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# Studies on Shelf-Life of Some Promising Mango (*Mangifera indica* L.) Hybrids under Ambient Condition

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**Abstract**

Eleven mango hybrids Alfazli, Amrapali, Jawahar, Mahmoodbahar, Mallika, Neeleshan, Neeludin, Prabhashankar, Ratna, Sabri, Sunder Langra and Langra were taken as local check to study their shelf life. The PLW and spoilage of fruit increased with prolongation of storage period, regardless of cultivars. On termination day of storage (15$^{th}$ day) the minimum PLW (18.65%) and spoilage (22.36%) was noted in Mallika while highest PLW (34.85%) and spoilage (58.67%) were obtained in check variety Langra. TSS content in fruits increased up to 12$^{th}$ day and further extension in storage period it declined in all the cultivars. On concluding day of experiment (15$^{th}$ day) the maximum TSS was noted in Mallika (23.02°Brix) while the lowest was obtained inLangra (18.18°Brix). The titratable acidity and ascorbic acid content in fruits decreased progressively upto end of the experiment. On 15$^{th}$ day of storage the maximum titratable acidity was recorded in Mallika (0.346%) while the lowest was obtained in Sabri (0.132%). The highest ascorbic acid produced by Langra (92.86 mg/100g juice) while,the lowest ascorbic acid was noticed in Mahmoodbahar (15.18 mg/100g juice). Total sugar enhanced gradually up to 9$^{th}$ day of storage, except in Mallika which showed increasing trend up to 12$^{th}$ day. On last day of storage the maximum total sugars was noticed in Mallika (14.98%) however, the lowest was recorded in Langra (11.74%). On 12$^{th}$ day of storage Mallika was organoleptically rated as excellent. On last day of storage,Amrapali, Mahmoodbahar, Mallika and Neeludin were fair while rest of the cultivars were under poor grade quality.The keeping quality of Mallika, Alfazli, Ratna and Amrapali were better than other hybrids and check variety Langra.Especially fruits of Mallika can be stored for longer period at ambient conditions.

**Keywords**

Shelf-life
Mango
Physiological weight loss
Spoilage, ascorbic acid
Organoleptic quality

## INTRODUCTION

Mango *(Mangifera indica* L.*)* is a diffuse-porous species and one of the most important tropical tree crops (Lu et al., 2000) belongs to the family Anacardiaceae (Morton, 1987). Mango fruits have increasing commercial importance throughout the world and are a valued source of income in all mango producing countries (Siddiqui, 2008; Siddiqui et al., 2014a). It is an important fruit crop of India acknowledged as "King of fruits" and the "national fruit of India". Mango is widely grown for its special features like high nutritive value, high productivity, processing potential, delicious taste and suitability to be grown in widely ecological amplitude. Reputed as fruit for excellence, mango has assumed a leading position among commercial fruits (Singh, 2004). In India, mango accounts approximately 2.50 million hectare area and 18.002 million tonnes production (NHB, 2013) having superior position in the world market. Apart from the use of ripe mango, young and unripe fruits are utilized for culinary purposes as well as for preparing pickles, chutneys and amachur. Like all other fresh commodities, the potential market of mango is directly correlated with the quality of the fruits. To facilitate access to the domestic and offshore markets, mango fruit storage potential and fruit quality consistency needs to be improved (Simmons et al., 1997).Further keeping quality of fruits is also an important criteria during the selection of varieties to a particular region. Mango is a climacteric fruits which shows rapid increase in respiration after harvest and cannot be stored for long time at ambient condition due to fast ripening and degradative metabolism. Higher yield, better quality and longer life span of the produce are the slogans of the day. Mango cultivars differ in flavour (Berardini et al., 2005) nutritional characteristics (Ahmad et al., 2007) and storage behaviour (Elahi and Khan, 1973, Kim et al., 2007). High market losses, inadequate information on postharvest physiology and biochemistry of cultivars are the limiting factors in international mango trade (Medlicott and Thompson,

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1985). Bose and Mitra (1990) reported that despite of enormous wealth of mango cultivars available in the country but ideal cultivar of mango is still lacking. Horticulturists are trying to develop such cultivars. Most of the present day cultivars appeared to have been selected for characters like size, quality and period of maturity. An increase in the storage life and improvement of mango fruits quality is really desirable to prevent these gluts in the market and to curtail the post-harvest losses (Siddiqui et al.,2014a). So during the selection of a variety, high yield potential with longer shelf life are important aspects to fulfill the demand of the day. Keeping all the above facts under considerations the present investigation was carried out with eleven released hybrids from different parts of the country with local check variety Langra.

## MATERIALS AND METHODS

### Mango hybrids for experiment

The experiment was carried out on fruits from the 20 years old healthy plants of eleven hybrids of mango as well as the most important variety of this region Langra was also included as check. Selected hybrids were Alfazli, Amrapali, Jawahar, Mahmoodbahar, Mallika, Neeleshan, Neeludin, Prabhashankar, Ratna, Sabri, SundarLangra and Langra (check) and used as treatments $T_1$, $T_2$, $T_3$, $T_4$, $T_5$, $T_6$, $T_7$, $T_8$, $T_9$, $T_{10}$, $T_{11}$ and $T_{12}$ respectively. All the12 treatments were replicated thrice times.

### Evaluation ofshelf life of fruits

All the observations of the fruits under storage were determined at 3 days interval starting from the date of harvesting till the end of storage. The standard methods for the estimation of physico-chemical parameters are described here.

### Physiological loss in weight (PLW)

To estimate the PLW, initial weight of fruits under each treatment was measured replication wise at the time of storage and final weight was also measured at end of storage. PLW was computed in terms of percentage of initial weight basis.

### Spoilage loss of fruits

The spoiled fruits on each day of observations were separated out from all the treatments and weighed separately. The percentage of spoiled fruits on each day of observation from each treatment was calculated.

### Changes in Total Soluble Solids (TSS)

The Total Soluble Solids of fruits was recorded with the help of a hand refractometer (Rangana, 2010). It was determined by applying 2 drops of homogenized juice on the prism of hand refractometer. TSS (°Brix) was noted directly from the digital screen at room temperature (30°C±2).

### Titratable acidity

The titratableacidity of mango hybrids was determined by the method as suggested by Rangana(2010). Clear homogenized juice extracted from the fruits was titrated against standard sodium hydroxide solution (N/10) by using phenolphthalein ($C_{20}H_{14}O_4$) as an indicator. The final results were expressed as percent citric acid.

### Reducing and Total sugars

The reducing sugar and Total sugars were estimated by Lane and Eyon (1923).

Known amount of sample was titrated against Fehling solution A and B by using methylene blue as an indicator. The appearance of brick red colour determined the end point. The reducing and total sugar was calculated in percentage in the juice considering 10 ml of Fehling solution A and B equal to 0.05 g of glucose.

### Ascorbic acid

Ascorbic acid content of the juice was determined by titrating freshly extracted juice against 2, 6 Dichlorophenol indophenols dye (A.O.A.C, 2000). The ascorbic acid (mg/100g) was calculated.

### Organoleptic evaluation

To assess the acceptability of consumer studies on organoleptic evaluation were conducted by score card system with a panel of five semi trained judges.They evaluated the colour, flavour, taste, appearance and overall acceptability of fruits on the basis of 9-point Hedonic scale (Amerineet al., 1965). The observations were conducted when the 75 per cent fruits ripened. Sensory evaluation of mango fruits of different cultivars during storage was recorded from 6th day of storage at three days intervals

### Statistical methods

Observations recorded during the investigation were subjected to analysis of variance using completely

randomized design as described by Cooharan and Cox (1975) and the significance of different source of variation was tested by error mean square by 'F' test.

## RESULTS

### Physiological loss in weight (per cent)

The physiological loss in weight (PLW) of fruits during storage was recorded at three day interval.It is evident from the Table-1that in all the cultivars as the day of storage increased the PLW gradually and significantly increased till the last day of storage. Atthe last day of storage ($15^{th}$ day) Mallika gave lowest PLW (18.65%) and proved its superiority over remaining cultivars. The highest PLW (34.85%) was observed in check variety Langra followed by Jawahar (31.60%) and Sabri (30.96%).

### Spoilage loss of fruits (per cent)

The spoilage losses during storage of different cultivars are presented in Table-2.At the $15^{th}$day of storage the minimum spoilage loss (22.36%) was also observed in cultivar Mallika, however, it was found uneconomical due to more than 12% spoilage while the highest spoilage loss (58.67%) was recorded in check variety Langra followed by Sunder Langra (54.51%)and Sabri (51.34%).

### Changes in Total soluble solids ($^0$Brix)during storage

The data regarding to total soluble solids (TSS) content of the stored fruits are given in Table-3.The TSS content of mango fruits increased with advancement of storage period up to $12^{th}$ day of storage, irrespective of cultivars and thereafter it declined on last day of storage ($15^{th}$ day). However, in case of Amrapali and Langra it was declined after $9^{th}$ day. At the termination day ($15^{th}$ day) of experiment the highest TSS ($23.02^{O}$Brix) was noticed in Mallika which showed statistical parity with Sunder Langra ($22.36^0$Brix) and Jawahar ($22.12^0$Brix). While the lowest TSS ($18.18^0$Brix) was recorded in check variety Langra followed by Neeleshan ($19.96^0$Brix) and Sabri ($20.12^0$Brix).

### Changes in titratable acidity (per cent) during storage

The titratable acidity of different mango hybrids during storage was estimated as anhydrous citric acid and expressed as per cent. The titratable acidity of fruits decreased gradually with prolongation of storage period, regardless of cultivar on first day observation (Table-4). At the initial day of storage (0 day) mango hybrid Sabri followed by Neeludin contained the minimum 0.29% and 0.32% titratable acidity respectively. While as, the maximum acidity (0.60%) was noted in Mallika followed by Jawahar (0.58%) and Amrapali (0.56%). At the last day of experiment ($15^{th}$ day) the lowest acidity was again recorded in Sabri (0.13%) followed by Neeludin (0.18%)and Sunder Langra (0.20%). However the maximum acidity was noticed in Mallika(0.34%) followed by Jawahar (0.31%) and check variety Langra (0.29%).

### Changes in TSS/acidity ratio during storage

It is clear from the Table-5that the TSS/acidity ratio increased with prolongation of storage period up to the last day of storage in all the cultivars. At the last day of experiment the maximum TSS/acidity ratio was recorded in cultivars Sabri(152.64) followed by Neeludin (119.76) and Sunder Langra (110.82) while the least (61.44) was obtained in check variety Langra followed by Mallika (66.52) and Jawahar (70.89).

### Changes in reducing sugar (per cent) during storage

Results show that the reducing sugar of mango fruits increased progressively with prolongation of storage period up to $9^{th}$ day of storage, regardless of cultivars except Mallika reflected increasing trend up to $12^{th}$ day and further extension in storage period it declined significantly(Table-6). Maximum reducing sugar was observed significantly atthe time of harvesting in the fruits of Alfazli(2.64%) followed by Sabri (2.27%) and check variety Langra (2.19%).Whereas, the lowest reducing sugar content was noted in Neeleshan(1.48%) which was at par with Mallika (1.72%). At the end day of experiment the highest reducing sugar was maintained by Amrapali (7.02%) followed by Mahmoodbahar (6.78%). However the lowest reducing sugar was obtained in Alfazli(5.88%) which was at par with Sunder Langra (5.79%).

### Changes in total sugar (per cent) during storage

The total sugar in mango fruits increased steadily up to $9^{th}$ day of storage, irrespective of cultivars and thereafter it decreased except inMallika which

exhibited increasing trend up to 12th day of storage (Table-7).

On first day of observations the maximum total sugars was recorded in Alfazli (5.70%) which was statistically at par with Jawahar (5.10%) and the lowest value was found in Neeleshan(3.56%). On 12th day of storage the maximum reducing sugar was observed in Neeludin(15.48%) which was at par with Mahmoodbahar (15.37%) and the lowest was observed in check variety Langra (12.38%). On concluding day (15th day) of experiment the highest total sugar was noticed in Amrapali(14.98%) which was statistically on equal footing to Neeludin (14.51%) and and the lowest total sugar was found in check variety Langra (11.74%) followed by Sunder Langra (12.65%).

**Changes in Ascorbic acid (mg/100g juice) during storage**

The ascorbic acid or vitamin C content of various mango fruits were estimated at three days intervals andthe values are expressed in mg/100 g of juice. The data recorded are presented in Table-8.It is obvious from the table that ascorbic acid content in mango fruits gradually and significantly declined up to last days of storage as the days of storage increased in all the cultivars. It was noticed that the maximum ascorbic acid (133.63mg/100g juice) was recorded on first day of observation (0 day) in check variety Langra followed by Sunder Langra (94.60 mg/100g juice) and Amrapali (61.28 mg/100g juice) whereas, minimum was observed in Ratna (38.50 mg/100 g juice) which was at par with Mahmoodbahar (38.76 mg/100 g juice) and Sabri (39.42 mg/100g juice). Similarly on last day of storage (15th day) the check variety Langra again showed maximum ascorbic acid (92.86 mg/100g juice) and found the most outstanding being significantly superior to the rest of cultivars followed by Sunder Langra (64.76 mg/100g juice) and Alfazli (60.94 mg/100g juice). Howeverthe lowest ascorbic acid (15.18 mg/100g juice) content was recorded in Mahmoodbaharfollowed by Ratna (19.13 mg/100g juice) and Prabhashankar (20.32 mg/100g juice).

**Organoleptic evaluation of fruits**

Organoleptic scores (Table-9) increased gradually up to 9th day of storage, irrespective of cultivars except Mallika which showed increasing trend up to 12th day of storage. The maximum organoleptic score (96.64) was obtained on 9th day in check variety Langra and considered as excellent grade which was statistically similar to Amrapali (96.24) followed byMahmoodbahar (93.32) and Sabri (90.64) while remaining cultivars are organoleptically rated as good. On 12th day of storage organoleptically excellent rating was obtained only in Mallika (91.33). The cultivars Amrapali (82.42) and Mahmoodbahar (80.46) were organoleptically rated as good and rest of the cultivars showed either fair or poor grade. On termination of experiment (15th day) none of the cultivars organoleptically rated either as excellent or good grade. Organoleptically fair grade was obtained in Mallika (78.46), Amrapali (74.20) Mahmoodbahar (71.45) and Neeludin (70.24) whereas remaining cultivars showed poor grade.

## DISCUSSION

**Physiological loss in weight (PLW)**

During the course of investigation it was observed that physiological loss in weight (PLW) increased significantly with the increasing period of storage, irrespective of cultivars. Similar results were obtained in the work done on banana (Parmar and Chundawat, 1984, Emerald and Sreenarayanan, 1999), Sapota(Siddiqui et al., 2014b,Gautam and Chundawat, 1990, Sarkar et al., 1995) and mango (Singh et al, 1993 and Singh et al., 1998). The lowest PLW was noted in Mallika which showed superiority over remaining cultivars while the maximumPLW was obtained in check variety Langra. The higher rate of PLW in Langra might be due to early ripening consequently enhanced rate of various physiological and degradative metabolic processes during storage.These results get support from the work of Singh et al., (2004) and Gill and Dhillon (2008) in mango. The higher weight loss in mango fruits might be due to greater loss of moisture owing to higher rate of evapo-transpiration and respiration through uninterrupted atmospheric column under higher temperature and low relative humidity. The thinner skinner fruits with less waxy coating may show more PLW while the reverse is true with thick-skinned fruits.

**Spoilage of fruits**

The spoilage of fruits increased successively with the prolongation of storage period, irrespective of cultivars. The cultivar Mallika gave the lowest spoilage loss during storage at all the days and check variety Langra produced the highest spoilage loss. Similar increase in rotting of fruit with the

advancement of storage period was reported in mango (Kumar and Nagpal, 1997, Singhet al.,1998), Kinnow orange (Kumar and Chauhan, 1990), guava (Singh and Chauhan, 1993) and litchi (Brahmachari, 1990, Singh et al., 2004, Dutta et al.,2008). Increase in spoilage loss with prolongation of storage period might be due to existing pathogen on the surface of fruits, which might have proliferated with time resulting in increased rotting. The fruits of check variety Langra exhibited more spoilage probably owing to enhanced rate of respiration and ripening. Fruits become pulpy and senescent rapidly due to various physiological and biochemical events and other degradative process under normal conditions. According to Singh (1980) when the loss due to spoilage exceeds 10-15 per cent further storage of fruits are supposed to be uneconomical.

**Total soluble solids**

The total soluble solids of the mango fruits enhanced gradually and significantly upto 12$^{th}$ day, regardless of cultivars. However in case of Amrapali and Langra it declined after 9$^{th}$ day of storage.During storage TSS of mango fruits increased with the advancement of storage period was also reported by Joshi and Roy (1985), Tirmazi and Wills (1981) and Kumar et al.(1992). According to Stahl and Cambell (1936) the conversion of cell wall materials such as pectin and hemicellulose in reducing substances during storage are responsible for increasing TSS in fruits. The increase in TSS may be accounted to the moisture loss, hydrolysis of polysaccharides and conversion of organic acids into sugars. The decrease in TSS on prolonged storage could be due to greater utilization of reserved sugars in respiration process during prolonged storage. Slow and gradual increase in TSS in cultivar Mallika might be due to delay in ripening. These findings elucidate the reports of Garget al. (1976), Singh (1988) and Khader (1989), Dutta et al. (2008) and Gill and Dhillon (2008) in mango.

**Titratable acidity**

The level of titratable acidity of mango fruits declined slowly throughout the period of storage in all the cultivars. However, the trend of the decline varied among different cultivars. On first day of experiment *i.e.* just after harvesting of the fruits the lowest acidity was observed in Sabri and significantly maximum acidity was estimated cultivars values were reduced. Other cultivars also exhibited reducing tendency in titratable acidity percentage. It has been opined that decline in acid content is at least impart due to utilization of organic acids in energy production and alcoholic fermentation (Purvis, 1933). Delayed ripening, slower rate of physiological events and reduced biochemical degradation might be responsible for high acid in cultivar Mallika. Decline in titratable acidity during storage as a result of conversion of acids into salts and sugars have also been obtained by Gill andDhillon (2008), Kumar et al. (1992) and Joshi and Roy (1985)in mango.

**Reducing sugar**

Reducing sugar increased progressively with prolongation of storage period upto 9$^{th}$ day, regardless of cultivars except Mallika reflected increasing trend up to 12$^{th}$ day and further extension in storage period it decline significantly. Similar observations regarding increase in content of reducing sugars was also observed by Kumar etal. (1992) in mango, Singh and Mandal (2000) in litchi, Chandramontiet al. (1991) andSarkaretal.(1994) in banana. The changes in reducing sugar are very much related to TSS content. Hydrolysis of starch yielding mono and di-saccharides is one of the reasons for increase in the level of these sugars. On termination day (15$^{th}$ day) of experiment the higher levels of reducing sugar was maintained by Amrapali and Mahmoodbahar was probably due to reduced level of catabolic activities and less utilization of these sugars in respiration.

**Total sugars**

Irrespective of cultivars, the level of total sugars increased significantly with the prolongation of storage period up to 9$^{th}$ day of storage except in Mallika. In case of Mallika total sugars increased to maximum up to 12$^{th}$ day of storage. After attaining its peak it declined slightly on the last day of storage in all the cultivars. A similar trend of changes in total sugars was also reported by Sahni and Khurdiya (1989) in different varieties of mango. The possible reason for an increase in total sugars might be due to conversion of starch and polysaccharides into soluble sugars. The reduced rate of respiration, slow conversion of starch and polysaccharides into soluble sugars and their less utilization in respiration and other catabolic process might be the probable cause of high content of total sugars in fruits. The decline of total sugars on the last of storage might be due to break down of sugars during prolonged period of storage. Corroborative results were also reported by

Subramaniamet al. (1976),Garg et al.(1976), Rajput etal. (1999), Joshi and Roy (1985) and Gill andDhillon (2008).

**Ascorbic acid**

The ascorbic acid content in fruits decreased gradually with the advancement of storage period in all the cultivars. During storage period the oxidative enzymes like ascorbic acid oxidase, perroxidase, catalase and polyphenol oxidase might be activated causing decreases in ascorbic acid content of the fruits. This may also be due to oxidation of L-ascorbic acid into dehydro ascorbic acid by enzyme ascorbinase (Mapson, 1970). On the end day of storage experiment ($15^{th}$ day) the check variety Langra gave maximum ascorbic acid whereas lowest was noted in Mahmoodbahar. Joshi and Roy (1985) and Sahni and Khurdiya (1989) also found decreasing trend of ascorbic acid during storage of mango fruits. These findings are in close conformity with the results of Khader, (1989), Sahni and Khurdiya, (1989), Kumaret al. (1992), Rajput and Pandey (1998), Singh et al. (2004) and Gill and Dhillon (2008) in different cultivars of mango.

**Organoleptic qualities**

The majority of the factors rated good up to $9^{th}$ day of storage to all the cultivars howeverAmrapali, Mahmoodbahar and Mallika fruits rated good up to $12^{th}$ day of storage. The faster rate of senescence might beresponsible for the deterioration in the qualities of fruits. The texture becomes soft due to solubilizaiton of pectic substances from the middle lamella whereas loss of the flavour might be due to disintegration of flavouring substances like ketones and aldehydes. The deterioration in shape, colour and general appearance might be due to physiological changes and shrinkage caused by loss of moisture from the tissues of fruits. Kapse et al. (1985),Ranjan (1992) and Gill and Dhillon (2008) also found more or less similar trend of deterioration in mango fruits during storage.

**Table 1: Changes in physiological loss in weight (%) during storage**

| Treatment | Cultivars | Days of storage | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | 3 | 6 | 9 | 12 | 15 | Mean |
| $T_1$ | Alfazli | 0.00 | 2.34 (8.80) | 6.10 (14.30) | 11.24 (19.59) | 18.45 (25.43) | 26.32 (30.86) | 12.89 (19.80) |
| $T_2$ | Amrapali | 0.00 | 2.85 (9.72) | 5.76 (13.89) | 8.62 (17.07) | 15.12 (22.88) | 26.17 (30.76) | 11.70 (18.86) |
| $T_3$ | Jawahar | 0.00 | 3.78 (11.21) | 7.15 (15.51) | 13.21 (21.31) | 21.38 (27.54) | 31.60 (34.20) | 15.42 (21.95) |
| $T_4$ | Mahmoodbahar | 0.00 | 4.55 (12.31) | 8.70 (17.15) | 14.13 (22.08) | 21.14 (27.37) | 28.12 (32.02) | 15.33 (22.19) |
| $T_5$ | Mallika | 0.00 | 2.06 (8.25) | 3.98 (11.51) | 6.65 (14.94) | 10.17 (18.59) | 18.65 (25.58) | 8.30 (15.78) |
| $T_6$ | Neeleshan | 0.00 | 4.10 (11.68) | 6.87 (15.19) | 12.64 (20.82) | 21.16 (27.38) | 30.15 (33.30) | 14.98 (21.68) |
| $T_7$ | Neeludin | 0.00 | 3.35 (10.55) | 5.90 (14.06) | 11.58 (19.89) | 19.17 (25.96) | 28.06 (31.98) | 13.61 (20.49) |
| $T_8$ | Prabhashankar | 0.00 | 3.49 (10.77) | 6.38 (14.63) | 11.23 (19.58) | 17.26 (24.54) | 26.18 (30.77) | 12.91 (20.06) |
| $T_9$ | Ratna | 0.00 | 2.12 (8.37) | 6.00 (14.18) | 10.82 (19.20) | 15.31 (23.03) | 22.35 (28.21) | 11.32 (18.60) |
| $T_{10}$ | Sabri | 0.00 | 4.30 (11.97) | 7.84 (16.26) | 14.16 (22.10) | 22.10 (28.04) | 30.96 (33.80) | 15.87 (22.43) |
| $T_{11}$ | Sunder Langra | 0.00 | 3.64 (11.00) | 6.76 (15.07) | 12.85 (21.00) | 20.42 (26.86) | 29.14 (32.67) | 14.56 (21.32) |
| $T_{12}$ | Langra (check) | 0.00 | 5.61 (13.70) | 8.12 (16.55) | 16.32 (23.82) | 24.81 (29.87) | 34.85 (36.18) | 17.94 (24.03) |
| Mean | | 0.00 | 3.52 (10.69) | 6.63 (14.86) | 11.95 (20.12) | 18.87 (25.63) | 27.71 (31.70) | |

| C.D. at 5% | | CV |
|---|---|---|
| T | 0.38 | 2.54 % |
| D | 0.24 | |
| T x D | 0.85 | |

**Table 2: Spoilage Loss (%) in fruits during storage**

| Treatment | Cultivars | Days of storage | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **0** | **3** | **6** | **9** | **12** | **15** | **Mean** |
| $T_1$ | Alfazli | 0.00 | 0.00 | 2.65 (9.37) | 8.17 (16.61) | 15.21 (22.95) | 28.74 (32.41) | 10.95 (16.27) |
| $T_2$ | Amrapali | 0.00 | 0.00 | 3.16 (10.24) | 10.24 (18.66) | 18.54 (25.50) | 39.26 (38.79) | 14.24 (18.64) |
| $T_3$ | Jawahar | 0.00 | 0.00 | 5.80 (13.93) | 15.60 (23.26) | 26.31 (30.86) | 48.13 (43.93) | 19.17 (22.40) |
| $T_4$ | Mahmoodbahar | 0.00 | 0.00 | 2.76 (9.56) | 12.18 (20.42) | 22.35 (28.21) | 49.58 (44.76) | 17.37 (20.59) |
| $T_5$ | Mallika | 0.00 | 0.00 | 2.08 (8.29) | 5.64 (13.74) | 10.16 (18.58) | 22.36 (28.22) | 8.05 (13.77) |
| $T_6$ | Neeleshan | 0.00 | 0.00 | 5.16 (13.13) | 13.12 (21.23) | 24.10 (29.40) | 45.28 (42.29) | 17.53 (21.21) |
| $T_7$ | Neeludin | 0.00 | 0.00 | 4.21 (11.84) | 9.98 (18.41) | 20.68 (27.05) | 39.84 (39.13) | 14.94 (19.29) |
| $T_8$ | Prabhashankar | 0.00 | 0.00 | 5.46 (13.51) | 11.89 (20.17) | 21.76 (27.80) | 41.82 (40.29) | 16.19 (20.35) |
| $T_9$ | Ratna | 0.00 | 0.00 | 3.74 (11.15) | 8.24 (16.68) | 16.48 (23.95) | 32.54 (34.78) | 12.20 (17.31) |
| $T_{10}$ | Sabri | 0.00 | 0.00 | 6.14 (14.34) | 17.26 (24.54) | 27.35 (31.53) | 51.34 (45.77) | 20.42 (23.24) |
| $T_{11}$ | Sunder Langra | 0.00 | 0.00 | 5.66 (13.76) | 16.18 (23.71) | 28.12 (32.02) | 54.51 (47.59) | 20.89 (23.42) |
| $T_{12}$ | Langra (check) | 0.00 | 0.00 | 7.24 (15.61) | 18.46 (25.44) | 30.42 (33.47) | 58.67 (50.00) | 22.96 (24.90) |
| Mean | | 0.00 | 0.00 | 4.51 (12.06) | 12.25 (20.24) | 21.79 (27.61) | 42.67 (40.68) | |

| **C.D. at 5%** | | **CV** |
|---|---|---|
| **T** | 0.46 | 3.16 % |
| **D** | 0.37 | |
| **T x D** | 1.28 | |

**Table 3: Changes in TSS contents of fruit during storage**

| Treatment | Cultivars | Days of storage | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **0** | **3** | **6** | **9** | **12** | **15** | **Mean** |
| $T_1$ | Alfazli | 12.64 | 17.38 | 20.70 | 21.05 | 21.12 | 20.70 | 18.93 |
| $T_2$ | Amrapali | 16.28 | 19.35 | 21.74 | 24.22 | 22.96 | 21.45 | 21.00 |
| $T_3$ | Jawahar | 16.70 | 20.14 | 20.96 | 21.84 | 22.84 | 22.12 | 20.77 |
| $T_4$ | Mahmoodbahar | 14.13 | 16.22 | 18.32 | 20.10 | 21.84 | 20.84 | 18.58 |
| $T_5$ | Mallika | 11.24 | 14.65 | 16.84 | 19.54 | 23.56 | 23.02 | 18.14 |
| $T_6$ | Neeleshan | 11.84 | 12.70 | 17.95 | 20.68 | 21.18 | 19.96 | 17.39 |
| $T_7$ | Neeludin | 14.10 | 17.56 | 19.36 | 21.77 | 23.42 | 21.80 | 19.67 |
| $T_8$ | Prabhashankar | 10.88 | 12.96 | 16.88 | 20.72 | 22.16 | 20.65 | 17.38 |
| $T_9$ | Ratna | 11.24 | 16.48 | 19.35 | 22.64 | 23.78 | 21.06 | 19.09 |
| $T_{10}$ | Sabri | 13.20 | 15.64 | 18.84 | 21.45 | 22.10 | 20.12 | 18.56 |
| $T_{11}$ | Sunder Langra | 12.58 | 18.64 | 22.56 | 23.18 | 23.70 | 22.36 | 20.50 |
| $T_{12}$ | Langra (check) | 13.75 | 17.14 | 19.34 | 20.84 | 19.46 | 18.18 | 18.12 |
| Mean | | 13.22 | 16.57 | 19.40 | 21.50 | 22.34 | 21.02 | |

| **CD at 5%** | | **CV** |
|---|---|---|
| **T** | 0.46 | 3.68% |
| **D** | 0.33 | |
| **T x D** | 1.13 | |

**Table 4: Changes in acidity (per cent) of fruit during storage**

| Treatment | Cultivars | Days of storage | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | 3 | 6 | 9 | 12 | 15 | Mean |
| $T_1$ | Alfazli | 0.418 | 0.365 | 0.308 | 0.275 | 0.248 | 0.234 | 0.308 |
| $T_2$ | Amrapali | 0.564 | 0.482 | 0.412 | 0.312 | 0.256 | 0.226 | 0.375 |
| $T_3$ | Jawahar | 0.588 | 0.556 | 0.482 | 0.404 | 0.388 | 0.312 | 0.455 |
| $T_4$ | Mahmoodbahar | 0.502 | 0.476 | 0.402 | 0.364 | 0.310 | 0.281 | 0.389 |
| $T_5$ | Mallika | 0.605 | 0.548 | 0.506 | 0.446 | 0.396 | 0.346 | 0.475 |
| $T_6$ | Neeleshan | 0.449 | 0.408 | 0.346 | 0.308 | 0.267 | 0.208 | 0.331 |
| $T_7$ | Neeludin | 0.322 | 0.268 | 0.248 | 0.232 | 0.206 | 0.182 | 0.243 |
| $T_8$ | Prabhashankar | 0.496 | 0.418 | 0.354 | 0.332 | 0.308 | 0.272 | 0.363 |
| $T_9$ | Ratna | 0.536 | 0.485 | 0.402 | 0.358 | 0.332 | 0.246 | 0.393 |
| $T_{10}$ | Sabri | 0.296 | 0.264 | 0.228 | 0.208 | 0.180 | 0.132 | 0.218 |
| $T_{11}$ | Sunder Langra | 0.447 | 0.386 | 0.267 | 0.248 | 0.218 | 0.202 | 0.295 |
| $T_{12}$ | Langra (check) | 0.508 | 0.452 | 0.386 | 0.348 | 0.324 | 0.296 | 0.386 |
| Mean | | 0.478 | 0.426 | 0.362 | 0.320 | 0.286 | 0.245 | |

| **CD at 5%** | | **CV** |
|---|---|---|
| **T** | 0.0106 | 4.16% |
| **D** | 0.0068 | |
| **T x D** | 0.0237 | |

**Table 5: Change in TSS/ acidity ratio during storage**

| | | Days of storage | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Treatment** | **Cultivars** | **0** | **3** | **6** | **9** | **12** | **15** | **Mean** |
| $T_1$ | Alfazli | 30.24 | 47.63 | 67.23 | 76.53 | 85.16 | 88.45 | 65.87 |
| $T_2$ | Amrapali | 28.87 | 40.16 | 52.79 | 77.61 | 89.69 | 94.90 | 64.00 |
| $T_3$ | Jawahar | 28.41 | 36.23 | 43.50 | 54.05 | 58.86 | 70.89 | 48.66 |
| $T_4$ | Mahmoodbahar | 28.15 | 34.08 | 45.64 | 55.21 | 70.52 | 74.15 | 51.29 |
| $T_5$ | Mallika | 18.58 | 26.74 | 33.35 | 43.80 | 59.55 | 66.52 | 41.42 |
| $T_6$ | Neeleshan | 26.37 | 31.14 | 51.98 | 67.13 | 79.40 | 95.95 | 58.66 |
| $T_7$ | Neeludin | 43.80 | 65.54 | 78.18 | 93.92 | 113.81 | 119.76 | 85.84 |
| $T_8$ | Prabhashankar | 21.94 | 31.06 | 47.70 | 62.46 | 71.95 | 75.91 | 51.84 |
| $T_9$ | Ratna | 20.97 | 34.04 | 48.15 | 63.29 | 71.63 | 85.60 | 53.95 |
| $T_{10}$ | Sabri | 44.67 | 59.34 | 82.66 | 103.22 | 122.78 | 152.64 | 94.22 |
| $T_{11}$ | Sunder Langra | 28.19 | 48.38 | 84.62 | 93.45 | 108.71 | 110.82 | 79.03 |
| $T_{12}$ | Langra (check) | 27.11 | 37.99 | 50.20 | 59.87 | 60.06 | 61.41 | 49.44 |
| Mean | | 28.94 | 41.03 | 57.17 | 70.88 | 82.68 | 91.42 | 62.02 |

| **CD at 5%** | | **CV** |
|---|---|---|
| **T** | 1.75 | 4.36 % |
| **D** | 1.24 | |
| **T x D** | 4.30 | |

**Table 6: Changes in reducing sugar (per cent) during storage**

| Treatment | Cultivars | Days of storage | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | 3 | 6 | 9 | 12 | 15 | Mean |
| $T_1$ | Alfazli | 2.64 | 3.78 | 5.48 | 7.08 | 6.62 | 5.88 | 5.25 |
| $T_2$ | Amrapali | 1.90 | 2.67 | 3.85 | 7.68 | 7.39 | 7.02 | 5.09 |
| $T_3$ | Jawahar | 2.12 | 3.54 | 5.68 | 6.94 | 6.68 | 6.25 | 5.20 |
| $T_4$ | Mahmoodbahar | 2.09 | 3.12 | 6.17 | 7.46 | 7.21 | 6.78 | 5.47 |
| $T_5$ | Mallika | 1.72 | 2.76 | 4.08 | 5.70 | 6.75 | 6.36 | 4.56 |
| $T_6$ | Neeleshan | 1.48 | 2.19 | 4.32 | 6.88 | 6.54 | 6.28 | 4.62 |
| $T_7$ | Neeludin | 2.01 | 3.46 | 5.46 | 7.32 | 7.02 | 6.65 | 5.32 |
| $T_8$ | Prabhashankar | 1.98 | 2.88 | 5.75 | 7.76 | 6.98 | 6.56 | 5.32 |
| $T_9$ | Ratna | 1.83 | 3.24 | 5.27 | 7.23 | 6.62 | 6.38 | 5.10 |
| $T_{10}$ | Sabri | 2.27 | 2.82 | 5.90 | 7.38 | 6.52 | 6.12 | 5.17 |
| $T_{11}$ | Sunder Langra | 2.08 | 3.65 | 5.54 | 6.53 | 6.20 | 5.79 | 4.97 |
| $T_{12}$ | Langra (check) | 2.19 | 3.84 | 5.96 | 6.98 | 6.64 | 6.18 | 5.30 |
| Mean | | 2.03 | 3.16 | 5.29 | 7.08 | 6.76 | 6.35 | |

| **C.D. at 5%** | | **CV** |
|---|---|---|
| **T** | 0.14 | 3.87 % |
| **D** | 0.09 | |
| **T x D** | 0.32 | |

**Table 7: Changes in Total sugar (%) during storage**

| Treatment | Cultivars | Days of storage | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | 3 | 6 | 9 | 12 | 15 | Mean |
| $T_1$ | Alfazli | 5.70 | 8.39 | 11.50 | 14.76 | 13.80 | 13.15 | 11.22 |
| $T_2$ | Amrapali | 4.58 | 5.87 | 8.14 | 15.82 | 15.36 | 14.98 | 10.79 |
| $T_3$ | Jawahar | 5.10 | 7.78 | 11.92 | 14.68 | 13.79 | 12.86 | 11.02 |
| $T_4$ | Mahmoodbahar | 4.81 | 6.82 | 13.28 | 16.15 | 15.37 | 14.48 | 11.82 |
| $T_5$ | Mallika | 3.87 | 6.11 | 8.64 | 12.46 | 14.18 | 13.76 | 9.84 |
| $T_6$ | Neeleshan | 3.56 | 5.22 | 9.17 | 14.38 | 13.96 | 12.68 | 9.83 |
| $T_7$ | Neeludin | 4.36 | 7.40 | 11.56 | 16.26 | 15.48 | 14.51 | 11.60 |
| $T_8$ | Prabhashankar | 4.11 | 6.48 | 12.40 | 16.05 | 14.87 | 13.98 | 11.32 |
| $T_9$ | Ratna | 3.92 | 6.91 | 11.37 | 14.96 | 14.26 | 13.72 | 10.86 |
| $T_{10}$ | Sabri | 4.78 | 6.54 | 12.58 | 15.12 | 14.70 | 13.88 | 11.27 |
| $T_{11}$ | Sunder Langra | 4.65 | 7.88 | 11.62 | 13.66 | 13.12 | 12.65 | 10.60 |
| $T_{12}$ | Langra (Check) | 4.46 | 7.32 | 11.64 | 13.52 | 12.38 | 11.74 | 10.18 |
| Mean | | 4.49 | 6.89 | 11.15 | 14.82 | 14.27 | 13.53 | |

| **C.D. at 5%** | | **CV** |
|---|---|---|
| **T** | 0.27 | 3.51 % |
| **D** | 0.18 | |
| **T x D** | 0.62 | |

**Table 8: Changes in ascorbic acid (mg/100g juice) during storage**

| Treatment | Cultivars | Days of storage | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | 3 | 6 | 9 | 12 | 15 | Mean |
| $T_1$ | Alfazli | 78.64 | 71.70 | 62.52 | 54.56 | 50.18 | 48.06 | 60.94 |
| $T_2$ | Amrapali | 61.28 | 55.16 | 48.32 | 40.36 | 35.10 | 30.78 | 45.17 |
| $T_3$ | Jawahar | 49.21 | 43.35 | 38.54 | 32.17 | 27.19 | 24.62 | 35.85 |
| $T_4$ | Mahmoodbahar | 38.76 | 32.14 | 24.86 | 21.72 | 17.85 | 15.18 | 25.09 |
| $T_5$ | Mallika | 41.54 | 35.48 | 28.32 | 22.93 | 20.10 | 18.06 | 27.74 |
| $T_6$ | Neeleshan | 50.81 | 45.62 | 39.78 | 32.16 | 27.24 | 23.85 | 36.58 |
| $T_7$ | Neeludin | 46.49 | 41.36 | 36.50 | 30.48 | 25.18 | 21.73 | 33.62 |
| $T_8$ | Prabhashankar | 40.68 | 35.42 | 31.49 | 26.45 | 22.81 | 20.32 | 29.53 |
| $T_9$ | Ratna | 38.50 | 33.28 | 29.32 | 24.56 | 21.40 | 19.13 | 27.70 |
| $T_{10}$ | Sabri | 39.42 | 35.62 | 30.26 | 26.45 | 24.38 | 22.18 | 29.72 |
| $T_{11}$ | Sunder Langra | 94.60 | 87.15 | 80.62 | 73.40 | 68.19 | 64.76 | 78.12 |
| $T_{12}$ | Langra (check) | 133.63 | 123.42 | 115.68 | 110.14 | 102.12 | 92.86 | 112.98 |
| Mean | | 59.46 | 53.31 | 47.18 | 41.28 | 36.81 | 33.46 | |

| **C.D. at 5%** | | **CV** |
|---|---|---|
| **T** | 1.34 | 4.10 % |
| **D** | 0.86 | |
| **T x D** | 2.99 | |

**Table 9: Changes in organoleptic quality of fruits during storage**

| Treatment | Cultivars | Days of storage | | | | |
|---|---|---|---|---|---|---|
| | | 6 | 9 | 12 | 15 | Mean |
| $T_1$ | Alfazli | 84.26 | 87.34 | 75.10 | 68.35 | 78.76 |
| $T_2$ | Amrapali | 94.35 | 96.24 | 82.42 | 74.20 | 86.80 |
| $T_3$ | Jawahar | 77.18 | 88.40 | 70.38 | 62.19 | 74.54 |
| $T_4$ | Mahmoodbahar | 80.45 | 93.32 | 80.46 | 71.45 | 81.42 |
| $T_5$ | Mallika | 76.30 | 85.28 | 91.33 | 78.46 | 82.84 |
| $T_6$ | Neeleshan | 73.68 | 80.31 | 77.49 | 61.37 | 73.21 |
| $T_7$ | Neeludin | 74.26 | 82.46 | 78.64 | 70.24 | 76.40 |
| $T_8$ | Prabhashankar | 72.32 | 81.48 | 76.26 | 60.17 | 72.56 |
| $T_9$ | Ratna | 74.40 | 82.55 | 72.42 | 64.28 | 73.41 |
| $T_{10}$ | Sabri | 78.00 | 90.64 | 62.10 | 58.25 | 72.25 |
| $T_{11}$ | Sunder Langra | 88.19 | 80.37 | 65.23 | 49.32 | 70.78 |
| $T_{12}$ | Langra (check) | 90.27 | 96.46 | 60.21 | 40.46 | 71.85 |
| Mean | | 80.31 | 87.07 | 74.34 | 63.33 | |

| **C.D. at 5%** | | **CV** |
|---|---|---|
| **T** | 2.85 | 5.16 % |
| **D** | 1.84 | |
| **T x D** | 6.37 | |

## CONCLUSION

On the basis of physico-chemical attributes of fruits it can be concluded that the keeping quality of Mallika, Alfazli, Ratna and Amrapali were better than other hybrids and check variety Langra. Fruits of Mallika can be stored for a longer period of storage at ambient conditions. Results clearly indicated that PLW, Spoilage, TSS, TSS/Acid ratio, reducing and total sugars were increased however, titratable acidity, ascorbic acid content and organoleptic quality reducedduring storage period of mango hybrids. It can be inferred that cultivars Mallika maintained organoleptically excellent grade up to 12$^{th}$ day of storage while Amrapali and Mahmoodbahar rated as good grade. Post-harvest life of all the hybrids under trial was found better than Langra. Mango hybrid Mallika can prefer for long time storage and it would be also helpful in the long transportation.

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