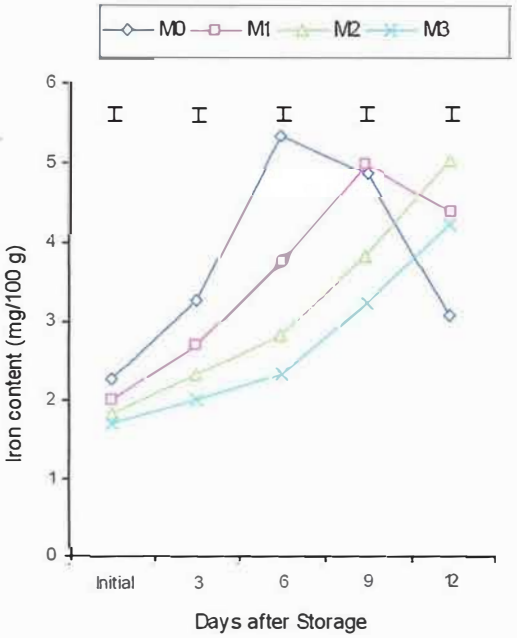


Fig. 2.29 Iron content of mango pulp as influenced by different doses of MH solution at different days after storage. Vertical bars represent LSD at 0.05 level

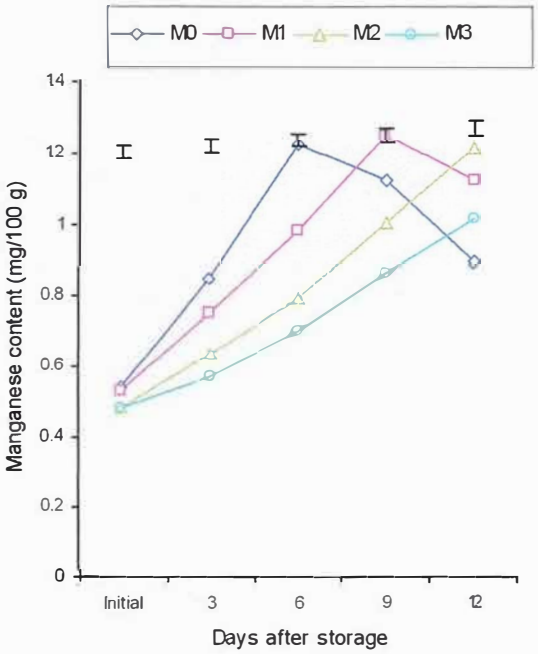


Fig. 2.30 Manganese content of mango pulp as influenced by different doses of MH solution at different days after storage. Vertical bars represent LSD at 0.05 level

Graph represents
M_0 =Control
M_1=200 ppm of MH solution
M_2=400 ppm of MH solution
M_3 =600 ppm of MH solution

Table 2.14 Changes of magnesium and copper content in postharvest mango varieties during storage at ambient condition

Treatments	Magnesium content (mg/100 g) at different days					Copper content (mg/100 g) at different days				
Variety	Initial	3	6	9	12	Initial	3	6	9	12
V_1	16.37 a	16.74 a	17.59 b	17.61 a	16.95 a	0.32 b	0.28 b	0.24 b	0.21 b	0.18 b
V_2	15.39 b	15.98 b	16.42 a	16.98 b	16.53 b	0.35 a	0.31 a	0.27 a	0.24 a	0.20 a
Level of significance	***	***	***	***	***	***	***	***	***	***

Table 2.15 Combined effects of varieties and different doses of Maleic hydrazide solution on magnesium and copper content of postharvest mango during storage at ambient condition

Treatments combination	Magnesium content (mg/100 g) at different days					Copper content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1M_0	16.88 a	17.28 a	18.25 a	17.15 cd	15.22 g	0.32 cd	0.26 e	0.21 e	0.16 e	0.11 e
V_1M_1	16.63 b	16.98 b	17.82 b	18.13 a	16.25 e	0.33 b-d	0.28 c-d	0.24 cd	0.21 d	0.17 d
V_1M_2	16.22 c	16.55 c	17.45 c	17.88 b	18.45 a	0.31 d	0.27 de	0.25 cd	0.23 cd	0.20 c
V_1M_3	15.75 d	16.15 d	16.85 d	17.26 cd	17.89 c	0.32 cd	0.29 cd	0.26 bc	0.25 bc	0.22 bc
V_2M_0	15.65 de	16.45 c	17.55 c	16.62 f	14.79 h	0.35 ab	0.29 cd	0.23 de	0.18 e	0.13 e
V_2M_1	15.48 ef	16.13 d	16.25 e	17.35 c	15.55 f	0.34 a-c	0.30 bc	0.26 bc	0.23 cd	0.17 d
V_2M_2	15.32 f	15.88 e	16.12 e	17.13 d	18.12 b	0.36 a	0.32 ab	0.28 b	0.26 b	0.23 b
V_2M_3	15.12 g	15.45 f	15.75 f	16.82 e	17.65 d	0.35 ab	0.33 a	0.31 a	0.29 a	0.26 a
Level of significance	**	NS	***	NS	*	*	NS	NS	NS	*
CV%	0.72	0.65	0.62	0.66	0.63	3.17	3.63	4.16	4.69	5.69

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
M_0 =Control
M_1=200 ppm of MH solution
M_2=400 ppm of MH solution
M_3 =600 ppm of MH solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Table 2.16 Changes of iron and manganese content in postharvest mango varieties during storage at ambient condition

Treatments	Iron content (mg/100 g) at different days					Manganese content (mg/100 g) at different days				
Variety	Initial	3	6	9	12	Initial	3	6	9	12
V_1	2.34 a	2.96 a	3.97 a	4.62 a	4.58 a	0.60 a	0.79 a	1.02 a	1.16 a	1.16 a
V_2	1.55 b	2.18 b	3.16 b	3.81 b	3.77 b	0.42 b	0.60 b	0.83 b	0.96 b	0.96 b
Level of significance	***	***	***	***	***	***	***	***	***	***

Table 2.17 Combined effects of varieties and different doses of Maleic hydrazide solution on iron and manganese content of postharvest mango during storage at ambient condition

Treatments combination	Iron content (mg/100 g) at different days					Manganese content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1M_0	2.68 a	3.65 a	5.75 a	5.25 a	3.46 d	0.62 a	0.94 a	1.32 a	1.22 b	0.99 d
V_1M_1	2.35 b	3.05 b	4.12 c	5.35 a	4.78 b	0.63 a	0.85 b	1.08 c	1.35 a	1.22 b
V_1M_2	2.22 bc	2.72 c	3.25 d	4.22 c	5.43 a	0.58 b	0.73 d	0.89 d	1.11 d	1.32 a
V_1M_3	2.12 c	2.43 d	2.74 e	3.65 d	4.66 b	0.55 c	0.65 e	0.78 e	0.94 f	1.09 c
V_2M_0	1.85 d	2.88 bc	4.95 b	4.46 b	2.68 e	0.45 d	0.75 c	1.12 b	1.02 e	0.79 f
V_2M_1	1.65 e	2.35 d	3.38 d	4.58 b	3.96 c	0.42 e	0.64 e	0.88 d	1.14 c	1.01 d
V_2M_2	1.42 f	1.92 e	2.42 f	3.43 e	4.63 b	0.38 f	0.53 f	0.69 f	0.89 g	1.10 c
V_2M_3	1.28 f	1.58 f	1.88 g	2.78 f	3.79 c	0.41 e	0.48 g	0.62 g	0.78 h	0.92 e
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	5.45	4.12	2.98	2.52	2.54	4.20	3.05	2.30	2.01	2.01

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
M_0 =Control

M_1=200 ppm of MH solution
M_2=400 ppm of MH solution
M_3 =600 ppm of MH solution

* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level

NS means non significant

8.4.8 Zinc content

Variation in respect of Zn content of mango pulp due to the effect of varieties demonstrated highly significant at different days after storage (Appendix 2.12). The results indicated that Zn content decreased markedly with the advancement of storage duration from both the varieties (Table 2.18). It also revealed that Khirshapat was found to provide more Zn quantity as compared to Langra. Zn content ranged between 1.31 to 1.54 mg per 100 g of mango pulp at initial day and 0.76 to 0.89 mg per 100 g at 12th day. The highest (1.54 and 0.89 mg/100 g) was obtained from Khirshapat and the lowest (1.31 and 0.76 mg/100 g) was obtained from Langra at initial and 12th day, respectively. There were no available research findings relating to Zn content in the scientific review.

Different doses of MH solution caused significant variation in Zn content of mango pulp at different days after storage (Appendix 2.12). The results observed a decreasing trend of Zn content of mango pulp with the advancement of storage period from the fruit treated with different doses of MH solution. It also denoted that the decreasing trend was very high from control and very low from the fruit treated with M_3 treatment (Fig. 2.31). At 12th day, the maximum (0.99 mg/100 g) was obtained from the fruit treated with M_3 treatment and the lowest (0.63 mg/100 g) was obtained from control. Zn content of mango pulp decreased in the storage period was possibly due to either the transmission of Zn from pulp to stone and peel or Zn content of mango pulp may be depressed or suppressed as influenced by metabolic activities during storage.

The combined effect of varieties and imposed different doses of MH solution in terms of Zn content of mango showed non significant variation at different days after storage (Appendix 2.12). There exhibited the decreasing trend of Zn content of mango pulp from various treatment combinations (Table 2.19).

8.5 Shelf life

Highly significant variation was observed from varieties on shelf life of mango (Appendix 2.12). The longest shelf life (13.17 days) was recorded from Khirshapat and the shortest (11.83 days) was recorded from Langra (Fig. 2.32). Variation in

shelf life between varieties might be possible due to genetical. The present findings from the research revealed that Khirshapat was better than Langra in preservation.

Imposed different doses of MH solution in this investigation in terms of shelf life of mango showed highly significant (Appendix 2.12). The shelf life of mango ranged between 8.00 to 15.50 days from different storage treatments (Fig 2.23). The longest shelf life (15.50 days) was noticed from the fruit treated with M_3 treatment followed by the shelf life of the fruits treated with M_2 (13.67 days), and M_1 (12.83 days), treatments whereas; the shortest shelf life (8.00 days) was noticed from control, respectively (Fig. 2.24). The longest shelf life obtained from the fruit treated with M_3 treatment might be possibly due to suppression or depression of physiological and biochemical activities which is responsible for slower senescence of harvested fruits and consequently led to the longest shelf life. The results are in conformity with the findings of Tefera *et al.* (2007), Gautam *et al.* (2003) also found the similar results.

The combined effects of varieties and induced different dosses of MH solution had non significant effect in terms of shelf life of mango (Appendix 2.12). The shelf life ranged between 7.33 to 16.00 days from various treatment combinations. The longest shelf life (16.00 days) was obtained from the treatment combination of V_2M_3, whereas the shortest (7.33 days) was obtained from V_1M_0.

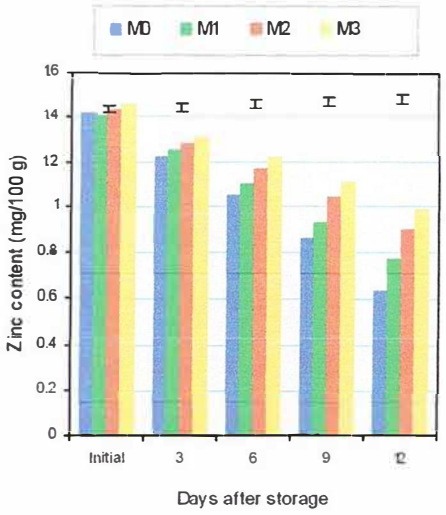


Fig. 2.31 Effect of different doses of MH solution on zinc content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

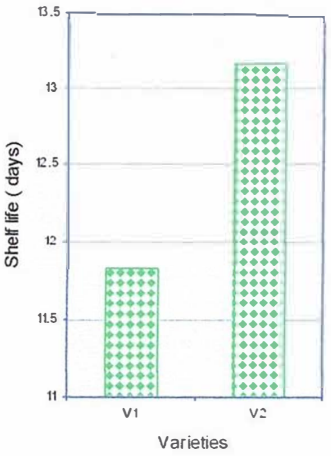


Fig. 2.32 Effect of varieties on shelf life of mango

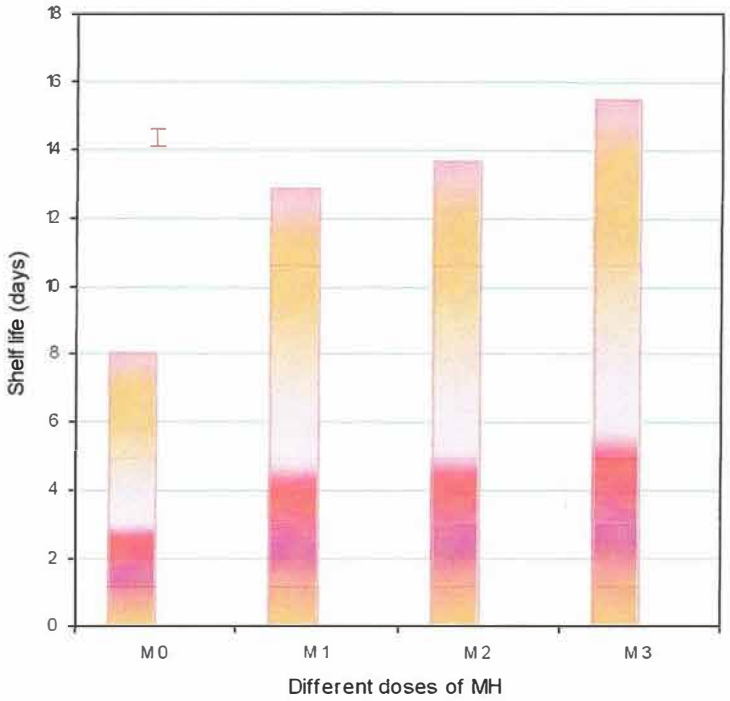


Fig. 2.33 Effect of different doses of MH solution on shelf life of mango. Vertical bars represent LSD at 0.05 level

Graph represents

V_1 = Langra	M_1=200 ppm of MH solution
V_2 = Khirshapat	M_2=400 ppm of MH solution
M_0 = Control	M_3 =600 ppm of MH solution

Table 2.18 Changes of zinc content in varieties and shelf life of postharvest mango during storage at ambient condition

Treatments	Zinc content (mg/100 g) at different days					Shelf life
Variety	Initial	3	6	9	12	Total days
V_1	1.31 b	1.20 b	1.07 b	0.92 b	0.76 b	11.83 b
V_2	1.54 a	1.32 a	1.20 a	1.05 a	0.89 a	13.17 a
Level of significance	***	***	***	***	***	***

Table 2.19 Combined effects of varieties and different doses of Maleic hydrazide solution on zinc content and shelf life of postharvest mango during storage at ambient condition

Treatments combination	Zinc content (mg/100 g) at different days					Shelf life
Varieties × Treatments	Initial	3	6	9	12	Total days
V_1M_0	1.30 ef	1.15 f	0.98 f	0.78 g	0.53 f	7.33 e
V_1M_1	1.28 f	1.18 e	1.03 e	0.87 f	0.70 e	12.33 c
V_1M_2	1.32 de	1.22 d	1.11 d	0.99 d	0.85 c	12.67 c
V_1M_3	1.33 d	1.24 d	1.15 c	1.05 c	0.94 b	15.00 ab
V_2M_0	1.52 bc	1.28 c	1.12 d	0.93 e	0.73 d	8.67 d
V_2M_1	1.51 c	1.31 b	1.16 c	0.99 d	0.84 c	13.33 c
V_2M_2	1.54 b	1.33 b	1.22 b	1.09 b	0.95 b	14.67 b
V_2M_3	1.58 a	1.37 a	1.28 a	1.17 a	1.03 a	16.00 a
Level of significance	NS	NS	NS	NS	**	NS
CV%	1.47	1.68	1.88	2.16	2.58	5.76

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
M_0 =Control
M_1=200 ppm of MH solution
M_2=400 ppm of MH solution
M_3 =600 ppm of MH solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

9.0 Experiment 3

Effect of different doses of Gibberellic acid on physicochemical behavior and shelf life of postharvest mango

9.1 Changes in skin color

Different doses of Gibberellic acid (GA3) strongly influenced the skin color of both the fruits namely Langra and Khirshapat (Table 3.1). Both varieties demonstrated the original green color at the initial day of harvesting. At 3rd day, Langra developed into a trace in yellow color at control (G_0) and light green color at 100 ppm (G_1) and 200 ppm (G_2) as well as held green color at 400 ppm (G_3) treatment. Khirshapat showed trace in yellow color at control, light green color at G_1 and G_2 treatment. But, it retained its original green color at G_3 treatment.

At 6th day, Langra was noticed yellow at control (G_0), yellowish green at 100 ppm (G_1) and 200 ppm (G_2) while light green was observed from 400 ppm (G_3) treatment. On the other hand, Khirshapat developed yellowish green, trace in yellow and yellowish green color at G_0, G_1, and G_2 treatments, respectively but, it retained its original green color at G_3 treatment.

At 9th day, Langra gave deep yellow color at control, greenish yellow at G_1 and G_2 as well as trace in yellow color at G_3 treatments. Khirshapat showed yellow color at control, greenish yellow and trace in yellow at G_1 and G_2 treatments. But, it also retained its original green color at G_3 treatment.

After 12th day of storage, Langra was found blackish yellow at control and yellow at G_1 and yellowish green at G_2 and G_3 treatments. On the other hand, Khirshapat was also found blackish yellow color at G_0, yellow, yellowish green and trace in yellow at G_1, G_2 and G_3 treatments, respectively. After 15 days of storage, Langra showed no existence at control and G_1 treatment yellow and greenish yellow at G_2 and G_3 treatments, respectively. Khirshapat completely denoted as putrefied condition at G_0, and G_1, treatment and yellow and yellowish green was noticed from G_2 and G_3 treatments, respectively.

Table 3.1 Changes in skin color of two mango varieties as influenced by different doses of Gibberellic acid during storage at ambient condition

Varieties	Treatments	Days after storage					
		Initial	3	6	9	12	15
V_1	G_0	Green	Trace in yellow	Yellow	Deep yellow	Blackish yellow	_
	G_1	Green	Light green	Yellowish green	Greenish yellow	Yellow	_
	G_2	Green	Light green	Yellowish green	Greenish yellow	Yellowish green	Yellow
	G_3	Green	Green	Light green	Trace in yellow	Yellowish green	Greenish yellow
V_2	G_0	Green	Trace in yellow	Yellowish green	Yellow	Light spotted yellow	_
	G_1	Green	Light green	Trace in yellow	Greenish yellow	Yellow	_
	G_2	Green	Light green	Yellowish green	Trace in yellow	Yellowish green	Yellow
	G_3	Green	Green	Green	Green	Trace in yellow	Yellowish green

Table indicates

V_1 = Langra G_0 =Control G_2=200 ppm of GA3

V_2 = Khirshapat G_1=100 ppm of GA3 G_3 =400 ppm of GA3

9.2 Changes in physical characters during storage environments

Different parameters subjected to the physical changes of mangoes are presented and elucidated in the following sub-headings.

9.2.1 Physiological weight loss

Varieties had highly significant variation in relation to PWL at different days after storage (Appendix). At each day, Khirshapat (V_2) gradually showed more PWL as compared to Langra with the increase of storage duration (Table 3.2). The highest (10.62%) and lowest (9.72%) of PWL were reported from Khirshapat and Langra at 12^{th} day, respectively. The results explored that total PWL progressively augmented with the advancement of storage duration. The findings also elucidated that Langra showed better performance in respect of PWL as compared to Khirshapat. Water loss through lenticel seems to be the probable cause of physiological weight loss in the fruits during storage. Lower lenticel density in Langra facilitated lesser water loss leading to minimum total weight loss (Azad, 2001). Singh *et al.* (2000) also reported more or less the same findings.

Analysis of variance of mango in terms of PWL as influenced by different doses of Gibberellic acid (GA3) showed highly significant variation at different days after storage (Appendix 3.1 and). At different days, it explored that control treatment was very faster in PWL compared to G_1, G_2 and G_3 treatments. At 12^{th} day, the maximum PWL (11.64%) was noticed at G_0 and minimum (9.09%) at G_3 treatment (Fig. 3.1). These phenomena happened might be possibly due to 400 ppm of GA3 solution reduced the metabolic activities of mango resulting in lower PWL. These results are in partial coincided with the findings of Reddy and Haripriya (2002).

The combined effect of varieties and different doses of GA3 solution demonstrated significant variation in PWL at different days after storage (Appendix 3.1). At different days, it denoted that various treatments combination affected in PWL gradually with the advancement of storage duration. At 12^{th} day, there showed the maximum PWL (11.97%) at V_2G_0 and the minimum (8.65%) at V_1G_3. It also

indicated that langra lost the minimum amount of water along with G_3 treatment followed by the other treatment combinations.

9.2.2 Moisture content

The analysis of variance of imposed varieties exhibited highly significant variation in moisture content at different days after storage except initial day (Appendix 3.1). At different days, it interpreted that moisture content augmented with the passing of storage duration. The increasing trend was more or less the similar from initial to 9th day and thereafter, it reduced the increasing trend due to decay. It also illustrated that each day of storage, Khirshapat gave more moisture comparing to Langra. The highest (87.85%) and the lowest (85.85%) were recorded from V_2 and V_1 at 12th day, respectively (Table 3.2). Shajahan *et al.* (1994) observed different results in this regard and the moisture content increased in Langra than Khirsapat. But, these results are in agreement with the findings of Azad (2001). This variation might be possible due to genetical, location, weather effect and soil quality or maturity of the fruit.

Variation among the means of different doses of GA3 solution in relation to moisture content was noticed to be significant at different days after storage except initial day (Appendix 3.1). At different days of storage, moisture content increased in a continuous stream with the increase of storage duration. The last increased point was observed from control and G_1 treatment at 6 and 9th day (Fig. 3.2) whereas; G_2 and G_3 treatments produced increasingly onward. Untreated fruit gave the highest moisture content (87.40%) at 9th day and the lowest (85.30%) was recorded from G_3 treatment. The increasing trend of moisture content from initial to 6th day might be possibly due to metabolic activities and osmotic pressure inside the mango fruit as well as its decreased might be due to suppression of metabolic activities resulting in decaying and drying.

The combined effect of varieties and different doses of GA3 solution in respect of moisture content showed non significant variation at different days after storage (Appendix 3.1). At different days of storage, moisture content was added in mango with the increase of storage period. The treatment combinations of V_2G_0, V_2G_1 and

V_2G_2 provided the maximum moisture content (88.40%, 88.40% and 88.80%) at 6, 9 and 12th days, respectively (Table 3.3). In this storage period, the lowest values (83.50%, 84.30% and 85.10%) were added from the treatment combination of V_1G_3 (Table 3.3). The increase of moisture content from initial to consequent day might be possible due to metabolic activities and osmotic principles and decreasing in a certain day might be due to suppression metabolic activities resulting in drying, transpiration and evaporation. Moisture content increased in the present study is in partially agreement with the findings of El-Mahmoudi and Eisawi (1968) in banana.

9.2.3 Dry matter content

The variation in varieties means in relation to dry matter content showed highly significant at different days after storage (Appendix 3.2). At each day, dry matter decreased successively with the passing of storage duration. It indicated that Langra provided comparatively more dry matter comparing to Khirshapat. At initial day, Langra produced higher (17.65%) dry matter whereas, Khirshapat gave lower (15.64%) and at 12th day, Langra received the maximum (14.20%) whereas Khirshapat received 12.15 % (Table3.4). These results are in partially supported by the findings of Hassain (1991).

Different doses of GA3 solution imposed in this study in terms of dry matter content of mango pulp showed highly significant variation at different days after storage (Appendix 3.2). At different days of storage, dry matter content reduced continuously with the advancement of storage duration (Fig. 3.3). It also denoted that G_3 treatment contributed the highest dry matter (15.50%) at 6th day whereas; the lowest dry matter (12.65%) was reported from control.

The combined effect of varieties and different doses of GA3 solution on dry matter content of mango pulp exhibited non significant variation at different days after storage (Appendix 3.2). At initial day, the highest dry matter content (17.80%) was obtained from the treatment combination of V_1G_3 which was statistically similar with the treatment combination of V_1G_0, V_1G_1 and V_1G_2 whereas; the lowest (15.40%) was obtained from the treatment combination of V_2G_0 which was also statistical similar with the combinations of V_2G_1 and V_2G_2. At 12th day, the highest value

(14.90%) was noticed from the treatment combination of V_1G_3 and V_1G_0 and the lowest value (11.20%) was noticed from V_2G_2 (Table 3.5). The successively decrease in dry matter content with the advancement of storage period might be possibly due to breaking down the complex carbohydrates into simple molecules and H_2O as well as adding water through osmotic process and metabolic activities. The decreasing of dry matter content of mango pulp was not supported by the findings of Hossain (1999).

9.2.4 Ash content

Variation in varieties means in respect of ash content of mango pulp exhibited significant variation at different days after storage except 3rd day (Appendix 3.2). At different days of storage, values of ash content decreased continuously with the passing of storage duration. It was noticed that langra produced comparatively more ash than Khirshapat at all days of storage. Higher (1.01%) ash content was recorded from Langra at initial day whereas Khirshapat gave (0.90%) and again, higher (0.81%) was gathered from Langra and lesser achievement (0.70%) was gathered from Khirshapat.

Different doses of GA3 solution were identified as non significant variation in respect of ash content of mango pulp at different days after storage (Appendix 3.2). It indicated that ash content influenced by different doses of GA3 decreased slightly from G_3 treatment and markedly from control (Fig. 3.4).

The combined effect of varieties and different doses of GA3 solution were reported to be non-significant variation in terms of ash content of mango at various days after storage (Appendix 3.2 and Table 3.5).There was no available research findings regarding ash content of mango. It also exposited that ash content was intimately associated with dry matter content. The results of the present study elucidated that ash content decreased in relation to dry matter content.

9.3 Changes in biochemical properties of mango during storage environments

Various changes regarding to biochemical properties of mango fruits as influenced by GA3 are presented and discussed under the following sub-headings.

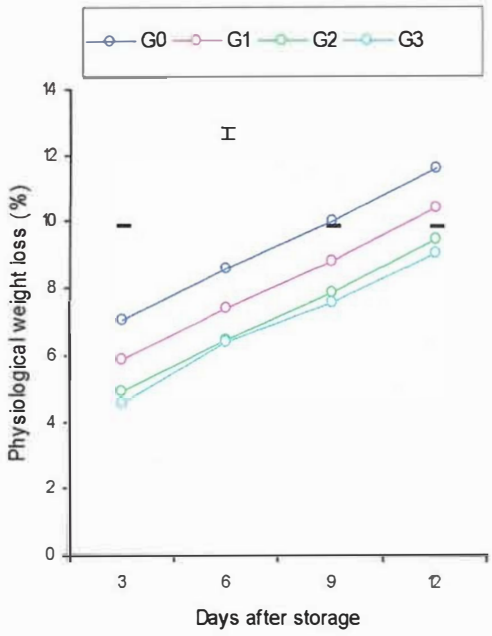


Fig. 3.1 Effect of different doses of Giberellic acid (GA3) on physiological weight of mango at different days after storage. Vertical bars represent LSD at 0.05 level

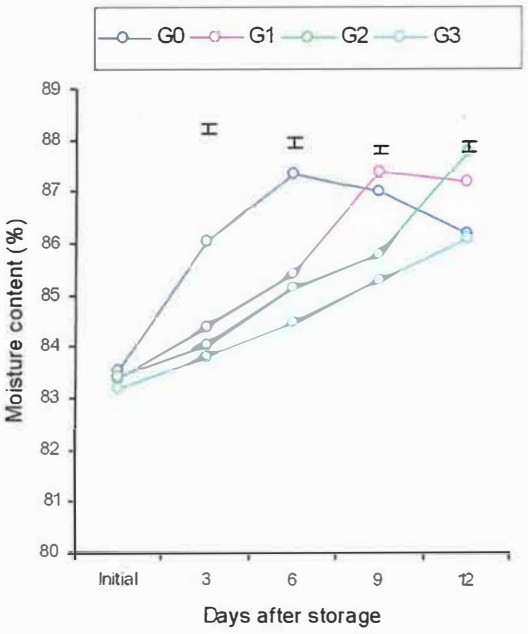


Fig. 3.2 Effect of different doses of Gibberelic acid (GA3) on moisture content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

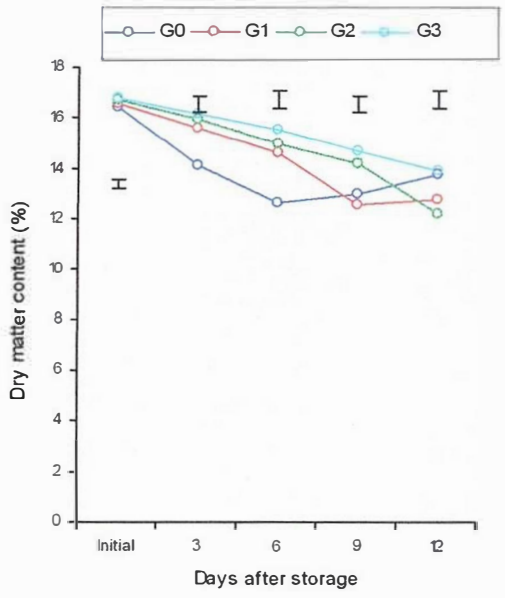


Fig. 3.3 Dry matter content of mango pulp as influenced by different doses of Gibberellic acid (GA 3) at different days after storage. Vertical bars represent LSD at 0.05 level

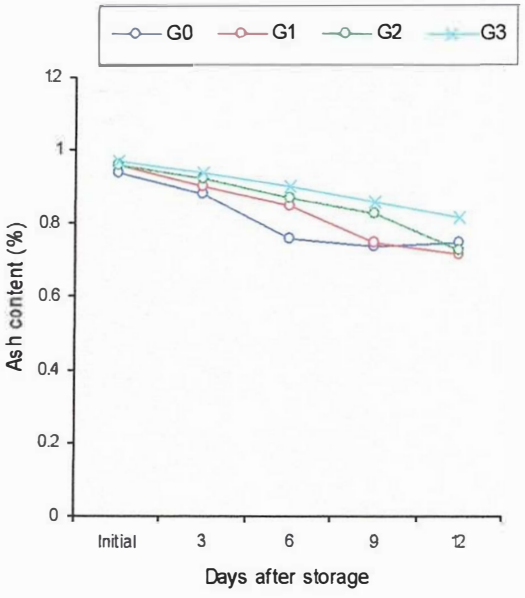


Fig. 3.4 Ash content of mango pulp as influenced by different doses of Gibberellic acid (GA 3) at different days after storage. Vertical bars represent LSD at 0.05 level

Graphs represent
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution

Table 3.2 Changes of physiological weight loss and moisture content in mango varieties during storage at ambient condition

Treatments	Physiological weight loss (%) at different days				Moisture content (%) at different days				
Variety (V)	3	6	9	12	Initial	3	6	9	12
V_1	5.15 b	6.65 b	8.13 b	9.72 b	82.43 b	83.53 b	84.53 b	85.36 b	85.80 b
V_2	6.05 a	7.78 a	9.02 a	10.62 a	84.36 a	85.62 a	86.68 a	87.40 a	87.85 a
Level of significance	***	***	***	***	***	***	***	***	***

Table 3.3 Combined effects of varieties and different doses of Gibberellic acid solution on physiological weight loss and moisture content of postharvest mango during storage at ambient condition

Treatments combination	Physiological weight loss (%) at different days				Moisture content (%) at different days				
Varieties × Treatments	3	6	9	12	Initial	3	6	9	12
V_1G_0	6.70 b	8.20 b	9.65 b	11.30 b	82.50 b	84.80 c	86.30 b	85.93 d	85.10 f
V_1G_1	5.40 d	6.90 c	8.35 d	9.98 d	82.40 b	83.40 d	84.40 d	86.40 c	86.20 e
V_1G_2	4.35 f	5.85 d	7.40 f	8.96 f	82.63 b	83.10 de	83.90 e	84.80 e	86.80 d
V_1G_3	4.15 g	5.65 d	7.10 g	8.65 g	82.20 b	82.80 e	83.50 f	84.30 f	85.10 f
V_2G_0	7.40 a	8.96 a	10.35 a	11.97 a	84.60 a	87.23 a	88.40 a	88.10 a	87.30 c
V_2G_1	6.30 c	7.90 b	9.30 c	10.90 c	84.40 a	85.40 b	86.40 b	88.40 a	88.20 b
V_2G_2	5.50 d	7.05 c	8.40 d	10.07 d	84.25 a	85.05 bc	86.40 b	86.80 b	88.80 a
V_2G_3	5.00 e	7.22 c	8.03 e	9.52 e	84.20 a	84.80 c	85.50 c	86.30 c	87.10 cd
Level of significance	***	*	*	**	NS	NS	NS	NS	NS
CV%	1.24	2.89	0.85	0.71	0.41	0.28	0.25	0.23	0.23

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non -significant

Table 3.4 Dry matter and ash content of mango pulp changes in varieties during storage at ambient condition

Treatments	Dry matter content (%) at different days					Ash content (%) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	17.65 a	16.48 a	15.48 a	14.65 a	14.20 a	1.01 a	0.96	0.90 a	0.85 a	0.81 a
V_2	15.64 b	14.46 b	13.38 b	12.61 b	12.15 b	0.90 b	0.86	0.79 b	0.74 b	0.70 b
Level of significance	***	***	***	***	***	*	NS	*	*	*

Table 3.5 Combined effects of varieties and different doses of Gibberellic acid solution on dry matter and ash content of postharvest mango during storage at ambient condition

Treatments combination	Dry matter content (%) at different days					Ash content (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1G_0	17.50 a	15.20 c	13.70 e	14.10 c	14.90 a	1.00	0.91	0.81 ab	0.81 ab	0.80
V_1G_1	17.60 a	16.60 b	15.60 c	13.60 d	13.80 b	1.01	0.95	0.90 a	0.80 ab	0.77
V_1G_2	17.70 a	16.90 ab	16.10 b	15.20 b	13.20 c	1.01	0.97	0.93 a	0.88 ab	0.78
V_1G_3	17.80 a	17.20 a	16.50 a	15.70 a	14.90 a	1.02	0.99	0.95 a	0.91 a	0.87
V_2G_0	15.40 c	13.10 e	11.60 f	11.93 f	12.70 d	0.88	0.84	0.70 b	0.67 b	0.70
V_2G_1	15.60 bc	14.60 d	13.60 e	11.60 f	11.80 e	0.90	0.85	0.80 ab	0.70 ab	0.67
V_2G_2	15.75 bc	14.95 c	13.80 e	13.20 e	11.20 f	0.91	0.87	0.81 ab	0.78 ab	0.68
V_2G_3	15.80 b	15.20 c	14.50 d	13.70 d	12.90 cd	0.92	0.88	0.85 ab	0.80 ab	0.76
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	1.18	1.27	1.40	1.45	1.53	10.57	13.86	11.98	13.73	14.07

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non -significant

9.3.1 Vitamin C content

Differences between two varieties in relation to vitamin C content of mango pulp were highly significant at different days after storage (Appendix 3.3). At various days of storage, it expounded that Langra showed better performance in synthesis of vitamin C as compared to Khirshapat (Table 3.6). It also narrated that quantity of vitamin C diminished with the advancement of storage period. At the initial day, Langra accumulated the highest (131.65 mg/100 g) quantity of vitamin C whereas; Khirshapat gave the lowest (45.99 mg/100 g). At 12th day, Langra again, was notified the highest (17.18 mg/100 g) producer of vitamin C and Khirshapat was the lowest (9.25 mg/100 g) producer (Table 3.6). These results annotated that vitamin C content successively came down with the augmentation of storage duration in both the varieties. It might be probably due to rising of ethylene synthesis resulting in oxidation of ascorbic acid. The results of the present study are in agreement with the findings of Azad (2001), Shyamalamma (1995), Gofur *et al.* (1994) and Absar *et al.* (1993).

Variation among the means of different doses of GA3 solution in terms of vitamin C content exhibited highly statistical significant at different days after storage (Appendix 3.3). At initial day, green mangoes treated with G_3 dose accumulated the highest (89.43 mg/100 g) amount of vitamin C whereas; the lowest (87.78mg/100 g) was accumulated in the untreated mango but, the lowest value was statistically at par with G_1 treatment. After initial level, it diminished in a continuous stream with the passing of storage time (Fig. 3.5). It also explored that diminishing rate was faster in control, but it was slower in G_3 treated fruit. At 12th day, vitamin C content ranged between 8.70 to 17.70 mg per 100 g of pulp obtained from control (T_0) and G_3 treated fruit, respectively. The reduction of vitamin C content in both treated and untreated mangoes at different storage period might be possible due to oxidation of ascorbic acid and G_3 dose was possibly causing delay ripening which resulted in lower oxidation of vitamin C. These results are in supported by the findings of Hossain (1999). Jain and Mukherjee (2001) also reported the similar results.

The combined effect of varieties and different doses of GA3 solution showed significant variation in respect of vitamin C content at different days after storage

except initial day (Appendix 3.3 and Table 3.7). At various days during storage, it was notified that vitamin C content fell away with the rising of storage period. The quantity of vitamin C ranged between 4.90 to 21.50 mg per 100 g of fresh mango pulp at 12th day in the treatment combination of V_1G_3 and V_2G_0, respectively (Table 3.7).

9.3.2 Titratable acidity

Variation in between varieties means in terms of titratable acidity was observed to be highly significant at different days after storage (Appendix 3.4). At various days during storage, Langra showed higher titratable acid content as compared with Khirshapat. Titratable acidity fell off with the passing of storage period. The diminishing trend was very fast from initial to 3rd day and thereafter, its trend was comparatively slower (Table 3.8). At initial day, the highest (3.88%) was derived from Langra whereas the lowest (2.60%) was derived from Khirshapat. At 12th day, the highest (0.35%) was reported from langra whereas; Khirshapat produced the lowest amount (0.29%). The abating trend of titratable acidity at storage period was reported by Upadhyay and Tripathi (1985), Leon and Lima (1968) and Medlicott *et al.* (1986). According to them, acidity was reduced during storage growth on attainment of maturity and ripening. The results of the present investigation might be possibly due to genetical dissimilarities between two varieties.

Different doses of GA3 solution used in this investigation in terms of titratable acidity exhibited significant variation among the means at various days after storage (Appendix 3.4). At various days of storage, titratable acid content came down very sharply from initial to 3 days and then, it came down steadily (Fig. 3.6). In all the storage period, higher titratable acidity (3.29, 1.30, 1.00, 0.79 and 0.49%) was noted at G_3 treatment from initial to 12th days followed by 3.15, 0.75, 0.45, 0.26 and 0.14% from untreated mangoes, respectively (Fig. 3.6). These results are in conformity with the findings of Gain and Mukherjee (2001) and Khumlert (1992) also found the similar results.

The combined effect of varieties and different doses of GA3 solution in relation to titratable acidity of mango pulp exhibited significant variation at different days after storage except 9th and 12th days (Appendix 3.4 and Table 3.9). At different days of storage, there showed a diminishing trend of titratable acid content

with the expansion of storage period (Table 3.9). At 6th day, the highest (1.10%) quantity was obtained from the treatment combination of V_1G_3 which was statistical similar with the combination of V_1G_2 and the lowest acid concentration (0.35%) obtained from the treatment combination of V_2G_0 (Table 3.9). These occurrences might be probably due to the reduction of acid oxidation at V_2G_3 combination and, to have genetical variation in between varieties.

9.3.3 Pulp pH

The analysis of variance in between the varieties showed significant in respect of pulp pH of mango at different days after storage except initial and 12th day (Appendix 3.4 and Table 3.8). At various days of storage, there noticed an increasing trend of pulp pH with the rising of storage period. In each storage period, pulp pH exposited more in Khirshapat compared with Langra. Higher pulp pH (4.55) was notified from Khirshapat at 3rd day whereas; lower (4.30) was identified from Langra. At 12th day, the highest pH (6.80) was identified with Khirshapat and the lowest value (6.70) was identified with Langra. The growing up trend of pulp pH was also observed by Yuniarti (1980), Kumar *et al.* (1993) and Shahjahan *et al.* (1994). This phenomenon might be possible due to oxidation of acid during storage resulting in higher pH and also might have genetical dissimilarities between varieties.

Different doses of GA3 solution imposed to this trial demonstrated significant variation in pulp pH at different days after storage (Appendix 3.4). The rising trend of pulp pH was found from different treated and untreated fruits at various days of storage (Fig. 3.7). Pulp pH was higher in control at all stages of storage period followed by the fruits treated with G_1, G_2 and G_3 treatments. The pH of mango pulp was the highest (7.05) in control whereas the fruits treated with G_3 treatment gave the lowest (6.45) value at 12th day (Fig. 3.7). The results of the present investigation of GA3 solution at G_3 treatment retarded the loss of acid oxidation resulting in lower pH value. These results are in partially supported by the report of Jain and Mukherjee (2001).

The combined effect of varieties and different doses of GA3 solution implied to this study in pulp pH were noticed to be non significant at different days after storage (Appendix 3.4). There was the indication of an enhancing trend of pulp pH from various treatment combinations at different days of storage (Table 3.9). At 12th

day, the highest (7.10) pH value was obtained from the treatment combination of V_2G_0 and the lowest (6.4) was obtained from the treatment of combination of V_1G_3.

9.3.4 Total soluble solid (Brix %) content

Statistically highly significant variation was found in TSS content between two varieties at different days after storage (Appendix 3.5). The results showed that TSS content of mango pulp enlarged continuously with the rising of storage period. The increasing trend was faster from initial to 6th day thereafter; it increased slower. From initial to 6th day, Khirshapat was performed better in TSS accumulation than Langra. But, after 6th day, Langra performed better than Khirshapat up to 12th day. At 9th day, the highest (16.28%) TSS quantity was noticed from Khirshapat and the lowest (16.03%) was noticed from Langra (Table 3.10). Increased in the percentage of TSS during storage in mango pulp was reported by Singh (1968). Absar *et al.* (1993) reported that TSS was increased with maturity of mango fruit, but, they found highest TSS in Langra. Mollah and Siddique (1973) reported that TSS value varied from cultivar to cultivar. These might be possible due to genetically differences between varieties.

Different doses of GA3 solution subjected to the postharvest mangoes in this study were observed to be significant variation in respect of TSS content at different days after storage (Appendix 3.5). At different days of storage, it narrated that TSS accumulation augmented with the expansion of storage duration. The results also illustrated that TSS content was sharply grown up from untreated mangoes from initial to 6th day and then, it fell off significantly (Fig. 3.8). The other treatment such as G_1 also increasingly provided TSS from initial to 9th day and thereafter, it decreased sharply. Mango fruits treated with G_2 also produced more or less similar increasing trend from initial to 12th day. But, the fruits treated with G_3 dose provided very steady rate in TSS accumulation at various days (Fig. 3.8). The highest (19.25, 19.25 and 19.30%) accumulation of TSS was derived from G_0, G_1 and G_2 treatment at 6, 9 and 12th days whereas, the lowest (10.20, 13.00 and 16.00%) was derived from G_3 treatment, respectively. The results of the present study are strongly supported by the findings of Jain and Mukherjee (2001). These happened possibly due to ripening condition resulting in maximizing TSS gathering in control and 400 ppm of GA3 solution retarded in ethylene synthesis that caused delay ripening and

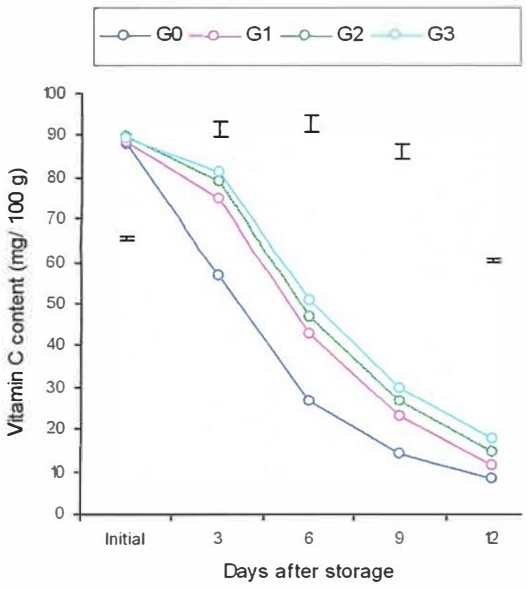


Fig. 3.5 Effect of different doses of GA3 on vitamin C content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

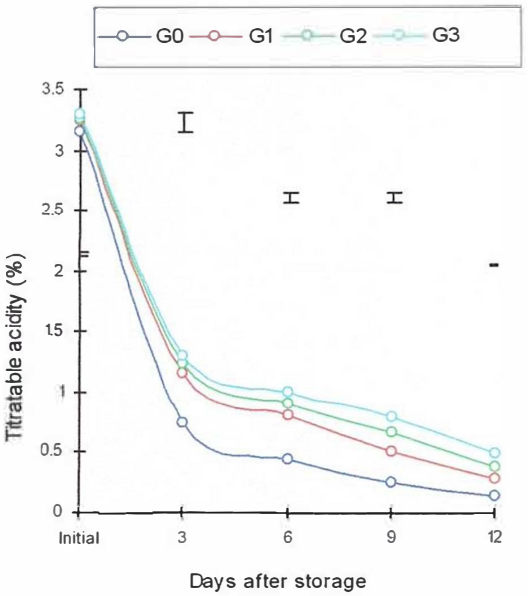


Fig. 3.6 Titratable acidity of mango pulp as influenced by different doses of GA3 at different days after storage. Vertical bars represent LSD at 0.05 level

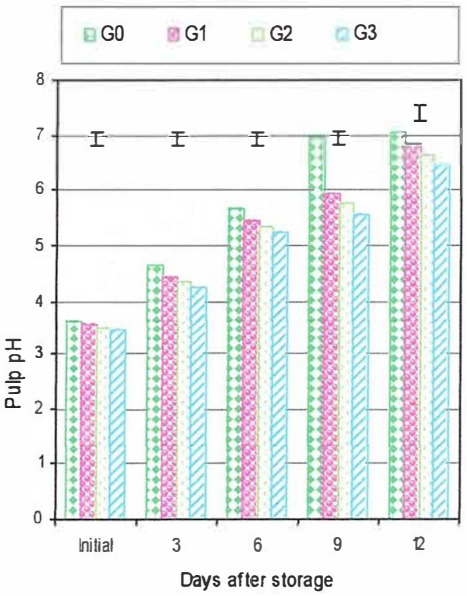


Fig. 3.7 Pulp pH of mango as influenced by different doses of GA3 at different days after storage. Vertical bars represent LSD at 0.05 level

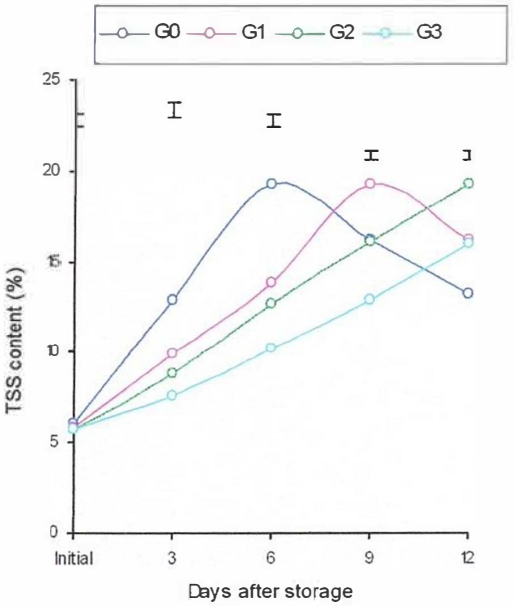


Fig. 3.8 Effect of different doses of GA3 on total soluble solid content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

Graphs represent
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution

Table 3.6 Changes of vitamin C content of mango pulp in varieties during storage at ambient condition

Treatments	Vitamin C content (mg/100 g) at different days				
Variety (V)	Initial	3	6	9	12
V_1	131.65 a	111.48 a	64.40 a	35.23 a	17.18 a
V_2	45.99 b	34.38 b	19.49 b	11.90 b	9.25 b
Level of significance	***	***	***	***	***

Table 3.7 Combined effects of varieties and different doses of Gibberellic acid solution on vitamin C content of postharvest mango pulp during storage at ambient condition

Treatments combination	Vitamin C content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12
V_1G_0	130.80 a	87.51 c	40.30 d	20.50 d	12.50 e
V_1G_1	131.50 a	115.50 b	67.53 c	35.40 c	15.20 c
V_1G_2	131.90 a	120.60 a	72.20 b	40.20 b	19.50 b
V_1G_3	132.50 a	122.30 a	77.55 a	44.80 a	21.50 a
V_2G_0	44.80 c	25.60 g	13.66 h	8.30 h	4.90 h
V_2G_1	45.50 bc	34.30 f	18.30 g	10.80 g	7.80 g
V_2G_2	47.30 b	37.40 e	21.40 f	13.20 f	10.40 f
V_2G_3	46.35 bc	40.20 d	24.60 e	15.30 e	13.90 d
Level of significance	NS	***	***	***	***
CV%	1.22	1.44	2.61	3.82	1.28

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Table 3.8 Changes of titratable acidity and pulp pH of postharvest mango pulp between varieties during at ambient condition

Treatments	Titratable acidity (%) at different days					Pulp pH at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	3.88 a	1.20 a	0.86 a	0.61 a	0.35 a	3.50	4.30 b	5.30 b	5.93 b	6.70
V_2	2.60 b	1.03 b	0.71 b	0.49 b	0.29 b	3.58	4.55 a	5.55 a	6.18 a	6.80
Level of significance	***	***	***	***	***	NS	***	***	***	NS

Table 3.9 Combined effects of varieties and different doses of Gibberellic acid solution on titratable acidity and pulp pH of postharvest mango during storage at ambient condition

Treatments combination	Titratable acidity (%) at different days					Pulp pH at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1G_0	3.80 b	0.95d	0.55 e	0.30 e	0.15 g	3.60 ab	4.60 ab	5.60 ab	6.90 a	7.00 ab
V_1G_1	3.90 ab	1.20 bc	0.85 c	0.58 c	0.33 e	3.50 ab	4.30 de	5.30 de	5.80 cd	6.80 b-d
V_1G_2	3.82 b	1.28 ab	0.95 b	0.72 b	0.40 c	3.50 ab	4.20 ef	5.20 ef	5.60 e	6.60 d-f
V_1G_3	3.98 a	1.35 a	1.10 a	0.85 a	0.52 a	3.40 b	4.10 f	5.10 f	5.40 f	6.40 f
V_2G_0	2.50 d	0.55 e	0.35 f	0.22 f	0.12 h	3.70 a	4.70 a	5.70 a	7.00 a	7.10 a
V_2G_1	2.60 d	1.10 c	0.75 d	0.42 d	0.25 f	3.60 ab	4.60 ab	5.60 ab	6.10 b	6.90 a-c
V_2G_2	2.70 c	1.20 bc	0.85 c	0.60 c	0.35 d	3.50 ab	4.50 bc	5.50 bc	5.90 c	6.70 c-e
V_2G_3	2.60 cd	1.25 ab	0.90 bc	0.73 b	0.45 b	3.50 b	4.40 cd	5.40 cd	5.70 de	6.50 ef
Level of significance	**	***	*	NS	NS	NS	NS	NS	NS	NS
CV%	1.65	4.82	4.07	5.80	5.26	2.95	2.40	1.96	1.73	1.85

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

ultimately in lower TSS accumulation. It also explained that TSS gathering is strongly related to ripening and it caused decrease owing to decaying.

The combined effect of varieties and imposed different doses of GA3 solution on TSS content were found to be significant at different days after storage except initial and 3rd day (Appendix 3.5). The result was expounded a rising behavior of TSS content at different days after storage (Table 2.11). The highest accumulation (19.50, 19.30 and 19.50) was derived from the treatment combination of V_1G_0, V_1G_1 and V_1G_2 at 6, 9 and 12th days, whereas; the lowest value (10.30, 12.90 and 15.90) was identified from the treatment combination of V_2G_3, respectively.

9.3.5 Total sugar content

Highly significant variation was noticed between both the varieties means in terms of total sugar content of mango pulp at different days after storage (Appendix 3.5). The results interpreted that TSC accumulated successively with the rising of storage duration. The accumulating trend was more or less sharp from initial to 9th day in both the varieties, thereafter; it grew up slightly slower. At all days of storage Khirshapat contributed more accumulation of of TSC than Langra. At initial day, Khirshapat gave the highest (5.80%) whereas; Langra produced the lowest (5.34%). At 12th day, Khirshapat produced the highest quantity (18.80%) and the lowest (18.35%) was obtained from Langra. Upadhyay and Tripathi (1985) reported that total sugar content was augmented gradually, when stored for 6 days at room temperature. Sugar content increased during ripening (Srivastava, 1967). These results are in conformity with the findings of Shahjahan *et al.* (1994). Tsuda *et al.* (1999) also found the similar results. The increase in TSC might be due to conversion of complex starch or carbohydrate into simple compound like sucrose, Fructose, galactose etc.

Different doses of GA3 solution implied to the investigation on total sugar content of mango pulp exhibited significant variation at different days after storage (Appendix 3.5). At different days of storage, the results noticed that TSC augmented markedly with the rising of storage period (Fig. 3.9). The developing trend was very fast in untreated mango followed by other treatments *viz.*, G_1, G_2 and G_3, respectively. The highest quantity of TSC (20.95% and 20.60%) was recorded in control and G_1 treated mangoes at 9 and 12th days, whereas; the lowest (11.64%

and 14.60%) was recorded at G_3 treatment. The findings of the present investigation are inconformity with the reports of Jain and Mukherjee (2001) and Singh *et al.* (1995). The enhancing trend of total sugar at untreated mangoes might be possible due to breaking down of complex carbohydrate into simple compound but, G_3 treatment made delay ripening at storage period resulting in lower conversion of complex compound into simple molecules.

The combined effect of varieties and used different doses of GA3 solution in this study in relation to total sugar content of mango pulp showed non significant variation at different days after storage (Appendix 3.5). These results noted that total sugar content accumulated successively with the rising of storage period (Table 3.11). At 12^{th} day the maximum (20.80%) quantity of TSC was achieved from the treatment combination of V_2G_1 whereas, the minimum (14.40%) was achieved from the treatment combination of V_1G_3 (Table 3.11).

9.3.6 Reducing sugar content

Analysis of variance demonstrated significant variation on reducing sugar content of mango pulp at different days after storage except at 6^{th} day (Appendix 3.6). There was noticed an enhancing trend of reducing sugar with the expanding of storage period (Table 3.12). It also stated that Khirshapat was better in achieving of reducing sugar than Langra at different days of storage. The highest (5.18%) quantity of this sugar was notified from Khirshapat whereas; the lowest (4.86%) was notified from Langra at 12^{th} days of storage (Table 3.12). These results are in agreement with the report of Upadhyay and Tripathi (1985). Casttrillo et al. (1992) elucidated that reducing sugar was increased during storage period. Khirshapat producing comparatively more reducing sugar might be possibly due to genetical variation in both the varieties.

Different doses of GA3 solution applied to this study were found to be significant in respect of reducing sugar content of mango pulp at different storage period except initial day (Appendix 3.6). The results narrated that reducing sugar of mango pulp was grown up continuously at different days after storage. It also revealed that untreated mangoes were performed better in accumulating of reducing sugar as compared to the other treatments. Control treatment was recorded as more successive producer of reducing sugar up to 9^{th} day and then, it fell off due to

starting spoilage. At 12th day, the maximum (6.18%) amount of reducing sugar was recorded at G_1 and the lowest (3.78%) was recorded at G_3 treatment (Table 3.12). The results of the present investigation are in conformity with the findings of Jain and Mukherjee (2001). Lower changing trend of reducing sugar content treated with G_3 treatment might be possibly due to delay ripening which resulted in lower conversion of carbohydrates into simple's molecules.

The combined effect of varieties and used different doses of GA3 solution of mango pulp exhibited non significant variation in terms of reducing sugar content of mango pulp at different days after storage except 6th day (Appendix 3.6). The results elucidated that reducing sugar content augmented continuously at three days interval up to 9th day thereafter, it abated from the treatment combination of V_2G_0 (Table 3.13). At 12th day, the highest (6.35%) quantity was obtained from the treatment combination of V_2G_2 and the lowest (3.7%) was obtained from V_1G_3.

9.3.7 Non reducing sugar content

The variation between the varieties means exhibited highly significant in respect of non-reducing sugar content at different days after storage (Appendix 3.6). There demonstrated an enlarging trend of non reducing sugar content at different days of storage. At all days, it was noticed that Khirshapat was much better than Langra in achieving of non reducing sugar content (Table 3.12). At 12th day, higher (13.63%) amount of non reducing sugar was recorded from Khirshapat and the lowest (13.46%) amount was recorded from Langra. These results are in conformity with the report of Ali and Mazhar (1960). They reported that non reducing sugar content of ripe fruits was 11.20%. The result obtained from the investigation might be possible due to varietals dissimilarities.

Different doses of GA3 solution subjected to this trial produced the significant variation in respect of non reducing sugar content of mango pulp at different days (Appendix 3.6). The results stated that non reducing sugar content of mango pulp grew up markedly at various days. It also mentioned that untreated fruits were notified better in accumulation of more quantity of non reducing sugar followed by other treatments. This growing up trend was continued up to 9th day and then, it fell off owing to becoming hackneyed. Lower rising trend was noted from the fruit treated with G_3 treatment. The highest result (15.20%) was obtained from control

and the lowest value (10.82%) was obtained from G_3 treatment (Table 3.12). These events might be probably due to G_3 treatment resisted ethylene synthesis of mango pulp resulted in delay ripening and little amount of non reducing sugar deposition. These results are in partially agreement with the reports of Khumlert (1992).

The combined effect of varieties and used different doses of GA3 solution showed non significant variation in terms of non reducing sugar content of mango pulp at different days after storage (Appendix 3.6). There was exposition that a hastening trend of non reducing sugar was notified from different treatment combinations at various days of storage (Table 3.13). At 9th day, the highest (14.80%) quantity of non reducing sugar was derived from the treatment combination of V_2G_0 whereas; the lowest (8.20%) was derived from the treatment combination of V_1G_3.

9.3.8 Crude fibre content

The analysis of variance of mango varieties imposed in this investigation was found to be significant in respect of crude fibre content of mango pulp at different days after storage (Appendix 3.7). The results noticed a growing up trend of crude fibre from both the varieties at different days of storage. It also indicated that Langra was notified better in performing of crude fibre accumulation. At initial day, Langra gave the highest (1.29%) quantity of crude fiber as compared to Khirshapat (1.18%). The amount of crude fiber diminished successively with the increase of storage period from both the varieties. At 12th day, the highest (0.56%) quantity of crude fiber was recorded from Langra whereas; the lowest (0.41%) was reported from Khirshapat (Table 3.14). These results are in partially conformity with the findings of Peter *et al.* (2007). The fall down of crude fibre content with the rising of storage period might be possible due to metabolic activities resulting in hydrolysis of cellulose and lignin into simple molecules.

Various doses of GA3 solution implied to this trial had significant effect on crude fiber content of mango pulp at different days after storage except initial day (Appendix 3.7). The results illustrated that crude fiber content came down successively with the hastening of storage period (Fig. 3.10). At all days of storage, it was notified that crude fiber content was comparatively higher at the fruit treated with G_3 treatment followed by the other treatments. At 3rd day, the maximum

(1.19%) amount of crude fiber was reported from G_3 treatment which was statistically at par with G_1 and G_2 treatments and the lowest (0.91%) was reported from G_0 treatment. At 12th day, the maximum (0.62%) was obtained from G_3 whereas; the lowest (0.42%) was obtained from G_1 treatment which was also statistically at par with G_0 and G_2 (Table 3.14). The diminishing trend of crude fiber influenced by G_3 treatment might be possible due to interruption of ripening resulted in lower declining trend of crude fiber content.

The combined effect of varieties and different doses of GA3 solution were found to be non significant variation in terms of crude fiber content of mango pulp at different days after storage (Appendix 3.7). The results interpreted that crude fibre fell off gradually with the hastening of storage period (Table 3.15). It also elucidated that the treatment combination of V_1G_3 was better in receiving of crude fiber content at all storages duration. At 6th day, the highest (1.13%) quantity of crude fiber was noted from the treatment combination of V_1G_3 which was statistically at par with V_1G_2 and V_2G_3 and the lowest (0.41%) was noted from the treatment combination of V_2G_0.

9.3.9 Total lipid content

The analysis of variance of varieties was highly significant in terms of lipid content in mango pulp at different days after storage (Appendix 3.7). It noticed an enhancing trend of lipid content in mango pulp with the hastening of storage duration. At all days of storage, Langra was observed higher amount of lipid producer comparing to Khirshapat. At 12th day, higher (0.70%) amount of lipid was noticed from Langra and lower (0.65%) was noticed from Khirshapat (Table 3.14). These phenomenon might be possible due to the genetically dissimilarities between two varieties.

Different doses of GA3 solution subjected to this study in terms of lipid content were found to be highly significant at different days after storage (Appendix 3.7). It was exposited that a growing up trend of lipid content was found with the rising of storage period at various days of storage (Fig. 3.11). It also illustrated that control treatment accumulated comparatively higher amount of lipid followed by G_1, G_2 and G_3 treatments from initial to 9th days of storage; and then, it fell off due to starting of decay. At 9th day, the highest (0.80%) amount of lipid content was

obtained from control whereas; the lowest (0.52%) was obtained from the fruit treated with G_3 treatment. At 12th day, G_1 treated fruit gave the highest (0.77%) amount of lipid and the lowest (0.62%) was noted from the fruit treated with G3 treatment. These occurrences might be possible due to G_3 treatment caused delay ripening which resulted in lower production of lipid content

The interaction effects of varieties and imposed various doses of GA3 solution in this trial demonstrated significant variation in respect of lipid content of mango pulp at different days after storage except initial and 3rd day (Appendix 3.7). The results narrated that an increasing trend of lipid content in mango pulp was visible with the hastening of storage duration (Table 3.15). It also explained that the treatment combination of V_1G_0 produced more quantity of lipid at initial to 9th day and then, it came down due to starting in deterioration of fruits. At this time, lower quantity was reported from the treatment combination of V_2G_3. At 9th day, the highest (0.84%) quantity of lipid was reported from the treatment combination of V_1G_0 whereas; the lowest (0.51%) was reported from the treatment combination of V_2G_0, which was statistically at par with V_2G_3. The decrease behavior at V_2G_0 might be perhaps due to spoilage situation of mango fruits and lower in lipid accumulation at V_2G_3 might be due to delay ripening.

9.3.10 Water soluble protein content

The analysis of variance of mango varieties showed significant variation in respect of WSPC in mango pulp at different days after storage except 12th day (Appendix 3.8). There showed an increase trend of WSPC with the advancement of storage duration. It also revealed that Langra was better in WSPC synthesis as compared to Khirshapat at all stages of storage. At 9th day, the highest (1.00%) synthesis of WSPC was noticed from Langra whereas; the lowest (0.88%) was noticed from Khirshapat (Table 3.16). These events were possible due to some of seed protein of mango might have to be disseminated to pulp portion during ripening and complex metabolic activities.

Different doses of GA3 solution subjected to this investigation in terms of WSPC exhibited significant variation at different days after storage except at initial and 12th day (Appendix 3.8). Various results derived from the biochemical analysis was notified an augmenting trend of WSPC in mango pulp with the expansion of

storage period (Fig. 3.12). It also denoted that WSPC was achieved more in untreated fruit followed by the fruit treated with G_1, G_2 and G_3, treatments, respectively. The growing up trend of WSPC in control was very sharp from initial to 6th day thereafter; it declined due to deterioration of fruit condition. At the same time, the increasing trend of WSPC from the fruit treated with G_3 treatment was very slow due to delay ripening. At 9th day, the highest (1.21%) accumulation of WSPC was obtained from control which was statistically identical with G_1 treatment and the lowest (0.69%) was obtained from G_3 treatment which was also statistically at par with G_2 treatment, respectively. It explained that extension of WSPC synthesis was strongly depended upon the fruit ripening.

The combined effect of varieties and applied different doses of GA3 solution in this experiment showed non significant variation in respect of WSPC at different days after storage (Appendix 3.8). The results reported from the studies elucidated that WSPC grew up gradually from initial to 9th day with the treatment combination of V_1G_0 then, it abated due to putrefied condition of fruits whereas, the lower increasing trend was notified from the treatment combination of V_2G_3. At 9th day, the highest (1.25%) quantity of WSPC was derived from the treatment combination of V_1G_0 which was statistically at par with V_1G_1 and V_2G_0 whereas; the lowest (0.65%) was derived from the treatment combination of V_2G_3, which was also statistically at par with V_2G_2 and V_1G_3 (Table 3.17).

9.4 Changes in mineral contents of mango during storage environments

Different changes regarding minerals of mango fruits are presented and interpreted in the following sub-headings.

9.4.1 Phosphorus content

Variation between varieties means in relation to P contents demonstrated highly significant variation at different days after storage (Appendix 3.7). It notified very slow rising trend of P contents in both the varieties with the expansion of storage period (Table 3.16). It also denoted that Langra provided more quantity of Phosphorus as compared to Khirshapat. The growing up trend of P in Langra was more or less similar up to 9th day thereafter, its trend abated due to spoilage of fruits. At 12th day, higher (23.34 mg/100 g) quantity was noticed from Langra and lower (20.69 mg/100 g) was noticed from Khirshapat. Better performance in rising

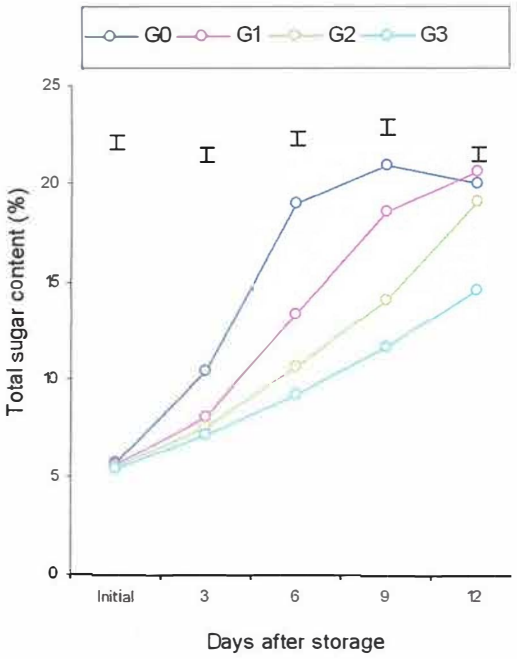


Fig. 3.9 Effect of different doses of GA3 on total sugar content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

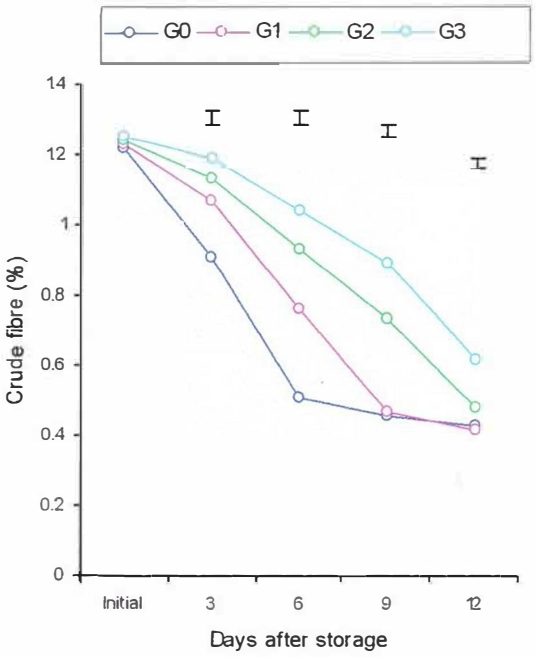


Fig. 3.10 Crude fibre content of mango pulp as influenced by different doses of GA3 at different days after storage. Vertical bars represent LSD at 0.05 level

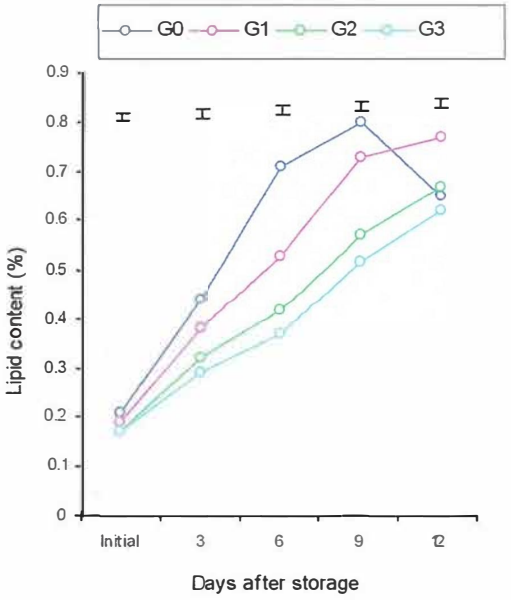


Fig. 3.11 Lipid content of mango pulp as influenced by different doses of GA3 at different days after storage. Vertical bars represent LSD at 0.05 level

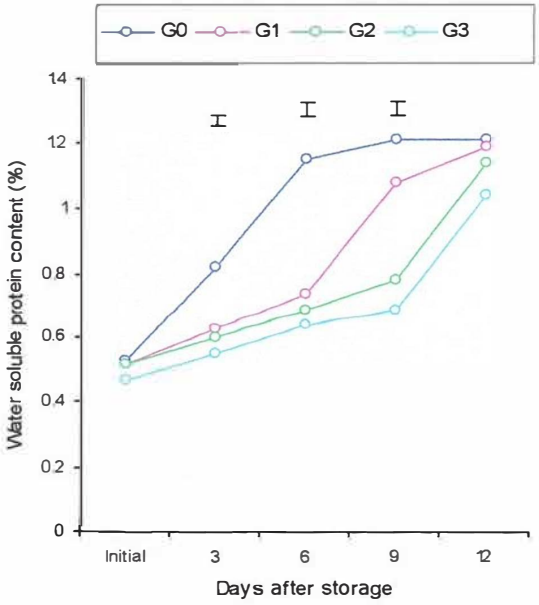


Fig. 3.12 Effect of GA3 on water soluble protein content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

Graphs represent
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution

trend of P content in Langra might be probably due to genetical dissimilarities. It also elucidated that the expansion of P content in mango was intimately associated with ripening during storage. These results are in partially supported by the findings of Nadkarni (1963) when he worked with 16 cultivars and found the range between 10-30 mg/100 g among the cultivars.

Different doses of GA3 solution imposed to this trial in relation to P content showed highly significant at different days after storage (Appendix 3.8). The results stated that P content grew up steadily at various days. It also revealed that P content in control expanded in slow motion from initial to 6th day thereafter; it augmented in further slow motion than its previous trend. After 9th day, it declined possibly due to purified situation of fruit (Fig. 3.13). At 12th day, the maximum (23.04 mg/100 g) quantity of P was noted from the fruit treated with G_1 and the minimum value (21.03 mg/100 g) was noted from the fruit treated with G_3 treatment. Lower quantity from the fruit treated with G_3 treatment might be probably due to delay ripening which resulted in lower accumulation of P content. The results of the present research are partially supported by the findings of Peter *et al.* (2007).

The combined effect of varieties and used various doses of GA3 solution exhibited significant variation on P content of mango pulp at different days after storage except at initial and 3rd day (Appendix 3.8). It observed a growing up trend of P content with the expansion of storage period (Table 3.17). It also revealed that P content accumulated gradually from initial to 9th day from the treatment combination of V_1G_0 and then, it decreased due to bad fruit situation. In this time, it was found lower changing trend from the fruit treated with the treatment combination of V_2G_3. At 12th day, the highest (24.44 mg/100 g) quantity was notified from the treatment combination of V_1G_1 whereas; the lowest (19.65 mg/100 g) was notified from the treatment combination of V_2G_3. It also revealed that Langra along with G_3 treatment was recommended as the best treatment combination in keeping good preservation quality followed by the other treatment combinations. This treatment combination strictly impeded the ripening of mango fruits during storage.

Table 3.10 Changes of total soluble solid and total sugar content of postharvest mango pulp in varieties during storage at ambient condition

Treatments	TSS content (%)at different days					Total sugar content (%) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	5.30 b	9.28 b	13.78 b	16.28 a	16.35 a	5.34 b	8.08 b	12.80 b	16.08 b	18.35 b
V_2	6.35 a	10.33 a	14.28 a	16.03 b	16.05 b	5.80 a	8.58 a	13.28 a	16.58 a	18.80 a
Level of significance	***	***	***	***	***	***	***	***	***	***

Table 3.11 Combined effects of varieties and different doses of Gibberellic acid solution on total soluble solid and total sugar content of postharvest mango during storage at ambient condition

Treatments combination	TSS content (%) at different days					Total sugar content (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1G_0	5.50 d	12.50 b	19.50 a	16.50 b	13.50 f	5.50 cd	10.20 b	18.80 b	20.70 b	19.80 d
V_1G_1	5.30 e	9.30 d	13.30 d	19.30 a	16.30 c	5.40 d	7.90 d	13.20 d	18.40 d	20.40 b
V_1G_2	5.20 e	8.20 e	12.20 e	16.20 c	19.50 a	5.30 de	7.30 e	10.30 f	13.80 f	18.80 f
V_1G_3	5.20 e	7.10 f	10.10 g	13.10 e	16.10 d	5.17 e	6.90 f	8.90 h	11.40 h	14.40 h
V_2G_0	6.50 a	13.50 a	19.00 b	16.00 d	13.00 g	6.00 a	10.70 a	19.20 a	21.20 a	20.20 c
V_2G_1	6.40 ab	10.40 c	14.50 c	19.20 a	16.20 cd	5.80 b	8.30 c	13.60 c	18.80 c	20.80 a
V_2G_2	6.30 bc	9.33 d	13.30 d	16.00 d	19.10 b	5.70 bc	7.90 d	10.90 e	14.40 e	19.40 e
V_2G_3	6.20 c	8.10 e	10.30 f	12.90 f	15.90 e	5.68 bc	7.40 e	9.40 g	11.90 g	14.80 g
Level of significance	NS	NS	***	**	**	NS	NS	NS	NS	NS
CV%	1.82	1.17	0.76	0.49	0.50	2.05	1.27	0.79	0.76	0.57

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Table 3.12 Changes of reducing and non reducing sugar content of postharvest mango pulp between varieties and influenced by different doses of Gibberellic acid solution during storage at ambient condition

Treatments	Reducing sugar content (%) at different days					Non-reducing sugar content (%) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	1.29 b	1.96 b	3.82	4.81 b	4.86 b	4.03 b	6.11 b	9.29 b	11.26 b	13.46 b
V_2	1.66 a	2.35 a	3.83	5.13 a	5.18 a	4.13 a	6.23 a	9.43 a	11.48 a	13.63 a
Level of significance	***	***	NS	***	***	*	*	**	***	**
Treatments (G)										
G_0	1.55	3.05 a	6.05 a	6.25 a	4.75 c	4.20 a	7.40 a	12.90 a	14.70 a	15.20 a
G_1	1.48	2.03 b	4.14 b	5.98 b	6.18 a	4.10 ab	6.08 b	9.93 b	12.63 b	14.43 b
G_2	1.43	1.83 c	2.88 c	4.38 c	5.38 b	4.05 b	5.78 c	7.73 c	9.73 c	13.73 c
G_3	1.45	1.73 c	2.23 d	3.28 d	3.78 d	3.98 b	5.43 d	6.88 d	8.43 d	10.82 d
Level of significance	NS	***	***	***	***	*	***	***	***	***

Table 3.13 Combined effects of varieties and different doses of Gibberellic acid solution on reducing and non reducing sugar content of postharvest mango pulp during storage at ambient condition

Treatments combination	Reducing sugar content (%) at different days					Non-reducing sugar content (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1G_0	1.40 b	2.90 b	5.90 a	6.10 b	4.60 f	4.10 ab	7.30 b	12.80 b	14.60 b	15.10 b
V_1G_1	1.30 bc	1.80 ef	4.63 b	5.80 c	6.00 b	4.05 b	6.10 c	9.90 c	12.60 c	14.40 c
V_1G_2	1.25 bc	1.65 fg	2.65 de	4.15 e	5.15 d	4.00 b	5.65 e	7.65 d	9.65 d	13.65 d
V_1G_3	1.20 c	1.50 g	2.10 e	3.20 f	3.70 g	3.97 b	5.40 f	6.80 e	8.20 f	10.70 f
V_2G_0	1.70 a	3.20 a	6.20 a	6.40 a	4.90 e	4.30 a	7.50 a	13.00 a	14.80 a	15.30 a
V_2G_1	1.65 a	2.25 c	3.65 c	6.15 b	6.35 a	4.15 ab	6.05 cd	9.95 c	12.65 c	14.45 c
V_2G_2	1.60 a	2.00 d	3.10 cd	4.60 d	5.60 c	4.10 ab	5.90 d	7.80 d	9.80 d	13.80 d
V_2G_3	1.69 a	1.95 de	2.35 de	3.35 f	3.85 g	3.98 b	5.45 f	6.95 e	8.65 e	10.95 e
Level of significance	NS	NS	*	NS	NS	NS	NS	NS	*	NS
CV%	7.20	4.80	11.14	2.13	2.11	2.63	1.72	1.13	0.93	0.78

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Table 3.14 Changes of crude fibre and lipid content of mango pulp between varieties during storage at ambient condition

Treatments	Crude fibre (%) at different days					Lipid content (%) at different days				
Variety(V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	1.29 a	1.17 a	0.90 a	0.73 a	0.56 a	0.19 a	0.37 a	0.52 a	0.68 a	0.70 a
V_2	1.18 b	0.98 b	0.71 b	0.54 b	0.41 b	0.18 b	0.35 b	0.49 b	0.63 b	0.65 b
Level of significance	*	***	***	***	***	***	***	***	***	***

Table 3.15 Combined effects of varieties and different doses of Gibberellic acid solution on crude fibre and lipid content of postharvest mango pulp during storage at ambient condition

Treatments combination	Crude fibre (%) at different days					Lipid content (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1G_0	1.28	1.00 cd	0.60 d	0.55 c	0.52 a	0.22 a	0.45 a	0.74 a	0.84 a	0.69 c
V_1G_1	1.29	1.16 a-c	0.86 b	0.56 c	0.51 a	0.20 b	0.39 c	0.54 c	0.76 b	0.80 a
V_1G_2	1.30	1.22 ab	1.02 ab	0.82 ab	0.57 a	0.19 bc	0.33 e	0.43 e	0.58 d	0.68 cd
V_1G_3	1.30	1.28 a	1.13 a	0.98 a	0.63 a	0.17 cd	0.30 f	0.38 g	0.53 e	0.63 e
V_2G_0	1.16	0.81 d	0.41 e	0.36 d	0.34 b	0.20 b	0.43 b	0.67 b	0.75 b	0.60 f
V_2G_1	1.17	0.97 cd	0.67 cd	0.37 d	0.32 b	0.18 c	0.37 d	0.52 d	0.69 c	0.74 b
V_2G_2	1.18	1.03 bc	0.83 bc	0.63 c	0.38 b	0.16 d	0.31 f	0.41 f	0.56 d	0.66 d
V_2G_3	1.20	1.10 a-c	0.95 ab	0.80 b	0.60 a	0.16 d	0.28 g	0.36 h	0.51 e	0.61 ef
Level of significance	NS	NS	NS	NS	NS	NS	NS	**	***	***
CV%	8.59	9.90	13.03	14.72	14.69	5.53	2.99	2.11	1.64	1.53

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

9.4.2 Potassium content

Imposed varieties in terms of K content exhibited highly significant variation at different days after storage (Appendix 3.9). It noticed a rising trend of K content in both the varieties with the advancement of storage period at different days (Table 3.18). In all the storage period, Langra was identified as higher producer of K content comparing to Khirshapat. It also indicated that the rising trend of K content was stopped at 9th day. At this period, higher (0.29%) amount of K was noted from Langra and lower (0.27%) was noted from Khirshapat (Table 3.18). This event might be possible due to spoilage of mango fruits which resulted in lower metabolic activities. Langra was better producer of K content possibly due to genetical dissimilarities between varieties. At storage period, K content increased might be possible due to transmission of K from stone and peel to pulp of mango.

Different doses of GA3 solution implied to this experiment in terms of K content of mango were noticed significant at different days after storage (Appendix 3.9). The results narrated that K content developed in a continuous stream with the increase of storage period. But, K content from the untreated fruit fell away at 9th day, whereas other treatments such as G_1, G_2 and G_3 treatment retained their increasing behavior (Fig. 3.14). In this period, it was found a very lower changing up trend of K content in the fruit treated with G_3 treatment. At 9th day, the maximum (0.30%) of K content was manifested from the untreated fruit whereas; the lowest (0.26%) was manifested from the fruit treated with G_3 treatment which was statistically at par with G_2 treatment. Lower quantity of K in the fruits treated with G_3 treatment might be possible due to delay ripening that caused lower transmission of K content. These results are in partially supported by the findings of Peter *et al.* (2007). The results of the present investigation revealed that K content of mango pulp was grown up slightly in the storage period. But, G_3 treatment interrupted its growing up trend during storage period.

The combined effect of varieties and subjected to different doses of GA3 solution in relation to K content of mango pulp exhibited non significant variation at different days after storage (Appendix 3.9). The results indicated that K content of mango pulp from different treatment combination developed gradually with the increasing of storage time (Table 3.19). But, K content from the treatment

combination of V_1G_0 had diminished at 9th day. In this period, the highest (0.31%) quantity of K was notified from the treatment combination of V_1G_0 which was statistically identical with V_1G_1 and V_2G_0 whereas; the lowest (0.25%) was notified from the treatment combination of V_2G_3 (Table 3.19).

9.4.3 Calcium content

Analysis of variance of applied varieties to this investigation in terms of Ca exhibited highly significant variation at different days after storage (Appendix 3.9). It manifested an increasing trend of Ca content with the rising of storage time from both the varieties (Table 3.18). It also narrated that Khirshapat was performed better in achieving of Ca content comparing to Langra. At 12th day, higher (22.39 mg/100 g) quantity of Ca was perceived from Khirshapat and lower (20.32 mg/100 g) was perceived from Langra. This event might be possible due to genetical variation between two varieties. These results are in partially supported by the report of Nadkarni (1963).

Different doses of GA3 solution in relation to Ca content of mango pulp exhibited highly significant variation at different days after storage (Appendix 3.9). At various days during storage, Ca content expanded successively with the rising of storage time (Fig. 3.15). It also annotated that Ca content in control augmented sharply from initial to 6th day and then, it increased smoothly thereafter, it declined due to decay. At the same time, Ca content from the fruit treated with G_3 treatment accumulated very smoothly. At 9th day, the highest (24.39 mg/100 g) quantity of Ca was noticed from untreated fruit whereas; the lowest (15.81 mg/100 g) was noticed from the fruit treated with G_3 treatment. This phenomenon caused by G_3 treatment might be possible due to delay ripening that caused in lower transmission of Ca content from peel and stone to pulp of mango. But, the results of the present investigation are not supported by the findings of Peter *et al.* (2007).

The combined effect of varieties and different doses of GA3 solution in respect of Ca content of mango pulp demonstrated highly significant variation at different days after storage (Appendix 3.9). It showed an increasing trend of Ca content of mango pulp from various treatment combinations (Table 3.19). At 9th day, the highest (25.28 mg/100 g) quantity of Ca was manifested from the treatment combination of V_2G_0 and the lowest (14.96 mg/100 g) was manifested

from the treatment combination of V_1G_3, respectively. The results of the presented investigation revealed that the treatment combination of V_1G_3 was better in mango preservation.

9.4.4 Magnesium content

Highly significant variation was noticed in Mg content between the varieties means at different days after storage (Appendix 3.10). The results denoted that Mg content grew up gradually with rising of storage period (Table 3.20). It also indicated that Mg content accumulated steadily from initial to 9th day thereafter, it abated slightly due to starting of bad the fruit situation. At 9th day, higher (17.44 mg/100 g) was notified from Langra and lower (16.81 mg/100 g) was notified from Khirshapat. These phenomena might be probably due to genetical dissimilarities between the varieties. There were no available research findings in terms of Mg content during storage in the scientific literature but, the results of the present study revealed that Langra was batter in Mg accumulation and that progressively increase during storage.

Different doses of GA3 solution imposed in this trial showed highly significant in relation to Mg content of mango pulp at different days after storage (Appendix 3.10). The results denoted that a smooth accumulating trend of Mg content of mango pulp with the rising of storage period (Fig. 3.16). It also explained that Mg content from control enlarged gradually from initial to 6th day and then, it diminished very sharply. The highest (18.02 and 17.58 mg/100 g) quantity of Mg was derived from control and G_2 treatment at 6 and 9th days whereas, the lowest (16.18 and 16.57 mg/100 g) was derived from the fruit treated with G_3 treatment, respectively. The growing up situation of Mg content in mango pulp might have been related to starting of ripening. Peter *et al.* (2007) showed a slight change of Mg content during storage period.

The combined effect of varieties and various doses of GA3 solution were found to be significant variation in terms of Mg content at various days after storage except initial day (Appendix 3.10). It perceived an increasing trend of Mg content of mango pulp with the augmentation of storage time (Table 3.21). At 6th day, the highest (18.59 mg/100 g) quantity of Mg was recorded from the treatment combination of V_1G_0 whereas; the lowest (15.78 mg/100 g) was recorded from the

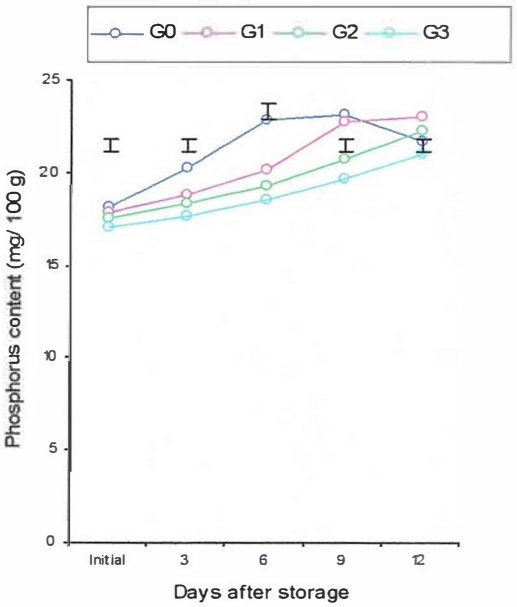


Fig. 3.13 Effect of different doses of GA3 on phosphorus content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

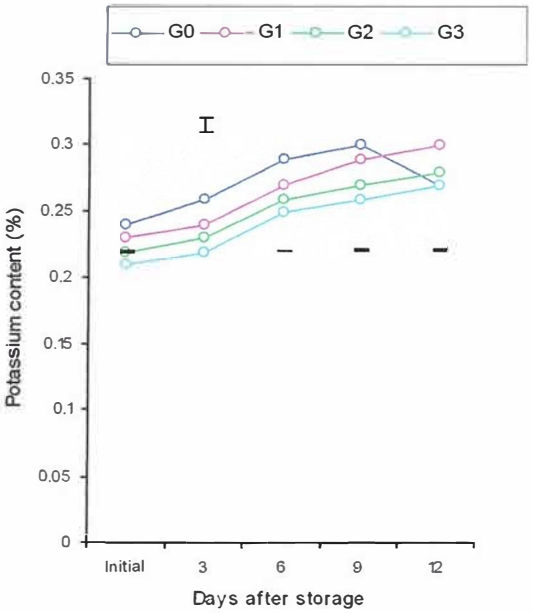


Fig. 3.14 Potassium content of mango pulp as influenced by different doses of GA3 at different days after storage. Vertical bars represent LSD at 0.05 level

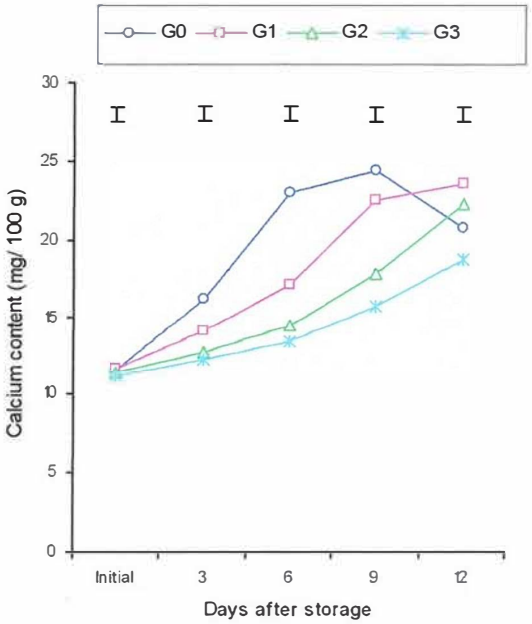


Fig. 3.15 Calcium content of mango pulp as influenced by different doses of GA3 at different days after storage. Vertical bars represent LSD at 0.05 level

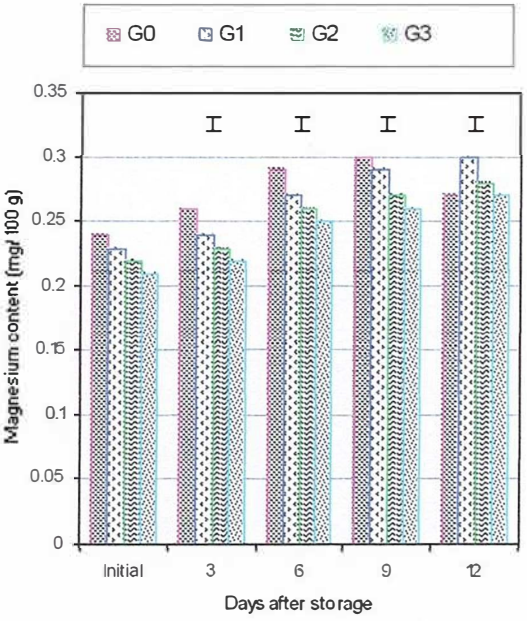


Fig. 3.16 Effect of different doses of GA3 on magnesium content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

Graphs represent

G_0 = Control
G_1 = 100 ppm of GA 3 solution
G_2 = 200 ppm of GA 3 solution
G_3 = 400 ppm of GA 3 solution

Table 3.16 Changes of water soluble protein and phosphorus content of mango pulp in varieties during storage at ambient condition

Treatments	Water soluble protein content (%) at different days					Phosphorus (mg/100 g) at different days				
Variety	Initial	3	6	9	12	Initial	3	6	9	12
V_1	0.56 a	0.70 a	0.86 a	1.00 a	1.18	19.00 a	20.10 a	21.59 a	22.93 a	23.34 a
V_2	0.46 b	0.60 b	0.74 b	0.88 b	1.11	16.34 b	17.46 b	18.89 b	20.27 b	20.69 b
Level of significance	**	*	*	*	NS	***	***	***	***	***

Table 3.17 Combined effects of varieties and different doses of Gibberellic acid solution on water soluble protein and phosphorus content of postharvest mango pulp during storage at ambient condition

Treatments combination	Water soluble protein content (%) at different days					Phosphorus (mg/100 g) different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1G_0	0.55 ab	0.88 a	1.20 a	1.25 a	1.23 a	19.45 a	21.55 a	24.33 a	24.53 a	23.05 c
V_1G_1	0.56 a	0.68 bc	0.80 b	1.16 ab	1.22 a	19.25 b	20.15 b	21.56 b	24.13 b	24.44 a
V_1G_2	0.58 a	0.65 bc	0.75 bc	0.86 cd	1.18 ab	18.83 c	19.63 c	20.52 c	21.95 c	23.45 b
V_1G_3	0.53 ab	0.60 bc	0.70 bc	0.73 de	1.08 ab	18.45 d	19.05 d	19.95 d	21.12 e	22.42 d
V_2G_0	0.50 ab	0.75 ab	1.10 a	1.16 ab	1.18 ab	16.82 e	18.93 d	21.44 b	21.84 c	20.34 g
V_2G_1	0.48 ab	0.58 bc	0.67 bc	1.00 bc	1.15 ab	16.53 f	17.44 e	18.83 e	21.34 d	21.64 e
V_2G_2	0.45 ab	0.55 c	0.62 bc	0.70 de	1.10 ab	16.26 g	17.12 f	18.15 f	19.56 f	21.13 f
V_2G_3	0.40 b	0.50 c	0.57 c	0.65 e	1.00 b	15.75 h	16.35 g	17.12 g	18.32 g	19.65 h
Level of significance	NS	NS	NS	NS	NS	NS	NS	*	*	**
CV%	14.80	14.22	13.32	11.30	9.28	0.60	0.56	0.66	0.49	0.48

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Table 3.18 Changes of potassium and calcium content of mango pulp between varieties during storage at ambient condition

Treatments	Potassium (%) at different days					Calcium (mg/100 g) at different days				
Variety(V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	0.24 a	0.25 a	0.27 a	0.29 a	0.29 a	10.53 b	12.92 b	16.06 b	19.14 b	20.32 b
V_2	0.22 b	0.23 b	0.26 b	0.27 b	0.27 b	12.42 a	14.81 a	17.94 a	21.17 a	22.39 a
Level of significance	***	***	**	***	***	***	***	***	***	***

Table 3.19 Combined effects of varieties and different doses of Gibberellic acid solution on potassium and calcium content of postharvest mango pulp during storage at ambient condition

Treatments combination	Potassium content (%) at different days					Calcium content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1G_0	0.25 a	0.27 a	0.30 a	0.31 a	0.28 bc	10.65 d	15.35 b	22.09 b	23.49 b	19.88 f
V_1G_1	0.24 ab	0.25 b	0.28 b	0.30 ab	0.31 a	10.75 d	13.11 d	16.12 d	21.52 c	22.48 c
V_1G_2	0.23 bc	0.24 bc	0.26 bc	0.28 b-d	0.29 ab	10.45 e	11.78 e	12.48 g	16.58 e	21.01 e
V_1G_3	0.22 c	0.23 b-d	0.25 c	0.27 c-e	0.28 bc	10.25 f	11.45 f	12.56 h	14.96 f	17.89 h
V_2G_0	0.23 bc	0.25 ab	0.28 ab	0.29 a-c	0.26 c	12.45 b	17.06 a	23.82 a	25.28 a	21.68 d
V_2G_1	0.22 bc	0.23 b-d	0.26 bc	0.27 c-e	0.28 bc	12.65 a	15.25 b	18.22 c	23.63 b	24.65 a
V_2G_2	0.21 cd	0.22 cd	0.25 c	0.26 de	0.27 bc	12.35 bc	13.75 c	15.45 e	19.12 d	23.56 b
V_2G_3	0.20 d	0.21 d	0.24 c	0.25 e	0.26 c	12.22 c	13.16 d	14.26 f	16.65 e	19.68 g
Level of significance	NS	NS	NS	NS	NS	NS	**	*	***	***
CV%	4.71	4.47	4.00	3.81	3.59	0.92	0.77	0.62	0.53	0.50

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

treatment combination of V_2G_3.

9.4.5 Copper content

Variation between varieties in relation to Cu of mango pulp exhibited highly significant at different days after storage (Appendix 3.10). The results indicated that Cu content of mango pulp came down gradually with the rising of storage period (Table 3.20). It also stated that Cu content of Khirshapat was more as compared to Langra. At initial day, higher (0.36 mg/100 g) content of Cu was noticed from Khirshapat and lower (0.33 mg/100 g) was noticed from Langra. At 12^{th} day, Khirshapat had higher (0.20 mg/100 g) amount of Cu and lower (0.18 mg/100 g) amount was noticed from Langra (Table 3.20). These events might be possible due to genetical dissimilarities between the varieties. There were no available research reports in respect of Cu content of mango at the scientific literature. The results of the present studies revealed that green mangoes contained more copper comparing to stored mangoes and Khirshapat was better in copper accumulation than Langra. The present research findings also explored that Cu content abated gradually during storage period.

Different doses of GA3 solution subjected to the present study in terms to Cu content of mango pulp showed highly significant variation at different days after storage (Appendix 3.10). The results narrated that Cu content came down successively with the rising of storage period at various days. The abating trend from control was higher than the fruit treated with G_1, G_2 and G_3, treatment respectively (Fig. 3.17). At 12^{th} day, higher quantity of Cu (0.25 mg/100 g) was derived from the fruit treated with G_3 treatment whereas; lower (0.13 mg/100 g) was derived from control. It meant that G_3 treatment was much better than the other treatments in conservation of Cu. So, the present findings explored that G_3 treatment was much better in mango preservation and reduced the losses of Cu content.

The combined effect of varieties and imposed different doses of GA3 solution in respect of Cu content of mango pulp were perceived to be non signlficant variation at various days after storage (Appendix 3.10). The results narrated that Cu content in different treatment combination diminished with the rising of storage duration. At 12^{th} day, the highest (0.26 mg/100 g) was recorded from the treatment combination

of V_2G_3, and the lowest (0.12 mg/100 g) was recorded from the treatment combination of V_1G_0 (Table 3.21).

9.4.6 Iron content

The analysis of variance of varieties in respect of Fe content of mango pulp was perceived to be highly significant at different days after storage (Appendix 3.11). There showed an expanding trend of Fe content with the passing of storage duration. The expanding trend of Fe content had more or less similar from initial to 9th day thereafter, it diminished slightly. At 12th day, higher (4.57 mg/100 g) quantity of Fe was derived from Langra and lower (3.74 mg/100 g) was derived from Khirshapat. These results are in partially supported by the findings of Nadkarni (1963).

Highly significant variation was perceived due to the effect of different doses of GA3 solution in terms of Fe content in mango pulp at various days after storage (Appendix 3.11). The results denoted that Fe content accumulated markedly from initial to 6th day and then, it fell off significantly at control and similarly G_1 treated fruits abated of Fe after 9th day. But, Fe content notified from the other fruits treated with G_2 and G_3 treatments augmented continuously up to 12th day (Fig. 3.18). At 12th day, the maximum (5.10 mg/100 g) quantity of Fe was noticed from the fruit treated with G_2 treatment whereas; the lowest (2.71 mg/100 g) was noticed from the untreated fruit, respectively. Little quantity of Fe obtained from untreated fruits was possibly due to starting of decay which resulted in lower amount. On the other hand, G_3 treated fruits was better because of its lower accumulation of Fe content with the advancement of storage duration.

The combined effect of varieties and different doses of GA3 solution were found to be non significant in terms of Fe content of mango pulp at different days after storage (Appendix 3.11). The results stated growing up trend of Fe content from initial to 6th day thereafter, it abated very fast in the treatment combination of V_1G_0 whereas; the lowest growing up trend was obtained from the treatment combination of V_2G_3 (Table 3.23). At 6th day, the highest (5.51 mg/100 g) quantity of Fe was reported from the treatment combination of V_1G_0 and the lowest (2.12 mg/100 g) was reported from the treatment combination of V_2G_3.

9.4.7 Manganese content

Manganese content of mango pulp was perceived to be differed significantly in both the varieties mean at different days after storage (Appendix 3.11). The results denoted that Mn content extended gradually with the increase of storage period (Table 3.22). It also stated that Langra performed better in Mn content accumulation comparing to Khirshapat. At 12th day, the highest (1.17 mg/100 g) quantity of Mn was recorded from Langra whereas; the lowest (0.99 mg/100 g) was recorded from Khirshapat (Table 3.22). There were no available research reports regarding Mn content in the scientific literature. The results of the present research findings invented that Langra was better than Khirshapat in Mn content accumulation but, it was increased during storage period.

Different doses of GA3 solution had highly significant in respect of Mn content of mango pulp at different days after storage (Appendix 3.11). It indicated that Mn content increased successively from initial to 6th days, and then it fell off sharply in control. On the other hand, it expanded from initial to 9th day thereafter; it abated in the fruit treated with G_1 treatment. At the same time, very lower rising trend of Mn content was notified from the fruit treated with G_3 treatment (Fig. 3.19). At 12th day, Mn content ranged between 0.89 to 1.27 mg per 100 g of fresh pulp of mango. The maximum (1.27 mg/100 g) was noted from G_2 treated fruits and the minimum (0.89 mg/100 g) was noted from control.

The combined effect of varieties and used different doses of GA3 solution in relation to Mn content of mango pulp were found to be non significant at various days after storage except 9th day (Appendix 3.11). The results denoted a developing trend of Mn content in different treatment combination with the rising of storage duration (Table 3.23). At 9th day, the highest (1.38 mg/100 g) was obtained from the treatment combination of V_1G_1, and the lowest (0.82 mg/100 g) was reported from the treatment of V_2G_3.

9.4.8 Zinc content

Variation in respect of Zn content of mango pulp due to the effect of varieties exhibited highly significant at different days after storage (Appendix 3.12). The results explained that Zn content fell off sharply with the rising of storage duration in both the varieties (Table 3.24). It also narrated that Khirshapat was perceived to

produce more Zn content as compared to Langra. Zn content of mango pulp ranged between 1.27 to 1.53 mg per 100 g of mango pulp at initial level and 0.77 to 0.91 mg per 100 g at 12th day. The highest (1.53 and 0.91 mg/100 g) was noticed from Khirshapat and the lowest (1.27 and 0.77 mg/100 g) was noticed in Langra from initial and 12th day. There were no available research findings in terms of Zn content in the scientific review. The results of the present studies revealed that green mango especially, Khirshapat contained more Zn than Langra, but, its quantity continuously decreased with the advancement of storage duration.

Different doses of GA3 solution were found to be significant variation in Zn content of mango pulp at different days after storage (Appendix 3.12). The results noticed a diminishing trend of Zn content of mango pulp with the hastening of storage period from the fruit treated with different doses of GA3 solution. It also explained that the falling off trend was very high in control and very low in the fruit treated with G_3 treatment (Fig. 3.20). At 12th day, the maximum (1.01 mg/100 g) was recorded from the fruit treated with G_3 treatment and the lowest (0.65 mg/100 g) was recorded from control. Zn content of mango pulp came down in the storage period was probably due to dissemination of Zn from pulp to stone and peel at stored condition or Zn content of mango pulp may be depressed or suppressed as influenced by metabolic activities during storage.

The combined effect of varieties and imposed different doses of GA3 solution in respect of Zn content of mango exhibited significant variation at different days after storage except 3 and 6th day (Appendix 3.12). A falling trend of Zn content of mango pulp was recorded from various treatment combinations (Table 3.25). At 12th day, the maximum (1.06 mg/100 g) quantity of Zn was recorded from Khirshapat along G_3 treatment whereas; the lowest (0.54 mg/100 g) value was recorded from Langra without treatment, respectively.

9.5 Shelf life

There was found to be significant variation between the varieties on shelf life of mango (Appendix 3.12). The longest shelf life (13.92 days) was obtained from Khirshapat and the shortest (12.67 days) was obtained from Langra (Fig. 3.21). Variation in shelf life between varieties might be possible due to genetical. The present findings from the data revealed that Khirshapat was better than Langra in preservation.

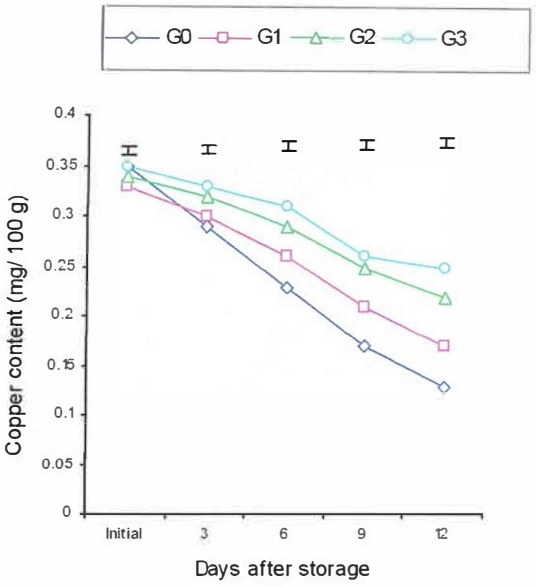


Fig. 3.17 Effect of different doses of GA3 on copper content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

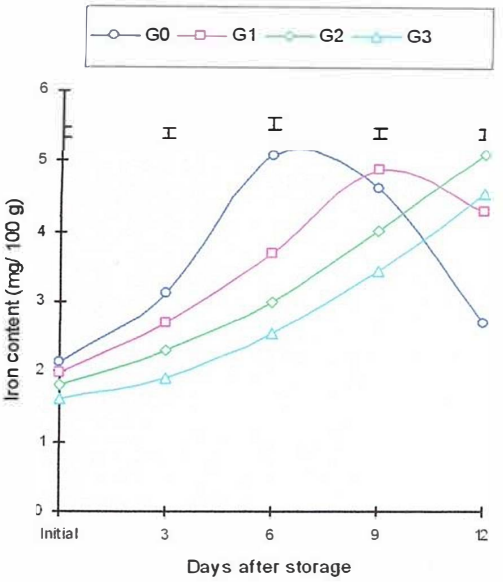


Fig. 3.18 Iron content of mango pulp as influenced by different doses of GA3 at different days after storage. Vertical bars represent LSD at 0.05 level

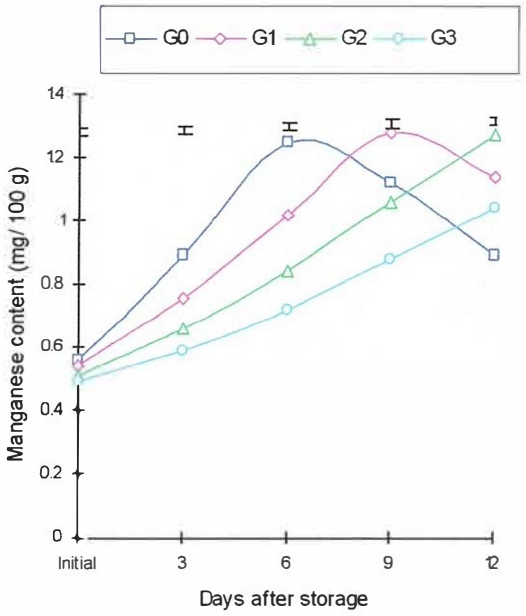


Fig. 3.19 Manganese content of mango pulp as influenced by different doses of GA3 at different days after storage. Vertical bars represent LSD at 0.05 level

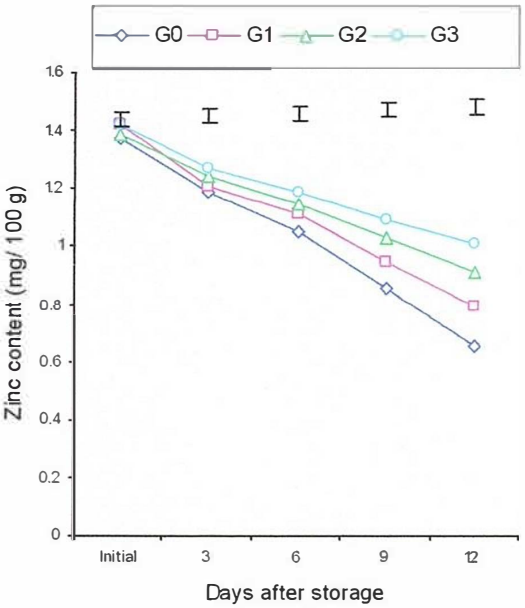


Fig. 3.20 Effect of different doses of GA3 on zinc content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

Graphs represent
G_0 = Control
G_1 = 100 ppm of GA 3 solution
G_2 = 200 ppm of GA 3 solution
G_3 = 400 ppm of GA 3 solution

Table 3.20 Changes of magnesium and copper content of mango pulp in varieties during storage at ambient condition

Treatments	Magnesium content (mg/100 g) at different days					Copper content (mg/100 g) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	16.29 a	16.80 a	17.33 a	17.44 a	17.20 a	0.33 b	0.30 b	0.26 b	0.21b	0.18 b
V_2	15.40 b	16.13 b	16.69 b	16.81 b	16.53 b	0.36 a	0.32 a	0.29 a	0.23 a	0.20 a
Level of significance	***	***	***	***	***	***	***	***	***	***

Table 3.21 Combined effects of varieties and different doses of Gibberellic acid solution on magnesium and copper content of postharvest mango pulp during storage at ambient condition

Treatments combination	Magnesium content (mg/100 g) at different days					Copper content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1G_0	16.55 a	17.66 a	18.59 a	17.55 ab	16.45 d	0.34 b-d	0.28 d	0.22 f	0.16 f	0.12 e
V_1G_1	16.35 b	16.75 b	17.24 c	17.72 a	16.72 c	0.31 e	0.29 cd	0.25 de	0.20 de	0.15 d
V_1G_2	16.22 bc	16.52 c	16.92 d	17.51 b	18.28 a	0.32 de	0.30 cd	0.27 cd	0.23 bc	0.20 c
V_1G_3	16.05 c	16.28 d	16.58 e	16.96 c	17.35 b	0.33 c-e	0.31 bc	0.29 bc	0.25 ab	0.23 b
V_2G_0	15.45 de	16.48 c	17.46 b	16.47 d	15.48 f	0.36 ab	0.30 cd	0.24 ef	0.18 ef	0.14 de
V_2G_1	15.55 d	15.95 e	16.44 e	16.92 c	15.92 e	0.35 a-c	0.31 bc	0.27 cd	0.22 cd	0.18 c
V_2G_2	15.35 ef	16.65 bc	17.06 cd	17.65 ab	18.15 a	0.36 ab	0.33 ab	0.30 b	0.26 a	0.23 b
V_2G_3	15.25 f	15.45 f	15.78 f	16.18 e	16.58 cd	0.37 a	0.35 a	0.33 a	0.27 a	0.26 a
Level of significance	NS	***	***	***	***	NS	NS	NS	NS	NS
CV%	0.67	0.64	0.62	0.62	0.62	3.10	3.44	3.76	4.79	5.62

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Table 3.22 Changes of iron and manganese content of postharvest mango pulp between varieties during storage at ambient condition

Treatments	Iron content (mg/100 g) at different days					Manganese content (mg/100 g) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	2.32 a	2.96 a	4.02 a	4.68 a	4.57 a	0.60 a	0.80 a	1.04 a	1.16 a	1.17 a
V_2	1.44 b	2.06 b	3.14 b	3.80 b	3.74 b	0.44 b	0.65 b	0.87 b	1.01 b	0.99 b
Level of significance	***	***	***	***	***	***	***	***	***	***

Table 3.23 Combined effects of varieties and different doses of Gibberellic acid solution on iron and manganese content of postharvest mango pulp during storage at ambient condition

Treatments combination	Iron content (mg/100 g) at different days					Manganese content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1G_0	2.54 a	3.55 a	5.51 a	5.04 b	3.14 f	0.64 a	0.96 a	1.33 a	1.19 b	0.96 f
V_1G_1	2.42 ab	3.13 b	4.14 c	5.34 a	4.74 c	0.62 b	0.84 b	1.12 c	1.38 a	1.24 b
V_1G_2	2.25 b	2.76 c	3.48 d	4.47 c	5.45 a	0.59 c	0.74 d	0.92 d	1.14 c	1.36 a
V_1G_3	2.05 c	2.38 d	2.97 f	3.88 e	4.95 b	0.56 d	0.66 e	0.79 e	0.94 f	1.12 d
V_2G_0	1.72 d	2.68 c	4.67 b	4.18 d	2.27 g	0.48 e	0.82 c	1.16 b	1.04 d	0.81 g
V_2G_1	1.55 d	2.26 d	3.23 e	4.44 c	3.82 e	0.45 f	0.67 e	0.92 d	1.18 b	1.03 e
V_2G_2	1.35 e	1.85 e	2.54 g	3.54 f	4.74 c	0.43 g	0.58 f	0.76 f	0.98 e	1.17 c
V_2G_3	1.15 f	1.45 f	2.12 h	3.02 g	4.12 d	0.41 h	0.52 g	0.65 g	0.82 g	1.96 f
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	*	NS
CV%	5.65	4.23	3.19	2.50	2.55	4.06	2.93	2.22	1.96	1.96

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Applied different doses of GA3 solution in this investigation in terms of shelf life of mango showed highly significant (Appendix 3.12). The shelf life of mango ranged between 8.17 to 17.00 days from different doses of GA3 solution. The longest shelf life (17.00 days) was reported from the fruit treated with G_3 treatment followed by the shelf life of the fruits treated with G_2 (14.83 days), and G_1 (13.17 days) treatments whereas; the shortest shelf life (8.17 days) was reported from control, (Fig. 3.22). The longest shelf life obtained from the fruit treated with G_3 treatment might be probably due to suppression or depression of physiological and biochemical activities in responding for slower senescence of harvested fruits and consequently led to the longest shelf life. The results of the present investigation are in conformity with the findings of Ranjan *et al.* (2005), Jain and Mukherjie (2001) and Mondal *et al.* (1995).

Fig. 3.21 Effect of varieties on shelf life of mango

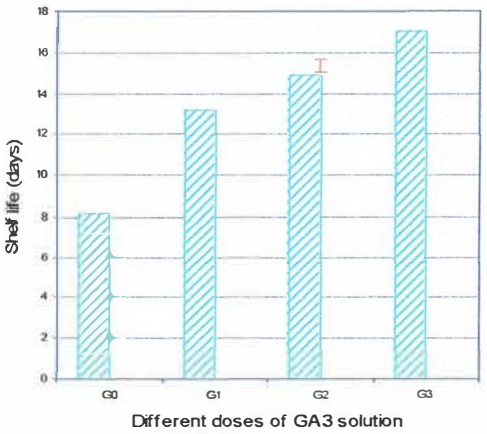


Fig. 3.22 Effect of different doses of GA3 on shelf life of mango. Vertical bars represent LSD at 0.05 level

Graph represents

V_1 = Langra	G_1 = 100 ppm of GA3 solution
V_2 = Khirshapat	G_2 = 200 ppm of GA3 solution
G_0 =Control	G_3 = 400 ppm of GA3 solution

The combined effects of varieties and subjected to different doss of GA3 solution in terms of shelf life of mango were observed non significant (Appendix 3.12). The shelf life was ranged between 7.67 to 18.00 days from various treatment combinations. The longest shelf life (18.00 days) was noticed from the treatment combination of V_2G_3, whereas the shortest (7.67 days) was noticed from V_1G_0, respectively.

Table 3.24 Changes of zinc content of mango pulp and shelf life of postharvest mango in varieties during storage at ambient condition

Treatments	Zinc content (mg/100 g) at different days					Shelf life
Variety (V)	Initial	3	6	9	12	Total days
V_1	1.27 b	1.15 b	1.06 b	0.91 b	0.77 b	12.67 b
V_2	1.53 a	1.30 a	1.19 a	1.05 a	0.91 a	13.92 a
Level of significance	***	***	***	***	***	**

Table 3.25 Combined effects of varieties and different doses of Gibberellic acid solution on zinc content of mango pulp and shelf life of postharvest mango during storage at ambient condition

Treatments combination	Zinc content (mg/100 g) at different days					Shelf life
Varieties × Treatments	Initial	3	6	9	12	Total days
V_1G_0	1.25 e	1.12 f	0.95 g	0.76 f	0.54 f	7.67 h
V_1G_1	1.28 d	1.14 ef	1.05 f	0.88 e	0.72 e	12.67 f
V_1G_2	1.26 de	1.16 e	1.11 e	0.98 d	0.86 c	14.33 d
V_1G_3	1.27 de	1.19 d	1.13 de	1.03 c	0.95 b	16.00 b
V_2G_0	1.48 c	1.26 c	1.14 cd	0.96 d	0.75 d	8.67 g
V_2G_1	1.55 a	1.28 c	1.16 c	1.02 c	0.87 c	13.67 e
V_2G_2	1.52 b	1.31 b	1.19 b	1.08 b	0.96 b	15.33 c
V_2G_3	1.56 a	1.35 a	1.25 a	1.15 a	1.06 a	18.00 a
Level of significance	NS	NS	**	**	**	NS
CV%	1.52	1.73	1.90	2.16	2.53	5.66

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
G_0 = Control
G_1 = 100 ppm of GA3 solution
G_2 = 200 ppm of GA3 solution
G_3 = 400 ppm of GA3 solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

10.0 Experiment 4

Influence of different doses of Bavistin DF on physicochemical properties and shelf life of mango varieties during storage

10.1 Changes in skin color

Different doses of Bavistin DF (BDF) significantly affected the skin color of both the fruits namely Langra and Khirshapat (Table 4.1). Both varieties demonstrated the original green color at the initial stage of harvesting. At 3rd day, Langra developed trace in yellow color at control (B_0) and green color at 250 ppm (B_1), 500 ppm (B_2) and 750 ppm (B_3), and Khirshapat was perceived light green at control and retained its green color at B_1, B_2 and B_3 treatments.

At 6th day, Langra was noted yellow, greenish yellow, yellowish green and trace in yellow color at control, B_1, B_2 and B_3 treatments, respectively. On the other hand, Khlrshapat was notified greenish yellow, trace in yellow and yellowish green color at B_0, B_1, and B_2 treatments but, it retained its original green color at B_3 treatment.

At 9th day, Langra was modified deep yellow color at control, greenish yellow at B_1 and yellowish green at B_2 as well as trace in yellow at B_3 treatments, which Khirshapat exhibited yellow color at control, yellowish green color at B_1 and B_2 and light green color at B_3 treatment.

At 12th day of storage, Langra was transformed into black spotted yellow color at control and yellow, greenish yellow and yellowish green color at B_1, B_2 and B_3 treatments, respectively. On the other hand, Khirshapat was converted into light spotted yellow at B_0, yellow, greenish yellow and trace in yellow at B_1, B_2 and B_3 treatments, respectively.

At 15th day of storage, Langra was found to be decomposed at B_0 and B_1, yellow and greenish yellow at B_2 and B_3 treatments, respectively. At the same time Khirshapat was notified as completely rotten at B_0 and B_1 treatment and changed into deep yellow and greenish yellow at B_2 and B_3 treatments, respectively. The results of the present study are in partially agreement with the findings of Dhemre and Waskar (2004).

Table 4.1 Changes in skin color of two mango varieties as influenced by different doses of Bavistin DF during storage at ambient condition

Varieties	Treatments	Days after storage					
		Initial	3	6	9	12	15
V_1	B_0	Green	Trace in yellow	Yellow	Deep yellow	Black spotted yellow	_
	B_1	Green	Green	Greenish yellow	Greenish yellow	Yellow	_
	B_2	Green	Green	Yellowish green	Yellowish green	Greenish yellow	Yellow
	B_3	Green	Green	Trace in yellow	Trace in yellow	Yellowish green	Greenish yellow
V_2	B_0	Green	Trace in yellow	Greenish yellow	Yellow	Light spotted yellow	_
	B_1	Green	Green	Trace in yellow	Yellowish green	Yellow	_
	B_2	Green	Green	Yellowish green	Yellowish green	Greenish yellow	Deep yellow
	B_3	Green	Green	Green	Light green	Yellowish green	Greenish yellow

Table indicates

V_1 = Langra B_0 =Control B_2=500 ppm of BDF solution

V_2 = Khirshapat B_1= 250 ppm of BDF solution B_3 =750 ppm of BDF solution

10.2 Changes in physical characters during storage environments

Different parameters oriented to the physical changes of mangoes are presented and interpreted in the following sub-headings.

10.2.1 Physiological weight loss

Varieties were found to be highly significant in terms of PWL at different days after storage (Appendix 4.1 and Table 4.2). At each day, Khirshapat (V_2) successively showed more PWL comparing to Langra with the rising of storage duration (Table 4.2). Higher (10.86%) and lower (9.85%) of PWL were obtained from Khirshapat and Langra at 12th day, respectively. The results also denoted that total PWL progressively grew up with the increase of storage duration. The data also explained that Langra was better than Khirshapat owing to its lesser PWL. Water loss through lenticel seems to be the possible reason of physiological weight loss in the fruits during storage. Lower lenticel density in Langra facilitated lesser water loss leading to minimum total weight loss (Azad, 2001). Singh *et al.* (2000) also observed more or less the similar findings.

Analysis of variance of mango pulp in relation to PWL as influenced by different doses of BDF solution was found to be highly significant at different days after storage (Appendix 4.1). At different days, the results noted that control treatment was very swift in PWL compared to B_1, B_2 and B_3 treatments (Fig. 4.1). At 12th day, the maximum PWL (11.68%) was perceived in B_1 and the minimum (9.35%) in B_3. These phenomena happened might be probably due to 750 ppm (B_3) of BDF solution diminished the metabolic activities of mango pulp resulting in lower-PWL. These results of the present investigation are strongly supported by the findings of Dhemre and Waskar (2004). Parmar and Chundawat (1989) also observed the more or less similar results. These results are also conformity with the findings of Ahmed and Singh *et al.* (2000).

The combined effect of varieties and different doses of BDF showed significant variation in PWL at different days after storage except 12th day (Appendix 4.1). At different days, the results stated that various treatments combination showed in PWL successively with the rising of storage duration. At 9th day, there found the maximum PWL (10.65%) at V_2B_0 and the minimum (7.25%) at V_1B_3. It also revealed

that Khirshapat lost the highest amount of water along with B_3 treatment followed by other treatment combinations.

10.2.2 Moisture content

The analysis of variance of imposed varieties showed highly significant variation in moisture content at different days after storage except initial day (Appendix 4.1 and Table 4.2). At different days, the results interpreted that moisture content increased with the increase of storage period. The increasing trend was more or less similar from initial to 9th days and thereafter its increasing tendency decreased due to starting decay. It also denoted that each day of storage, Khirshapat absorbed more moisture comparing to Langra. Higher (88.13%) and lower (85.05%) were derived from Khirsapat and Langra at 12th day (Table 4.2). The reports were quite different than the present results as stated by Shajahan *et al.* (1994) and they observed that moisture content increased in Langra than Khirsapat. But, these results are in agreement with the findings of Azad (2001). This variation might be possible due to genetical, location, weather effect, soil quality or maturity of the fruit etc.

Variation among the means of different doses of BDF solution in connection with moisture content was perceived to be significant at different days after storage except initial day (Appendix 4.1). At different days, moisture content increased continuously with the advancement of storage duration. The last growing up trend of moisture content was noticed from control and B_1 treatment at 6 and 9th days (Fig. 4.2) whereas; B_2 and B_3 treatments also showed their increasing trend. Untreated fruit absorbed the highest moisture content (87.45%) at 9th day and the lowest (85.05%) was noted from B_3 treatment, respectively. The increasing trend of moisture content from initial to 6th days might be possibly due to metabolic activities and osmotic pressure inside the mango fruit as well as its decreased might be possible due to suppression of metabolic activities that resulted in decaying and drying.

The combined effect of varieties and different doses of BDF solution in terms of moisture content demonstrated non significant variation at different days after storage (Appendix 4.1 and Table 4.3). At different days of storage, moisture content

was absorbed in mango pulp with the advancement of storage period. The treatment combination of V_2B_0, V_2B_1 and V_2B_2 produced the maximum moisture content (88.60%, 89.00% and 89.30%) at 6, 9 and 12th days, respectively. In this storage period, the lowest values (82.70%, 83.50% and 84.30%) were obtained from the treatment combination of V_1B_3, respectively (Table 4.3). Moisture content increased in the present study is in partially agreement with the findings of El-Mahmoudi and Eisawi (1968) in banana.

10.2.3 Dry matter content

The variation in varieties means in connection with dry matter content exhibited highly significant variation at different days after storage (Appendix 4.2 and Table 4.4). At different days of storage, dry matter content diminished successively with the rising of storage duration. It denoted that Langra produced comparatively more dry matter comparing to Khirshapat. At initial day, Lngra gave higher (18.65%) dry matter while, Khirshapat had lower (15.48%) and at 12th day, Langra achieved higher (14.95%) while Khirshapat achieved lower (11.88%), respectively (Table 4.4). These results are in partially supported by the findings of Hossain (1999).

Different doses of BDF solution used in this study in terms of dry matter content of mango pulp exhibited highly significant variation at different days after storage except initial day (Appendix 4.2). At different days of storage, dry matter content diminished continuously with the increase of storage duration (Fig. 4.3). It also revealed that B_3 treatment gave the highest dry matter (15.75%) at 6th day while; the lowest dry matter (12.95%) was recorded from control.

The combined effect of varieties and different doses of BDF solution on dry matter content of mango pulp showed non significant at different days after storage (Appendix 4.2 and Table 4.5). At initial day, the highest dry matter content (18.80%) was obtained from the treatment combination of V_1B_3 which was statistically similar with the treatment combination of V_1B_0, V_1B_1 and V_1B_2 whereas; the lowest (15.30%) was recorded from the treatment combination of V_2B_0 which was also statistically similar with the combination of V_2B_1, V_2B_2, and V_2B_3. At 12th day, the highest value (15.80%) was reported from the treatment combination of

V_1B_0 which was statistically at par with V_1B_3 and the lowest value (10.70%) was notified from V_2B_2 (Table 4.5). The successive decrease in dry matter content with the increase of storage period might be possibly due to breaking down of the complex carbohydrates into simple molecules and H_2O as well as adding water through osmotic process and metabolic activities. The abating trend in dry matter content of mango pulp is not supported by the findings of Hossain (1999).

10.2.4 Ash content

Variation in varieties means in connection with ash content of mango pulp showed significant variation at different days after storage (Appendix 4.2 and Table 4.4). At different days of storage, values of ash content fell off continuously with the advancement of storage duration. It narrated that Langra gave comparatively more ash than Khirshapat at all days of storage. Higher (1.03%) ash content was derived from Langra at initial day whereas; Khirshapat produced the lowest (0.87%) and again at 12th day higher (0.83%) was recorded from Langra and lower achievement (0.67%) was recorded from Khirshapat (Table 4.4).

Different doses of BDF solution were selected as non significant in connection with ash content of mango pulp at different days after storage (Appendix 4.2). The results indicated that ash content imposed by different doses of BDF solution diminished slightly from B_3 treatment and markedly from control (Fig. 4.4). At 9th day, the highest (0.85%) was noticed from B_3 and the lowest (0.72%) was noticed from control.

The combined effect of varieties and different doses of BDF solution were manifested to be non-significant in connection with ash content of mango pulp at various days after storage (Appendix 4.2 and Table 4.5). At various days, the results obtained from investigation that ash content gradually decreased with the rising of storage period (Table 4.5). It may suggest from the present data that ash content demonstrated good correlation with the dry matter content.

10.3 Changes in biochemical properties of mango during storage environments

Different behavior of biochemical properties in connection with mango pulp as affected by various doses of BDF solution are presented and interpreted in the following sub-headings.

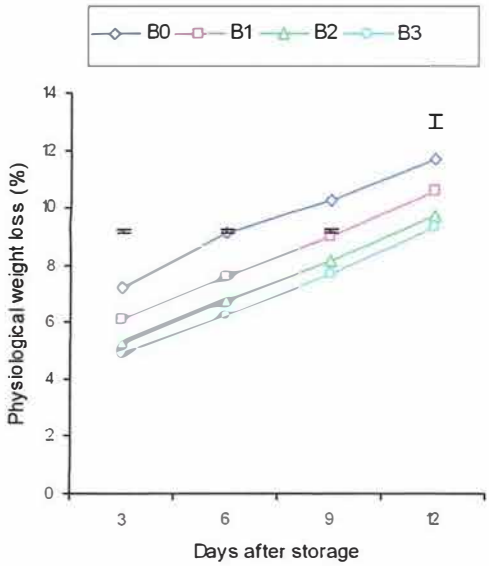


Fig. 4.1 Effect of different doses of Bavistin DF (BDF) on physiological weight of mango at different days after storage. Vertical bars represent LSD at 0.05 level

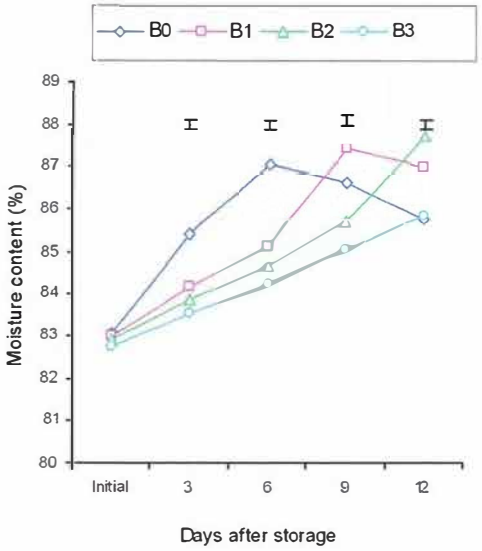


Fig. 4.2 Effect of different doses of Bavistin DF (BDF) on moisture content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

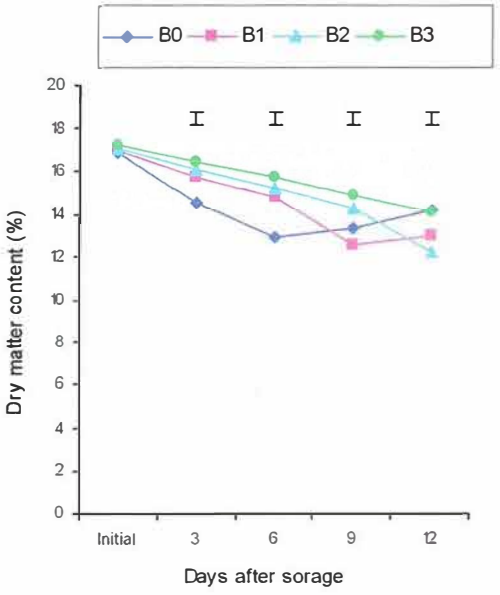


Fig. 4.3 Dry matter content of mango pulp as influenced by different doses of Bavistin DF (BDF) at different days after storage. Vertical bars represent LSD at 0.05 level

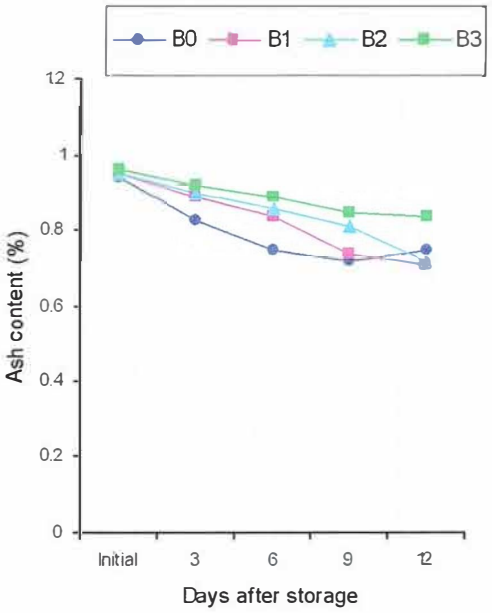


Fig. 4.4 Ash content of mango pulp as influenced by different doses of Bavistin DF (BDF) at different days after storage. Vertical bars represent LSD at 0.05 level

Graphs represent

B_0 =Control

B_1=250 ppm of BDF solution

B_2=500 ppm of BDF solution

B_3 =750 ppm of BDF solution

Table 4.2 Changes of physiological weight loss of mango and moisture content of mango pulp between varieties during storage condition

Treatments	Physiological weight loss (%) at different days				Moisture content (%) at different days				
Variety (V)	3	6	9	12	Initial	3	6	9	12
V_1	5.49 b	6.94 b	8.33 b	9.85 b	81.35 b	82.68 b	83.73 b	84.65 b	85.05 b
V_2	6.33 a	8.00 a	9.26 a	10.86 a	84.53 a	85.85 a	86.85 a	87.78 a	88.13 a
Level of significance	***	***	***	***	***	***	***	***	***

Table 4.3 Combined effects of varieties and different doses of Bavistin DF solution on physiological weight loss and moisture content of postharvest mango at ambient condition

Treatments combination	Physiological weight loss (%) at different days				Moisture content (%) at different days				
Varieties × Treatments	3	6	9	12	Initial	3	6	9	12
V_1B_0	6.90 b	8.50 b	9.85 b	11.12 b	81.50 c	83.80 d	85.50 d	85.10 f	84.20 f
V_1B_1	5.70 e	7.10 e	8.55 e	10.15 cd	81.40 c	82.60 e	83.60 e	85.90 e	85.50 e
V_1B_2	4.85 g	6.25 g	7.65 g	9.25 e	81.30 c	82.30 ef	83.10 f	84.10 g	86.20 d
V_1B_3	4.50 h	5.90 h	7.25 h	8.90 e	81.20 c	82.00 f	82.70 g	83.50 h	84.30 f
V_2B_0	7.60 a	9.85 a	10.65 a	12.25 a	84.70 a	87.00 a	88.60 a	88.20 b	87.30 c
V_2B_1	6.65 c	8.15 c	9.50 c	11.10 b	84.60 ab	85.80 b	86.70 b	89.00 a	88.50 b
V_2B_2	5.80 d	7.30 d	8.70 d	10.30 c	84.50 ab	85.50 b	86.30 c	87.30 c	89.30 a
V_2B_3	5.25 f	6.70 f	8.20 f	9.80 d	84.30 b	85.10 c	85.80 d	86.60 d	87.40 c
Level of significance	**	***	**	NS	NS	NS	NS	NS	NS
CV%	0.88	0.70	0.60	2.21	0.24	0.24	0.24	0.25	0.23

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3 =750 ppm of BDF solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Table 4.4 Changes of dry matter and ash content of mango pulp between varieties during storage at ambient condition

Treatments	Dry matter content (%) at different days					Ash content (%) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	18.65 a	17.33 a	16.28 a	15.35 a	14.95 a	1.03 a	0.97 a	0.91 a	0.86 a	0.83 a
V_2	15.48 b	14.15 b	13.15 b	12.23 b	11.88 b	0.87 b	0.81 b	0.76 b	0.70 b	0.67 b
Level of significance	***	***	***	***	***	**	**	**	**	**

Table 4.5 Combined effects of varieties and different doses of Bavistin DF solution on dry matter and ash content of postharvest mango pulp at room temperature

Treatments combination	Dry matter content (%) at different days					Ash content (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1B_0	18.50 a	16.20 c	14.50 d	14.90 c	15.80 a	1.02	0.91 ab	0.82 ab	0.80 ab	0.82 ab
V_1B_1	18.60 a	17.40 b	16.40 c	14.10 d	14.50 b	1.02	0.97 a	0.92 a	0.82 ab	0.78 ab
V_1B_2	18.70 a	17.70 ab	16.90 b	15.90 b	13.80 c	1.03	0.98 a	0.94 a	0.89 a	0.79 ab
V_1B_3	18.80 a	18.00 a	17.30 a	16.50 a	15.70 a	1.04	1.00 a	0.96 a	0.92 a	0.95 a
V_2B_0	15.30 b	13.00 f	11.40 g	11.80 g	12.70 d	0.86	0.75 b	0.67 b	0.64 b	0.67 b
V_2B_1	15.40 b	14.20 e	13.30 f	11.00 h	11.50 e	0.87	0.81 ab	0.76 ab	0.65 b	0.63 b
V_2B_2	15.50 b	14.50 e	13.70 e	12.70 f	10.70 f	0.87	0.82 ab	0.78 ab	0.73 ab	0.64 b
V_2B_3	15.70 b	14.90 d	14.20 d	13.40 e	12.60 d	0.88	0.84 ab	0.81 ab	0.77 ab	0.73 ab
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	1.24	1.28	1.37	1.47	1.51	11.25	11.98	12.74	13.64	15.24

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3=750 ppm of BDF solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

10.3.1 Vitamin C content

Variation between varieties means in terms of vitamin C content of mango pulp was highly statistical significant at different days after storage (Appendix 4.3 and Table 4.6). At various days, the results denoted that Langra was better in performing of vitamin C accumulation as compared to Khirshapat (Table 4.6). It also stated that quantity of vitamin C came down with the rising of storage period. At the initial stage, Langra produced higher (131.86 mg/100 g) quantity of vitamin C while; Khirshapat had lower (41.30 mg/100 g). At 12^{th} day, Langra was noticed as higher (15.35 mg/100 g) producer of vitamin C and Khirshapat was lower (7.88 mg/100 g) producer (Table 4.6).These results revealed that vitamin C content gradually came down with the passing of storage duration in both the varieties. It might be probably due to rising of ethylene synthesis resulting in oxidation of ascorbic acid. The results of the present study are in agreement with the findings of Azad (2001), Shyamalamma (1995), Gafur *et al.* (1994) and Absar *et al.* (1993).

Variation among the means of different doses of BDF solution in connection with vitamin C content was performed highly statistical significant at different days after storage (Appendix 4.3). At initial day, green mangoes treated with B_3 treatment produced the highest (88.24 mg/100 g) amount of vitamin C while; the lowest (85.25 mg/100 g) was notified from the untreated mangoes. After initial day, the results diminished successively with the advancement of storage time (Fig. 4.5). It also denoted that the diminishing tendency was hastily in control, but it was delay in B_3 treated fruit. At 12^{th} day, the maximum (16.00 mg/100 g) was derived from B_3 treatment and the minimum (7.35 mg/100 g) was derived from control, respectively.The reduction of vitamin C content in both treated and untreated mangoes at different storage period might be possible due to oxidation of ascorbic acid and B_3 treatment was possibly causing delay ripening resulting in lower oxidation in vitamin C. These results of the present investigation are in agreement with the findings of Ahmed and Singh (2000). Parmar and Chundawat (1989) also found more or less similar result.

The combined effect of varieties and different doses of BDF solution showed significant variation in respect of vitamin C content at different days after storage

(Appendix 4.3 and Table 4.7). At various days, the results were found that vitamin C content came down with the extending of storage period. The quantity of vitamin C ranged between 3.90 to 19.70 mg per 100 g of fresh mango pulp at 12th day. The highest (19.70 mg/100 g) was obtained from the treatment combination of V_1B_1 and the lowest (3.90 mg/100 g) was obtained from the treatment combination of V_2B_0.

10.3.2 Titratable acidity

Variation between varieties means in connection with titratable acidity was perceived to be highly significant at different days after storage (Appendix 4.4 and Table 4.8). At varlous days of storage, Langra was noted higher titratable acid producer as compared to Khirshapat. Titratable acidity abated with the advancement of storage period. The abating trend was hastily from initial to 3rd day and thereafter, it was slower. At initial day, higher (3.77%) was derived from Langra while lower (2.47%) was noticed from Khirshapat. At 12th day, higher (0.31%) was recorded in Langra while; Khirshapat gave lower amount (0.24%). The decreasing trend of titratable acidity during storage period was reported by Upadhyay and Tripathi (1985), Leon and Lima (1968) and Medlicott *et al.* (1986) also found the similar results. According to them, acidity was reduced during storage growth on attainment of maturity and ripening. The results of the present investigation might be possibly due to genetical dissimilarities between two varieties.

Different doses of BDF solution imposed to this investigation in terms of titratable acidity showed significant variation among the means at various days after storage (Appendix 4.4). At various days of storage, titratable acid content diminished hastily from initial to 3 days and then, it diminished steadily (Fig. 4.6). In all the storage period, higher titratable acidity (3.19, 1.20, 0.92, 0.74 and 0.42%) was derived from B_3 treatment from initial to 12th days followed by 3.09, 0.68, 0.40, 0.22 and 0.11% from untreated mangoes (Fig. 4.6). These results are supported by the findings of Ahmed and Singh (2000). These phenomena happened might be possible due to B_3 treatment delayed ripening that caused in lower diminishing trend of titratable acidity while control treatment caused ripening fast resulting in high decreasing trend of titrable acid content.

The combined effect of varieties and different doses of BDF solution in relation to titratable acidity of mango pulp demonstrated significant variation at different days after storage except initial days (Appendix 4.4 and Table 4.9). At different days of storage, there perceived a decreasing trend of titratable acid content with the rising of storage period (Table 4.9). At 6^{th} day, the highest (1.00%) quantity was recorded from the treatment combination of V_1B_3 and the lowest acid concentration (0.30%) was recorded from the treatment combination of V_2B_0 (Table 4.9). This occurrence might be probably due to the reduction of acid oxidation at V_2B_3 combination as well as genetical variation in between varieties.

10.3.3 Pulp pH

The analysis of variance between the varieties exhibited significant variation in terms of pulp pH of mango at different days after storage except at 6^{th} day (Appendix 4.4 and Table 4.8). At various days of storage, there observed a growing up trend of pulp pH with the increase of storage period. In each storage period, pulp pH was found more in Khirshapat compared to Langra. Higher pulp pH (6.96) was noted from Khirshapat at 12^{th} day whereas; lower (6.85) was noted from Langra. The growing up trend of pulp pH was also observed by Yuniarti (1980), Kumar *et al.* (1993) and Shahjahan *et al.* (1994). This phenomenon might be possible due to oxidation of acid during storage resulting in higher pH and also might have been genetical dissimilarities between varieties.

Different doses of BDF solution subjected to this trial showed significant variation in pulp pH at different days after storage (Appendix 4.4). The results indicated that the growing up trend of pulp pH was perceived from different treated and untreated mangoes at various days of storage (Fig. 4.7). Pulp pH was higher in control at all stages of storage followed by the fruits treated with B_1, B_2 and B_3 treatments, respectively. pH value of mango pulp was higher (7.05) in control which was statistically at par with B_1 and B_2 treatment whereas; the fruits treated with B_3 produced lower (6.57) value at 12^{th} day (Fig. 4.7). The results of the present investigation at B_3 treatment interrupted the loss of acid oxidation resulting in lower pH value. These results are in agreement with the findings of Ahmed and Singh (2000).

The combined effect of varieties and different doses of BDF solution imposed to this study in pulp pH were noticed to be non significant at different days after storage (Appendix 4.4). There was found a rising trend of pulp pH from various treatment combinations at different days of storage (Table 4.9). At 6th day, the highest (6.90) pH value was reported from the treatment combination of V_2B_0 which was statistically at par with V_1B_0 and the lowest (6.70) was reported from the treatment of combination of V_1B_3, respectively.

10.3.4 Total soluble solid (Brix %) content

Statistically highly significant variation was observed in TSS content between two varieties at different days after storage (Appendix 4.5). The results exhibited that TSS content of mango pulp developed in a continuous stream with the expansion of storage period. The developing trend was hastily from initial to 6th day thereafter; it increased slower. From initial to 6th day, Khirshapat was better in TSS accumulation than Langra, but, after 6th day, Langra performed better than Khirshapat up to 12th day. At 9th day, higher (17.90%) TSS quantity was noted from Khirshapat and lower (17.00%) was noted from Langra (Table 3.10). The higher percentage of TSS during storage in mango was reported by Singh (1968). Absar *et al.* (1993) reported that TSS was increased with maturity of mango fruit. But, they found highest TSS in Langra. Mollah and Siddique (1973) reported that TSS value varied from cultivar to cultivar. These might be possible due to genetically differences between varieties.

Different doses of BDF solution implied to the postharvest mangoes in this study were noticed significant variation in terms of TSS content at different days after storage (Appendix 4.5). At different days of storage, the results showed that TSS accumulation increased with the increase of storage duration. It also explored that TSS content was hastily grown up from untreated mangoes from initial to 6th day and then, it came down significantly (Fig. 4.8). The other treatment viz., B_1 also increasingly produced TSS from initial to 9th day and thereafter, it decreased sharply. Mango fruits treated with B_2 also produced more or less similar enhancing trend from initial to 12th days. But, the fruits treated with B_3 treatment gave very slower motion in TSS accumulation at various days after storage. The highest (21.25 and 21.30%)

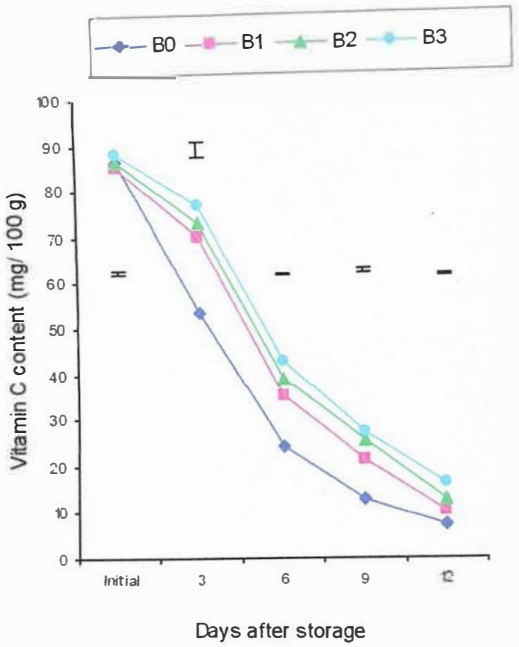


Fig. 4.5 Effect of different doses of BDF on vitamin C content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

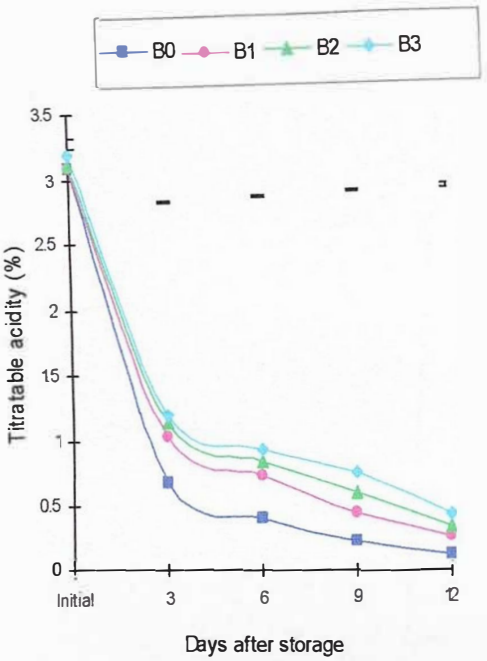


Fig. 4.6 Titratable acidity of mango pulp as influenced by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 level

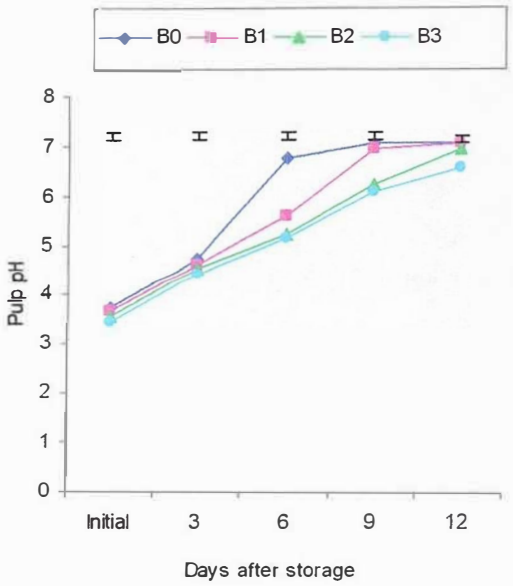


Fig. 4.7 Pulp pH of mango as influenced by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 level

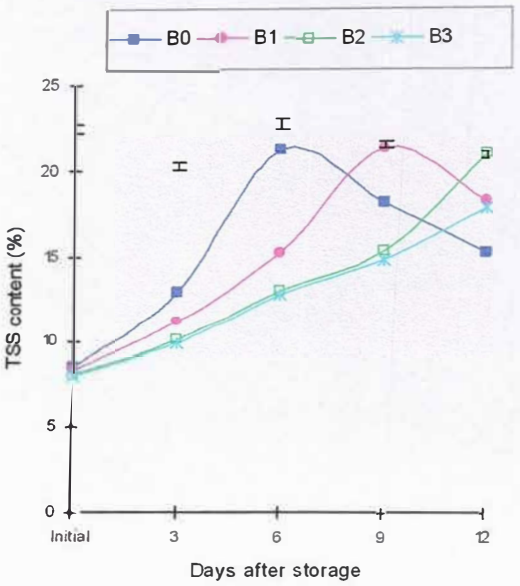


Fig. 4.8 Effect of different doses of BDF on total soluble solid content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

Graphs represent

B_0 =Control

B_1=250 ppm of BDF solution

B_2=500 ppm of BDF solution

B_3 =750 ppm of BDF solution

Table 4.6 Changes of vitamin C content of mango pulp in varieties during storage at ambient condition

Treatments	Vitamin C content (mg/100 g) at different days				
Variety (V)	Initial	3	6	9	12
V_1	131.86 a	107.05 a	54 43 a	32.90 a	15.15 a
V_2	41.30 b	29.64 b	16.30 b	10.43 b	7.88 b
Level of significance	***	***	***	***	***

Table 4.7 Combined effects of varieties and different doses of Bavistin DF solution on vitamin C content of postharvest mango at ambient condition

Treatments combination	Vitamin C content (mg/100 g) at different days				
Varieties x Treatments	Initial	3	6	9	12
V_1B_0	131.30 b	84.75 d	37.30 d	18.50 d	10.80 e
V_1B_1	130.70 b	110.50 c	55.40 c	33.20 c	13.60 c
V_1B_2	132.60 a	114.30 b	60.70 b	38.60 b	16.50 b
V_1B_3	132.90 a	118.70 a	64.30 a	41.30 a	19.70 a
V_2B_0	41.50 d	22.45 h	11.20 h	7.30 h	3.90 h
V_2B_1	39.80 e	29.60 g	15.30 g	9.20 g	6.60 g
V_2B_2	40.30 de	31.80 f	17.50 f	11.90 f	8.70 f
V_2B_3	43.60 c	34.70 e	21.20 e	13.30 e	12.30 d
Level of significance	*	***	***	***	***
CV%	0.85	0.98	0.32	0.58	0.92

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3 =750 ppm of BDF solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Table 4.8 Changes of titratable acidity and pH of postharvest mango pulp in varieties during storage at room temperature

Treatments	Titratable acidity (%) at different days					Pulp pH at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	3.77 a	1.10 a	0.78 a	0.55 a	0.31 a	3.55 b	4.55 b	5.65	6.53 b	6.85 b
V_2	2.47 b	0.92 b	0.65 b	0.43 b	0.24 b	3.65 a	4.65 a	5.73	6.65 a	6.96 a
Level of significance	***	***	***	***	***	*	*	NS	*	*

Table 4.9 Combined effects of varieties and different doses of Bavistin DF solution on titratable acidity and pulp pH of postharvest mango pulp during storage at ambient condition

Treatments combination	Titratable acidity (%) at different days					Pulp pH at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1B_0	3.70 b	0.88 e	0.50 f	0.25 e	0.12 e	3.70 ab	4.70 ab	6.70 a	7.00 ab	7.00 ab
V_1B_1	3.75 ab	1.10 c	0.75 d	0.50 c	0.28 c	3.60 bc	4.60 bc	5.60 b	6.90 b	7.00 ab
V_1B_2	3.80 ab	1.15 b	0.88 b	0.65 b	0.35 b	3.50 bc	4.50 bc	5.20 cd	6.20 c	6.90 b
V_1B_3	3.83 a	1.25 a	1.00 a	0.80 a	0.48 a	3.40 c	4.40 c	5.10 d	6.00 d	6.50 c
V_2B_0	2.48 cd	0.47 f	0.30 g	0.18 f	0.09 e	3.80 a	4.80 a	6.80 a	7.10 a	7.10 a
V_2B_1	2.40 d	0.95 d	0.68 e	0.35 d	0.20 d	3.70 ab	4.70 ab	5.60 b	7.00 ab	7.10 a
V_2B_2	2.43 d	1.10 c	0.78 d	0.52 c	0.30 c	3.60 a-c	4.60 a-c	5.30 c	6.30 c	7.00 ab
V_2B_3	2.55 c	1.15 b	0.84 c	0.68 b	0.35 b	3.50 bc	4.50 bc	5.20 cd	6.20 c	6.63 c
Level of significance	NS	***	***	*	**	NS	NS	NS	NS	NS
CV%	1.89	2.17	2.99	4.35	7.04	2.95	2.31	1.86	1.61	1.47

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3 =750 ppm of BDF solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

gathering of TSS content was perceived from B_0 and B_1 treatment at 6 and 9th days while, the lowest (12.90 and 14.85%) was noted from B_3 treatment (Fig. 4.8). The results of the present studies are strongly supported by the findings of Dhemre and Waskar (2004). Ahmed and Singh (2000) also found the similar results. These happened possibly due to ripening condition resulting in maximizing TSS accumulation in control and 750 ppm of BDF solution resisted in ethylene synthesis that caused delay ripening and ultimately in lower TSS accumulation. It also revealed that TSS accumulation is strongly related to ripening and it caused falling off owing to decaying.

The combined effect of varieties and applied different doses of BDF solution in connection with TSS content were perceived to be significant at different days after storage except initial and 3rd day (Appendix 4.5). It was exposited an enhancing behavior of TSS content at different days after storage (Table 4.11). The highest accumulation (22.00, 21.80 and 21.60%) was obtained from the treatment combination of V_1B_0, V_1B_1 and V_1B_2 at 6, 9 and 12th days, while; the lowest value (13.20, 14.50 and 17.50%) was notified from the treatment combination of V_2B_3, respectively.

10.3.5 Total sugar content

Highly significant variation was manifested between both the varieties means in terms of total sugar content of mango pulp at different days after storage (Appendix 4.5 and Table 4.10). It elucidated that TSC gathered in a continuous stream with expanding of storage duration. This gathering trend was more or less hastily from initial to 9th days in both the varieties, thereafter; it expanded slightly slower. At all days of storage, Khirshapat produced more quantity of TSC than Langra. At initial day, Khirshapat had higher (6.09%) while; Langra provided lower (5.57%). At 12th day, it gave higher quantity (19.64%) and lower (19.07%) was noted in Langra. Upadhyay and Tripathi (1985) reported that total sugar content was expanded gradually, when stored for 6 days at room temperature. Sugar content increased during ripening (Srivastava, 1967). These results are in conformity with the findings of Shahjahan *et al.* (1994). Tsuda *et al.* (1999) also found the

similar results. The increase in TSC might be possible due to conversion of complex starch or carbohydrate into simple compound.

Different doses of BDF solution subjected to the investigation in connection with total sugar content of mango pulp demonstrated significant variation at different days after storage except initial (Appendix 4.5). At different days, the results found that TSC increased hastily with expanding of storage period (Fig. 4.9). The increasing trend was very swift in untreated mango followed by other treatments *viz.* B_1, B_2 and B_3 treatment, respectively. The highest quantity of TSC (21.06 and 21.36%) was obtained from control and B_1 treated mangoes at 9 and 12th days, while; the lowest (12.40% and 15.70%) was reported from B_3 treatment. The results of the present investigation are in conformity with the reports of Dhemre and Waskar (2004). The enhancing trend of total sugar at untreated mangoes might be perhaps due to breaking down of complex carbohydrate into simple compound but, B_3 treatment made delay ripening at storage period.

The combined effect of varieties and implied different doses of BDF solution in this study in terms of total sugar content of mango pulp exhibited non significant variation at different days after storage (Appendix 4.5). The results indicated that total sugar content accumulated progressively with the advancement of storage period (Table 4.11). At 9th day, the maximum (21.31%) quantity of TSC was formed from the treatment combination of V_2B_0 while, the minimum (12.10%) was formed from the treatment combination of V_1B_3, respectively (Table 4.11).

10.3.6 Reducing sugar content

Analysis of variance showed significant effect on reducing sugar content of mango pulp at different days after storage except at 6th day (Appendix 4.6). The results observed an expanding trend of reducing sugar with the rising of storage period (Table 4.12). It also annotated that Khirshapat was better in gathering of reducing sugar than Langra at different days of storage. Higher (5.47%) quantity of this sugar was observed from Khirshapat while; lower (5.20%) was noted from Langra at 12th day of storage (Table 4.12). These results are in agreement with the findings of Upadhyay and Tripathi (1985). Casttrillo *et al.* (1992) stated that reducing sugar content was augmented during storage period. Khirshapat providing

more reducing sugar might be possibly due to genetical variation in both the varieties.

Different doses of BDF subjected to this study were perceived to be significant in respect of reducing sugar content of mango pulp at different storage period except initial (Appendix 4.6). The results explained that reducing sugar of mango pulp was increased progressively at different days of storage. It also stated that untreated mangoes were better in forming of reducing sugar as compared to the other treatments. Control treatment was considered as more progressive producer of reducing sugar up to 9th day and then, it came down owing to starting decay. At 12th day, the maximum (6.27%) amount of reducing sugar was obtained from B_1 treatment and the lowest (4.32%) was obtained at B_3 treatment. The results of the present study are in conformity with the findings of Dhemre and Waskar (2004). Lower increasing trend of reducing sugar content treated with B_3 treatment might be possibly due to delay ripening that resulted in lesser conversion of carbohydrates into simple's molecules.

The combined effect of varieties and different doses of BDF solution of mango pulp demonstrated non significant variation in terms of reducing sugar content of mango pulp at different days after storage (Appendix 4.6). The results exposited that reducing sugar content grew up progressively at three days interval up to 9th day thereafter, it came down from the treatment combination of V_2B_0 (Table 4.13). At 9th day, the highest (6.44%) quantity was noticed from the treatment combination of V_2B_0 and the lowest (3.90%) was noticed from V_1B_3.

10.3.7 Non reducing sugar content

The variation between the varieties means demonstrated highly significant in respect of non-reducing sugar content at different days after storage (Appendix 4.6). The results were noticed as an enhancing trend of non reducing sugar content at different days of storage. At all the days, it revealed that Khirshapat was much better than Langra in receiving of non reducing sugar content (Table 4.12). At 12th day, higher (14.20%) amount of non reducing sugar was recorded from Khirshapat and lower (13.88%) amount was recorded from Langra. These results are in conformity with the report of Ali and Mazhar (1960). They reported that non

reducing sugar content of ripe fruits was 11.20%. The results obtained from the investigation might be possible due to varietals dissimilarities.

Different doses of BDF solution imposed to this trial were noticed to be significant variation in connection with non reducing sugar content of mango pulp at different days after storage except at initial stage (Appendix 4.6). The results stated that non reducing sugar content of mango pulp was formed progressively at various days. It denoted that untreated fruits were noticed better in achieving of more quantity of non reducing sugar followed by the other treatments. This increasing trend was markedly up to 9th day and thereafter, it increased slowly owing to becoming hackneyed. Lower rising trend was perceived from the fruit treated with B_3 treatment. At 12th day, the highest result (15.28%) was recorded from control and lowest value (11.39%) was recorded from B_3 treatment (Table 4.12). These events might be probably due to B_3 treatment retarded ethylene synthesis of mango pulp resulting in delay ripening and little amount of non reducing sugar achieving. These results are in agreement with the statement of Ahmed and Singh (2000).

The combined effect of varieties and different doses of BDF solution exhibited non significant in terms of non reducing sugar content of mango pulp at different days after storage (Appendix 3.6). The results were exposited a growing up trend of non reducing sugar from different treatment combination at various days (Table 3.13). At 9th day, the highest (14.87%) quantity of non reducing sugar was notified from the treatment combination of V_2B_0 while; the lowest (8.42%) was notified from the treatment combination of V_1B_3, respectively.

10.3.8 Crude fibre content

The analysis of variance of mango varieties subjected to this investigation was perceived to be significant in respect of crude fiber content of mango pulp at different days after storage (Appendix 4.7). The results denoted that a growing up trend of crude fibre was noticed from both the varieties at different days of storage. It stated that Langra was found better in accumulation of crude fiber content. At initial day, Langra gave higher (1.22%) quantity of crude fibre as compared to Khirshapat (1.12%). The quantity of crude fibre came down in a continuous stream with the increase of storage period from both the varieties. At 12th day, higher

(0.51%) quantity of crude fiber was obtained from Langra while; lower (0.39%) was obtained from Khirshapat (Table 4.14). There were no available research findings in connection with crude fibre content of mango pulp in the scientific literature. The falling off of crude fibre content with the rising of storage period might be probable due to metabolic activities resulting in hydrolysis of cellulose and lignin into simple molecules.

Various doses of BDF solution used in this trial were observed to be significant on crude fiber content of mango pulp at different days after storage except initial day (Appendix 4.7). The results elucidated that crude fibre content decreased successively with the advancement of storage period (Fig. 4.10). At all days of storage, it was noticed that crude fibre content was comparatively more at the fruit treated with B_3 treatment followed by the other treatments. At 3rd day, the maximum (1.07%) amount of crude fiber was recorded from B_3 treatment which was statistically at par with B_2 treatment and the lowest (0.77%) was recorded from B_0 treatment (Table 4.14). At 12th day, the maximum (0.60%) was obtained from B_3 treatment while, the lowest (0.38%) was obtained from B_0 treatment which was also statistically at par to B_1 and B_2 treatment (Table 4.14). The results of the present study are partially supported by the findings of Mathooko (2000).The diminishing trend of crude fiber influenced by B_3 treatment might be possible due to retardation to ripening resulting in lower declining trend of crude fiber content during storage.

The combined effect of varieties and different doses of BDF solution were observed to be non significant variation in terms of crude fiber content of mango pulp at different days after storage (Appendix 4.7). The results annotated that crude fibre content came down continuously with the rising of storage period (Table 4.15). It denoted that the treatment combination of V_1B_3 was better in accumulation of crude fibre content at all storage period. At 6th day, the highest (1.00%) quantity of crude fibre was reported from the treatment combination of V_1B_3 and the lowest (0.39%) was reported from the treatment combination of V_2B_0, respectively.

10.3.9 Total lipid content

The analysis of variance of varieties showed non significant variation in terms of lipid content in mango at different days after storage except 9th day (Appendix

4.7). The results were noticed an increasing trend of lipid content in mango pulp with the advancement of storage period. At all days of storage, Langra was perceived higher in forming lipid content than Khirshapat. At 9th day, higher (0.60%) amount of lipid was obtained from Langra and lower (0.58%) was obtained from Khirshapat (Table 4.14). These occurrences might be possible due to genetically dissimilarities between two varieties.

Different doses of BDF solution to this study in terms of lipid content were observed to be highly significant at different days after storage (Appendix 4.7). The results were exposited an increasing trend of lipid content with the rising of storage period at various days of storage (Fig. 4.11). It illustrated that control treatment received comparatively higher amount of lipid followed by B_1, B_2 and B_3 treatments from initial to 9th days of storage; and then, it came down due to starting decay. At 9th day, the highest (0.76%) amount of lipid was derived from control whereas; the lowest (0.44%) was derived from the fruit treated with B_3 treatment. At 12th day, B_2 treated fruit produced the highest (0.71%) amount of lipid which was statistically at par with B_1 and the lowest (0.57%) was recorded from the fruit treated with B_3 treatment which was also statistically at par with control. These occurrences might be possible due to B_3 treatment caused delay ripening that resulted in lower production of lipid content and keeping the quality good. These results are partially supported by the statement of Bandyoppadhyay and Nair (1990).

The interaction effects of varieties and implied different doses of BDF solution in this trial showed significant variation in terms of lipid content of mango pulp at different days after storage except 9th day (Appendix 4.7). The results indicated that a slightly growing up trend of lipid content in mango pulp was noticed with the advancement of storage duration (Table 4.15). It revealed that the treatment combination of V_1B_0 was found as more producers (0.78%) of lipid at initial to 9th day and then, it fell off due to starting bad fruits situation. At this time, lower (0.43%) quantity was noticed from the treatment combination of V_2B_3.

10.3.10 Water soluble protein content

The analysis of variance of mango varieties was perceived to be significant variation in connection with WSPC in mango at different days after storage except 3,

9 and 12th day (Appendix 4.8). The results elucidated an increasing trend of WSPC with the increase of storage duration. It denoted that Langra was better in WSPC accumulation as compared to Khirshapat at all the stages of storage. At 6th day, higher (0.91%) synthesis of WSPC was derived in Langra while; lower (0.79%) was recorded in Khirshapat (Table 4.16). Anon (1962) suggested that protein content might be differed from cultivar to cultivar and stages of maturity as well as ripening. These events was possible due to some of seed protein of mango might have to be disseminated to pulp portion through complex metabolic activities during ripening and also might have the genetical variation between the varieties.

Different doses of BDF solution implied to this investigation in terms of WSPC demonstrated significant variation at different days after storage except initial and 12th day (Appendix 4.8). Various results of WSPC were found an augmenting trend in mango pulp with the increase of storage period (Fig. 4.12). It indicated that WSPC was gathered more in untreated fruit followed by the fruit treated with B_1, B_2 and B_3, treatments. The growing up trend of WSPC in control was hastily from initial to 6th days thereafter; it declined due to starting decay. At the same time, the increasing trend from the fruit treated with B_3 treatment was very slow due to delay ripening. At 9th day, the highest (1.23%) gathering of WSPC was notified from control which was statistically at par with B_1 treatment and the lowest (0.74%) was notified from B_3 treatment which was also statistical at par with B_2 treatment. It elucidated that extension of WSPC synthesis was strongly depended upon fruit ripening during storage. Lakshminarayana (1980) reported that mango fruits contained different quantity of protein during storage period. Peter *et al.* (2007) recommended that that protein content increased with the advances of storage duration.

The combined effect of varieties and imposed different doses of BDF solution in this experiment exhibited non significant variation in respect of WSPC at different days after storage (Appendix 4.8). The results reported from the studies annotated that WSPC increased in a continuous stream from initial to 9th days from the treatment combination of V_1B_0 then, it abated due to starting decomposition while, the lowest increasing trend was observed from the treatment combination of V_2B_3. At 9th day, the highest (1.25%) quantity of WSPC was recorded from the treatment

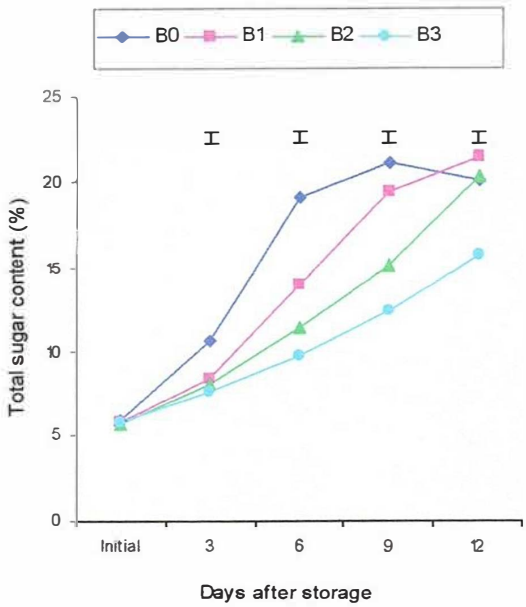


Fig. 4.9 Effect of different doses of BDF on total sugar content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

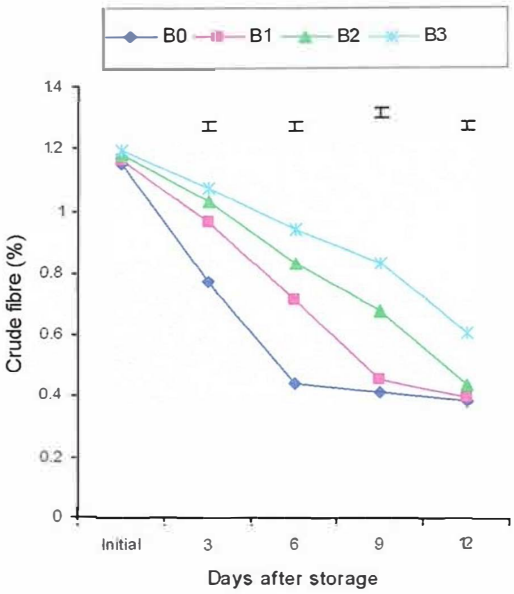


Fig. 4.10 Crude fibre content of mango pulp as influenced by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 level

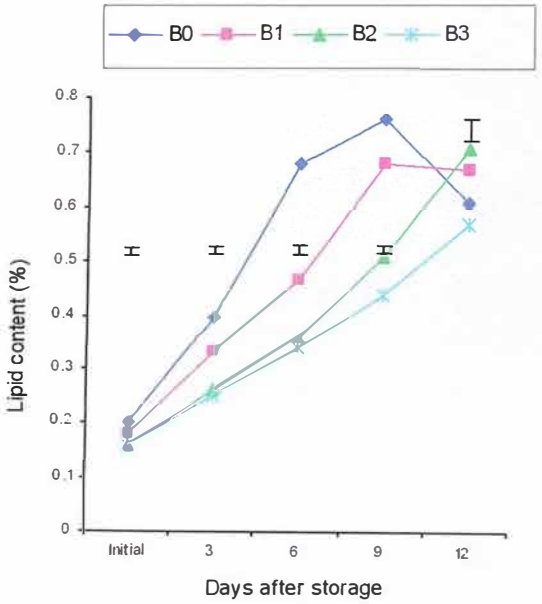


Fig. 4.11 Lipid content of mango pulp as influenced by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 level

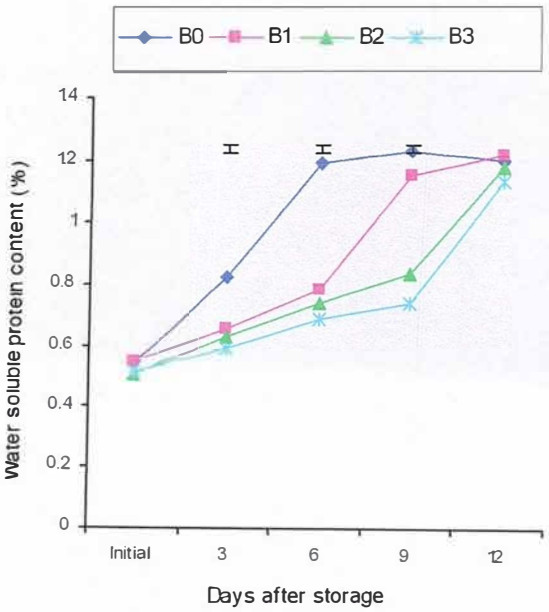


Fig. 4.12 Effect of different doses of BDF on water soluble protein content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

Graphs represent
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3 =750 ppm of BDF solution

Table 4.10 Pattern of total soluble solid and total sugar content of postharvest mango pulp between varieties during storage at ambient condition

Treatments	TSS content (%) at different days					Total sugar content (%) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	7.73 b	10.60 b	15.75 a	17.90 a	18.65 a	5.57 b	8.39 b	13.29 b	16.70 b	19.07 b
V_2	8.73 a	11.58 a	15.53 b	17.00 b	17.58 b	6.09 a	8.95 a	13.85 a	17.26 a	19.64 a
Level of significance	***	***	**	***	***	***	***	***	***	***

Table 4.11 Combined effects of varieties and different doses of Bavistin DF solution on total soluble solid and total sugar content of postharvest mango pulp at ambient condition

Treatments combination	TSS content (%) at different days					Total sugar content (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1B_0	8.00 c	12.50 b	22.00 a	19.00 c	16.00 g	5.65 b	10.37 b	18.80 b	20.82 b	19.83 e
V_1B_1	7.80 cd	10.80 d	15.80 c	21.80 a	18.80 c	5.58 b	8.11 e	13.79 d	19.09 d	21.09 b
V_1B_2	7.60 d	9.60 g	12.60 g	15.60 e	21.60 a	5.53 b	7.78 f	11.08 f	14.78 f	19.98 e
V_1B_3	7.50 d	9.50 g	12.60 g	15.20 f	18.20 d	5.50 b	7.30 g	9.50 h	12.10 h	15.40 g
V_2B_0	9.00 a	13.50 a	20.50 b	17.50 d	14.50 h	6.15 a	10.87 a	19.29 a	21.31 a	20.32 d
V_2B_1	8.80 ab	11.80 c	14.80 d	20.80 b	17.80 e	6.10 a	8.63 c	14.31 c	19.61 c	21.63 a
V_2B_2	8.60 b	10.60 e	13.60 e	15.20 f	20.50 b	6.00 a	8.40 d	11.70 e	15.40 e	20.60 c
V_2B_3	8.50 b	10.40 f	13.20 f	14.50 g	17.50 f	6.10 a	7.90 f	10.10 g	12.70 g	16.00 f
Level of significance	NS	NS	***	***	***	NS	NS	NS	NS	NS
CV%	2.03	0.96	1.14	0.81	0.68	1.82	1.22	0.78	0.62	0.55

In a column values having the same letter(s) do not differ significant as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3=750 ppm of BDF solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Table 4.12 Behavior of reducing and non reducing sugar content of postharvest mango pulp in varieties and influenced by different doses of Bavistin DF solution during storage condition

Treatments	Reducing sugar content (%) at different days					Non-reducing sugar content (%) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	1.45 b	2.17 b	3.82 b	5.17 b	5.20 b	4.13 b	6.22 b	9.47 b	11.53 b	13.88 b
V_2	1.72 a	2.46 a	4.11 a	5.44 a	5.47 a	4.32 a	6.49 a	9.74 a	11.82 a	14.20 a
Level of significance	**	***	***	***	***	***	***	***	***	***
Treatments (B)										
B_0	1.63	3.10 a	6.10 a	6.30 a	4.80 c	4.28	7.53 a	12.95 a	14.77 a	15.28 a
B_1	1.62	2.20 b	3.90 b	6.15 b	6.27 a	4.24	6.17 b	10.15 b	13.20 b	15.09 b
B_2	1.56	2.05 c	3.25 c	4.95 c	5.95 b	4.21	6.04 c	8.14 c	10.14 c	14.39 c
B_3	1.53	1.92 d	2.62 d	3.82 d	4.32 d	4.18	5.69 d	7.19 d	8.59 d	11.39 d
Level of significance	NS	***	***	***	***	NS	***	***	***	***

Table 4.13 Combined effects of varieties and different doses of Bavistin DF solution on reducing and non reducing sugar content of postharvest mango pulp at ambient condition

Treatments combination	Reducing sugar content (%) at different days					Non-reducing sugar content (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1B_0	1.48 bc	2.95 b	5.95 b	6.15 bc	4.65 e	4.17 bc	7.42 b	12.85 b	14.67 b	15.18 b
V_1B_1	1.48 bc	2.05 de	3.75 d	6.05 c	6.17 b	4.13 c	6.06 de	10.04 d	13.04 d	14.92 c
V_1B_2	1.42 c	1.90 ef	3.10 f	4.80 e	5.80 c	4.11 c	5.88 ef	7.98 f	9.98 f	14.18 e
V_1B_3	1.40 c	1.78 f	2.48 h	3.68 g	4.18 g	4.10 c	5.52 g	7.02 h	8.42 h	11.22 g
V_2B_0	1.77 a	3.24 a	6.24 a	6.44 a	4.94 d	4.38 a	7.63 a	13.05 a	14.87 a	15.38 a
V_2B_1	1.75 a	2.35 c	4.05 c	6.25 b	6.37 a	4.35 ab	6.28 c	10.26 c	13.36 c	15.26 ab
V_2B_2	1.70 a	2.20 cd	3.40 e	5.10 d	6.10 b	4.30 a-c	6.20 cd	8.30 e	10.30 e	14.60 d
V_2B_3	1.65 ab	2.05 de	2.75 g	3.95 f	4.45 f	4.25 a-c	5.85 f	7.35 g	8.75 g	11.55 f
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	6.71	4.58	2.68	2.00	1.99	2.51	1.67	1.10	0.91	0.76

In a column values having the same letter(s) do not differ significantly as per DMRT at 5 %level

Table represents

V_1 = Langra
V_2 = Khirshapat
B_0 =Control
B_1=25 0ppm of BDF solution
B_2=5 00ppm of BDF solution
B_3 =75 0ppm of BDF solution
* indicates at 5 %level
** indicate at 1 % level
*** indicate at 0.1 % level
NS means non significant

Table 4.14 Behavior of crude fibre and lipid content of postharvest mango pulp in varieties during storage environments at ambient condition

Treatments	Crude fibre (%) at different days					Lipid content (%) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	1.22 a	1.01 a	0.77 a	0.65 a	0.51 a	0.18	0.31	0.48	0.60 a	0.64
V_2	1.12 b	0.90 b	0.69 b	0.53 b	0.39 b	0.17	0.30	0.46	0.58 b	0.63
Level of significance	***	***	**	***	***	NS	NS	NS	***	NS

Table 4.15 Combined effects of varieties and different doses of BDF solution on crude fibre and lipid content of postharvest mango pulp during storage at ambient condition

Treatments combination	Crude fibre (%) at different days					Lipid content (%) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1B_0	1.20 a-d	0.84 d	0.49 d	0.46 de	0.44 cd	0.20 a	0.40 a	0.69 a	0.78 a	0.63 ab
V_1B_1	1.21 a-c	1.01 a-c	0.71 c	0.51 cd	0.46 b-d	0.18 ab	0.33 b	0.48 b	0.68 c	0.64 ab
V_1B_2	1.23 ab	1.08 a	0.88 b	0.73 b	0.49 bc	0.16 b	0.26 c	0.36 c	0.51 d	0.71 a
V_1B_3	1.25 a	1.10 a	1.00 a	0.90 a	0.65 a	0.16 b	0.25 c	0.34 c	0.44 e	0.58 b
V_2B_0	1.10 d	0.70 e	0.39 e	0.36 e	0.32 e	0.19 ab	0.39 a	0.67 a	0.73 b	0.58 b
V_2B_1	1.11 cd	0.91 cd	0.71 c	0.38 e	0.32 e	0.17 ab	0.32 b	0.47 b	0.67 c	0.70 a
V_2B_2	1.12 cd	0.97 bc	0.77 c	0.61 c	0.36 de	0.16 b	0.25 c	0.35 c	0.50 d	0.70 a
V_2B_3	1.13 b-d	1.03 ab	0.88 b	0.75 b	0.55 b	0.16 b	0.24 c	0.33 c	0.43 e	0.56 b
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	**	NS
CV%	4.54	5.42	7.28	10.49	11.82	6.05	6.15	3.19	1.79	6.43

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3=750 ppm of BDF solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

combination of V_1B_0 which was statistically at par with V_1B_1, V_2B_0 and V_2B_1 whereas; the lowest (0.70%) was recorded from the treatment combination of V_2B_3, which was also statistically at par with V_1B_3 and V_2B_2 (Table 4.17).

10.4 Changes in mineral contents of mango during storage environments

The data obtained from different behavior of mineral contents during storage period of mango fruits are presented and fairly interpreted in the following sub-headings.

10.4.1 Phosphorus content

Analysis of variance of varieties in connection with P contents showed highly significant at different days after storage (Appendix 4.8). The results gave a signal that P content increased smoothly in both the varieties with the expansion of storage period (Table 4.16). It was observed that Langra produced more quantity of P as compared to Khirshapat. The increasing trend of P in Langra was more or less similar up to 9th day thereafter, it abated due to becoming spoilage of fruits. At 12th day, higher (23.60 mg/100 g) quantity of P was recorded in Langra and lower (21.62 mg/100 g) was recorded in Khirshapat. Anon (1962) elucidated that P content of mango pulp might be differed from cultivar to cultivar. Better performance in increasing trend of P content in Langra might be probably due to genetical dissimilarities. It also revealed that the expansion of P content in mango was intimately associated with ripening during storage. The data of the present study are in partially supported by the findings of Nadkarni (1963) when he worked with 16 cultivars and found the ranged between 10-30 mg/100 g among the cultivars.

Different doses of BDF solution subjected to this trial in relation to P content exhibited highly significant variation at different days after storage (Appendix 4.8). The results narrated that P content increased steadily at various days of storage. It denoted that P content in control augmented at slow rate from initial to 6th days thereafter; it augmented at very slow motion than its previous trend. After 9th day, it declined possibly due to decomposition of fruits (Fig. 4.13). At 9th day, the maximum (23.43 mg/100 g) quantity of P content was obtained from the fruit treated with control and the minimum (20.40 mg/100 g) was obtained from the fruit treated with

B_3 treatment. Lower amount of P content from the fruit treated with B_3 treatment might be probably due to delay ripening that resulted in lower accumulation of P content. Peter *et al.* (2007) stated that P content was increasingly changed during storage. Watt and Merrill (1963) found 13.00 mg per 100 g of fresh green mango pulp.

The combined effect of varieties and implied various doses of BDF solution demonstrated non significant variation on P content of mango pulp at different days after storage except 12th day (Appendix 4.8). The results found a growing up trend of P content with the rising of storage period (Table 4.17). It annotated that P content increased gradually from initial to 9th day with the treatment combination of V_1B_0 and then, it fell off due to bad fruit situation. In this time, P content was noticed lower increasing trend from the fruit treated with the treatment combination of V_2B_3. At 12th day, the highest (24.45 mg/100 g) quantity of P was obtained from the treatment combination of V_1B_1 whereas; the lowest (20.66 mg/100 g) was obtained from the treatment combination of V_2B_3. It also explained that Langra along with B_3 treatment was regarded as the best treatment combination in keeping the quality good in preservation followed by the other treatment combinations. This treatment combination strictly impeded the ripening of mango fruits during storage.

10.4.2 Potassium content

Adopted varieties in terms of K content demonstrated highly significant at different days after storage (Appendix 4.9). The results explored a rising trend of K content was observed in both the varieties with the increase of storage period at different days (Table 4.18). In all the storage period, Langra was manifested more producer of K content comparing to Khirshapat. It also annotated that the increase trend of K content was suspended at 9th day. At this period, higher (0.28%) amount of K was recorded from Langra and lower (0.26%) was recorded from Khirshapat (Table 4.18). These occurrences might be possible due to deterioration of fruits that resulted in lower metabolic activities. Langra was better accumulator of K content possibly due to genetically dissimilarities between varieties. At different storage

period, K content increased might be possible due to transmission of K from stone and peel to pulp of mango during high metabolic activity.

Different doses of BDF solution imposed to this experiment in terms of K content of mango pulp were perceived to be significant at different days after storage (Appendix 4.9). The results exposited that K content accumulated in a continuous stream with the advancement of storage period, but, K content from the untreated fruit came down after 9th day, while other treatments *viz.*, B_1, B_2 and B_3 treatments retained their increasing behavior (Fig. 4.14). In this period, it noticed a very lower extending trend of K content in the fruit treated with B_3 treatment. At 9th day, the maximum (0.29%) of K content was recorded from the untreated fruit but it was statistically at par with B_1 and B_2 treatment while; the lowest (0.25%) was recorded from the fruit treated with B_3 treatment which was also statistically at par with B_1 and B_2 treatment. Lower quantity of K in the fruit treated with B_3 treatment might be possible due to delay ripening that caused lower transmission of K with good keeping quality. Peter *et al.* (2007) showed that K content was increased during storage. Watt and Merrill (1963) reported 189 mg K per 100 g of fresh green mango. The results of the present investigation interpreted that K content of mango pulp was grown up slightly in the storage period, but, B_3 treatment interrupted its growing up trend during storage period.

The combined effect of varieties and imposed different doses of BDF solution in relation to K content of mango pulp demonstrated non significant variation at different days after storage (Appendix 4.9). The results denoted that K content of mango pulp was increased gradually from different treatment combination with the expansion of storage time (Table 4.19). But, only the treatment combination of V_1B_0 produced the higher content of K up to 9th day. In this period, the highest (0.30%) quantity was reported from the treatment combination of V_1B_0 which was statistically at par with V_1B_1, V_1B_2, V_1B_3, V_2B_0, and V_2B_1, whereas, the lowest (0.24%) was reported from the treatment combination of V_2B_3 which was also statistically at par with V_2B_2.

10.4.3 Calcium content

Analysis of variance of induced varieties to this investigation in connection with Ca content demonstrated highly significant variation at different days after storage (Appendix 4.9). The results were perceived an increasing trend of Ca content with the extending of storage time from both the varieties (Table 4.18). It also narrated that Khirshapat was better in accumulation of Ca content as compared to Langra. At 12th day, higher (22.98 mg/100 g) quantity of Ca was recorded in Khirshapat and lower (21.25 mg/100 g) was recorded in Langra. These occurrences might be possible due to genetical variation between two varieties. These results are in partially supported by the findings of Nadkarni (1963). Calcium content differed from cultivar to cultivar during storage period was reported by Anon (1962).

Different doses of BDF solution on Ca content of mango pulp demonstrated significant variation at different days after storage (Appendix 4.9). At various days of storage, the results of Ca content extended in a continuous stream with the passing of storage time (Fig. 4.15). It also stated that Ca content of control extended sharply from initial to 6th day and then, it extended smoothly and thereafter, it declined due to starting of decomposition. At the same time, Ca content from the fruit treated with B_3 treatment gathered very smoothly. At 9th day, the highest (24.76 mg/100 g) quantity of Ca was recorded from untreated fruit while; the lowest (16.69 mg/100 g) was recorded from the fruit treated with B_3 treatment (Table 4.18). These phenomena caused by B_3 treatment might be possible due to delay ripening that caused in lower dissemination of Ca content from peel and stone to pulp of mango. Increased form of Ca content of mango pulp was stated by Anon (1963) and reported to be 10.00 mg of Ca per 100 g of fresh green mango pulp. But, these results are not supported by the findings of Peter *et al.* (2007).

The combined effect of varieties and different doses of BDF solution in terms of Ca content of mango pulp had significant variation at different days after storage except 6th day (Appendix 4.9). The results of Ca content were noticed an increasing trend from various treatment combinations (Table 4.19). At 9th day, the highest (25.58 mg/100 g) quantity of Ca was observed from the treatment combination of V_2B_0 and the lowest (15.94 mg/100 g) was observed from the treatment combination

of V_1B_3. The results of the present investigation annotated that the treatment combination of V_1B_3 was better in mango preservation.

10.4.4 Magnesium content

Highly significant variation was observed in terms of Mg content between the varieties means at different days after storage (Appendix 4.10). The results indicated that Mg content augmented gradually with the advancement of storage period (Table 4.20). It also denoted that Mg content extended steadily of initial to 9 days thereafter; it came down slightly due to starting decay of the fruit. At 9th day, higher (18.08 mg/100 g) was derived from Langra and lower (17.11 mg/100 g) was derived from Khirshapat. These phenomena might be probably due to genetical dissimilarities between the varieties. There were no available research findings in connection with Mg content during storage in the scientific literature. But, the data of the present study revealed that Langra contained more Mg over Khirshapat.

Different doses of BDF solution used in this trial exhibited highly significant on Mg content of mango pulp at different days after storage (Appendix 4.10). The results indicated a smooth gathering trend of Mg content of mango pulp with the extension of storage period (Fig. 4.16). It was also noticed that Mg content of control extended gradually from initial to 6 days and then, it abated very sharply. The highest (18.72 and 18.00 mg/100 g) quantity of Mg was obtained from control and B_1 treatment at 6 and 9th day while, the lowest (16.83 and 17.18 mg/100 g) was obtained from the fruit treated with B_3 treatment, respectively. The increasing tendency of Mg content in mango pulp during storage period might have been related to starting of ripening. This result is very much similar to the report of Peter *et al.* (2007).

The combined effect of varieties and various doses of BDF solution were observed to be non significant variation in connection with Mg content at various days after storage (Appendix 4.10). The results were noticed an extending trend of Mg content of mango pulp with the growing up of storage time (Table 4.21). At 6th day, the highest (19.15 mg/100 g) quantity of Mg was manifested from the treatment combination of V_1B_0 while; the lowest (16.25 mg/100 g) was reported from the treatment combination of V_2B_3.

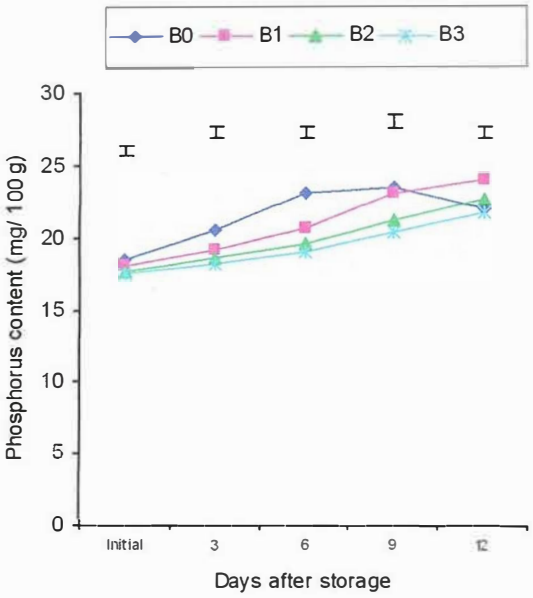


Fig. 4.13 Effect of different doses of BDF on Phosphorus content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

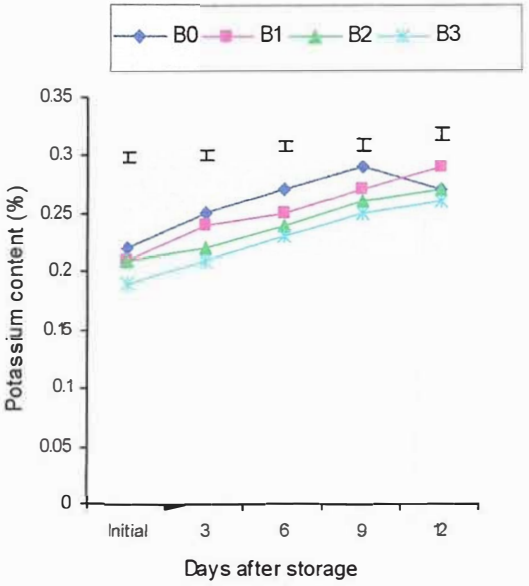


Fig. 4.14 Potassium content of mango pulp as influenced by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 level

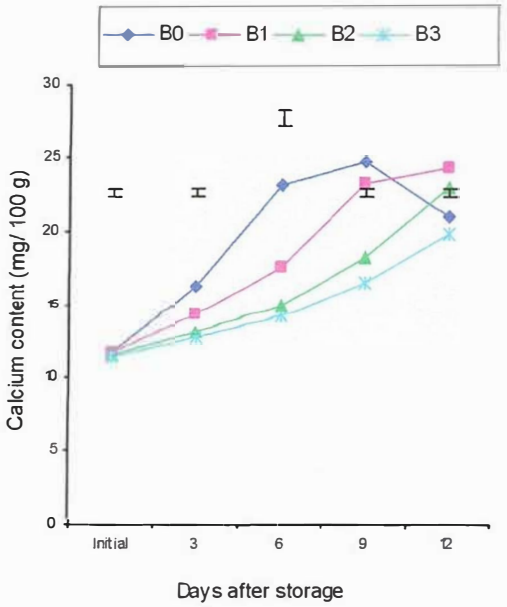


Fig. 4.15 Calcium content of mango pulp as influenced by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 level

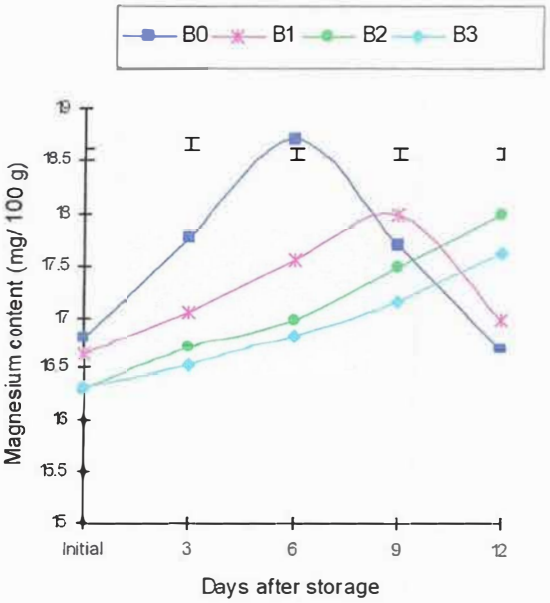


Fig. 4.16 Effect of different doses of BDF on Magnesium content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

Graphs represent
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3 =750 ppm of BDF solution

Table 4.16 Changes of water soluble protein and phosphorus content of postharvest mango pulp in varieties during storage environments at ambient condition

Treatments	Water soluble protein content (%) at different days					Phosphorus (mg/100 g) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	0.56 a	0.72	0.91 a	1.03	1.21	19.06 a	20.24 a	21.78 a	23.16 a	23.60 a
V_2	0.48 b	0.63	0.79 b	0.95	1.15	16.75 b	17.94 b	19.38 b	20.85 b	21.62 b
Level of significance	*	NS	*	NS	NS	***	***	***	***	***

Table 4.17 Combined effects of varieties and different doses of BDF solution on water soluble protein and phosphorus content of postharvest mango pulp at ambient condition

Treatments combination	Water soluble protein content (%) at different days					Phosphorus (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1B_0	0.58	0.87 a	1.22 a	1.25 a	1.22	19.65 a	21.75 a	24.26 a	24.59 a	23.12 d
V_1B_1	0.59	0.70 a-c	0.85 b	1.20 a	1.25	19.25 b	20.27 b	21.78 b	24.15 b	24.45 a
V_1B_2	0.55	0.68 a-c	0.80 bc	0.90 b	1.22	18.78 c	19.69 c	20.83 c	22.34 c	23.95 b
V_1B_3	0.53	0.64 bc	0.75 bc	0.78 bc	1.15	18.55 d	19.26 d	20.23 d	21.55 e	22.86 e
V_2B_0	0.49	0.78 ab	1.15 a	1.21 a	1.18	17.25 e	19.38 d	21.87 b	22.28 c	20.78 g
V_2B_1	0.50	0.62 bc	0.72 bc	1.10 a	1.18	16.89 f	17.92 e	19.43 e	21.93 d	23.54 c
V_2B_2	0.45	0.58 bc	0.68 bc	0.78 bc	1.14	16.50 g	17.42 f	18.38 f	19.92 f	21.48 f
V_2B_3	0.48	0.54 c	0.62 c	0.70 c	1.10	16.35 g	17.05 g	17.85 g	19.25 g	20.66 g
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	***
CV%	14.35	15.68	12.50	10.71	8.99	0.59	0.56	0.52	0.52	0.47

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3 =750 ppm of BDF solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Table 4.18 Changes of potassium and calcium content of postharvest mango pulp between varieties during storage environments at ambient condition

Treatments	Potassium content (%) at different days					Calcium content (mg/100 g) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	0.23 a	0.24 a	0.26 a	0.28 a	0.28 a	10.74 b	13.29 b	16.63 b	19.92 b	21.25 b
V_2	0.19 b	0.22 b	0.24 b	0.26 b	0.26 b	12.39 a	15.01 a	18.44 a	21.64 a	22.98 a
Level of significance	***	***	***	***	***	***	***	***	***	***

Table 4.19 Combined effects of varieties and different doses of BDF solution on potassium and calcium content of postharvest mango pulp during storage at ambient condition

Treatments combination	Potassium content (%) at different days					Calcium content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1B_0	0.23 ab	0.26 a	0.28 a	0.30 a	0.28 ab	10.75 d	15.48 b	22.32 b	23.93 c	20.32 g
V_1B_1	0.24 a	0.25 ab	0.26 ab	0.28 ab	0.30 a	10.82 d	13.42 d	16.62 d	22.26 d	23.35 c
V_1B_2	0.22 a-c	0.23 a-c	0.25 ab	0.27 ab	0.28 ab	10.65 d	12.25 e	14.23 g	17.55 f	22.17 d
V_1B_3	0.21 a-d	0.22 bc	0.24 ab	0.26 ab	0.27 ab	10.72 d	12.02 f	13.34 h	15.94 g	19.16 h
V_2B_0	0.20 b-e	0.23 a-c	0.25 ab	0.27 ab	0.25 b	12.58 a	17.15 a	23.98 a	25.58 a	21.98 e
V_2B_1	0.18 de	0.22 a-c	0.24 ab	0.26 ab	0.27 ab	12.48 ab	15.48 b	18.67 c	24.32 b	25.42 a
V_2B_2	0.19 c-e	0.21 bc	0.23 b	0.25 b	0.26 ab	12.35 b	13.95 c	15.92 e	19.22 e	23.84 b
V_2B_3	0.17 e	0.20 c	0.22 b	0.24 b	0.25 b	12.16 c	13.47 d	15.17 f	17.45 f	20.68 f
Level of significance	NS	NS	NS	NS	NS	*	**	NS	**	**
CV%	5.17	4.66	4.31	3.98	3.93	0.92	0.75	1.15	0.51	0.48

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3=750 ppm of BDF solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

10.4.5 Copper content

Variation between varieties mean in terms of Cu content of mango pulp demonstrated highly significant at different days after storage (Appendix 4.10). The results denoted that Cu content of mango pulp diminished in a continuous stream with the passing of storage period (Table 4.20). It also narrated that Cu content of Khirshapat was higher as compared to Langra. At initial day, higher (0.36 mg/100 g) content of Cu was noted in Khirshapat and lower (0.33 mg/100 g) was noticed in Langra, respectively. At 12th day, Khirshapat gave higher (0.19 mg/100 g), quantity of Cu and lower (0.16 mg/100 g) was noted in Langra (Table 4.20). These happened might be probably due to genetical dissimilarities between the varieties. There were no available research reports on Cu content of mango pulp at the scientific literature. The results of the present studies revealed that green mangoes contained more copper comparing to stored mangoes and Khirshapat was fairly good in copper accumulation than Langra. The present research findings also revealed that Cu content came down gradually during storage period.

Different doses of BDF solution implied to the present study in connection with Cu content of mango pulp exhibited significant variation at different days after storage (Appendix 4.10). The results narrated that Cu content fell off gradually with the advancement of storage period. The diminishing trend from control was higher than the fruit treated with B_1, B_2 and B_3, treatments respectively (Fig. 4.17). At 12th day, higher quantity of Cu (0.24 mg/100 g) was noticed from the fruit treated with B_3 treatment but, it was statistically at par with B_2 treatment while; lower (0.11 mg/100 g) was noticed from control. The data of B_3 treatment recorded from the investigation was fairly good over the other treatments in Cu preservation. So, the present findings revealed that B_3 treatment was much better in mango preservation.

The combined effect of varieties and applied different doses of BDF solution in relation to Cu content of mango pulp were found to be non significant variation at various days after storage (Appendix 4.10). The results stated that Cu content in different treatment combination came down with the extension of storage duration. At 12th day, the highest (0.24 mg/100 g) was derived from the treatment combination of V_2B_3, which was statistically at par with V_1B_3, V_2B_2 and V_1B_2 and the

lowest (0.09 mg/100 g) was derived from the treatment combination of V_1B_0 but, it was statistically at par with V_1B_1 and V_2B_2 (Table 4.21).

10.4.6 Iron content

The analysis of variance of varieties in connection with Fe content of mango pulp was observed to be highly significant at different days after storage (Appendix 4.11). The results found an extending trend of Fe content with the advancement of storage duration. The growing up trend of Fe content was more or less similar from initial to 9 days thereafter, it abated slightly. At 12th day, higher (4.72 mg/100 g) quantity of Fe was reported from Langra and lower (3.30 mg/100 g) was reported from Khirshapat (Table 4.22). These results are in partially supported by the findings of Nadkarni (1963). Fe content differed from cultivar to cultivar during storage period was supported by the report of Anon (1963).

Highly significant variation was noticed due to the effect of different doses of BDF solution in connection with Fe content of mango pulp at various days after storage (Appendix 4.11). The results obtained from the study indicated that Fe content was achieved hastily from initial to 6th day and then, it came down significantly at control and similarly B_1 treated fruits abated of Fe content after 9th day. But, Fe content recorded from the other fruits treated with B_2 and B_3 treatment extended successively up to 12th day (Fig. 4.18). At 12th day, the maximum (4.59 mg/100 g) quantity was derived from the fruit treated with B_2 treatment but, it was statistically at par with B_3 while; the lowest (2.89 mg/100 g) was derived from the untreated fruit due to starting decay. A smaller quantity of Fe obtained from untreated fruits at 12th day might be due to starting decomposition. On the other hand, B_3 treated fruits were fairly good because of its lower achievement of Fe content with the increase of storage duration.

The combined effect of varieties and different doses of BDF solution were observed to be non significant variation in relation to Fe content of mango pulp at different days after storage except 9 and 12th day (Appendix 4.11). The results narrated that enhancing trend of Fe content was found from initial to 6 days thereafter, it came down very fast from the treatment combination of V_1B_0 while; the lowest trend was found from the treatment combination of V_2B_3 (Table 4.23). At 9th

day, the highest (5.35 mg/100 g) quantity was recorded from the treatment combination of V_1B_1 and the lowest (3.15 mg/100 g) was recorded from the treatment combination of V_2B_2.

10.4.7 Manganese content

Manganese content of mango pulp was noticed to be differed significantly in both the varieties mean at different days after storage (Appendix 4.11). The results elucidated that Mn content extended gradually with the extension of storage period (Table 4.22). It also stated that Langra performed better in Mn accumulation comparing to Khirshapat. At 9th day, higher (1.20 mg/100 g) quantity of Mn was rnoted in Langra while; lower (1.05 mg/100 g) was noted in Khirshapat (Table 4.22). There were no available research reports in terms of Mn content in the scientific literature. The results of the present research revealed that Langra was fairly good than Khirshapat in Mn accumulation and it extended during storage period.

Different doses of BDF solution were found to be highly significant in connection with Mn content of mango pulp at different days after storage (Appendix 4.11). The results explained that Mn content extended continuously from initial to 6th days, and then it came down sharply in control. On the other hand, it increased from initial to 9th day thereafter; it diminished in the fruit treated with B_1 treatment. At the same time, very lesser augmenting trend of Mn content was perceived from the fruit treated with B_3 treatment (Fig. 4.19). At 12th day, Mn content ranged between 0.89 to 1.33 mg per 100 g of fresh mango pulp. The maximum (1.33 mg/100 g) was recorded from B_2 treated fruits and the minimum (0.89 mg/100 g) was recorded from control. There were no available research findings in terms of Mn content in the scientific literature. But, the data of the present research revealed that B3 treatment showed profound effect in delay ripening which resulted in lesser extending trend of Mn and keeping the quality good in preservation.

The combined effect of varieties and imposed different doses of BDF solution in relation to Mn content of mango pulp were observed to be non significant at various days after storage (Appendix 3.11). The results were exposited that a growing up trend of Mn content was perceived in different treatment combination with the extension of storage duration (Table 4.23). At 9th day, the highest (1.42

mg/100 g) was listed from the treatment combination of V_1B_1 and the lowest (0.87 mg/100 g) was listed from the treatment combination of V_2B_3.

10.4.8 Zinc content

Variation in respect of Zinc content of mango pulp due to the effect of varieties showed highly significant at different days after storage (Appendix 4.12). The results indicated that Zn content came down markedly with the extension of storage duration from both the varieties (Table 4.24). It was also exposited that Khirshapat was noticed better in Zn content accumulation as compared to Langra. At initial stage, higher (1.47 mg/100 g) was derived from control and lower (1.26 mg/ 100 g) was derived from Langra. Again, at 12^{th} day, higher (0.85 mg/100 g) was noticed from Khirshapat and the lesser (0.73 mg/100 g) was recorded from Langra. There were no available research findings in terms of Zn content in the scientific review. The results of the present studies invented that green mango especially, Khirshapat received more quantity of Zn than Langra, but, it continuously reduced with the increase of storage duration.

Different doses of BDF solution were found to be significant variation in connection with Zn content of mango pulp at different days after storage (Appendix 4.12). The results observed an extending trend of Zn content of mango pulp with the advancement of storage period from the fruit treated with different doses of BDF solution. It also stated that the coming down trend was very high in control and very low in the fruit treated with B_3 treatment (Fig. 4.20). At 12^{th} day, the maximum (0.96 mg/100 g) was noticed from the fruit treated with B_3 treatment and the lowest (0.65 mg/100 g) was noticed from control. Zn content of mango pulp decreased during storage period was possibly due to transmission of Zn from pulp to stone and peel at stored condition or Zn content of mango pulp might have been depressed or suppressed as influenced by metabolic activities during storage.

The combined effect of varieties and subjected to different doses of BDF solution on Zn content of mango pulp demonstrated non significant variation at different days after storage except initial day (Appendix 4.12). An expanding trend of Zn content of mango pulp was recorded from various treatment combinations (Table 4.25). At initial day, the maximum (1.52 mg/100 g)

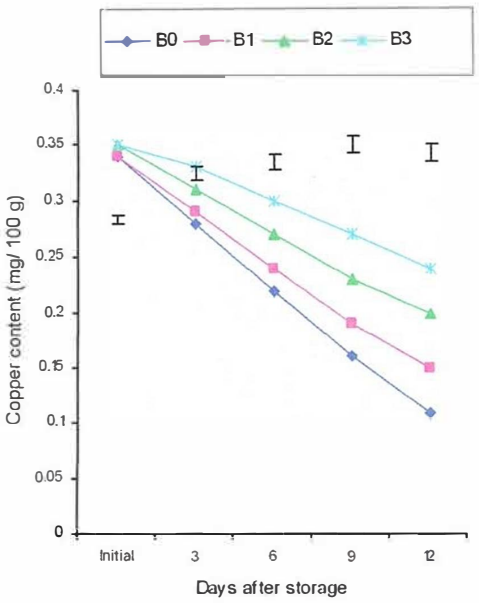


Fig. 4.17 Effect of different doses of BDF on copper content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

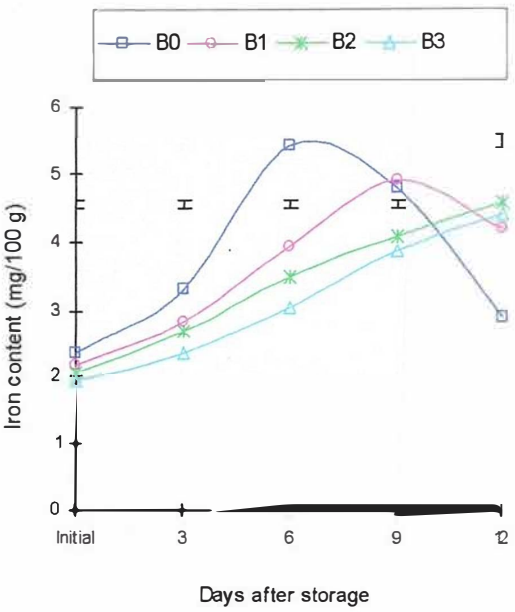


Fig. 4.18 Iron content of mango pulp as influenced by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 level

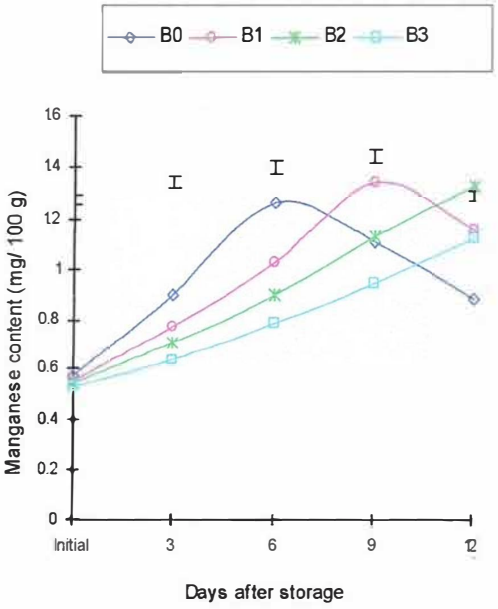


Fig. 4.19 Manganese content of mango pulp as influenced by different doses of BDF at different days after storage. Vertical bars represent LSD at 0.05 level

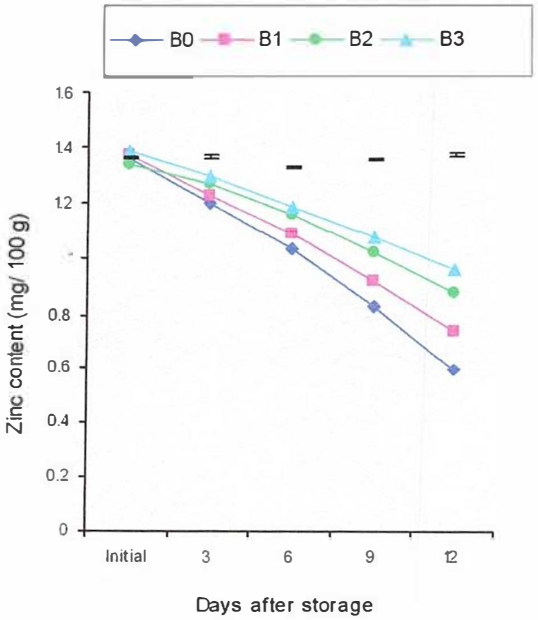


Fig. 4.20 Effect of different doses of BDF on Zinc content of mango pulp at different days after storage. Vertical bars represent LSD at 0.05 level

Graphs represent
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3=750 ppm of BDF solution

Table 4.20 Pattern of magnesium and copper content of postharvest mango pulp during storage environments at ambient condition

Treatments	Magnesium content (mg/100 g) at different days					Copper content (mg/100 g) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	17.01 a	17.53 a	18.03 a	18.08 a	17.81 a	0.33 b	0.28 b	0.24 b	0.20 b	0.16 b
V_2	16.02 b	16.49 b	17.01 b	17.11 b	16.85 b	0.36 a	0.32 a	0.27 a	0.23 a	0.19 a
Level of significance	***	***	***	***	***	***	***	***	***	***

Table 4.21 Combined effects of varieties and different doses of BDF solution on magnesium and copper content of postharvest mango at ambient condition

Treatments combination	Magnesium content (mg/100 g) at different days					Copper content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1B_0	17.25 a	18.22 a	19.15 a	18.12 b	17.16 d	0.31 c	0.25 c	0.19 d	0.14 d	0.09 d
V_1B_1	17.15 a	17.55 b	18.05 c	18.55 a	17.55 c	0.32 bc	0.27 bc	0.22 cd	0.17 cd	0.13 cd
V_1B_2	16.75 b	17.23 c	17.52 d	17.92 c	18.42 a	0.34 a-c	0.30 ab	0.26 a-c	0.22 bc	0.19 ab
V_1B_3	16.88 b	17.12 c	17.41 d	17.72 d	18.12 b	0.33 a-c	0.31 ab	0.28 ab	0.25 ab	0.23 a
V_2B_0	16.35 c	17.30 c	18.28 b	17.28 e	16.27 e	0.36 ab	0.30 ab	0.24 bc	0.18 cd	0.13 cd
V_2B_1	16.11 d	16.55 d	17.05 e	17.45 e	16.45 e	0.35 a-c	0.31 ab	0.26 a-c	0.21 bc	0.17 bc
V_2B_2	15.85 e	16.15 e	16.45 f	17.05 f	17.55 c	0.36 ab	0.32 a	0.28 ab	0.24 ab	0.21 ab
V_2B_3	15.75 e	15.95 f	16.25 g	16.65 g	17.12 d	0.37 a	0.34 a	0.31 a	0.28 a	0.24 a
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	0.64	0.67	0.61	0.60	0.62	3.10	3.54	4.16	5.02	6.10

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3 =750 ppm of BDF solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

Table 4.22 Behavior of iron and manganese content of postharvest mango pulp in varieties during storage environments at ambient condition

Treatments	Iron content (mg/100 g) at different days					Manganese content (mg/100 g) at different days				
Variety (V)	Initial	3	6	9	12	Initial	3	6	9	12
V_1	2.59 a	3.26 a	4.44 a	5.02 a	4.72 a	0.63 a	0.84 a	1.07 a	1.21 a	1.20 a
V_2	1.70 b	2.32 b	3.50 b	3.80 b	3.30 b	0.47 b	0.68 b	0.91 b	1.05 b	1.05 b
Level of significance	***	***	***	***	***	***	***	***	***	***

Table 4.23 Combined effects of varieties and different doses of BDF solution on iron and manganese content of postharvest mango pulp at ambient condition

Treatments combination	Iron content (mg/100 g) at different days					Manganese content (mg/100 g) at different days				
Varieties × Treatments	Initial	3	6	9	12	Initial	3	6	9	12
V_1B_0	2.82 a	3.82 a	5.92 a	5.32 a	3.42 c	0.65 a	0.98 a	1.34 a	1.19 c	0.96 e
V_1B_1	2.65 ab	3.35 b	4.45 c	5.35 a	4.64 b	0.64 a	0.87 b	1.12 c	1.42 a	1.24 b
V_1B_2	2.52 bc	3.12 c	3.92 d	5.02 b	5.52 a	0.62 ab	0.78 d	0.97 d	1.21 bc	1.40 a
V_1B_3	2.35 c	2.75 d	3.45 e	4.38 cd	5.31 a	0.60 b	0.72 e	0.86 e	1.02 d	1.19 c
V_2B_0	1.88 d	2.78 d	4.88 b	4.25 d	2.35 d	0.49 c	0.82 c	1.18 b	1.03 d	0.82 f
V_2B_1	1.73 de	2.32 e	3.42 e	4.45 c	3.75 c	0.46 cd	0.69 e	0.94 d	1.25 b	1.07 d
V_2B_2	1.64 ef	2.25 e	3.05 f	3.15 f	3.65 c	0.47 cd	0.63 f	0.82 e	1.05 d	1.25 b
V_2B_3	1.53 f	1.94 f	2.64 g	3.35 e	3.46 c	0.45 d	0.56 g	0.71 f	0.87 e	1.05 d
Level of significance	NS	NS	NS	***	***	NS	NS	NS	NS	NS
CV%	4.96	3.80	2.67	2.41	4.78	3.87	2.81	2.14	1.88	1.89

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents
V_1 = Langra
V_2 = Khirshapat
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3 =750 ppm of BDF solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

quantity of Zn was obtained from Khirshapat along with B_3 treatment while; the lowest (1.24 mg/100 g) value was obtained from Langra using no treatment.

10.5 Shelf life

There was perceived to be significant variation between the varieties in terms of shelf life of mango (Appendix 4.12 and table 4.24). The longest shelf life (13.58 days) was recorded in Khirshapat and the shortest (12.25 days) was recorded in Langra (Fig. 4.21). Variation in shelf life between varieties might be possible due to genetical. The results of the present investigation revealed that Khirshapat was much better over Langra in preservation.

Subjected to different doses of BDF solution in this investigation In connection with shelf life of mango exhibited highly significant (Appendix 4.12). The shelf life of mango ranged between 7.83 to 16.67 days was recorded from different doses of BDF solution. The longest shelf life (16.67 days) was obtained from the fruit treated with B_3 treatment followed by the shelf life of the fruits treated with B_2 (14.00 days), and B_1 (13.17 days) treatments while; the shortest shelf life (7.83 days) was obtained from control (Fig. 4.22). The longest shelf life obtained from the fruit treated with B_3 treatment might be probably due to suppression or depression of physiological and biochemical activities that was responsible for slower senescence of harvested fruits, and consequently led to the longest shelf life. The results of the present investigation are in conformity with the findings of Dhemre and Waskar (2004) and Ahmed and Singh (2000).

The combined effect of varieties and imposed different doss of BDF solution in respect of shelf life of mango were found to be non significant (Appendix 4.12). The shelf life was found to be differed between 7.33 to 17.33 days from various treatment combinations. The longest shelf life (17.33 days) was found from the treatment combination of V_2B_3 while, the shortest (7.33 days) was noticed from the treatment combination of V_1B_0 (Table 4.25).

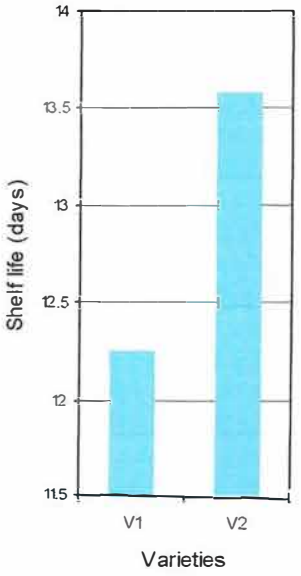


Fig. 4.21 Effect of varieties on shelf life of mango.

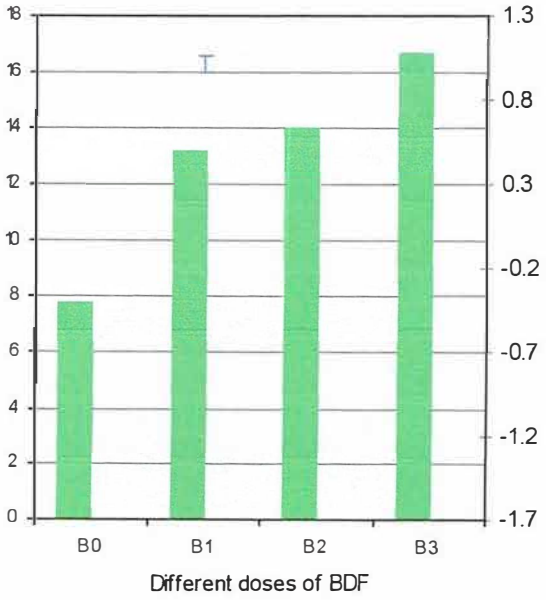


Fig. 4.22 Effect of different doses of BDF on shelf life of mango. Vertical bars represent LSD at 0.05 level

Graph represents

V_1 = Langra	B_1=250 ppm of BDF solution
V_2 = Khirshapat	B_2=500 ppm of BDF solution
B_0 =Control	B_3 =750 ppm of BDF solution

Table 4.24 Pattern of zinc content of mango pulp and shelf life of postharvest mango in varieties during storage environments at ambient condition

Treatments	Zinc content (mg/100 g) at					Shelf life
Variety (V)	Initial	3	6	9	12	Total days
V_1	1.26 b	1.19 b	1.06 b	0.90 b	0.73 b	12.25 b
V_2	1.47 a	1.30 a	1.18 a	1.02 a	0.85 a	13.58 a
Level of significance	***	***	***	***	***	**

Table 4.25 Combined effects of varieties and different doses of BDF solution on zinc content and shelf life of postharvest mango pulp at ambient condition

Treatments combination	Zinc content (mg/100 g) at					Shelf life
Varieties × Treatments	Initial	3	6	9	12	Total days
V_1B_0	1.26 c	1.13 f	0.97 e	0.76 e	0.53 e	7.33 e
V_1B_1	1.28 c	1.17 ef	1.02 d	0.85 d	0.67 d	12.67 d
V_1B_2	1.24 c	1.21 de	1.10 c	0.96 c	0.82 c	13.00 d
V_1B_3	1.25 c	1.25 cd	1.14 b	1.03 b	0.91 b	16.00 ab
V_2B_0	1.45 b	1.26 c	1.10 c	0.89 d	0.66 d	8.33 e
V_2B_1	1.46 b	1.29 bc	1.15 b	0.98 c	0.81 c	13.67 cd
V_2B_2	1.44 b	1.32 ab	1.21 a	1.07 b	0.93 b	15.00 bc
V_2B_3	1.52 a	1.34 a	1.24 a	1.13 a	1.01 a	17.33 a
Level of significance	*	NS	NS	NS	NS	NS
CV%	1.56	1.70	1.90	2.21	2.68	6.29

In a column values having the same letter(s) do not differ significantly as per DMRT at 5% level

Table represents

V_1 = Langra
V_2 = Khirshapat
B_0 =Control
B_1=250 ppm of BDF solution
B_2=500 ppm of BDF solution
B_3 =750 ppm of BDF solution
* indicates at 5% level
** indicate at 1 % level
*** indicate at 0.1% level
NS means non significant

CHAPTER FIVE

SUMMARY AND CONCLUSION

CHAPTER 5

SUMMARY AND CONCLUSION

11.1 Summary

The present investigation was conducted at the Protein and Enzyme Laboratory of the Department of Biochemistry and Molecular Biology of the University of Rajshahi during the period from January, 2005 to January, 2008. These research activities were also carried out in the regional Soil Resources Development Institute (SRDI) and Science Laboratory, BSCIR, Sympur, Rajshahi. The objectives of the investigation were to find out the technologically sound and economically viable methods for the reduction of postharvest losses and to determine the pattern of physicochemical changes, storability and shelf life of postharvest mango varieties. Four different experiments were undertaken in this investigation for achieving the goals.

The experiment 1 was involved with two factors consisting of varieties (*viz.*, Langra and Khirshapat) and different storage treatments {(viz., control, paraffin coating, perforated polyethylene cover, unperforated polyethylene cover, hot water $(55\pm1)^0$ C treatment and low temperature in refrigerator $(4\pm1)^0$ C}.The experiment 2 was included with two factors constituting of varieties as in experiment 1 and different doses of Maleic hydrazide solution (namely, control, 200, 400 and 600 ppm).The experiment 3 was assigned with two factors comprising of varieties as in experiment 1 and different doses of Gibberellic acid solution (viz., control, 100, 200 and 400 ppm).The experiment 4 was laid out with two factors including varieties as in experiment 1 and different doses of Bavistin DF solution (viz., control, 250, 500 and 750 ppm)

Mangos of both the varieties were collected from mango growers of Kansat, Shibgonj Upazila of Chapai Nowabgonj district and Charghat Upazila of Rajshahi district. The other materials subjected as postharvest treatments were bought from Rajshahi City Market, Rajshahi by early order. The experiments were laid out in Randomized Complete Block Design with three replicates. Various observations were made on different fruit characteristics, physicochemical properties and shelf life. External fruit features were evaluated with naked eyes and standard color charts were also used for the determination of skin color of mango. Physlcochemical

analyses of mango pulp were performed with the determination of edible portion, pulp to peel ratio, physiological weight loss, moisture content, dry matter content, ash content, vitamin C content, titratable acidity, pulp pH, TSS, total sugar, reducing sugar and non reducing sugar content, crude fibre, lipid content, water soluble protein content, different mineral as phosphorus, potassium, calcium, magnesium, copper, iron, manganese and zinc content. Shelf life of mango was determined externally by daily monitoring the physical appearance of the treated and untreated fruits as the total days required for ripening up to their suitability for the last consumption.

Three mango fruits were collected at random from three replicates of which each fruit was taken from the same type of treatment combination at an interval of 3rd, 6, 9 and 12th days of storage for physicochemical studies. The data obtained from the biochemical methods were statistically analyzed and the mean differences were evaluated with DMRT and LSD (LSD used only as graphical illustration) as well as interpreted systematically. The results of the different experiments are summarized below.

The results of the experiment 1 revealed that variety significantly influenced all the parameters studied. Markedly variation in between the two varieties in terms of skin color of treated and untreated mangoes during storage were encountered. Green color of untreated Langra was changed hastily than Khirshapat whereas, different storage treatments made delay their changes. Khirshapat treated with low temperature in refrigerator demonstrated better performance in holding green color up to 15th day of storage while, Langra showed up to 12th day. In addition, Langra increasingly produced higher quantity of edible portion, pulp to peel ratio, crude fibre, lipid, water soluble protein as well as different minerals namely, phosphorus, potassium, calcium, magnesium, iron and manganese content whereas, it decreased by providing more quantity of dry matter, ash, vitamin C and titratable acidity with the advancement of storage duration as compared to Khirshapat. On the other hand, Khirshapat successively lost more physiological weight and conserved more moisture content with the advancement of storage period comparing to Langra. It showed the gradual increase of pulp pH, TSS, sugar (total, reducing and non reducing) content followed by Langra. It also absorbed higher amount of copper and zinc content

comparing Langra but, these minerals decreased gradually with the increase of storage period. Khirshapat exhibited the longer (16.44 days) shelf life than langra (15.22 days).

Different storage treatments subjected to this experiment played the significant role on physicochemical characters and shelf life at different days after storage except ash, total sugar and non reducing sugar at initial day as well as zinc content at 3rd day. Among the storage treatments, untreated mangoes were found to provide progressively more quantity of edible portion, pulp to peel ratio, physiological weight loss, moisture content, pulp pH, TSS, sugar (total, and non reducing), lipid, water soluble protein, phosphorus, potassium, calcium, magnesium, iron as well as manganese content at a certain period of storage, and consequently, these composition declined owing to starting decomposition of fruits but, these characters perceived lower increasing tendency at low temperature in refrigerator in all days of storage period without considering initial day in both the cases except PWL where unperforated polyethylene cover markedly reduced PWL in all storage duration. In addition, the mango fruits treated with low temperature in refrigerator were noted higher producer but, it showed lesser decreasing tendency in terms of dry matter, ash, vitamin C, titratable acidity, crude fiber, copper and zinc content at different days of storage followed by other treatments due to delay ripening resulted in lower trend while, these components were also noticed as higher decreasing trend with lower accumulation from control without considering initial day of storage. The longest (36.50 days) shelf life of mangoes was obtained from the fruit treated with low temperature in refrigerator while, the shortest (7.83 days) was obtained from control.

The combined effect of varieties and applied different storage treatments were found to be significant in connection with physiochemical parameters at different days after storage, except at edible portion at all days, pulp to peel ratio at initial day, moisture content at 6, 9 and 12th day, dry matter at 6, 9 and 12th day, ash content at all days, tritrable acidity at 3 and 6th day, pulp pH at initial and 3rd day, TSS at initial, 3rd and 6th day, total sugar at all days, reducing sugar at initial, 3rd and 6th day, non reducing sugar at initial, 3rd, 6th and 12th day, phosphorus at initial day, potassium and calcium at all days, magnesium at 9 and 12th day, copper

and iron at all days, manganese at 6, 9 and 12th day as well as zinc content at initial, 3, 6 and 9th day.

Among different treatment combinations, it was noted that Langra along with control treatment without considering initial day successively increased higher quantity in edible portion, pulp to peel ratio, lipid, water soluble protein, phosphorus and potassium content up to 9th day and thereafter, these components decreased; augmented in magnesium and iron content increasingly up to 6th day then, these minerals diminished with the advancement of storage period while, the minimum increasing tendency was noticed from the treatment combination of Khirshapat having low temperature in refrigerator owing to retardation of ethylene synthesis resulting in delay. But, the treatment combination of Khirshapat with control progressively showed in PWL, augmented in moisture content up to 6th day then, it decreased; increased in pulp pH, augmented in TSS up to 6th day and then, it declined slightly; accumulated in sugar(total reducing and non reducing) as well as calcium content up to 9th day thereafter, these compositions came down due to starting rotten followed by other treatment combination while, the minimum extending trend was noted from the treatment combination of Langra with low temperature in refrigerator owing to delay ripening that resulted in lower synthesis without considering initial day of storage in all the cases.

Langra using low temperature in refrigerator showed higher quantity but, it diminished by degrees with the extention of storage period in terms of dry matter, ash content, vitamin C, titrable acidity as well as crude fibre content over the other treatment combination while, higher decreasing tendency was obtained from the treatment combination of Khirshapat using control treatment but, dry matter and ash content slightly increased after 6 days of storage without considering initial day of storage.

Khirshapat without treatment accumulated higher in copper and zinc content at initial day but, this variety using low temperature in refrigerator diminished very mildly at different days after storage followed by other treatment combinations whereas, highest diminishing trend was perceived from the treatment combination of Langra with control. The longest (38.00 days) shelf life of mangoes was found from the treatment combination of Khirshapat along with low temperature in refrigerator

while, the shortest (7.33 days) was noticed from the treatment combination of Langra without treatment.

The results of the experiment 2 explored that mango varieties showed significant variation in all the parameters studied. Sharp variation between the two varieties in connection with skin color of treated and untreated mangoes during storage was observed. Green color of Langra altered markedly as compared to Khirshapat from untreated mangos whereas; different doses of Maleic hydrazide (MH) solution retarded their rapid changes of green color. Khirshapat treated with 600 ppm (M_3) of MH showed better performance in retaining green color up to 9^{th} day of storage thereafter, it converted its original color into modified color while, Langra demonstrated up to 6^{th} day of storage. The results further elucidated that Langra increasingly accumulated higherr quantity of crude fibre, lipid, water soluble protein as well as different minerals *viz*., phosphorus, potassium, calcium, magnesium, iron and manganese contents while, it diminished the higher quantity of dry matter, ash, vitamin C and titratable acidity with the advancement of storage duration over Khirshapat. But, Khirshapat continuously showed higher physiological weight loss and contained higher moisture content with the extension of storage period as compared to langra. It exhibited the gradual increase in pulp pH, TSS, sugar (total, reducing and non reducing) content comparing to langra. It also developed higher quantity of copper and zinc content comparing to Langra but, these two mineral contents came down gently with the increase of storage period. Khirshapat showed longer (13.17 days) shelf life over Langra (11.83 days).

Different doses of MH solution imposed to this experiment significantly affected different physicochemical parameters and shelf life at different days after storage except moisture, titratable acidity, non reducing sugar, crude fibre and copper content at initial day as well as ash content at all days and water soluble protein content at initial and 12^{th} day. Among various doses of MH solution, untreated mangoes lost physiological weight at all the storage duration but, these mangoes increasingly absorbed more moisture; accumulated higher pulp pH, TSS, sugar (total, reducing and non reducing), lipid, water soluble protein, phosphorus, potassium, calcium, magnesium, iron as well as manganese content at a certain period of storage and thereafter, these properties fell off owing to beginning decay of

fruits except pulp pH but, these composition manifested lower rising tendency at 600 ppm of MH solution in all days of storage period without considering initial day in all cases. In addition, the mango fruits treated with M_3 treatment were recorded the highest producer but, they demonstrated smaller diminishing tendency in respect of dry matter, ash, vitamin C, titratable acidity, crude fiber, copper and zinc content at different days of storage as compared to other treatments due to delay ripening that caused lower diminishing trend while, these characters were also noted higher abating trend with lower accumulation from control without considering initial day of storage. The longest (15.50 days) shelf life of mangoes was recorded from the fruits treated with M_3 treatment while, the shortest (8.00 days) was obtained from control (M_0).

The combined effect of varieties and imposed different doses of MH solution were perceived to be significant in relation with physiochemical composition at different days after storage, except moisture, dry matter, ash, pulp pH, total sugar, reducing sugar, non reducing sugar, crude fibre, water soluble protein, potassium, iron, manganese at all days, tritrable acidity at initial, 6 , 9 and 12th day, TSS at initial and 3rd day, lipid at initial, 3 and 6th day, magnesium at 3 and 9th day, copper at 3 , 6 and 9th day and zinc content at initial, 3, 6 and 9th day as well as shelf life. Among different treatment combinations, the results were found that Langra along with M_0 treatment without considering initial day gradually increased higher quantity in TSS up to 6th day, lipid, water soluble protein, phosphorus and potassium content up to 9th day and then, these properties fell off; augmented in magnesium and iron content increasingly up to 6th day and consequently these mineral contents came down with the extension of storage period while, the minimum increasing tendency was recorded from the treatment combination of Khirshapat along with M_3 treatment because of interruption of ethylene synthesis resulting in delay ripening. The treatment combination of Khirshapat and control continuously showed PWL; accumulated in higher moisture content up to 6th day then, it decreased; enhanced in pulp pH; extended in TSS at 3rd day and then, it declined slightly; synthesized in sugar (total, reducing and non reducing) as well as calcium content up to 9th day thereafter, these properties fell off owing to deterioration of fruit situation over other treatment combinations while, the lowest extending trend was noticed from the

treatment combination of Langra with M_3 treatment due to delay ripening that resulted in lower synthesis without considering initial day of storage in all the cases.

Langra using M_3 treatment exhibited higher quantity but, it came down gently with the advancement of storage period in respect of dry matter, ash, vitamin C, titrable acidity as well as crude fibre content followed by the other treatment combinations while, higher decreasing tendency was noticed from the treatment combination of Khirshapat using control treatment but, dry matter and ash slightly augmented after 6^{th} day of storage without considering initial day of storage.

Khirshapat without treatment developed higher in copper and zinc content at initial day but, this variety using M_3 treatment abated very softly at different days after storage over the other treatment combinations whereas, the highest decreasing trend was obtained from the treatment combination of Langra with control. The longest (16.00 days) shelf life of mangos was counted from the treatment combination of Khirshapat along with M_3 treatment while, the shortest (7.33 days) was counted from the treatment combination of Langra using no treatment.

The findings of the experiment 3 invented that mango varieties demonstrated significant variation in all the parameters investigated except pulp pH, ash, reducing sugar and water soluble protein content at initial, 3, 6 and 12^{th} days of storage, respectively. There was exposition a hastily variation in between the two varieties in relation to skin color of treated and untreated mangoes during storage. Green color of untreated Langra was exchanged sharply as compared to Khirshapat whereas; different doses of GA3 solution resisted their fast changes of green color. Khirshapat treated with 400 ppm of GA3 solution exhibited better performance in holding green color up to 9^{th} day of storage thereafter, it transformed its original color into rotted colors while, Langra gave its original color up to 6^{th} day of storage and thereafter, it was modified as well. The results further denoted that Langra largely extended higher quantity of TSS at 9 and 12^{th} day, crude fibre, lipid, water soluble protein as well as different minerals *viz.*, phosphorus, potassium, calcium, magnesium, iron and manganese content while, it decreased by producing higher quantity of dry matter, ash, vitamin C and titratable acidity with the extending of storage duration over Khirshapat. But, Khirshapat showed higher PWL in a continuous stream and held in higher moisture with the augmentation of storage period as compared to Langra. It

was found the gradual extension of pulp pH, TSS, sugar (total, reducing and non reducing) contents comparing to langra. It also accumulated higher quantity of copper and zinc content comparing to Langra but, these two mineral contents came down gently with the increase of storage period. Khirshapat demonstrated longer (13.92 days) shelf life over Langra (12.67 days).

Different doses of GA3 solution applied to this experiment were perceived to be significant in terms of different physicochemical properties at different days after storage and shelf life except moisture, reducing sugar and crude fibre content at initial day as well as ash content at all days and water soluble protein content at initial and 12th day. Among different doses of GA3 solution, untreated mangoes were recorded markedly losing higher quantity of PW at all storage period but, these mangoes increasingly retained more moisture content; produced higher pulp pH, TSS, sugar (total, reducing and non reducing), lipid, water soluble protein, phosphorus, potassium, calcium, magnesium, iron as well as manganese content at a certain period of storage and thereafter, these properties fell off owing to deterioration of fruit situation except pulp pH but, these properties were noted lower enlarging tendency at 400 ppm of GA3 solution in all days of storage period without considering initial day in all the cases. In addition, the mango fruits treated with G_3 treatment were noted higher producer but, they showed lower decreasing tendency in connection with dry matter, ash, vitamin C, tltratable acidity, crude fiber, copper and zinc content at different days of storage as compared with the other treatments due to delay ripening causing in lower falling off trend while, these characters were also reported higher abating trend with lower accumulation from untreated mangoes without considering initial day of storage. The longest (17.00 days) shelf life of mangoes was counted from the fruit treated with G_3 treatment while, the shortest (8.17 days) was counted from control (G_0).

The interaction effect of varieties and different doses of GA3 solution was noticed to be non significant in terms of some physiochemical properties and shelf life of mango at different days after storage, but the combined effect also showed significant variation in some properties *viz.*, physiological weight loss at all days of storage; vitamin C, calcium and magnesium content at 3, 6, 9 and 12th day; TSS, lipid, phosphorus and zinc content at 6, 9 and 12th days; non reducing sugar and

manganese content at 9th day; tritrable acidity at 3 and 6th days as well as reducing sugar content at 6th day of storage. Among different treatment combinations, the results noted that Langra along with G_0 treatment without considering initial day gradually increased higher quantity in TSS up to 6 day, lipid, water soluble protein, phosphorus and potassium content up to 9th day and then, these composition came down and accumulating magnesium and iron content increasingly up to 6th day and thereafter, these mineral contents decreased with the extension of storage period while, the lowest increasing tendency was recorded from the treatment combination of Khirshapat using G_3 treatment owing to retardation of ethylene synthesis. The treatment combination of Khirshapat and control largely exhibited PWL; retained higher moisture content up to 6th day then, it diminished; expanded pulp pH; increased TSS at 3rd day and then, it decreased slightly; accumulated sugar (total, reducing and non reducing) as well as calcium content up to 9th day consequently, these compositions diminished owing to starting rotten over other treatment combinations whereas, the minimum increasing trend was recorded from the treatment combinations of Langra with G_3 treatment due to delay of ripening that resulted in lower synthesis without considering initial day of storage in all the cases.

Langra using G_3 treatment showed higher quantity but, it diminished by fits and bound with the extending of storage period in respect of dry matter, ash, vitamin C, titrable acidity as well as crude fibre content followed by other treatment combinations whereas, higher decreasing tendency was noted from the treatment combination of Khirshapat using control treatment but, dry matter and ash content slightly grew up after 6 days of storage without considering initial day of storage.

Khirshapat using G_3 treatment produced higher quantity of copper and zinc content but, it fell off by degrees at different days after storage over the other treatment combinations whereas, the highest abating trend was recorded from the treatment combination of Langra with control. The longest (18.00 days) shelf life of mangoes was counted from the treatment combination of Khirshapat along with G_3 treatment while, the shortest (7.67 days) was counted from the treatment combination of Langra using without treatment.

The findings of the experiment 4 revealed that mango varieties had significant variation in all the parameters studied except pulp pH at 6th day, lipid content at

initial, 3, 6 and 12th days and water soluble protein content at 3, 9, and 12th days of storage period. The results showed sharp variation between two varieties in terms of skin color of treated and untreated mangos during storage. Green color of untreated Langra was modified sharply over Khirshapat while; different doses of Bavistin DF solution strictly hindered their rapid changes of green color. Khirshapat treated with 750 ppm of BDF solution showed better performance in bearing green color up to 6th day of storage and then, it changed its original color into converted colors whereas; Langra developed its original color up to 6th day of storage and thereafter, it was bartered as well. The results further denoted that Langra largely increased higher quantity of TSS at 6, 9 and 12th day, crude fibre, lipid, water soluble protein as well as different minerals *viz*., phosphorus, potassium, calcium, magnesium, iron and manganese content while, it diminished by producing higher quantity of dry matter, ash, vitamin C and titratable acidity with the increasing of storage period over Khirshapat. But, Khirshapat showed more PWL in a continuous stream and held in higher moisture with the increasing of storage period as compared to Langra. There noticed the gradual increase of pulp pH, TSS at initial and 3 days; sugar (total, reducing and non reducing) content comparing to Langra. It also absorbed higher quantity of copper and zinc content comparing to Langra but, these two minerals decreased little by little with the extension of storage period. Khirshapat had longer (13.58 days) shelf life over Langra (12.25 days).

Different doses of BDF solution applied to this experiment were manifested to be significant in terms of different physicochemical properties at different days after storage and shelf life except moisture, dry matter, sugar (total, reducing and non reducing) and crude fibre content at initial day as well as ash content at all days and water soluble protein content at initial and 12th day. Among different doses of BDF solution, untreated mangos were noticed to reduce sharply large quantity of PW at all storage period but, these mangoes progressively contained more moisture; augmented higher pulp pH, TSS, sugar (total, reducing and non reducing), lipid, water soluble protein, phosphorus, potassium, calcium, magnesium, iron as well as manganese content at a certain period of storage and thereafter, these properties diminished due to starting of decay of fruits except pulp pH but, these properties showed lower increasing tendency at 750 ppm of BDF solution in all days of storage

period without considering initial day in all the cases. In addition, the mango fruits treated with B_3 treatment were perceived higher producer but, they showed decreasing tendency in terms of dry matter, ash, vitamin C, titratable acidity, crude fiber, copper and zinc content at different days of storage over the other treatments due to delay ripening while, these characters were also recorded higher diminishing trend with the lower accumulation from untreated mangoes without considering initial day of storage. The longest (16.67 days) shelf life of mangoes was counted from the fruit treated with B_3 treatment while, the shortest (7.83 days) was counted from control.

The interaction effect of varieties and different doses of BDF solution were recorded to be non significant in connection with some physiochemical characters and shelf life of mango at different days after storage, but, the combined effect also demonstrated significant variation in some properties *vis.,* physiological weight loss at 3, 6 and 9th day, vitamin C at all days, tritrable acidity at 3, 6, 9 and 12th day, TSS at 6, 9 and 9th day, lipid at 9th day, phosphorus at 12th day, calcium at initial, 3, 9 and 12th day, iron at 9 and 12th day and zinc at initial day of storage. Among different treatment combinations, Langra along with B_0 treatment without considering initial day mildly increased higher quantity in TSS at 6th day, lipid, water soluble protein, phosphorus and potassium content up to 9th day and then, these compositions decreased; magnesium and iron content increased up to 6th day and thereafter, these minerals decreased with the increase of storage period. On the other hand, the lowest increasing tendency was noticed from the treatment combination of Khirshapat using B_3 treatment owing to interruption of ethylene synthesis resulting in delay ripening. The treatment combination of Khirshapat and control largely showed PWL; absorbed higher moisture up to 6th day then, it decreased; extended pulp pH, increased in TSS at 3rd day and then, it decreased slightly; received sugar (total, reducing and non reducing) as well as calcium content up to 9th day consequently, these compositions fell off owing to starting rotten over other treatment combinations whereas, the minimum increasing trend was obtained from the treatment combination of Langra with B_3 treatment due to delay ripening resulting in lower synthesis without considering initial day of storage in all the cases.

Langra using B_3 treatment showed higher quantity of dry matter, ash, vitamin C, titrable acidity as well as crude fibre content followed by other treatment combination but, they were reduced gradually with the augmenting of storage period whereas, higher diminishing tendency was noticed from the treatment combination of Khirshapat using control treatment but, dry matter and ash content slightly increased after 6^{th} day of storage without considering initial day of storage.

Khirshapat using B_3 treatment gave higher quantity of Copper and Zinc content but decreased softly at different days after storage followed by other treatment combinations whereas, the highest failing trend was noted from the treatment combination of Langra with control. The longest (17.33 days) shelf life of mangoes was noted from the treatment combination of Khirshapat along with B_3 treatment while, the shortest (7.33 days) was found from the treatment combination of Langra using without treatment.

11.2 Conclusion

The overall findings of the present investigation trialed with four different experiments facilitated to draw the following conclusion:

1. Langra was found to be better in achieving higher quantity of edible portion, pulp to peel ratio, dry matter, ash, vitamin C, titratable acidity, crude fibre, lipid, and water soluble protein, phosphorus, potassium, magnesium, iron and manganese content overall the the parameters studied, but its shelf life was shorter and rapidly changed its skin color as compared to Khirshapat. Further investigation is to be needed for comparison with other varieties.
2. Among different postharvest treatments, most of the physical, biochemical and mineral properties were progressively increased with times from untreated fruits in case of all the experiments, and the remaining properties were gradually decreased that resulted in rapid ripening and consequently, it deteriorated. On the other hand, the mangoes treated with low temperature in refrigerator $(4\pm1)^0$C, 600, 400 and 750 ppm of MH, GA3 and BDF solution were found to be better in interrupting the changes of physical, biochemical and mineral contents which resulted in delay ripening that caused longer shelf life (*viz.*, 36.50, 15.50, 17.00 and 16.67 days) in different experiments, respectively.

3. From the interaction effects of both the varieties in all the experiments, it was found that Langra along with low temperature in refrigerator $(4\pm1)^0$ C, 600, 400 and 750 ppm of MH, GA3 and BDF solution respectively, showed delay changes of physical, biochemical and minerals properties that made delay ripening . On the other hand, Khirshapat using above mentioned treatments strongly retarded the changes of these properties which exhibited the longest shelf life (namely 38.00, 16.00, 18.00 and 17.3 days). It also using unperforated polyethylene cover extensively reduced PWL. So, this method may be adjusted with other systems.

11.3 Recommendation

The following recommendations are suggested based on the data obtained from the present experiments:

1. In terms of nutrient content, Langra was found to be higher quality as compared to Khirshapat. So, cultivation of this variety might be helpful for improving the nutritional status of the people of our country.
2. Khirshapat showed the longest shelf life. So, based on shelf life consideration, Khirshapat may be recommended for commercial production.
3. Physical, biochemical and mineral properties drastically changed in control treatment, but using low temperature in refrigerator was manifested to be the best storage environment for reduction of losses and extension of shelf life of mango. In addition, at 600, 400 and 750 ppm of MH, GA3 and BDF solution were also found to be suitable for reduction of losses and extension of shelf life in other experiments, respectively. So, these approaches may be brought to farmers for processing and storage of postharvest mango.
4. Unperforated polyethylene cover was found better than other systems in respect of reduction of PWL. So, this system may also be used commercially by the mango growers.

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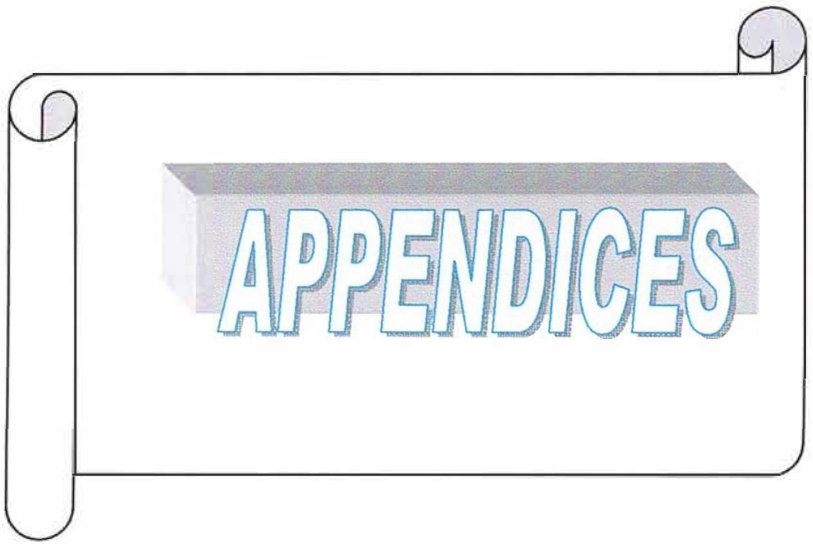
APPENDICES

Appendix 1.1 Monthly records of maximum and minimum temperature, relative humidity and rainfall during the study period at the Department of Biochemistry and Molecular Biology, University of Rajshahi, Bangladesh

Year	Month	Temperature (^{0}C)						Relative humidity (%)			Total rainfall (mm)
		Room temperature			Out side temperature						
		Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	
2005	May	32.24	22.22	27.23	38.87	23.39	31.13	73.90	67.65	70.78	76(6)*
	June	33.55	29.77	31.66	37.78	27.65	32.72	82.87	78.63	80.75	135(7)
	July	32.25	28.75	30.50	34.92	25.58	30.25	86.35	83.13	84.74	391(17)
2006	May	32.62	22.45	27.54	39.56	24.18	31.87	75.35	67.06	71.21	103(6)
	June	33.85	29.92	31.89	38.45	27.92	33.19	70.03	62.43	66.23	105(8)
	July	32.58	28.97	30.78	35.38	26.14	30.76	87.71	85.42	86.57	484(18)
2007	May	32.62	22.45	27.54	39.63	23.75	31.69	85.87	76.90	81.39	126(9)
	June	33.85	29.92	31.89	38.72	27.62	33.17	91.43	88.77	90.10	450(13)
	July	32.58	28.97	30.78	35.78	26.45	31.12	85.00	81.61	83.31	344(19)

* Figures in parentheses are the number of rainy days

Appendix 1.2 Analysis of variance of data on edible portion and pulp to peel ratio of mango as influenced by varieties and different storage treatments

Sources of variation	Degree of freedom	Mean sum of square									
		Edible portion (%) at different days					Pulp to peel ratio at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.081	0.080	0.192	0.083	0.085	0.001	0.001	0.001	0.001	0.001
Variety -V	1	8.644**	8.930**	10.704**	9.641**	10.017**	1.613***	0.706***	1.210***	0.348***	0.372***
Storage treatment -T	5	5.295**	16.617***	46.816***	60.252***	42.608***	0.051**	4.657***	15.127***	19.575***	27.698***
V x T	5	0.555^{NS}	0.559^{NS}	0.746^{NS}	0.499^{NS}	0.466^{NS}	0.025^{NS}	0.046**	0.059**	0.151***	0.156***
Error	22	1.078	1.062	0.992	1.063	1.105	0.011	0.011	0.011	0.011	0.011

Appendix 1.3 Analysis of variance of data on physiological weight loss of mango and moisture content of mango pulp as influenced by varieties and different storage treatments

Sources of variation	Degree of freedom	Mean sum of square								
		Physiological weight loss (%) at different days				Moisture content (%) at different days				
		3 D	6	9	12	Initial	3	6	9	12
Replication	2	0.000	0.000	0.001	0.001	0.001	0.001	0.000	0.001	0.001
Variety -V	1	4.000***	2.806***	4.410***	6.891***	37.027***	42.968***	39.837***	39.942***	40.006***
Storage treatment -T	5	26.028***	67.976***	207.427***	312.376***	0.093***	1.516***	6.950***	7.073***	8.061***
V x T	5	0.086***	0.140***	0.219***	0.109***	0.134 ***	0.054**	0.020^{NS}	0.019^{NS}	0.018^{NS}
Error	22	0.003	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011

Appendix represents
* indicates 5% level of probability
** indicates 1% level of probability
*** indicates 0.1% level of probability
NS- Non significant

Appendix 1.4 Analysis of variance of data on dry matter content and ash content of mango pulp as influenced by varieties and different storage treatments

Sources of variation	Degree of freedom	Mean sum of square									
		Dry matter content (%) at different days					Ash content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Variety -V	1	36.663***	42.968***	39.942***	39.942***	40.217***	0.126***	0.137***	0.133***	0.126***	0.130***
Storage treatment -T	5	0.106***	1.516***	6.978***	7.073***	8.053***	0.001 NS	0.005***	0.022***	0.025***	0.025***
V x T	5	0.133***	0.054**	0.018 NS	0.019 NS	0.017 NS	0.0008 NS	0.0007 NS	0.0006 NS	0.0007 NS	0.0009 NS
Error	22	0.011	0.011	0.011	0.011	0.012	0.0003	0.0003	0.0003	0.0003	0.0003

Appendix 1.5 Analysis of variance of data on vitamin C content of mango pulp as influenced by varieties and different storage treatments

Sources of variation	Degree of freedom	Mean sum of square				
		Vitamin C content (mg/100 g) at different days				
		Initial	3	6	9	12
Replication	2	0.000	0.000	0.000	0.000	0.028
Variety -V	1	81607.350***	58129.21***	16218.022***	1464.976***	379.405***
Storage treatment -T	5	24.382***	128.269***	887.248***	435.034***	244.965***
V x T	5	13.473***	4.170*	163.464***	76.972***	4.316***
Error	22	1.091	1.091	0.551	0.011	0.048

Appendix represents
* indicates 5% level of probability
** indicates 1% level of probability
*** indicates 0.1% level of probability
NS- Non significant

Appendix 1.6 Analysis of variance of data on titratable acidity and pH of mango pulp as influenced by varieties and different storage treatments

Sources of variation	Degree of freedom	Mean sum of square									
		Titratable acidity (%) at different days					Pulp pH at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.000	0.016	0.001	0.000	0.000	0.001	0.001	0.001	0.001	0.001
Variety -V	1	5.153***	2.953***	0.449***	0.360***	0.053***	0.123**	0.161***	0.303***	0.490***	0.250***
Storage treatment -T	5	0.020***	1.426***	0.615***	0.561***	0.484***	0.039*	1.138***	2.859***	5.788***	5.082***
V x T	5	0.010*	0.023^{NS}	0.007^{NS}	0.017***	0.015***	0.015^{NS}	0.010^{NS}	0.038*	0.052**	0.082***
Error	22	0.003	0.017	0.011	0.001	0.0012	0.011	0.011	0.011	0.011	0.011

Appendix 1.7 Analysis of variance of data on total soluble solid and total sugar content of mango pulp as influenced by varieties and different storage treatments

Sources of variation	Degree of freedom	Mean sum of square									
		TSS content (%) at different days					Total sugar content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.015	0.001	0.020
Variety -V	1	7.618***	7.775***	8.094***	7.398***	8.266***	1.488***	1.361***	1.228***	1.416***	1.881***
Storage treatment -T	5	0.047**	28.081***	113.093***	87.549***	67.398***	0.010^{NS}	15.319***	72.049***	100.311***	61.814***
V x T	5	0.004^{NS}	0.008^{NS}	0.015^{NS}	0.032*	0.090***	0.004^{NS}	0.005^{NS}	0.004^{NS}	0.028^{NS}	0.054^{NS}
Error	22	0.011	0.012	0.011	0.011	0.011	0.011	0.011	0.031	0.011	0.030

Appendix represents
* indicates 5% level of probability
** indicates 1% level of probability
*** indicates 0.1% level of probability
NS- Non significant

Appendix 1.8 Analysis of variance of data on reducing and non-reducing sugar content of mango pulp as influenced by varieties and different storage treatments

Sources of variation	Degree of freedom	Mean sum of square									
		Reducing sugar content (%) at different days					Non-reducing sugar content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.001	0.001	0.001
Variety -V	1	0.270***	0.281***	0.286***	0.202***	0.292***	0.481***	0.348***	0.533***	0.548***	0.442***
Storage treatment -T	5	0.013**	2.145***	13.188***	12.031***	4.016***	0.013^{NS}	6.892***	27.117***	46.493***	36.739***
V × T	5	0.005 ^{NS}	0.004 ^{NS}	0.004 ^{NS}	0.007 *	0.011**	0.014^{NS}	0.005^{NS}	0.024^{NS}	0.037*	0.020^{NS}
Error	22	0.003	0.003	0.003	0.003	0.003	0.011	0.011	0.011	0.011	0.011

Appendix 1.9 Analysis of variance of data on crude fibre and lipid content of mango pulp as influenced by varieties and different storage treatments

Sources of variation	Degree of freedom	Mean sum of square									
		Crude fibre (%) at different days					Lipid content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Variety -V	1	0.148***	0.128***	0.111***	0.098***	0.096***	0.022***	0.022***	0.026***	0.031***	0.040***
Storage treatment -T	5	0.002**	0.020***	0.075***	0.131***	0.222***	0.001***	0.051***	0.161***	0.142***	0.072***
V × T	5	0.003**	0.002*	0.001*	0.001***	0.001***	0.002***	0.001***	0.001***	0.001***	0.001**
Error	22	0.001	0.0012	0.0013	0.0013	0.0003	0.0003	0.0012	0.0013	0.0011	0.0011

Appendix represents
* indicates 5% level of probability
** indicates 1% level of probability
*** indicates 0.1% level of probability
NS- Non significant

Appendix 1.10 Analysis of variance of data on water soluble protein and phosphorus content of mango pulp as influenced by varieties and different storage treatments

Sources of variation	Degree of freedom	Mean sum of square									
		Water soluble protein content (%) at different days					Phosphorus content (mg/100 g) different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001
Variety -V	1	0.092***	0.123***	0.097***	0.116***	0.119***	80.102***	71.487***	71.487***	71.487***	69.890***
Storage treatment -T	5	0.005***	0.061***	0.297***	0.317***	0.184***	0.244***	4.667***	16.274***	18.563***	10.586***
V × T	5	0.003***	0.001**	0.001*	0.002***	0.001*	0.013^{NS}	0.196***	0.197***	0.199***	0.186***
Error	22	0.0002	0.0003	0.0010	0.0012	0.0013	0.011	0.011	0.011	0.011	0.011

Appendix 1.11 Analysis of variance of data on potassium and calcium content of mango pulp as influenced by varieties and different storage treatments

Sources of variation	Degree of freedom	Mean sum of square									
		Potassium content (%) at different days					Calcium content (mg/100 g) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.001	0.001	0.001
Variety -V	1	0.009***	0.011***	0.011***	0.010***	0.011***	27.826***	27.878***	27.405***	27.563***	27.248***
Storage treatment -T	5	0.002***	0.003***	0.004***	0.004***	0.002***	0.049**	14.937***	73.161***	69.326***	40.586***
V × T	5	0.0008^{NS}	0.0007^{NS}	0.0006^{NS}	0.0004^{NS}	0.0005^{NS}	0.006^{NS}	0.003^{NS}	0.002^{NS}	0.003^{NS}	0.012^{NS}
Error	22	0.00012	0.00013	0.00014	0.0002	0.00015	0.011	0.011	0.011	0.011	0.011

Appendix represents
* indicates 5% level of probability
** indicates 1% level of probability
*** indicates 0.1% level of probability
NS- Non significant

Appendix 1.12 Analysis of variance of data on magnesium and copper content of mango pulp as influenced by varieties and different storage treatments

Sources of variation	Degree of freedom	Mean sum of square									
		Magnesium content (mg/100 g) at different days					Copper content (mg/100 g) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.001	0.001	0.002	0.000	0.000	0.000	0.000	0.000
Variety -V	1	14.138***	12.285***	12.076***	12.781***	12.555***	0.008***	0.004***	0.004***	0.003***	0.003***
Storage treatment -T	5	0.115***	1.361***	3.412***	1.914***	2.531***	0.001***	0.002***	0.005***	0.010***	0.014***
V x T	5	0.067***	0.038*	0.039*	0.026^{NS}	0.028^{NS}	0.0005^{NS}	-0.0006^{NS}	-0.0006^{NS}	0.0007^{NS}	0.0007^{NS}
Error	22	0.011	0.011	0.011	0.011	0.012	0.00012	0.00013	0.00014	0.00015	0.00016

Appendix 1.13 Analysis of variance of data on iron and manganese content of mango pulp as influenced by varieties and different storage treatments

Sources of variation	Degree of freedom	Mean sum of square									
		Iron content (mg/100 g) at different days					Manganese content (mg/100 g) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.003	0.001	0.001	0.000	0.000	0.001	0.000	0.000
Variety -V	1	9.923***	10.240***	9.517***	9.456***	10.176***	0.325***	0.221***	0.253***	0.207***	0.207***
Storage treatment -T	5	0.189***	1.505***	5.132***	3.071***	5.811***	0.004***	0.061***	0.202***	0.117***	0.147***
V x T	5	0.007^{NS}	0.004^{NS}	0.021^{NS}	0.021^{NS}	0.015^{NS}	0.001***	0.001***	0.002^{NS}	0.002^{NS}	0.002^{NS}
Error	22	0.011	0.011	0.011	0.011	0.011	0.00012	0.00013	0.003	0.003	0.003

Appendix represents
* indicates 5% level of probability
** indicates 1% level of probability
*** indicates 0.1% level of probability
NS- Non significant

Appendix 1.14 Analysis of variance of the data on zinc content and shelf life of mango as influenced by varieties and postharvest treatments

Sources of variation	Degree of freedom	Mean sum of square					
		Zinc content (mg/100 g) at different days					Shelf life
		Initial	3	6	9	12	Total days
Replication	2	0.000	0.000	0.000	0.000	0.000	0.083
Variety -V	1	0.292***	0.265***	0.308***	0.303***	0.286***	13.444***
Storage treatment -T	5	0.009*	0.004 ^{NS}	0.035***	0.088***	0.162***	644.867***
V x T	5	0.001 ^{NS}	0.001 ^{NS}	0.003 ^{NS}	0.002 ^{NS}	0.003**	1.311*
Error	22	0.003	0.003	0.003	0.003	0.00014	0.477

Appendix represents
* indicates 5% level of probability
** indicates 1% level of probability
*** indicates 0.1% level of probability
NS- Non significant

Appendix 2.1 Analysis of variance of data on physiological weight loss of mango and moisture content of mango pulp as influenced by varieties and different doses of Maleic hydrazide solution

Sources of variation	Degree of freedom	Mean sum of square								
		Physiological weight loss (%) at different days				Moisture content (%) at different days				
		3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.007	0.001	0.001	0.010	0.003	0.012	0.006	0.012
Variety -V	1	4.914***	4.646***	4.779***	4.779***	45.375***	46.204***	46.204***	47.040***	46.121***
Maleic hadrazide- M	3	7.260***	7.397***	7.194***	7.194***	0.069^{NS}	4.386***	8.776***	5.464***	3.885***
V x M	3	0.042*	0.026*	0.033***	0.033***	0.003^{NS}	0.006^{NS}	0.006^{NS}	0.013^{NS}	0.007^{NS}
Error	14	0.008	0.005	0.003	0.003	0.103	0.046	0.042	0.051	0.042

Appendix 2.2 Analysis of variance of data on dry matter and ash content of mango pulp as influenced by varieties and different doses of Maleic hydrazide solution

Sources of variation	Degree of freedom	Mean sum of square									
		Dry matter content (%) at different days					Ash content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.004	0.009	0.012	0.004	0.013	0.001	0.001	0.001	0.001	0.002
Variety -V	1	46.204***	46.204***	46.204***	47.040***	45.844***	0.113**	0.120**	0.115**	0.116**	0.111**
Maleic hadrazide- M	3	0.056*	4.386***	8.776***	5.464***	3.956***	0.0009^{NS}	0.011^{NS}	0.021^{NS}	0.022^{NS}	0.010^{NS}
V x M	3	0.006^{NS}	0.006^{NS}	0.006^{NS}	0.013^{NS}	0.006^{NS}	0.0008^{NS}	0.0008^{NS}	0.0009^{NS}	0.0007^{NS}	0.0009^{NS}
Error	14	0.011	0.023	0.016	0.019	0.016	0.011	0.011	0.010	0.011	0.010

Appendix represents

* indicates 1% level of probability

** indicates 1% level of probability

*** indicates 0.1% level of probability

NS- Non significant

Appendix 2.3 Analysis of variance of data on vitamin C content of mango pulp as influenced by varieties and different doses of Maleic hydrazide solution

Sources of variation	Degree of freedom	Mean sum of square				
		Vitamin C content (mg/100 g) at different days				
		Initial	3	6	9	12
Replication	2	0.125	0.005	0.005	0.000	0.001
Variety -V	1	47680.988***	36539.889***	9594.001***	3153.334***	335.254***
Maleic hadrazide M	3	14.690***	622.621***	433.706***	242.224***	80.984***
V × M	3	9.042**	191.345***	143.046***	90.824***	0.094*
Error	14	1.131	0.658	0.045	0.037	0.018

Appendix 2.4 Analysis of variance of data on titratable acidity and pH of mango pulp as influenced by varieties and different doses of Maleic hydrazide solution

Sources of variation	Degree of freedom	Mean sum of square									
		Titratable acidity (%) at different days					Pulp pH at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.002	0.002	0.000	0.000	0.000	0.007	0.000	0.001	0.001	0.001
Variety -V	1	9.526***	0.196***	0.132***	0.083***	0.025***	0.042*	0.060*	0.060**	0.060*	0.060*
Maleic hadrazide- M	3	0.013^{NS}	0.381***	0.324***	0.297***	0.121***	0.065**	4.00***	1.655***	3.295***	1.960***
V × M	3	0.002^{NS}	0.032*	0.003^{NS}	0.001^{NS}	0.001^{NS}	0.005^{NS}	-0.0002^{NS}	0.0009^{NS}	0.0007^{NS}	-0.0002^{NS}
Error	14	0.010	0.008	0.007	0.003	0.001	0.008	0.010	0.004	0.008	0.011

Appendix represents

* indicates 1% level of probability *** indicates 0.1% level of probability

** indicates 1% level of probability NS- Non significant

Appendix 2.5 Analysis of variance of data on total soluble solid and total sugar content of mango pulp as influenced by varieties and different doses of Maleic hydrazide solution

Sources of variation	Degree of freedom	Mean sum of square									
		TSS content (%) at different days					Total sugar content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.004	0.001	0.009	0.004	0.001	0.001	0.001	0.004	0.001
Variety -V	1	7.260***	7.260***	0.094*	2.734***	0.240***	1.354***	1.500***	1.500***	1.354***	1.354***
Maleic hadrazide- M	3	0.100**	38.575***	157.034***	49.594***	39.375***	0.064**	12.423***	105.555***	104.043***	44.149***
V x M	3	0.0007^{NS}	0.0009^{NS}	0.424***	0.144***	5.700***	0.004^{NS}	0.003^{NS}	0.003^{NS}	0.001^{NS}	0.001^{NS}
Error	14	0.011	0.011	0.011	0.010	0.011	0.011	0.011	0.011	0.011	0.011

Appendix 2.6 Analysis of variance of data on reducing and non reducing sugar content of mango pulp as influenced by varieties and different doses of Maleic hydrazide solution

Sources of variation	Degree of freedom	Mean sum of square									
		Reducing sugar content (%) at different days					Non-reducing sugar content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Variety -V	1	0.437***	0.540***	0.540***	0.540***	0.540***	0.277***	0.240***	0.240***	0.184**	0.184**
Maleic hadrazide- M	3	0.042*	2.250***	16.105***	10.630***	6.105***	0.008^{NS}	4.170***	40.000***	48.662***	21.921***
V x M	3	0.001^{NS}	0.0006^{NS}	-0.004^{NS}	0.0008^{NS}	0.0009^{NS}	0.005^{NS}	0.003^{NS}	0.003^{NS}	0.001^{NS}	0.001^{NS}
Error	14	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011

Appendix represents

* indicates 1% level of probability

** indicates 1% level of probability

*** indicates 0.1% level of probability

NS- Non significant

Appendix 2.7 Analysis of variance of data on crude fibre and lipid content of mango pulp as influenced by varieties and different doses of Maleic hydrazide solution

Sources of variation	Degree of freedom	Mean sum of square									
		Crude fibre (%) at different days					Lipid content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Variety -V	1	0.086***	0.086***	0.076***	0.076***	0.104***	0.001*	0.001*	0.001*	0.002***	0.007***
Maleic hadrazide- M	3	0.005^{NS}	0.150***	0.335***	0.245***	0.090***	0.002***	0.023***	0.134***	0.143***	0.036***
V × M	3	0.0009^{NS}	0.0008^{NS}	0.0006^{NS}	0.0007^{NS}	0.001^{NS}	0.0007^{NS}	0.0008^{NS}	0.0008^{NS}	0.001**	0.001***
Error	14	0.003	0.003	0.003	0.003	0.003	0.0004	0.0003	0.00014	0.00015	0.0016

Appendix 2.8 Analysis of variance of data on water soluble protein and phosphorus content of mango pulp as influenced by varieties and different doses of Maleic hydrazide solution

Sources of variation	Degree of freedom	Mean sum of square									
		Water soluble protein content (%) at different days					Phosphorus content (mg/100 g) different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Variety -V	1	0.034^{NS}	0.043^{NS}	0.090*	0.057*	0.020^{NS}	64.452***	40.482***	40.249***	36.977***	20.981***
Maleic hadrazide- M	3	0.001^{NS}	0.060*	0.316***	0.335***	0.023^{NS}	0.778***	14.867***	32.232***	24.572***	4.576***
V × M	3	0.002^{NS}	0.0008^{NS}	0.001^{NS}	0.002^{NS}	0.001^{NS}	0.062*	1.909***	1.905***	1.829***	0.739***
Error	14	0.009	0.011	0.011	0.011	0.012	0.011	0.011	0.011	0.011	0.011

Appendix represents

* indicates 1% level of probability
** indicates 1% level of probability
*** indicates 0.1% level of probability
NS- Non significant

Appendix 2.9 Analysis of variance of data on potassium and calcium content of mango pulp as influenced by varieties and different doses of Maleic hydrazide solution

Sources of variation	Degree of freedom	Mean sum of square									
		Potassium content (%) at different days					Calcium content (mg/100 g) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001
Variety -V	1	0.011***	0.018***	0.011***	0.005***	0.005***	19.820***	22.349***	22.465***	22.640***	22.640***
Maleic hadrazide- M	3	0.001**	0.002***	0.001***	0.002***	0.0004*	0.213***	17.977***	104.242***	93.451***	23.167***
V x M	3	0.0008^{NS}	0.0006^{NS}	0.0003^{NS}	0.0004^{NS}	0.0006^{NS}	0.173***	0.115***	0.119***	0.104**	0.101**
Error	14	0.00011	0.00012	0.00013	0.00014	0.00015	0.011	0.011	0.011	0.011	0.011

Appendix 2.10 Analysis of variance of data on in magnesium and copper content of mango pulp as influenced by varieties and different doses of maleic hydrazide

Sources of variation	Degree of freedom	Mean sum of square									
		Magnesium content (mg/100 g) at different days					Copper content (mg/100 g) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.002	0.001	0.001	0.002	0.001	0.000	0.000	0.000	0.000	0.000
Variety -V	1	5.723***	3.488***	8.284***	2.350***	1.084***	0.005***	0.007***	0.005***	0.005***	0.003***
Maleic hadrazide- M	3	0.779***	1.255***	2.695***	0.953***	14.328***	0.0007^{NS}	0.001***	0.005***	0.011***	0.017***
V x M	3	0.110**	0.012^{NS}	0.206***	0.041^{NS}	0.059*	0.0008*	0.0005^{NS}	0.0009^{NS}	0.0003^{NS}	0.0003*
Error	14	0.013	0.011	0.011	0.013	0.011	0.00017	0.00021	0.00018	0.00019	0.00020

Appendix represents

* indicates 1% level of probability

** indicates 1% level of probability

*** indicates 0.1% level of probability

NS- Non significant

Appendix 2.11 Analysis of variance of data on iron and manganese content of mango pulp as influenced by varieties and different doses of Maleic hydrazide solution

Sources of variation	Degree of freedom	Mean sum of square									
		Iron content (mg/100 g) at different days					Manganese content (mg/100 g) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Variety -V	1	3.768***	3.650***	3.912***	3.888***	4.010***	0.194***	0.222**	0.217***	0.234***	0.240***
Maleic hadrazide- M	3	0.362***	1.763***	10.657***	4.248***	3.985***	0.005***	0.092***	0.318***	0.163***	0.115***
V × M	3	0.006^{NS}	0.006^{NS}	0.004^{NS}	0.003^{NS}	0.002^{NS}	0.002^{NS}	0.0006^{NS}	0.001^{NS}	0.001^{NS}	0.001^{NS}
Error	14	0.011	0.011	0.011	0.011	0.011	0.00011	0.00012	0.00013	0.00014	0.00015

Appendix 2.12 Analysis of variance of data on zinc content of mango pulp and shelf life of mango as influenced by varieties and different doses of Maleic hydrazide solution

Sources of variation	Degree of freedom	Mean sum of square					
		Zinc content (mg/100 g) at different days					Shelf life
		Initial	3	6	9	12	Total days
Replication	2	0.000	0.000	0.000	0.000	0.000	0.375
Variety -V	1	0.317***	0.094***	0.098***	0.090***	0.105***	10.667***
Maleic hadrazide- M	3	0.004**	0.009***	0.032***	0.077***	0.144***	61.444***
V × M	3	0.0006^{NS}	0.0007^{NS}	0.0005^{NS}	0.001^{NS}	0.004**	0.333^{NS}
Error	14	0.00016	0.00017	0.00018	0.00019	0.00020	0.518

Appendix represents

* indicates 1% level of probability

** indicates 1% level of probability

*** indicates 0.1% level of probability

NS- Non significant

Appendix 3.1 Analysis of variance of data on physiological weight loss of mango and moisture content of mango pulp as influenced by varieties and different doses of Gibberellic acid solution

Sources of variation	Degree of freedom	Mean sum of square								
		Physiological weight loss (%) at different days				Moisture content (%) at different days				
		3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.049	0.003	0.000	0.054	0.020	0.005	0.002	0.004
Variety -V	1	4.860***	7.673***	4.815***	4.779***	22.330***	26.355***	27.735***	25.010***	25.215***
Gibberellic acid- G	3	7.342***	6.178***	7.131***	7.651***	0.128^{NS}	5.919***	9.030***	5.897***	4.015***
V x G	3	0.052***	0.176*	0.027*	0.049**	0.068^{NS}	0.077^{NS}	0.085^{NS}	0.010^{NS}	0.015^{NS}
Error	14	0.005	0.044	0.005	0.005	0.117	0.058	0.045	0.039	0.041

Appendix 3.2 Analysis of variance of data on dry matter and ash content of mango pulp as influenced by varieties and different doses of Gibberellic acid solution

Sources of variation	Degree of freedom	Mean sum of square								
		Dry matter content (%) at different days					Ash content (%) at different days			
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.002	0.002	0.004	0.002	0.004	0.001	0.008	0.001	0.003	0.001
Variety -V	1	24.301***	24.301***	26.460***	25.010***	25.215***	0.069*	0.056^{NS}	0.069*	0.077*	0.063*
Gibberellic acid- G	3	0.141*	4.998***	9.225***	5.814***	4.015***	0.001^{NS}	0.004^{NS}	0.024^{NS}	0.019^{NS}	0.011^{NS}
V x G	3	0.006^{NS}	0.006^{NS}	0.030^{NS}	0.010^{NS}	0.015^{NS}	0.0006^{NS}	0.0008^{NS}	0.0003^{NS}	0.001^{NS}	0.0007^{NS}
Error	14	0.039	0.039	0.041	0.039	0.041	0.010	0.016	0.010	0.012	0.011

Appendix represents

* indicates 5 % level of probability *** indicates 0.1% level of probability

** indicates 1% level of probability NS means non significant

Appendix 3.3 Analysis of variance of the data on vitamin C content of mango pulp as influenced by varieties and different doses of Gibberellic acid solution

Sources of variation	Degree of freedom	Mean sum of square				
		Vitamin C content (mg/100 g) at different days				
		Initial	3	6	9	12
Replication	2	0.153	0.114	0.127	0.061	0.001
Variety -V	1	44032.666***	35669.543***	12099.203***	3264.334***	376.834***
Gibberellic acid- G	3	4.286*	756.069***	663.647***	272.194***	92.904***
V × G	3	0.818 NS	154.827***	225.909***	88.514***	0.934***
Error	14	1.169	1.102	1.199	0.811	0.028

Appendix 3.4 Analysis of variance of data on titratable acidity and pH of mango pulp as influenced by varieties and different doses of Gibberellic acid solution

Sources of variation	Degree of freedom	Mean sum of square									
		Titratable acidity (%) at different days					Pulp pH at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.000	0.000	0.000	0.000	0.000	0.004	0.001	0.001	0.004	0.001
Variety -V	1	9.754***	0.173***	0.135***	0.086***	0.020***	0.034 NS	0.375***	0.375***	0.375***	0.060 NS
Gibberellic acid- G	3	0.022**	0.368***	0.344***	0.313***	0.131***	0.044 *	0.175***	0.175***	2.320***	0.400***
V × G	3	0.018**	0.035***	0.005*	0.002 NS	0.001 NS	0.004 NS	0.015 NS	0.015 NS	0.015 NS	0.0003 NS
Error	14	0.003	0.003	0.001	0.001	0.00011	0.011	0.011	0.011	0.011	0.016

Appendix represents

* indicates 5 % level of probability

** indicates 1% level of probability

*** indicates 0.1% level of probability

NS means non significant

Appendix 3.5 Analysis of variance of data on total soluble solid and total sugar content of mango pulp as influenced by varieties and different doses of Gibberellic acid solution

Sources of variation	Degree of freedom	Mean sum of square									
		TSS content (%) at different days					Total sugar content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.002	0.001	0.004	0.012	0.001	0.001	0.005	0.001	0.001
Variety -V	1	6.615***	6.720***	1.500***	0.375***	0.540***	1.229***	1.500***	1.354***	1.500***	1.215***
Gibberellic acid- G	3	0.105**	32.300***	87.145***	39.090***	36.710***	0.118**	12.945***	113.474***	106.745***	44.415***
V × G	3	0.005^{NS}	0.007^{NS}	0.970***	0.045**	0.050**	0.006^{NS}	0.010^{NS}	0.014^{NS}	0.010^{NS}	0.015^{NS}
Error	14	0.011	0.013	0.011	0.006	0.006	0.013	0.011	0.011	0.016	0.011

Appendix 3.6 Analysis of variance of data on reducing and non reducing sugar content of mango pulp as influenced by varieties and different doses of Gibberellic acid solution

Sources of variation	Degree of freedom	Mean sum of square									
		Reducing sugar content (%) at different days					Non-reducing sugar content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.005	0.143	0.001	0.001	0.002	0.001	0.001	0.001	0.001
Variety -V	1	0.833***	0.901***	0.0005^{NS}	0.586***	0.586***	0.064*	0.076*	0.113**	0.271***	0.158**
Gibberellic acid- G	3	0.018^{NS}	2.223***	17.027***	11.751***	6.166***	0.053*	4.466***	43.398***	48.086***	21.888***
V × G	3	0.010^{NS}	0.008^{NS}	0.661*	0.023^{NS}	0.023^{NS}	0.009^{NS}	0.028^{NS}	0.006^{NS}	0.043*	0.011^{NS}
Error	14	0.011	0.011	0.181	0.011	0.011	0.012	0.011	0.011	0.011	0.011

Appendix represents

* indicates 5 % level of probability *** indicates 0.1% level of probability

** indicates 1% level of probability NS means non significant

Appendix 3.7 Analysis of variance of data on crude fibre and lipid content of mango pulp as influenced by varieties and different doses of Gibberellic acid

Sources of variation	Degree of freedom	Mean sum of square									
		Crude fibre (%) at different days					Lipid content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.001	0.001	0.003	0.000	0.000	0.000	0.000	0.000
Variety -V	1	0.079*	0.211***	0.213***	0.211***	0.0130***	0.002***	0.002***	0.006***	0.015***	0.014***
Gibberellic acid- G	3	0.001^{NS}	0.089**	0.323***	0.269***	0.050***	0.002***	0.027***	0.132***	0.100***	0.026***
V x G	3	0.0006^{NS}	0.0007^{NS}	0.0003^{NS}	0.0005^{NS}	0.009^{NS}	0.0005^{NS}	-0.0004^{NS}	0.001**	0.002***	0.002***
Error	14	0.011	0.011	0.011	0.009	0.005	0.00011	0.00012	0.00013	0.00014	0.00015

Appendix 3.8 Analysis of variance of data on water soluble protein and phosphorus content of mango pulp as influenced by varieties and different doses of Gibberellic acid solution

Sources of variation	Degree of freedom	Mean sum of square									
		Water soluble protein content (%) at different days					Phosphorus content (mg/100 g) different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.016	0.001	0.001
Variety -V	1	0.057**	0.069*	0.089*	0.090*	0.029^{NS}	42.294***	41.659***	43.902***	42.693***	42.135***
Gibberellic acid- G	3	0.005^{NS}	0.080**	0.334***	0.356***	0.032^{NS}	1.210***	6.924***	21.448***	16.098***	4.378***
V x G	3	0.002^{NS}	0.0003^{NS}	0.0005^{NS}	0.003^{NS}	0.0007^{NS}	0.007^{NS}	0.013^{NS}	0.081*	0.055*	0.075**
Error	14	0.006	0.009	0.011	0.011	0.011	0.011	0.011	0.018	0.011	0.011

Appendix represents

* indicates 5 % level of probability

** indicates 1% level of probability

*** indicates 0.1% level of probability

NS means non significant

Appendix 3.9 Analysis of variance of data on potassium and calcium content of mango pulp as influenced by varieties and different doses of Gibberellic acid solution

Sources of variation	Degree of freedom	Mean sum of square									
		Potassium content (%) at different days					Calcium content (mg/100 g) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001
Variety -V	1	0.002***	0.002***	0.001**	0.003***	0.003***	21.489***	21.263***	21.113***	24.786***	25.896***
Gibberellic acid- G	3	0.001***	0.002***	0.002***	0.002***	0.001**	0.239***	18.437***	109.634***	95.970***	25.369***
V × G	3	0.0005^{NS}	0.0006^{NS}	0.0007^{NS}	0.0007^{NS}	0.0005^{NS}	0.007^{NS}	0.067**	0.055*	0.220***	0.196***
Error	14	0.00011	0.00012	0.00013	0.00014	0.00015	0.011	0.011	0.011	0.011	0.011

Appendix 3.10 Analysis of variance of data in magnesium and copper content of mango pulp as influenced by varieties and different doses of Gibberellic acid solution

Sources of variation	Degree of freedom	Mean sum of square									
		Magnesium content (mg/100 g) at different days					Copper content (mg/100 g) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.001	0.001	0.004	0.000	0.000	0.000	0.000	0.000
Variety -V	1	4.779***	2.693***	2.516***	2.381***	2.673***	0.007***	0.005***	0.005***	0.003***	0.005***
Gibberellic acid- G	3	0.153***	1.507***	3.497***	1.132***	5.879***	0.001*	0.002***	0.007***	0.010***	0.016***
V × G	3	0.030^{NS}	0.471***	0.450***	0.423***	0.204***	0.0002^{NS}	0.0003^{NS}	0.0005^{NS}	0.0005^{NS}	0.0007^{NS}
Error	14	0.011	0.011	0.011	0.011	0.011	0.00021	0.00022	0.00023	0.00024	0.00024

Appendix represents

* indicates 5 % level of probability

** indicates 1% level of probability

*** indicates 0.1% level of probability

NS means non significant

Appendix 3.11 Analysis of variance of data on iron and manganese content of mango pulp as influenced by varieties and different doses of Gibberellic acid solution

Sources of variation	Degree of freedom	Mean sum of square									
		Iron content (mg/100 g) at different days					Manganese content (mg/100 g) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Variety -V	1	4.568***	4.806***	4.691***	4.726***	4.158***	0.154***	0.140***	0.168***	0.149***	0.189***
Gibberellic acid- G	3	0.317***	1.593***	7.364***	2.477***	6.292***	0.006***	0.101***	0.314***	0.163***	0.154***
V × G	3	0.002^{NS}	0.001^{NS}	0.004^{NS}	0.002^{NS}	0.012^{NS}	0.0003^{NS}	0.0004^{NS}	0.001^{NS}	0.002*	0.001^{NS}
Error	14	0.011	0.011	0.013	0.011	0.011	0.00011	0.00012	0.00013	0.00014	0.00015

Appendix 3.12 Analysis of variance of data on zinc content of mango pulp and shelf life of mango as influenced by varieties and different doses of Gibberellic acid solution

Sources of variation	Degree of freedom	Mean sum of square					
		Zinc content (mg/100 g) at different days					Shelf life
		Initial	3	6	9	12	Total days
Replication	2	0.000	0.000	0.000	0.000	0.000	0.042
Variety -V	1	0.413***	0.131***	0.094***	0.118***	0.122***	9.375**
Gibberellic acid- G	3	0.003**	0.007***	0.023***	0.060***	0.144***	84.819***
V × G	3	0.001^{NS}	0.0005^{NS}	0.003**	0.003**	0.004**	0.375^{NS}
Error	14	0.00021	0.00022	0.00023	0.00024	0.00025	0.565

Appendix represents

* indicates 5 % level of probability

** indicates 1% level of probability

*** indicates 0.1% level of probability

NS means non significant

Appendix 4.1 Analysis of variance of data on physiological weight loss of mango and moisture content of mango pulp as influenced by varieties and different doses of Bavistin DF solution

Sources of variation	Degree of freedom	Mean sum of square								
		Physiological weight loss (%) at different days				Moisture content (%) at different days				
		3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.000	0.036	0.004	0.004	0.004	0.005	0.004
Variety -V	1	4.208***	6.773***	5.273***	6.100***	60.484***	60.484***	58.594***	58.594***	56.734***
Bavistin DF - B	3	6.558***	9.566***	7.398***	6.367***	0.134 ^{NS}	3.874***	9.094***	6.674***	5.534***
V x B	3	0.026**	0.076***	0.016**	0.016^{NS}	0.004^{NS}	0.004^{NS}	0.004^{NS}	0.004^{NS}	0.004^{NS}
Error	14	0.003	0.003	0.003	0.053	0.041	0.041	0.041	0.045	0.041

Appendix 4.2 Analysis of variance of data on dry matter and ash content of mango pulp as influenced by varieties and different doses of Bavistin DF solution

Sources of variation	Degree of freedom	Mean sum of square								
		Dry matter content (%) at different days					Ash content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.005	0.004	0.004	0.004	0.004	0.001	0.001	0.001	0.001	0.002
Variety -V	1	60.484***	60.484***	58.594***	58.594***	56.734***	0.147**	0.154**	0.144**	0.154**	0.167**
Bavistin DF - B	3	0.134 ^{NS}	3.874***	9.094***	6.674***	5.534***	0.0005 ^{NS}	0.009 ^{NS}	0.022 ^{NS}	0.021 ^{NS}	0.022 ^{NS}
V x B	3	0.004^{NS}	0.004^{NS}	0.004^{NS}	0.004^{NS}	0.004^{NS}	0.0007^{NS}	0.0005^{NS}	0.0003^{NS}	0.0007^{NS}	0.002^{NS}
Error	14	0.045	0.041	0.041	0.041	0.041	0.011	0.011	0.011	0.011	0.013

Appendix represents

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Appendix 4.3 Analysis of variance of data on vitamin C content of mango pulp as influenced by varieties and different doses of Bavistin DF solution

Sources of variation	Degree of freedom	Mean sum of square				
		Vitamin C content (mg/100 g) at different days				
		Initial	3	6	9	12
Replication	2	0.010	0.005	0.000	0.001	0.001
Variety -V	1	49204.870***	35956.171***	8721.094***	3030.754***	317.554***
Bavistin DF - B	3	9.178***	623.696***	384.064***	243.294***	81.284***
V x B	3	2.715*	154.586***	99.504***	88.914***	0.254***
Error	14	0.547	0.448	0.013	0.016	0.011

Appendix 4.4 Analysis of variance of data on titratable acidity and pH of mango pulp as influenced by varieties and different doses of Bavistin DF solution

Sources of variation	Degree of freedom	Mean sum of square									
		Titratable acidity (%) at different days					Pulp pH at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.002
Variety -V	1	10.218***	0.189***	0.105***	0.083***	0.032***	0.060*	0.060*	0.034 ^{NS}	0.094*	0.070*
Bavistin DF - B	3	0.016**	0.323***	0.309***	0.303***	0.104***	0.100**	0.100**	3.234***	1.394***	0.317***
V x B	3	0.007^{NS}	0.039***	0.005***	0.002*	0.003**	0.0003^{NS}	0.0005^{NS}	0.004^{NS}	0.004^{NS}	0.0003^{NS}
Error	14	0.003	0.0003	0.0004	0.0005	0.0006	0.011	0.011	0.011	0.011	0.010

Appendix represents

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Appendix 4.5 Analysis of variance of data on total soluble solid and total sugar content of mango pulp as influenced by varieties and different doses of Bavistin DF solution

Sources of variation	Degree of freedom	Mean sum of square									
		TSS content (%) at different days					Total sugar content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.005	0.001	0.009	0.001	0.004	0.001	0.001	0.001	0.001	0.001
Variety -V	1	6.000***	5.704***	0.304**	4.860***	6.934***	1.638***	1.882***	1.865***	1.865***	1.904***
Bavistin DF - B	3	0.295***	11.944***	91.094***	52.850***	33.854***	0.020^{NS}	10.748***	98.343***	93.705***	37.530***
V x B	3	0.0003^{NS}	0.004^{NS}	2.204***	0.330***	0.164***	0.005^{NS}	0.005^{NS}	0.006^{NS}	0.006^{NS}	0.005^{NS}
Error	14	0.028	0.011	0.032	0.020	0.015	0.011	0.011	0.011	0.011	0.011

Appendix 4.6 Analysis of variance of data on reducing and non reducing sugar content of mango pulp as influenced by varieties and different doses of Bavistin DF solution

Sources of variation	Degree of freedom	Mean sum of square									
		Reducing sugar content (%) at different days					Non-reducing sugar content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Variety -V	1	0.446**	0.505***	0.505***	0.421***	0.421***	0.222***	0.437***	0.429***	0.513***	0.624***
Bavistin DF - B	3	0.013^{NS}	1.704***	13.750***	8.080***	5.169***	0.011^{NS}	3.903***	38.977***	47.618***	19.623***
V x B	3	0.0003^{NS}	0.0005^{NS}	0.0006^{NS}	0.003^{NS}	0.003^{NS}	0.001^{NS}	0.006^{NS}	0.007^{NS}	0.006^{NS}	0.012^{NS}
Error	14	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011

Appendix represents

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Appendix 4.7 Analysis of variance of data on crude fibre and lipid content of mango pulp as influenced by varieties and different doses of Bavistin DF solution

Sources of variation	Degree of freedom	Mean sum of square									
		Crude fibre (%) at different days					Lipid content (%) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001
Variety -V	1	0.069***	0.066***	0.041**	0.094***	0.090***	0.0009^{NS}	0.001^{NS}	0.001^{NS}	0.002***	0.0007^{NS}
Bavistin DF - B	3	0.002^{NS}	0.103***	0.275***	0.230***	0.063***	0.002***	0.029***	0.150***	0.131***	0.023***
V x B	3	0.0005^{NS}	0.001^{NS}	0.005^{NS}	0.001^{NS}	0.0008^{NS}	0.0007^{NS}	-0.0003^{NS}	0.0003^{NS}	0.001**	0.003^{NS}
Error	14	0.003	0.003	0.003	0.004	0.003	0.00031	0.00032	0.00033	0.00034	0.002

Appendix 4.8 Analysis of variance of data on water soluble protein and phosphorus content of mango pulp as influenced by varieties and different doses of Bavistin DF solution

Sources of variation	Degree of freedom	Mean sum of square									
		Water soluble protein content (%) at different days					Phosphorus content (mg/100 g) different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001
Variety -V	1	0.041*	0.051^{NS}	0.076*	0.043^{NS}	0.022^{NS}	32.017***	31.740***	34.344***	32.063***	23.522***
Bavistin DF - B	3	0.003^{NS}	0.064**	0.312***	0.336***	0.009^{NS}	1.203***	6.672***	18.996***	12.906***	6.175***
V x B	3	0.001^{NS}	0.0003^{NS}	0.001^{NS}	0.002^{NS}	0.001^{NS}	0.012^{NS}	0.008^{NS}	0.003^{NS}	0.010^{NS}	0.782***
Error	14	0.006	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.013	0.011

Appendix represents

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Appendix 4.9 Analysis of variance of data on potassium and calcium content of mango pulp as influenced by varieties and different doses of Bavistin DF solution

Sources of variation	Degree of freedom	Mean sum of square									
		Potassium content (%) at different days					Calcium content (mg/100 g) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.030	0.001	0.001
Variety -V	1	0.010***	0.004***	0.003***	0.003***	0.004***	16.484***	17.750***	19.620***	17.802***	17.957***
Bavistin DF - B	3	0.001**	0.001***	0.001***	0.001***	0.001**	0.074**	15.707***	96.679***	89.048***	23.389***
V x B	3	0.0003^{NS}	0.0003^{NS}	0.0007^{NS}	0.0008^{NS}	0.0005^{NS}	0.039*	0.096**	0.048^{NS}	0.084**	0.084**
Error	14	0.00041	0.00043	0.00052	0.00053	0.00063	0.011	0.011	0.040	0.011	0.011

Appendix 4.10 Analysis of variance of data on magnesium and copper content of mango pulp as influenced by varieties and different doses of Bavistin DF solution

Sources of variation	Degree of freedom	Mean sum of square									
		Magnesium content (mg/100 g) at different days					Copper content (mg/100 g) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Variety -V	1	5.910***	6.531***	6.304***	5.645***	5.578***	0.007***	0.007***	0.007***	0.006***	0.005***
Bavistin DF - B	3	0.361***	1.779***	4.382***	0.710***	2.005***	0.0003*	0.003***	0.007***	0.013***	0.018***
V x B	3	0.019^{NS}	0.017^{NS}	0.022^{NS}	0.027^{NS}	0.017^{NS}	0.0004^{NS}	0.0001^{NS}	0.0002^{NS}	0.0003^{NS}	0.0005^{NS}
Error	14	0.011	0.013	0.011	0.011	0.011	0.00062	0.00063	0.00074	0.00092	0.00083

Appendix represents

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Appendix 4.11 Analysis of variance of data on iron and manganese content of mango pulp as influenced by varieties and different doses of Bavistin DF solution

Sources of variation	Degree of freedom	Mean sum of square									
		Iron content (mg/100 g) at different days					Manganese content (mg/100 g) at different days				
		Initial	3	6	9	12	Initial	3	6	9	12
Replication	2	0.001	0.001	0.001	0.001	0.055	0.000	0.000	0.000	0.000	0.000
Variety -V	1	4.753***	5.273***	5.273***	8.894***	12.113***	0.154***	0.158***	0.154***	0.154***	0.135***
Bavistin DF - B	3	0.180***	0.942***	6.274***	1.567***	3.545***	0.002*	0.075***	0.251***	0.153***	0.192***
V x B	3	0.004^{NS}	0.020^{NS}	0.020^{NS}	0.292***	0.397***	0.0004^{NS}	0.0005^{NS}	0.0007^{NS}	0.0008^{NS}	0.0007^{NS}
Error	14	0.011	0.011	0.011	0.011	0.037	0.00032	0.00043	0.00054	0.00063	0.00033

Appendix 4.12 Analysis of variance of the data on zinc content of mango pulp and shelf life of mango as influenced by varieties and different doses of Bavistin DF solution

Sources of variation	Degree of freedom	Mean sum of square					
		Zinc content (mg/100 g) at different days					Shelf life
		Initial	3	6	9	12	Total days
Replication	2	0.000	0.000	0.000	0.000	0.000	0.042
Variety -V	1	0.265***	0.076***	0.083***	0.083***	0.086***	10.667**
Bavistin DF - B	3	0.002*	0.011***	0.029***	0.075***	0.153***	82.278***
V x B	3	0.002*	0.0003^{NS}	0.0005^{NS}	0.0007^{NS}	0.001^{NS}	0.333^{NS}
Error	14	0.00072	0.00074	0.00035	0.00065	0.00082	0.661

Appendix represents

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