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# SENSORY EVALUATION OF MANGOES (*MANGIFERA INDICA* L.) GROWN IN DIFFERENT REGIONS OF PAKISTAN

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**Abstract**

Decline in mango production and export in the last few years in Pakistan is a serious concern, therefore, efforts are being made to improve production and boost its exports. The aim of this study was to evaluate the physico chemical and sensorial characteristics of four popular mango (*Mangifera indica* L.) varieties (*Dusahri, Chaunsa, Ratol and Langra*) grown in three major areas of Pakistan; Multan (MUL), Rahim Yar Khan (RYK) and Mir Pur Khas (MPK). *Langra* variety exhibited higher acidity, lower pH and total soluble solids (TSS) among all the tested varieties. No significant ($p<0.05$) difference was observed for the site of production for these attributes. Colour characteristics of *Langra* variety collected from all three regions were found to be superior among the tested varieties. However, this variety was rated inferior for other sensory attributes (flavour, taste and overall acceptability). Furthermore, no correlation could be established for a particular variety to all three regions. Similarly, no parallel could be drawn between a single region and all four varieties for sensory profile except the variety *Ratol* which was shown to be highly acceptable for flavour, taste and overall acceptability in all three sites of its production.

## Introduction

Mangoes have been produced in Pakistan for about two thousand years, and the country is now the fifth largest producer (one million tones per annum) in the world followed by India, China, Mexico and Thailand. Pakistan is also a major exporter of mangoes, with an export of approximately 80,000 tons annually, being the third largest exporter in the world. Production is centered in two regions, the Punjab and the Sindh, producing 67% and 32% of the total production, respectively. All varieties grown in Pakistan are of Indian origin and are characterized by high brix and aroma (Collins *et al.* 2006).

Mango export witnessed more than 20% decline in 2008 than 2007 as Pakistan received the lowest per kg rate for its mangoes in the international market due to poor quality. The decline in export of mangoes can be attributed to lack of proper post-harvest handling which is yet a significant reason of poor quality of this fruit. Moreover, farmers are not able to determine the proper time of fruit maturity (Khan, 2008).

Some of the key components that contribute for the production and acceptance of a high quality fresh mangoes by the consumer are flavour, volatiles, texture and chemical constituents (Mamiro *et al*., 2007). Sensory profile of the mangoes especially colour has a great impact on consumers decision to buy a particular type of fruit or its products (Gössinger *et al*., 2008). Thus, fruit colour serves as a good index of the quality of the product and consumer perception. Acceptance for colour, taste and flavour of fruits is considerably important all over the world that enhances the import potential. The competitiveness for its sale is also primarily based on these factors in the international markets.

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The drop in export potential can be ascribed to a number of reasons like quality, supply chain, lack of infrastructure, low yields, cargo space, inland transport, processing and packing, weak marketing, ruthless competition and standardization. Additionally, consumer perception is also a significant factor that affects the market of fresh fruits like mango. In Pakistan, probably, no planned study has been carried out to establish the best variety grown in a particular area in relation to sensorial status of the mangoes. The objective of this study was to assess the sensory attributes and physico chemical quality of various mango varieties grown in the important areas of Pakistan to recommend a comparatively better variety for indigenous processing and export purposes.

## Materials and Methods

**Procurement of the materials:** Ripened mangoes representing four different popular varieties (*Dusahri*, *Chaunsa*, *Ratol* and *Langra*) were collected at similar maturity level from three major mango growing areas (MUL, RYK and MPK) of Pakistan (Fig. 1). The fruit was brought to the laboratory of the Department of Food Science and Technology, University College of Agriculture, Bahauddin Zakariya University, Multan, Pakistan. All mangoes were thoroughly washed with double distilled water to eliminate any pollutant, pesticide residue, dirt and dust from their surfaces.

**Pulp extraction for physico-chemical assay:** The fruit from each mango variety was weighed and passed through a mango pulper (locally fabricated) to separate pulp from the stone and skin. The pulp obtained was weighed and packed in labelled polyethylene bags. These pulp bags were stored in refrigerator at 4ºC for further analysis of the pulp.

**Physico chemical analysis:** Total soluble solids (TSS) were determined directly from each sample by using refractometer (Atago PEL-1, Japan) at room temperature (21±2 ºC) and expressed as ºBrix. The acidity of pulp was determined as citric acid % (g / 100 g) by titrating 10 g of fresh pulp sample against 0.1 N NaOH solution by following the AOAC method 942.15 (Anon., 1990). pH of the mango pulp samples was determined by taking 10 g of homogenized mango pulp sample of each variety in 50 mL clean beaker (Anon., 1990), using a digital pH meter (Jenway 3510-UK) at 25ºC.

**Sensory evaluation of mangoes:** The sensorial evaluation of various mango varieties was performed in the sensory laboratory of the Department of Food Science and Technology, University College of Agriculture, Bahauddin Zakariya University, Multan, Pakistan, using 9 point hedonic scale as described by Larmond (1977). One hundred panelists were selected on the basis of their ability to discriminate and scale a broad range of different attributes. An orientation program was organized for the panel members to brief them of the objectives of the study. Some panel members were hired from the fruit processing industry and were paid for analysis. Sensory analysis was completed in two consecutive days under the identical environmental conditions. The judges randomly tested the colour, flavour, taste and overall acceptability in three mango samples from each variety. The judges were provided with prescribed questionnaires to record their observation. The information contained on the performa was 9 = Like extremely; 8 = Like very much; 7 = Like moderately; 6 = Like slightly; 5 = Neither like nor dislike; 4 = Dislike slightly; 3 = Dislike moderately; 2 = Dislike very much; 1 = Dislike extremely. The panelists expectorated the pulp and rinsed mouth using distilled water between samples. Sensory testing was made in the panel room completely free of food/chemical odour, unnecessary sound and mixing of daylight.

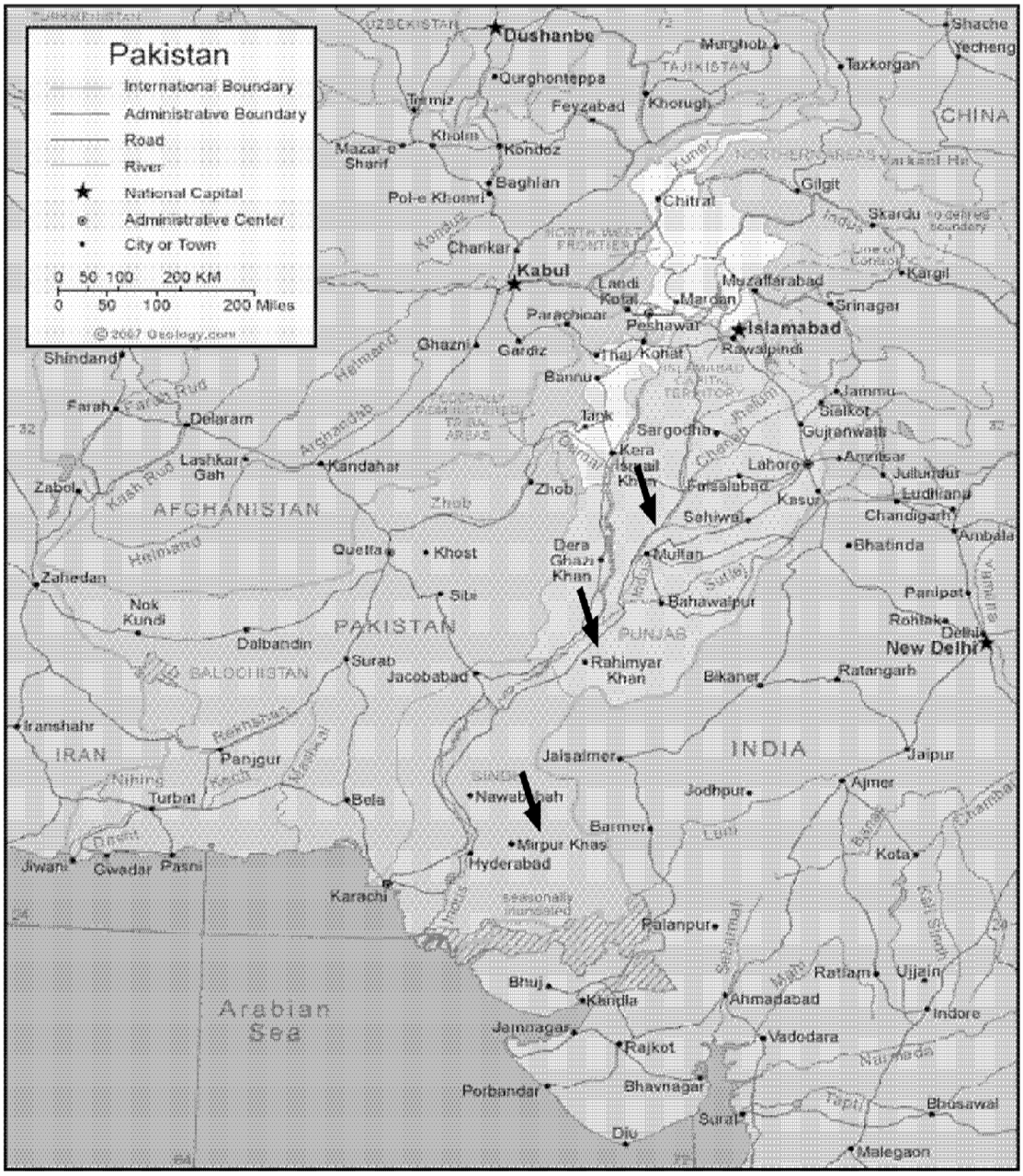


Fig. 1. Map of Pakistan showing (arrows pointing sites under investigation) the relative positions of different mangoes production regions.

**Statistical analysis:** The recorded data were subjected to two-way analysis of variance (ANOVA) to assess the effect of variety and region on physico-chemical and sensory profile of mangoes as described by Steel *et al*., (1996). Duncan's Multiple Range Test was applied to assess significant statistical differences between means at 5% level of probability (Duncan, 1952). Each experiment (in triplicate) was repeated at least twice and the values are presented as means ± SE.

## Results and Discussion

### Physico chemical characteristics of mangoes

**Acidity and pH:** The results pertaining to the acidity of various mango varieties are depicted in Fig. 2A. The *Langra* variety has shown the highest value ($p \leq 0.05$) for acidity

followed by *Dusahri*. Two varieties *Chaunsa* and *Ratol* differed non significantly ($p \leq 0.05$) for this chemical attribute. Similarly, pH of the mango varieties varied significantly showing the minimum pH for *langra*. The variability in pH of the mango varieties corresponded to the changes in the acidity of the respective variety with the exception of *Dusahri* variety for which the pH did not alter with the change in acidity (Fig. 2B).

Transition from one place of production to the other among three tested regions did not indicate any significant difference in acidity and pH of the mangoes however, the pH of the mangoes grown in MUL was slightly higher (data not shown). Variation in acidity among various varieties may be attributed to the extent of degradation of citric acid as a function of the activity of citric acid glyoxylase during ripening (Doreyappy-Gowda & Huddar 2001; Rathore *et al*., 2007). Another study (Kudachikar *et al*., 2001) also confirmed the changes in pH and acidity in mangoes during ripening process. The authors ascribed such changes to the stage of maturity of mangoes.

**Total soluble solids:** Three varieties i.e. *Dusahri, Chaunsa* and *Ratol* showed identical levels ($p \leq 0.05$) of TSS while *Langra* variety indicated a significantly lower TSS content (Fig. 2C). Mangoes grown in MUL, RYK and MPK did not primarily display any significant variation in their TSS content, indicating that the place of production has least or no influence on most of the physico-chemical attributes of the mangoes grown in Pakistan (Data not shown). The variability in TSS of different varieties might be attributed to the alteration occurring in cell wall structure during ripening process. Moreover, various hydrolytic enzymes also affect complex carbohydrates changing them into smaller compounds (Kays, 1991; Kittur *et al*., 2001).

**Sensory evaluation of mangoes**

**Colour:** Visual examination by the consumers is of significant importance that constitutes the fitness of any food for consumption and the same is true for the mangoes for which fruit's colour is one of the important quality parameters. Panelists rated mangoes of *Langra* variety to be the best among the tested varieties for colour followed by *Dusahri* variety. Relatively lower scores were assigned to varieties *Chaunsa* and *Ratol* (Fig. 3). Satyan *et al*., (1986) substantiated that changes in peel colour occur during ripening of the mangoes from green to yellow. No significant difference for colour scores could be observed when the regions were pooled irrespective of the varieties (Fig. 4). Table 1 represents the scores for various sensory attribute of four mango varieties in relation to their regions of production. It is evident from the results that *Langra* variety from all three major mango growing regions was rated superior for colour characteristics as compared to *Dusahri, Chaunsa and Ratol* from MUL, RYK and MPK.

Aina & Oladunjoye (1993) reported that colour changes in mangoes are primarily associated with several biochemical changes, both degradation and synthesis of various classes of molecules including carotenoids in fruit. The mangoes from various varieties collected from different production sites were not exactly at the similar ripening stage thus may vary in colour and other sensory characteristics.

**Flavour:** Flavour is the sensory impression of a food or other substance and is mainly determined by the chemical senses of taste and smell. The overall flavour impression is the result of the tastes perceived by the taste buds in the mouth and the aromatic compounds detected by the epithelium in the olfactory organ in the nose. Mango variety *Ratol* seemed to be highly acceptable for flavour since the scores assigned to this variety were the highest as compared to rest of the three varieties (*Dusahri, Chaunsa, Langra*).

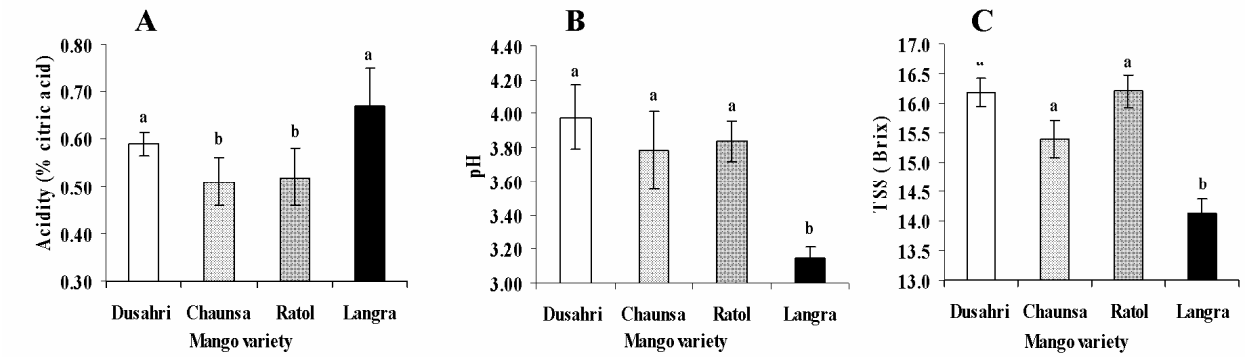


Fig. 2. Physico-chemical differences among various mango varieties (*Dusahri*, *Chaunsa*, *Ratol* and *Langra*). Acidity (A), pH (B) and Total Soluble Solids (TSS) (C) from three locations (Multan, Rahim Yar Khan and Mir Pur Khas). Means sharing the same letters are not different significantly at 5% level of probability by DMRT. Values are presented as means .Bars indicate ± SE.

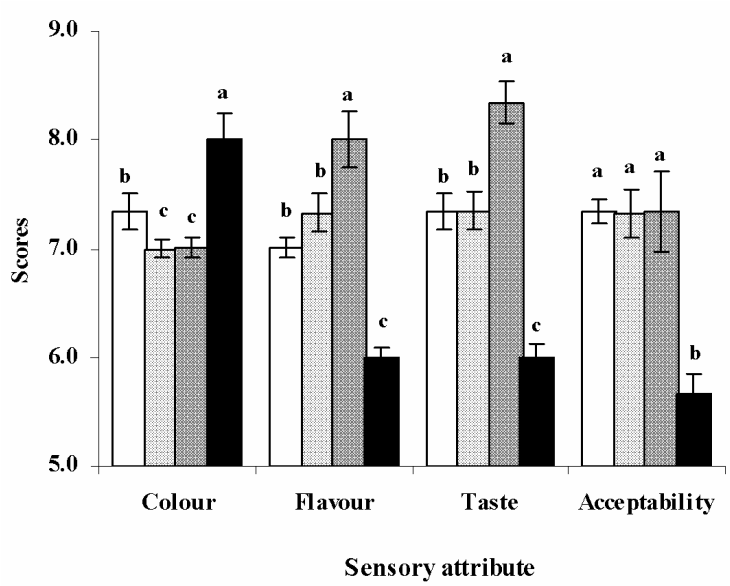


Fig. 3. Sensory evaluation of various mango varieties; *Dusahri* (white), *Chaunsa* **(**light grey**),** *Anwar Ratol* (dark grey**)** and *Langra* (black). from three locations (Multan, Rahim Yar Khan and Mir Pur Khas). Means sharing the same letters are not different significantly at 5% level of probability by DMRT. Values are presented as means. Bars indicate ± SE.

Moreover, *Langra* variety was still liked by the judges for flavour with lower scores in contrary to its higher colour scores, suggesting that sensory traits are not generally interrelated and contribute independently towards the overall sensory perception of the fruits (Fig. 3).

Thus, changes in mango flavour could not be ascribed to any single component (Engel & Tressl 1983) since various components (cis-ocimene and β-myrecene) contribute to typical green aroma of unripe mango (Gholap & Bandyopadhyay, 1975).

Transformational changes in fatty acid profile especially from palmitic acid to palmitoleic acid of mango during ripening of mangoes may be correlated with the changes in aroma and flavour characteristics (Gholap & Bandyopadhyay, 1975). Medicott *et al*., (1990) studied the changes in mango flavour with respect to the storage temperature and demonstrated that the mangoes stored at relatively low temperature exhibited higher flavour scores. Ripe fruit characteristics and flavour intensity are also reported to increase with storage (MacRae *et al*., 1989).

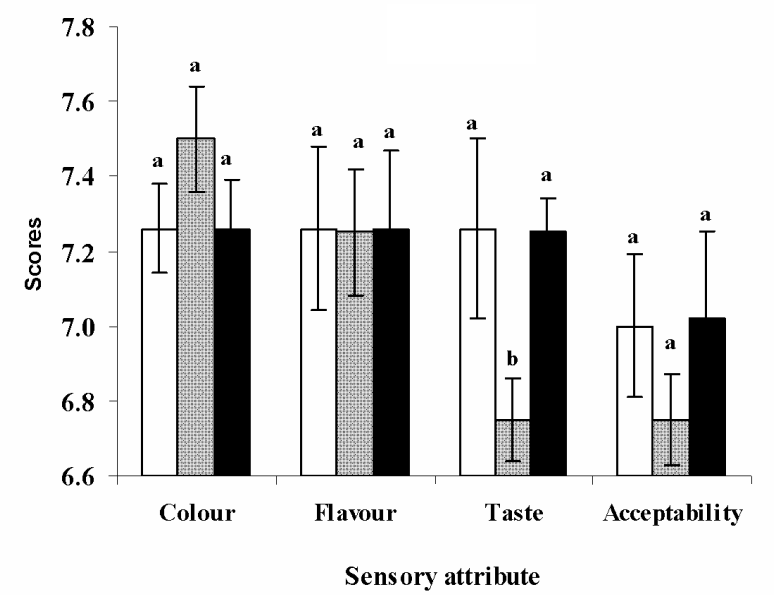


Fig. 4. Sensory evaluation of various mangoe varieties (*Dusahri, Chaunsa, Anwar Ratol* and *Langra*) grown in Multan (MUL) (white), Rahim Yar Khan (grey) (RYK) and Mir Pur Khas (MPK) (black). Means sharing the same letters are not different significantly at 5% level of probability by DMRT. Values are presented as means.Bars indicate ± SE.

In this study, comparison of locations of mango production exhibited that *Ratol* variety from MPK obtained the highest scores for flavour and the minimum flavour scores were recorded for *Langra* variety collected from all three major locations (Table 1). Sites of production, regardless of the varieties indicated no significant effect on the flavour of the mangoes as is revealed in Fig. 4. However, an interactive effect of variety and region showed that two varieties, *Dusahri* and *Chaunsa* almost exhibited a similar pattern for their flavour profile and transition from one location to the other did not alter the flavour score significantly, exception being the *Chaunsa* from MUL which had shown relatively higher flavour score (Table 1). Selveraj *et al*., (1989) confirmed the presence of various volatile compounds in different mango varieties and attributed the organoleptic changes in mangoes at number of ripening stages to the biochemical changes and the concentration of these volatile compounds.

**Taste:** Organic acid and sugars ratio primarily creates a sense of taste which is perceived by specialized taste buds on the tongue. Thus, sweetness due to sugar and sourness from organic acids are dominant components in the taste of many fruits (Kays, 1991).

The score presented in Fig. 3 for taste of various mango varieties' clearly indicated that the variety *Ratol* was perceived to be the best for taste among all the varieties under experimentation. *Dusahri* and *Chaunsa* did not indicate any significant difference for taste while the judges assigned the lowest scores for taste to the variety *Langra* (Fig. 3). Mangoes from RYK were rated to be inferior in quality as far as taste was concerned when evaluated across the variety (Fig. 4). Mangoes representing *Ratol* variety collected from RYK were assigned the highest score for taste while the fruit of *Langra* variety collected from all three locations were least accepted by the panel members, however they were not rejected for their taste attribute. The results further demonstrated that *Dusahri* and *Ratol* from MUL and *Chaunsa* and *Ratol* from MPK predominantly depicted the same degree of liking for their taste (Table 1).

**Table 1. Sensory profile of various mango varieties grown in three major areas of Pakistan.**

| Sites | Variety | Sensory characteristics | | | |
|---|---|---|---|---|---|
| | | Colour | Taste | Flavour | Acceptability |
| Multan | *Dusahri* | 7.02±0.13$^{b}$ | 8.00±0.26$^{b}$ | 7.02±0.19$^{c}$ | 7.00±0.06$^{b}$ |
| | *Chaunsa* | 7.00±0.16$^{b}$ | 7.02±0.17$^{c}$ | 8.00±0.33$^{b}$ | 8.00±0.40$^{a}$ |
| | *Ratol* | 7.00±0.16$^{b}$ | 8.02±0.28$^{b}$ | 8.00±0.26$^{b}$ | 7.00±0.23$^{b}$ |
| | *Langra* | 8.00±0.19$^{a}$ | 6.00±0.29$^{d}$ | 6.00±0.16$^{d}$ | 6.00±0.06$^{c}$ |
| Rahim Yar Khan | *Dusahri* | 8.00±0.17$^{a}$ | 7.00±0.13$^{c}$ | 7.00±0.25$^{c}$ | 7.00±0.06$^{b}$ |
| | *Chaunsa* | 7.00±0.16$^{b}$ | 7.00±0.33$^{c}$ | 7.00±0.18$^{c}$ | 7.00±0.06$^{b}$ |
| | *Ratol* | 7.00±0.25$^{b}$ | 8.56±0.26$^{a}$ | 7.00±0.23$^{c}$ | 8.00±0.40$^{a}$ |
| | *Langra* | 8.00±0.13$^{a}$ | 6.00±0.22$^{d}$ | 6.00±0.13$^{d}$ | 5.00±0.12$^{d}$ |
| Mir Pur Khas | *Dusahri* | 7.00±0.24$^{b}$ | 7.02±0.12$^{c}$ | 7.00±0.09$^{c}$ | 8.03±0.15$^{a}$ |
| | *Chaunsa* | 7.00±0.20$^{b}$ | 8.02±0.20$^{b}$ | 7.00±0.18$^{c}$ | 7.00±0.23$^{b}$ |
| | *Ratol* | 7.02±0.12$^{b}$ | 8.00±0.26$^{b}$ | 8.53±0.34$^{a}$ | 7.03±0.20$^{b}$ |
| | *Langra* | 8.00±0.14$^{a}$ | 6.00±0.13$^{d}$ | 6.00±0.16$^{d}$ | 6.00±0.12$^{c}$ |

Means sharing similar superscript a-d are statistically non-significant at 5% level of probability

Sugar and acids are a primary taste compounds, enhance human perception of specific flavour notes in mango, including aroma, but pH, acidity and TSS are also related well to sourness and astringency (Malundo *et al*., 2001). Abbasi *et al*., (2009) attributed the change in the taste mango to storage time and reported that taste score of mango increased from 3.54 to 8.42 after four weeks of storage.

**Overall acceptability:** In this study, three varieties *viz*., *Dusahri, Chaunsa, Ratol* were equally acceptable to the panelists as is evident from the results shown in Fig. 3. The variety *Langra* was recognized to be relatively inferior but the judges did not reject this variety for overall acceptability.

Interestingly, a great variability in the scores for overall acceptability of these four mango varieties was observed when pooled with respect to the regions of their production. *Chaunsa* from MUL, *Ratol* from RYK and *Dusahri* from MPK rated as best by the judges suggesting that no particular variety could be regarded the best from all three regions or no particular region represented a single variety that could be ranked excellent for acceptability (Table 1). Degree of ripeness at which a fruit is tested, plays a major role in the assessment of its sensory qualities and acceptability (Mtebe *et al*., 2006).

A number of biochemical reactions or metabolic activities are involved in the ripening process of mango fruit such as increased respiration, ethylene production, change in structural polysaccharides causing softening, degradation of chlorophyll and synthesis of carotenoids, changes in carbohydrates or starch conversion into sugars, organic acids, lipids, phenolics and a number of volatile compounds. All these changes lead to ripening of fruit with softening of texture to acceptable quality. These factors predominantly contribute towards developing a total sensory profile of the mango fruit (Herianus *et al*., 2003).

The current study was aimed to facilitate the growers, exporters and government authorities to export mango varieties that would be well perceived by the consumer all around the world. The information derived from the present research would also assist the local fruit industry to select mango varieties for the production of various fruit products that impart highly acceptable sensorial attributes.

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