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# Storage Studies of Jam Prepared from Different Mango Varieties

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**Abstract:** Six mango varieties i.e. Chaunsa, Dusehri, Langra, Anwar Ratol, Malda and Fajri were subjected to physicochemical analysis to assess their suitability for jam preparation Storage stability of jam from selected mango varieties (Chaunsa, Dusehri and Anwar Ratol) was also investigated at ambient temperature (25±3°C) and relative humidity 60±6%. Fajri mango had the highest pulp content (77.62%) while Anwar Ratol pulp had the highest total soluble solids (21.9 °Brix), brix/acid ratio (43.80), reducing sugars (5.03%) and total sugars (18.20%). Mango jams were prepared and analyzed for physicochemical, microbial and sensory parameters at 30 days storage interval for 150 days. Anwar Ratol jam had the highest total soluble solids (68.20°Brix), brix/acid ratio (101.79), reducing sugars (19.88%) and total sugars (60.14%) whereas Chaunsa jam had the highest acidity (0.71%) and lowest pH (3.52). No detectable yeast and mold and negligible total viable count were observed in all mango jam samples during 150 days storage period. Sensory evaluation results revealed that Dusehri jam was ranked highest and more acceptable than others. However, all mango jams remained organoleptically acceptable after 150 days storage.

**Key words:** Mango jam, physicochemical analysis, sensory evaluation, storage studies

## INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most cultivated tropical fruits in the World; with over 25.1 million tons world annual production (Akhtar *et al*., 2010). Asia accounts for approximately 77% of global mango production and the Americas and Africa account for approximately 13% and 9%, respectively (FAO, 2007). Pakistan produces 1.7 million tons mangoes on an area of 151.5 thousand hectares and ranks 5th among mango growing countries (Maqbool and Malik, 2008).

Mango is the cherished fruit not only for its taste but also for nutritional values. It is an excellent source of fiber, vitamins A, C and the B complex, iron and phosphorus etc. Some of the key components that contribute for the production and acceptance of high quality fresh mangoes by the consumer are flavour, volatiles, texture and chemical constituents (Tedjo *et al*., 2002; Mamiro *et al*., 2007). Due to improper handling, packaging, storage and poor post harvest management, producers and traders in Pakistan face 20-30% losses of the commodity (Tahir *et al*., 2002) that corresponds to 320.7 thousand tons with a value of Rs. 3 billion contributing to foreign exchange of $ 315 per ton as compared to international price of $ 861 per ton (PHDEB, 2007).

The shelf life of mango varies among its varieties depending on storage conditions. It ranges from 4 to 8 days at room temperature and 2-3 weeks in cold storage at 13°C (Carrillo *et al*., 2000). In spite of the low stability of the fresh fruit and its seasonal supply, the share of its production that is processed is very limited. In order to make the mango fruit available during the off season it is processed to make juices, jams, squashes, nectars, chutney, pickles, toffees, canned mango slices etc. (Hussain *et al*., 2005). Processing of mango fruits into juice, jam or dried products ensures its consumption throughout the year besides recovery of bio-constituents such as vitamin A (Doreyappa and Ramanjaneya, 1995). The physico-chemical characteristics of mango fruits and the technological qualities of their processed products vary with mango varieties as some are more suitable than others for specific applications (Mercadante and Rodriguez, 1998). Mango fruit processing into jam provide added value to the fruit. Jam is usually prepared from cooked fruit or vegetable, sugars, citric acid and pectin (Broomfield, 1996). Ripe mango varieties are best suited for jam processing based on their viscosity (Kansci *et al*., 2003). Realizing the importance of mango fruit, nutrition, perishable nature, seasonal availability and no indigenous research work on suitability of mango varieties for jam production; it was deemed necessary to prepare preserved fruit product i.e. mango jam. The present study was carried out to assess the suitability of different mango varieties for jam preparation and to investigate the storage stability of mango jam at ambient temperature.

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## MATERIALS AND METHODS

**Procurement of the materials:** Ripened mangoes of six different varieties i.e. Chaunsa, Dusehri, Langra, Anwar Ratol, Malda and Fajri were procured from fruit market of Rawalpindi in triplicate at 15 days time intervals and taken to Food Science and Product Development Institute (FSPDI) research labs. National Agricultural Research Center (NARC). Mangoes were thoroughly washed with distilled water to remove dirt, dust, pesticide residue and microflora on the surface of fruits. The fruit from each mango variety was weighed, peeled and cored; the flesh of each variety was cut into small pieces with stainless steel knives and pulp was prepared by using an electric blender. Physicochemical analysis of mango pulp, jam preparation and storage studies of mango jam were conducted for three replications of each mango variety.

**Physicochemical analysis of pulp:** Mango pulp was analyzed for pulp content, Total Soluble Solids (TSS), acidity, pH, brix/acid ratio, reducing sugars and total sugars according to standard methods as described by AOAC (2005). Total Soluble Solids of pulp were estimated by using Abbe's Refractometer (ATAGO 3T) and the readings were corrected at 20°C whereas, pH was measured by digital pH meter (Orion 420 $A^+$).

**Selection of mango varieties for jam preparation:** Mango varieties (Chaunsa, Langra and Anwar Ratol) were selected for jam preparation on the basis of physico-chemical/nutritional characteristics (high total soluble solids, brix/acid ratio, sugars and pH) desired for good jam making.

**Preparation of mango jam:** Mango pulps of three varieties (Chaunsa, Langra and Anwar Ratol) were processed into mango jam according to guidelines described by FAO (1997). During cooking of fruit pulp, sugars, pectin, citric acid and sodium benzoate were added. The prepared jams were hot filled into pre-sterilized (autoclaved at 121°C for 15 min) glass jars, closed and stored at ambient temperature (25±3°C).

**Storage studies of mango jam:** Mango jams stored at ambient temperature (25±3°C) and 60±6% relative humidity for five months were subjected to physicochemical parameters (Total Soluble Solids (TSS), acidity, pH, brix/acid ratio, reducing sugars and total sugars) at one month interval according to standard methods of AOAC (2005).

The microbial load of stored jam samples was determined by the enumeration of total viable count, yeast and mould concentration at different storage intervals as described by compendium of methods for the microbial examination of foods (APHA, 2001). Nutrient agar (Oxoid, UK) was used for periodical determination of total viable count in the stored mango jam samples. Nutrient medium was suspended/litre of distilled water, mixed thoroughly, pH adjusted at 7.2 (25°C), heated with frequent agitation and boiled for 1 min to completely dissolve the ingredients and autoclaved at 121°C for 15 min. One-gram sample was taken from each mango jam sample using aseptic techniques, placed in labeled sterile dilution bottles and made into a volume of 100 ml by distilled water to achieve 10-1 suspension under sterile conditions. The contents were mixed thoroughly and aliquots were serially diluted and enumerated onto Nutrient agar. Plates were subsequently incubated (Binder, Germany) for 48h at 37°C and colonies formed on the surface and medium were counted using colony counter (Funke Gerber, Germany). Similarly, yeast growth was checked on plate count agar amended with chloramphenicol @ 40 ppm, while potato dextrose agar was used to detect moulds. Samples were incubated at 25°C for 7 days.

**Sensory evaluation:** Sensory evaluation of mango jams was carried out in triplicate for colour, taste, flavour and overall acceptability by a panel of seven judges at intervals of 0, 30, 60, 90, 120 and 150 days. The panel members were selected on the basis of their ability to discriminate and scale a broad range of different attributes of mango and mango products. Samples were presented in succession and panelists were asked to rate evaluation variables according to 9-point Hedonic scale as described by Larmond (1977).

**Statistical analysis:** The data obtained for each parameter was subjected to statistical analysis using Statistica 6.0 software. All the experiments were conducted in triplicate and thus data were mean of three replications. The Analysis of Variance (ANOVA) was applied to determine the level of significance. The least significant differences among means at $p<0.05$ were further compared through Duncan Multiple Range test (DMRt) according to the methods described by (Steel *et al*., 1997). Bar graphs were developed using Microsoft Excel sheet.

## RESULTS AND DISCUSSION

**Physicochemical characteristics of mango pulp:** Data regarding physicochemical characteristics of different mango varieties are presented in Table 1. It was observed that Fajri mango had the highest pulp (77.62%) followed by Chaunsa (75.37%) whereas Malda possessed the lowest pulp content (67.93%). Pulp content of all mango varieties were comparable with the mango pulp range reported by Anila and Radha (2003) and Nour *et al.* (2011). As regards Total Soluble Solids (TSS) of different mango pulps, Anwar Ratol had the maximum (21.90 °Brix) while Langra had the minimum TSS (15.00 °Brix). DMR-test revealed that all mango

Table 1: Physicochemical characteristics of different mango pulps

| Mango varieties | Pulp (%) | T.S.S. (°Brix) | Acidity (%) | Brix/acid ratio | pH | Reducing sugars (%) | Total sugars (%) |
|---|---|---|---|---|---|---|---|
| Chaunsa | 75.37±1.68$^{ab}$ | 19.10±0.36$^{c}$ | 0.55±0.042$^{ab}$ | 34.73±2.71$^{b}$ | 3.91±0.03$^{b}$ | 4.26±0.04$^{c}$ | 15.37±0.08$^{c}$ |
| Dusehri | 73.79±1.40$^{b}$ | 20.50±0.25$^{b}$ | 0.52±0.051$^{b}$ | 39.42±3.82$^{ab}$ | 3.99±0.03$^{a}$ | 4.02±0.06$^{d}$ | 16.64±0.10$^{b}$ |
| Langra | 70.45±1.49$^{cd}$ | 15.00±0.28$^{f}$ | 0.65±0.061$^{a}$ | 23.07±1.89$^{c}$ | 3.72±0.02$^{d}$ | 2.98±0.03$^{f}$ | 11.59±0.13$^{f}$ |
| Malda | 67.93±1.14$^{d}$ | 16.80±0.20$^{e}$ | 0.59±0.040$^{ab}$ | 28.47±2.14$^{c}$ | 3.84±0.01$^{c}$ | 3.57±0.07$^{e}$ | 13.16±0.09$^{e}$ |
| Anwar Ratol | 72.58±1.57$^{bc}$ | 21.90±0.46$^{a}$ | 0.50±0.053$^{b}$ | 43.80±4.66$^{a}$ | 3.96±0.02$^{a}$ | 5.03±0.05$^{a}$ | 18.20±0.14$^{a}$ |
| Fajri | 77.62±1.91$^{a}$ | 17.60±0.22$^{d}$ | 0.63±0.072$^{a}$ | 27.93±3.04$^{c}$ | 3.70±0.03$^{d}$ | 4.41±0.02$^{b}$ | 14.48±0.17$^{d}$ |

All values are mean of three replications. Means followed by same letters do not differ significantly ($p<0.05$)

varieties were significantly different from each other. The variation in TSS content among varieties might be due to their inherent characteristics as well as maturity/ripening stage.

In case of acidity, Langra had the highest (0.65%) and Anwar Ratol had the lowest (0.50%) value for acidity. Variation in acidity among different varieties might be due to the activity of citric acid glyoxalase during ripening process which lead to the degradation of citric acid (Doreyappa and Ramanjaneya, 2001; Rathore *et al*., 2007). Highest brix/acid ratio was observed in Anwar Ratol (43.80) followed by Dusehri (39.42) while Langra had the lowest brix/acid ratio (23.07). Sabato *et al*. (2009) reported that the TSS and acidity of mango fruits usually associated with metabolism and significantly affected by the ripening process, therefore dependant on maturity index of the fruit. For pH, highest and lowest pH values were recorded in Dusehri (3.99) and Fajri (3.70) respectively. The variability in pH of the mango varieties corresponded to the changes in the acidity of the respective varieties (Akhtar *et al*., 2009). Decrease in pH of the pulp was proportional to increase in acidity were in confirmation with the earlier investigations of Hussain *et al*. (2008).

As regards sugars, highest reducing and total sugars was observed in Anwar Ratol (5.03% and 18.20%) whereas lowest value was observed in Langra (2.98% and 11.59%) mango samples. All mango varieties were significantly different from each other for reducing as well as total sugars. About half of the soluble sugars of mango pulp are mainly composed of fructose, with about 30% sucrose and 20% glucose (Akhtar *et al*., 2010). The variation in sugar contents between different mango varieties might be attributed to physiological changes and polysaccharides metabolism during ripening process that contribute to accumulation of sugars (Sabato *et al*., 2009).

**Physicochemical characteristics of mango jam:** Data pertaining to physicochemical characteristics of mango jam are depicted in Fig. 1. The composition of mango jams prepared from three mango varieties i.e. Chaunsa, Dusehri and Anwar Ratol were found within prescribed limits of Codex Alimentarius Commission (2009). Highest TSS content (68.20 °Brix) was observed in jam prepared from Anwar Ratol variety. Similar TSS of mango jam was reported by Nour *et al*. (2011) during a study on Sudanese mangoes for jam making. As regards acidity of mango jams, Chaunsa jam had the highest (0.71%) and Dusehri jam had the lowest (0.65%) acidity. Dusehri mango jam had the maximum brix/acid ratio (103.08) and it varied significantly to Chaunsa jam. In case of pH, highest value was recorded in Dusehri jam (3.64) while Chaunsa jam had the lowest pH (3.52) and was significantly different from other mango jams. pH plays a dual role in fruit juices and other fruit products by acting as a flavour promotion and preservative also (Akhtar *et al*., 2010).

Reducing and total sugars of three mango jam indicated that Anwar Ratol jam contained the highest reducing and total sugars (19.88% and 60.14%). Mango jams differed significantly from each other for reducing as well as total sugars. It was observed that reducing and total sugars were higher in jams than in mango pulp, mainly due to addition of sugar as well as thermal process that reduced water content (Nour *et al*., 2011).

**Storage studies of mango jam:** Data regarding changes in total soluble solids of mango jams during storage revealed that there was a gradual increase in T.S.S. throughout the storage period (Fig. 1). Maximum increase (1.79%) was observed in Chaunsa jam, whereas Anwar Ratol mango jam had the minimum increase (1.48%). Increase in T.S.S. during storage might be due to acid hydrolysis of polysaccharides especially gums and pectin (Luh and Woodroof, 1975). Percent acidity of different mango jams exhibited a gradual increase during the storage period (Fig. 1). Highest increase (26.86%) was recorded in Anwar Ratol jam samples followed by Dusehri jam (23.08%). The increase in acidity might be ascribed to rise in the concentration of weakly ionized acids and their salts during storage. Increase in acidity might also be due to formation of acids by degradation of polysaccharides and oxidation of reducing sugars or by breakdown of pectic substances and uronic acid (Iqbal *et al*., 2001; Hussain *et al*., 2008). In case of brix/acid ratio, a declining trend was recorded over the entire storage period of 150 days. The declining trend was more pronounced (20.01%) in Anwar Ratol jam and least (16.94%) in Chaunsa jam. The decreasing trend in brix/acid ratio was due to higher rate of increase in acidity than brix during storage period.

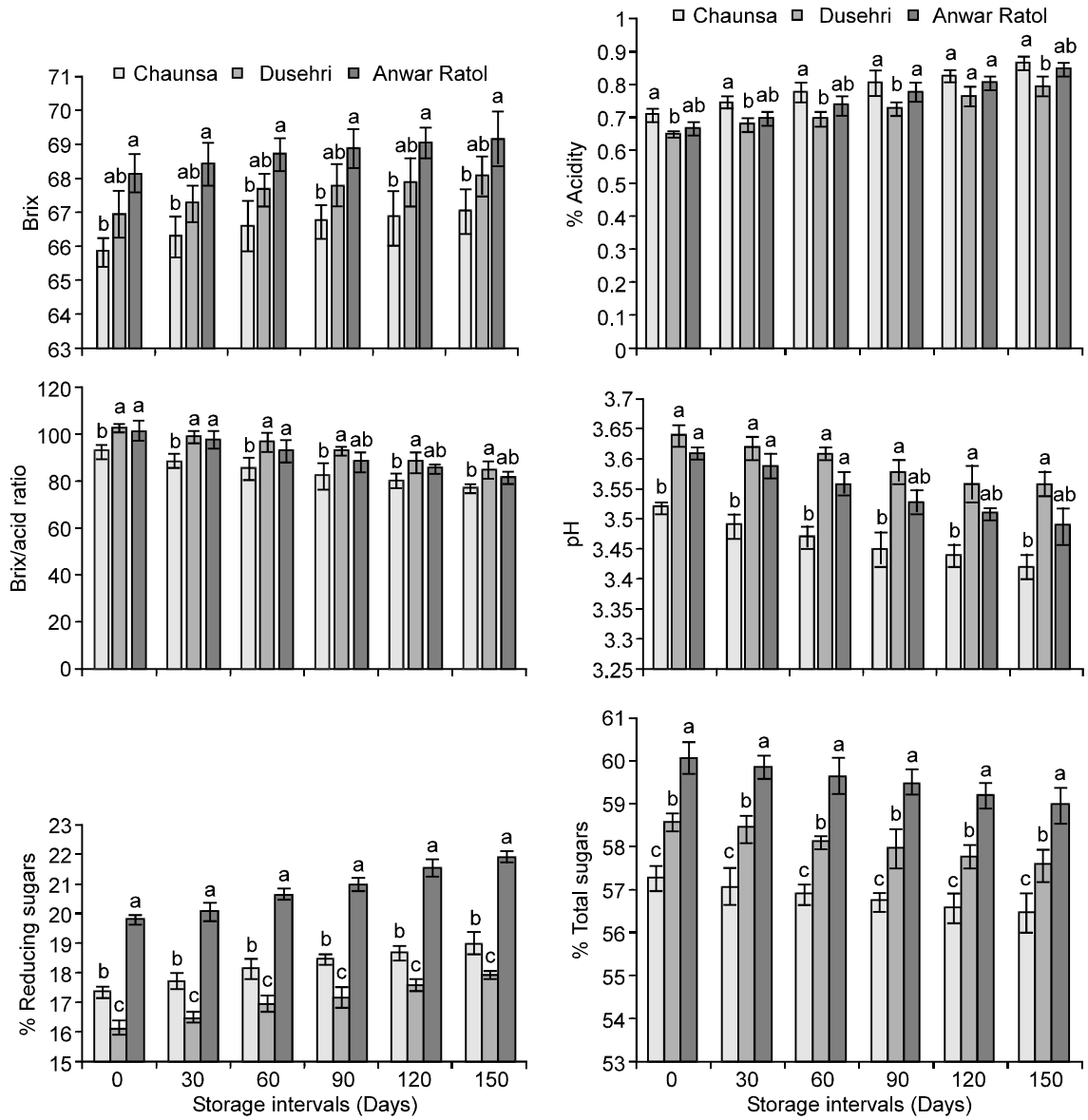


Fig. 1: Physico-chemical changes in mango jams during storage (25±3°C and RH 60±6%) (n = 3). Means followed by same letters do not differ significantly ($p<0.05$)

As regards pH of different mango jams, a decreasing trend was observed during the storage period (Fig. 1). The overall decrease in pH was maximum (3.32 %) and minimum (2.75%) in Anwar Ratol and Dusehri jam samples respectively. Change in pH is directly related to change in acidity of samples. Data regarding changes in sugars of mango jams indicated an increasing trend in reducing sugars and decreasing trend in total sugars throughout the storage period. The increase in reducing sugars might be due to inversion of non-reducing sugars during storage. The inversion of non-reducing sugar may be due to the presence of acids such as citric acid, malic acid which along with high temperature speed up the inversion process (Hicks, 1979). Similar findings were reported by Nour *et al.* (2011) during a study on Sudanese mango jam.

**Microbial evaluation of stored mango jam:** With respect to microbial analysis of jams prepared from three mango varieties, no detectable yeast and mold was observed during 150 days storage period. Data regarding total viable count of mango jams revealed an insignificant increase during the storage period (Fig. 2). However, total viable count of mango jams were well within permissible limits. As per standards, the maximum permissible limits in cooked food of total

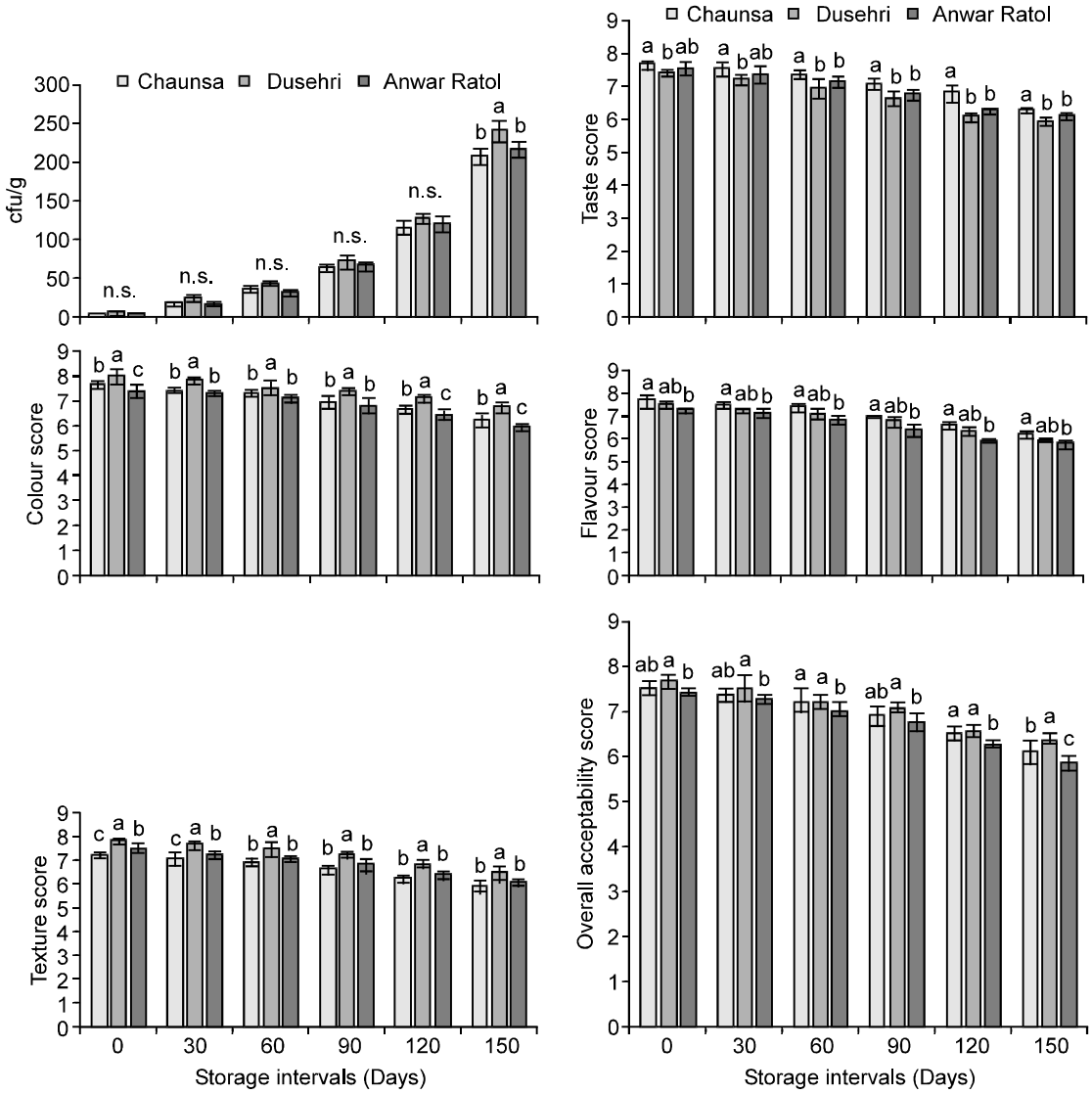


Fig. 2: Changes in microbiological and sensory quality attributes of mango jams during storage (25±3°C and RH 60±6%) (n = 3). n.s. = Non-significant. Means followed by same letters do not differ significantly (p<0.05)

viable count is 10,000 cfu/g (WHO, 1994). Sugar in solution exerted an osmotic pressure, which helped in keeping away osmophillic loads in the jams. The sugar content added in jams prevented microbial spoilage (Nicol, 1980). Results were in agreement with the earlier investigations of Nour *et al*. (2011) who reported no yeast and mold growth and insignificant total viable count in Sudanese mango jams during four months storage.

**Sensory evaluation:** Mango jam samples were sensory evaluated at 30 days interval for colour, taste, flavour, texture and overall acceptability. A decreasing trend in sensory scores of all mango jam samples was observed with the length of time. As regards colour, highest mean score for colour (8.05) was obtained by Dusehri jam whereas Anwar Ratol jam got the lowest score (7.43) at 0 days storage (Fig. 2). A gradual decrease in colour score was observed during storage period with highest loss (19.25 %) in Anwar Ratol jam and least score loss (15.40 %) in Dusehri jam. Decline in mango jam colour score might be due to change in colour attributed to Maillard and enzymatic browning, ascorbic acid degradation and polymerization of anthocyanins with other phenolics (Garcia *et al*., 1999). It is evident from the data on taste score of mango jams that Chaunsa jam samples were perceived to be the best among all jam samples throughout the storage period (Fig. 2). Chaunsa jam and Dusehri jam got the highest (7.71) and lowest (7.48) mean score for taste at

fresh stage respectively. During storage period, a decreasing trend in taste score of mango jams was recorded with maximum (19.79%) in Dusehri jam and minimum score loss (17.90%) in Chaunsa jam. Organic acid and sugars ratio primarily creates a sense of taste which is perceived by specialized taste buds on the tongue. Decrease in taste score during storage might be due to due to fluctuations in acids, pH and sugar/acid ratio (Rathore *et al*., 2007). With respect to flavour score of different mango jams, Chaunsa jam samples got the highest score at 0 days (7.71) as well as after 150 days (6.24) storage period whereas Anwar Ratol jam got the least score at 0 days (7.33) and after 150 days (5.81) storage period. Decrease in flavour scores among all mango jams were observed during storage with least score change (19.07%) in Chaunsa jam. The overall flavour impression is the result of the taste perceived by the taste buds in the mouth and the aromatic compounds detected by the epithelium in the olfactory organ in the mouth. Changes in flavour are the most sensitive index to quality deterioration during storage followed by colour (Eckerle *et al*., 1984).

As regards texture score of mango jam samples, Dusehri jam and Chaunsa jam got the highest (7.86) and lowest (7.28) score at 0 days respectively (Fig. 2). During storage maximum declining trend of texture score was recorded in Anwar Ratol jam (18.89%). Texture is comprised of those properties of a product that can be appraised visually or by touch. In case of overall acceptability of mango jam samples, Dusehri jam seemed to be highly acceptable since the scores assigned to Dusehri jam were highest at fresh (7.71) and throughout the storage period as compared to rest of two varieties, i.e. Chaunsa and Anwar Ratol jam. A decreasing trend in overall acceptability scores of all mango jam samples was observed with the length of storage period. Decrease in scores was highest (21.12%) in Anwar Ratol jam and lowest (16.60%) in Dusehri jam. However, all the mango jams remained acceptable after 150 days storage period. Sensory traits are not generally inter-related and contribute independently towards the overall sensory perception (Akhtar *et al*., 2009).

**Conclusion:** It was concluded that good quality mango jam from different mango varieties could be prepared and stored at ambient temperature for 150 days with minimum damage to the product quality. As regards sensory scores, mango variety Dusehri was ranked highest and most suitable for jam preparation.

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