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PHYSICO-CHEMICAL AND SENSORY PROFILING OF PROMISING MANGO CULTIVARS GROWN IN PERI-URBAN AREAS OF MULTAN, PAKISTAN

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Abstract

In the present scenario, Pakistani mango is facing serious apprehension about production decline and export, consequently present study was planned to categorize the paramount mango (*Mangifera indica* L.) cultivar in relation to its physical, chemical and sensorial attributes. Physiologically fully mature fruits of eight mango cultivars were picked and subjected for physical and proximate analysis. Among the eight cultivars, Fajri produced the maximum green and ripe fruit weight, fruit length and perimeter and physiological weight loss (453.0g, 403.0g, 13.80 cm, 21.57cm and 10.97%), respectively. The higher softness values were noticed in Aman Dusahri. The mark variations were observed among all the cultivars for proximate composition. There is an increase in pH values (5.47, 5.40 and 5.33) among Samar Bahisht Chaunsa, Aman Dusahri and Anwar Ratual, respectively with a progressive decrease in ascorbic acid and titrable acidity during ripening period. Likewise, maximum moisture and ash contents were observed in the mango pulp of Fajri and Sindhri (92.20% and 0.78%, respectively). Whereas appreciably higher total sugar contents were observed in pulp of Langra, Samar Bahisht Chaunsa and Anwar Ratual (20.67%, 20.43% and 20.33%, respectively. 19.83% TSS and 0.64% protein contents were recorded in Langra while the Fajri contained higher fat contents. The sensorial attributes varied significantly according to cultivars. Out of eight cultivars Langra obtained higher scores, while Anwar Ratual found to be highly satisfactory followed by Samar Bahisht Chunsa for flavor and taste. Both of these cultivars were equally acceptable for overall acceptability. However non of the cultivar is rejected by the panelists regarding the sensory evaluation.

Introduction

Fruits have become an integral part of human diet as they supply vitamins and minerals, the important constituents essential for human health (Mumzuroglu *et al*., 2003). Among these fruits mango (*Mangifera indica* L), generally named as "King of the Fruits, has been established as an emerging tropical export crop, produced in about 90 countries in the world. It is most relished fruit in the world and has attained a special place in the array of the delicious fruits and holds a typical nutritional and therapeutic value. Pakistan is the 5th largest mango producer with production of around one million tons per year, contributing a share of 7.6% in the world market. Multan the 6th largest city of Pakistan is the hub of mango production (Alam & Khan, 2001; Tahir *et al*., 2012).

The quality parameters such as size, shape, color, total soluble solids (TSS), acidity, pH, physiological weight, juice, pulp and moisture content are important for the table purpose and value addition of mango fruit (Jha *et al.,* 2008). Moreover, some of the key components that contribute for the production and acceptance of high quality fresh mangoes by the consumer are flavor, volatiles, texture and chemical constituents (Mamiro *et al*., 2007; Gaaliche *et al*., 2012). Sensory profile of the mangoes especially color has a great impact on consumers' decision to buy a particular type of fruit or its fruit products (Gössinger *et al.,* 2008). Thus, fruit color serves as a good index of the quality of the product and consumer perception. Acceptance for color, taste and flavor 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.

The ripening process of mango fruit involves numerous biochemical changes including increased respiration, ethylene production, fruit softening, and development of pigments, metabolic activities leading to changes in carbohydrates, organic acids, lipids, phenolics, volatile compounds, structural polysaccharides and softening of texture to acceptable quality (Lizada, 1993; Gomez-Lim, 1997). This ripening process takes place within 9-12 days postharvest at ambient temperature, depending on cultivar and stage of fruit maturity at harvest.

Despite a growing demand for traditional varieties of mango in Western markets and their maximum potential as an export oriented commodity due to their localized production and potential markets located across the globe (Jha *et al*., 2008) there has been a decline in mango production and export in the last few years in Pakistan. The drop in export potential can be ascribed to a number 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.

Since, the global competition among exporters of various fruit crops is expected to intensify over the next ten years among developing countries, therefore, international trade in recent years has promoted mangoes to higher ranks of popularity (Gourgue *et al*., 1992).

Physico-chemical, nutritional, and sensory profile of mango cultivars constitute a very strong basis as substantial quality parameters for promoting mango export in a highly competitive international market. These quality traits have been extensively studied in almost all major mango producing countries around the globe, however probably, no planned study has been carried out to identify best mango cultivar in Pakistan.

The findings of the current research may help establish the best variety grown in a particular area of Pakistan in relation to its physical quality, biochemical attributes, nutritional value and sensorial status. The aim of present study is to appraise selected promising mango cultivars (*Aman Dusahri*, *Chaunsa*, *Black Chaunsa (Late*), *Anwar Ratual, Anwar Ratual No.12*, *Langra, Fajri* and *Sindhri*) of Multan, a central mango growing region of Pakistan for their physico-chemical, nutritional and sensory characteristics at ripening stages.

Material and Methods

Sampling: Mangoes of eight popular selected cultivars (*Aman Dusahri*, *Chaunsa*, *Black Chaunsa (Late*), *Anwar Ratual, Anwar Ratual No.12*, *Langra, Fajri* and *Sindhri*) were obtained from major mango growing areas of Multan covering a periphery 200 KM. The orchards were selected based on their location and distance from each other. Trees for each cultivar with fruit bearing almost similar size, color and degree of maturity were randomly selected. Ten uniform fruits (based on their size and maturity) from each cultivars free from visual symptoms of any disease or blemishes were packed into soft board trays, brought to the laboratory of the Department of Food Science and Technology, Faculty of Agricultural Sciences and Technology, Bahauddin Zakariya University, Multan and kept at ambient temperature (21±1 C) until over-ripe. A single tray containing ten fruits from a single harvest was the treatment unit and this will be replicated three times (Herianus *et al.,* 2003)

Pulp extraction: The fruit from each mango cultivar was washed with tap water, air dried, 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 labeled polyethylene bags. These bags were stored in refrigerator at 4ºC for further analysis (Akhtar *et al.,* 2009; Akhtar *et al*., 2010).

Chemicals: Reagents used will be of analytical grade unless otherwise stated and the solutions will be prepared with distilled water. Glassware will be soaked overnight in a 10% nitric acid solution and then rinsed with distilled water before use. Standard solution for each element will be used for calibration, diluting a stock solution of 1,000 mg/l, supplied by Merck (Darmstadt, Germany).

Physical parameters

Green and ripe fruit weight (g): Weight of mature green and ripe fruits were measured on a Digital scale (grams) and recorded.

Physiological weight loss: Physiological weight loss (PWL) was calculated according to the formula:

$$\% \text{ Physiological loss in weight} = \frac{W1 - W2}{W1} \times 100$$

where
W1= Initial weight of unripe fruit (g)
W2= Final weight of ripe fruit

Fruit length and perimeter (cm): Fruit length and perimeter were measured (cm) with a vernier caliper and recorded.

Softness: Five fruits from each replication were randomly selected for recording subjective (non-destructive) hand softness. Hand softness of fruit during ripening was scored daily according to the rating scale: 1, hard; 2, sprung; 3, slightly soft; 4, eating soft; and 5, over soft (Malik & Singh, 2005).

Bio-chemical parameters

Moisture contents: For determination of moisture contents the samples were oven dried (Memmert, Germany) at 105±2°C for 24 h using method 925.098 as described by AOAC (Anon., 1990).

Ash: The ash contents were determined by incineration at 550°C by following the procedure of AOAC, method 923.03 (Anon., 1990).

Fat: The Fat of the sample was determined by defatting in a Soxhlet apparatus (J.P.Selecta–Spain) with 2:1 (v/v) chloroform by using the method ascribed in AOAC (Anon., 1990).

Protein: The protein contents of the fruit sample were determined by micro Kjeldahl (Glass Model Pyrex-1) for protein (N x 6.25) by using method 960.52 described in AOAC (Anon., 1990).

Total soluble solids: A digital hand held refractometer (Atago PAL-1 Japan) was used for the determination of total soluble solids (TSS). A drop of juice was placed on the prism of refractometer, and TSS was expressed as °Brix directly from the scale at room temperature (30±2°C).

Total sugars: Total sugars content was determined colorimetrically in fruit dry weight according to the method of Smith *et al*., (1956).

pH: pH was measured by taking a sufficient quantity of sample in 50 mL clean beaker using pH meter (Jenway 3510-UK) as ascribed in AOAC (Anon., 1990).

Titrable acidity: Fruit juice (10 mL) from each sample was taken in a beaker, diluted (1:4) with distilled water and TA was determined as citric acid by titration against 0.1 NaOH solution after adding 2-3 drops of phenolphthalein ($C_{20}H_{14}O_4$) as indicator (Akhtar *et al*., 2010).

Vitamin C: Ascorbic acid (Vitamin C) of the fruit sample was determined by the method of titration using 2,6 dichlorophenol indophenol following the procedure of AOAC, method 967.21(Anon., 1990).

Sensory attributes: The sensorial evaluation of various mango cultivars was performed in the sensory laboratory of the Department of Food Science and Technology, Faculty of Agricultural Sciences and Technology,

Bahauddin Zakariya University, Multan, Pakistan, using 9 point hedonic scale as described by Larmond (1987). Forty five panelists were selected on the basis of their ability to discriminate and scale a broad range of different attributes. The judges tested the color, flavor, taste and overall acceptability in three mangoes samples from each cultivars based on 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 odor, unnecessary sound and mixing of daylight. In addition, each person evaluated the overall appearance judging the whole fruit from consumer point of view.

Statistical analysis: Data were subjected to analysis of variance under Randomized Complete Block Design using statistical soft ware MSTAT-C (Michigan State University, USA). LSD values at p>0.05 were obtained for comparison of mean values (Steel *et al*., 1997).

Results

Green and ripened fruit weight (g): Significant differences were observed among all the cultivars studied (Table 1). Mango cv. Fajri followed by Sindhri had the highest mature green (453.0 g and 323.8 g) and ripened fruit weight (403.0 g and 315.33 g) , while the lowest green and ripened fruit weight was recorded in mango cv. Anwar Ratual, i.e., 164.6g and 156.3g, respectively.

Fruit length: Data regarding fruit length of mango cultivars showed significant differences (Table 1). Cv. Fajri produced the highest fruit length (13.80 cm) followed by cv. Sindhri (13.47 cm). It was noted that Anwar Ratual had the smallest fruit length (8.63cm).

Fruit perimeter: Data on fruit perimeter were also found statistically significant (Table 1). Maximum fruit perimeter was observed in cv. Fajri (21.57 cm) followed by cv. Samar Bahisht Chaunsa (20.60 cm). Minimum fruit perimeter was recorded in cv. Sindhri (8.10 cm).

Physiological weight loss: Cv. Fajri exhibited higher PWL (10.97%) followed by cvs. Anwar Ratual Late (No. 12) (7.00%) and Samar Bahisht Chaunsa (6.60%) while lowest PWL were recorded in cvs. Sindhri and Aman Dusahri i.e., 2.60 and 2.53%, respectively.

Subjective fruit softness: The results in Table 2 show subjective fruit softness among mango cultivars during ripening. Fruit softness varied notably according to mango cultivars. The higher fruit softness values were detected in cv. Aman Dusahri followed by Sindhri, Anwar Ratual, Chaunsa, Black Chaunsa (Late), Anwar Ratual No.12 and Fajri. While, cv. Langra had the lowest softness values.

Table 1. Physical profiling of eight mango cultivars.

Cultivars	GFW (g)	RFW (g)	FL (cm)	FP (cm)	PWL (%)
Aman Dusahri	267.47d	260.67d	12.70c	20.20c	2.53f
Samar Bahisht Chaunsa	287.03c	268.07 c	11.27d	20.60b	6.60c
Black Chaunsa (Late)	188.13g	179.67f	10.27e	16.40f	4.47e
Anwar Ratual	164.60h	156.33g	8.63g	19.70d	5.00d
Anwar Ratual No. 12	196.80f	182.93 f	9.30f	19.50e	7.00b
Langra	222.50e	211.13e	9.47f	19.87d	5.10d
Fajri	453.00a	403.33a	13.80a	21.57a	10.97a
Sindhri	323.80b	315.33b	13.47b	8.10g	2.60f
LSD p>0.05	**3.9032**	**3.3349**	**0.1967**	**0.1999**	**0.3180**

GFW= Green fruit weight, RFW= Ripened fruit weight, FL= Fruit length, FP= Fruit perimeter, PWL= Physiological fruit weight
Means sharing similar letters in the columns are not significant by LSD at 5% level of probability

Table 2. Fruit softness of eight mango cultivars.

Days	Dushari	Chaunsa	Black Chaunsa (Late)	Anwar Ratual	AR-12	Langra	Fajri	Sindhri
1	1.01 g	0.94 g	0.93 g	1 g	0.85 g	0.72 g	0.63 g	1.02 g
2	1.07 f	1.01 f	0.97 f	1.03 f	0.89 f	0.84 f	0.84 f	1.07 f
3	1.21 e	1.08 e	1.02 e	1.12 e	0.94 e	0.9 e	0.99 e	1.18 e
4	1.67 d	1.35 d	1.22 d	1.46 d	1.13 d	1.07 d	1.05 d	1.59 d
5	2.43 c	1.77 c	1.61 c	1.98 c	1.55 c	1.5 c	1.47 c	2.13 c
6	3.29 b	2.06 b	1.87 b	2.17 b	1.87 b	1.74 b	1.67 b	2.99 b
7	3.86 a	2.81 a	2.48 a	3.02 a	2.31 a	2.26 a	2.13 a	3.46 a

Means sharing similar letters in the columns are not significant by LSD at 5% level of probability

Moisture contents: Data illustrated (Table 3) show significant differences for moisture contents in fruit pulp among mango cultivars. Cv. Fajri contained the highest (93.20%) moisture contents while the lowest moisture contents (80.70%) were recorded in Langra.

Ash contents: Data regarding ash content (Table 3) shows significant variations ($p \leq 0.05$). Maximum ash contents were noticed in Mango cv. Sindhri (0.78%), while the minimum ash contents were found in cv. Aman Dusahri (0.13%).

pH: The pH varied significantly and was the highest (5.47) in the fruit pulp of cv. Samar Bahisht Chaunsa (Table 3). The lowest pH (4.02) was observed from the pulp of Sindhri.

Titrable acidity: Titrable acidity illustrated in Table 3 found statistically significant among cultivars. The highest titratable acidity (0.49%) was observed in Sindhri followed by Anwar Ratual Late (No. 12) (0.41%). The fruits of Samar Bahisht Chaunsa and Fajri were non-significantly different from each other and had the lowest content of titratable acidity 0.12% and 0.14%.

Ascorbic acid (VC):. All the mango cultivars show marked variations in respect of vitamin C or ascorbic acid (Table 3). The highest vitamin C contents were obtained from pulp of mango cv. Langra (165.0 mg/100g) followed by Fajri (159.0 mg/100g). The lowest vitamin C was found in mango cv. Anwar Ratual (126 mg/100g) followed by Anwar Ratual No.1 (129 mg/100g).

Total sugar: Table 3 show non significant variation among Mango cvs. Langra, Samar Bahisht Chaunsa and Anwar Ratual. Cv. Langra contained maximum sugar contents (20.67%) followed by Samar Bahisht Chaunsa (20.34%) and Anwar Ratual (20.33%). While minimum sugar contents were found in cv. Sindhri (16.00%).

Total soluble solids content: Data in Table (3) show total soluble solids in fruit pulp of the eight mango cultivars. Total soluble solids were varied significantly according to mango cvs. The maximum TSS contents were detected in the pulp of mango cv. Langra (19.83%) followed by cv. Black Chaunsa (Late) (16.13%) while Fajri cv. had the lowest content of total soluble solids (11.60%).

Proteins: The protein contents for eight mango cultivars were found statistically significant (Table 3). Mango cv. Langra contained highest protein contents (0.64%) followed by cv. Samar Bahisht Chaunsa (0.58%) while lowest protein contents were observed in Mango cv. Fajri (0.44%).

Fats: Results in Table 3 shows that the fats contents varied from cultivar to cultivar. Cv. Fajri had highest fat content (0.55%) compared to other selected mango cultivars while, lowest fat content were obtained in mango cv. Langra (0.40%).

Sensory evaluation of mangoes: The significant variations found for color, flavor, taste, after taste, mouth feel and overall acceptability among mango cultivars (Table 4). Samar Bahisht Chaunsa and Langra were superior in color followed by Sindhri as compared to other cultivars and Fajri scored lowest. Anwar Ratual attained highest score for flavor followed by Samar Bahisht Chaunsa, while the minimum score was recorded for Fajri. Similarly the score presented in Table 4 for taste of various mango cultivars indicated Anwar Ratual found to be the excellent followed by Samar Bahisht Chaunsa whereas the lowest scores assigned to Fajri. The results for sensory parameters like after taste and mouth feel indicated that Anwar Ratual and Samar Bahisht Chaunsa are statistically alike and achieved highest scores followed by Aman Dusahri, while the lowest score was consigned to Mango cv. Sindhri. Samar Bahisht Chaunsa, and Anwar Ratual obtained highest score for overall acceptability.

Table 3. Chemical profiling of eight mango cultivars.

Cultivars	MC (%)	Ash (%)	pH	TA (%)	VC (mg/100g)	TSS (%)	TS (%)	Fats (%)	Proteins (%)
Aman Dusahri	83.83cd	0.13f	5.40ab	0.26e	136.3e	15.63c	18.333b	0.41de	0.51d
Samar Bahisht Chaunsa	81.40de	0.22ef	5.47a	0.12g	133.7f	14.13e	20.43 a	0.43cd	0.58b
Black Chaunsa (Late)	84.23c	0.48c	5.39ab	0.29d	139.7d	16.13b	19.00b	0.43cd	0.55c
Anwar Ratual	86.00c	0.30de	5.33b	0.23f	126.0h	14.97d	20.333a	0.45c	0.49e
Anwar Ratual No. 12	89.33b	0.63b	4.17d	0.41b	129.0g	15.13d	16.333c	0.44c	0.46f
Langra	80.70e	0.53bc	4.67c	0.37c	165.0a	19.83a	20.67a	0.40e	0.64a
Fajri	92.20a	0.41cd	5.43ab	0.14g	159.0b	11.60f	16.667c	0.52b	0.44g
Sindhri	83.70cd	0.78a	4.02e	0.49a	143.0c	15.70c	16.000c	0.55a	0.47f
LSD p>0.05	**2.6043**	**0.1260**	**0.1117**	**0.0203**	**1.7309**	**0.4013**	**1.0600**	**0.0218**	**0.0146**

MC= Moisture contents, TA= Titrable acidity, VC= Vitamin C, TSS= Total soluble Solids, TS= Total Sugar

Means sharing similar letters in the columns are not significant by LSD at 5% level of probability

Table 4. Sensory profiling of eight mango cultivars.

Cultivars	color	Flavor	Taste	After taste	Mouth feel	Over all acceptability
Aman Dusahri	6.96±0.1328^{c}	6.98±0.1480^{c}	7.72±0.1210^{c}	7.59±0.1330^{b}	7.02±0.4808^{bc}	7.10±0.1227^{b}
Samar Bahisht Chaunsa	8.13±0.1328^{a}	7.589±0.1480^{b}	8.26±0.1210^{b}	8.19±0.1330^{a}	8.21±0.4808^{ab}	8.85±0.1227^{a}
Black Chaunsa (Late)	7.04±0.1328^{bc}	6.289±0.1480^{d}	6.39±0.1210^{d}	6.37±0.1330^{c}	6.35±0.4808^{cd}	6.35±0.1227^{c}
Anwar Ratual	6.71±0.1343^{c}	8.09±0.1496^{a}	8.78±0.1224^{a}	8.06±0.1345^{a}	8.71±0.4861^{a}	8.60±0.1241^{a}
Anwar Ratual No. 12	5.83±0.1328^{d}	6.48±0.1480^{d}	5.28±0.1210^{ef}	4.60±0.1330^{e}	4.59±0.4808^{e}	4.65±0.1227^{f}
Langra	8.02±0.1328^{a}	5.50±0.1480^{e}	5.00±0.1210^{f}	5.39±0.1330^{d}	5.50±0.4808d^{e}	5.50±0.1227^{d}
Fajri	4.57±0.1328^{e}	3.87±0.1480^{g}	4.41±0.1210^{g}	4.45±0.1330^{e}	5.80±0.4808^{cde}	4.48±30.1227^{f}
Sindhri	7.36±0.1314^{b}	4.43±0.1464^{f}	5.59±0.1197^{e}	4.45±0.1316^{e}	4.96±0.4757^{e}	5.04±0.1214^{e}

Means sharing similar letters in the columns are not significant by LSD at 5% level of probability

Discussion

The higher green and ripened fruit weight were recorded for Fajri (453.0 g and 403.0 g) which were close those reported by Jilani *et al*., (2010) who found maximum fruit weight in Fajri and minimum in Anwar Ratual. Similar results were also documented by earlier scientists (Shafqat *et al*., 1992; Syamal & Mishra, 1989). The variability in fruit weight among different cultivars might be due to genotypic and environmental influences and management practices (Mannan *et al*., 2003).

The variations among fruits for fruit length and fruit perimeter might be to their different genetic makeup. The results on fruit length and perimeter are partially in agreement with the findings obtained by Bibi *et al.,* (2006) who reported that Alphanso produced the longest fruit followed by Fajri and Sindhri.

The maximum physiological weight loss was recorded in Fajri (10.97%). These results are fully in agreement with the findings of Yashoda *et al.,* (2006) who observed 10% PWL which may be ascribed to cultivar difference or ripening conditions. Mannan *et al*., (2003) mentioned that developing fruits increased in weight initially and reduced to some extent after ripening. The similar trends in mango ripening are also reported by others (Hulme, 1971; Medlicott & Thompson, 1985; Aina, 1990; Singha *et al.,* 1991) for the majority of climacteric fruits. Factors like respiration, transpiration and biological aspects are responsible for the PWL in mango during ripening (Naryana *et al.,* 1996).

The shelflife of fruit is reliant on textural softness which is due to cell wall alteration ensuing in structural changes in starch and non-starch polysaccharide (Yashoda *et al.,* 2006). Therefore, mango cv. Langra had lowest softness values stated better shelf life as compared to other tested cultivars in the present study. Postharvest shelflife and quality of mango fruit is decreased with enhanced textural softness and respiration rate during ripening period (Razzaq *et al.,* 2013).

The moisture contents (%) in mango fruits were enhanced gradually as ripening progressed. Similar results were documented by Mahmood *et al*., (2012) for cherry fruits. Sobeih & El-Helaly (2002); Tawfik (2003) reported great variation in moisture percentage (%) that differed according to mango cultivars. The current results on moisture contents are partially agreed with the findings of Uddin *et al*., (2006) who reported 74.58% to 86.36% among 16 mango cultivars. Abourayya *et al*., (2011) recorded highest moisture content percentage (79.78% during 2007 and 80.11% during 2008), while, the lowest moisture content percentage (77.55% in 2007 and 75.00% in 2008). Similarly Mollah & Siddique (1973) recorded 78.11% to 87.12% moisture content in 12 mango varieties and Samad (1975) found 78.96% to 87.55% moisture content in 10 mango varieties.

The present results for ash contents are partially agreed with the results obtained by Nour *et al*., (2011) who recorded ash contents range of 0.67-1.1% for 3 mango cultivars. These results are partially supported the findings of Uddin *et al*., 2006; Absar *et al*., 1993 who reported pH range of 4-5 in different mango varieties.

The level of titrable acidity in fruits is decreased continuously with the development of skin color and increase in sugar contents till ripening. The decrease in titrable acidity during ripening was also documented by Elahi & Khan, 1973; Mamiro *et al*., 2007. The present study is in close proximity with the results of Prasad, 1977; Chaudhari *et al.,* 1997). They recorded 0.14 to 0.59% titratable acidity in some other mango cultivars. Likewise, TA in ripe pulp of Florida grown mangoes ranged between 0.4% and 0.24% (Beyer *et al.,* 1979). TA was found in the range of 2.96 to 0.03%, while working with four mango varieties from Pakistan viz. Malda, Anwar Ratual, Katha and Dusahri.

Mangoes are valuable source of vitamin C. Thomas & Oke, (1980); Mamiro *et al*., (2007); Othman & Mbogo, (2009) observed the decreased vitamin C contents in fruits during ripening may be ascribed to the vulnerability of vitamin C to oxidative destruction. The present findings are strongly agreed with the results reported by Jilani *et al*., (2010); Shafqat *et al.,* (1992) where Gulab-e-Khas and Sanglakhi topped for Vitamin C. Similar vitamin C contents were also previously stated for various mango varieties (Padmini & Prabha, 1997).

Yellowness of the fruit is accompanied by a progressive sweetness of the fruit pulp due to conversion of starch into sugars resulting from starch hydrolysis (Aina, 1990). Similarly, Zaied *et al*., (2007) found high percent total sugars in mangoes of Egypt. Syamal & Mishra, (1989) and Jilani *at al.,* (2010) observed that mango cultivars had different sugar contents and Langra excelled this parameter.

Our results are partially related with the findings of Rajwana *et al*., (2010) and are full in agreement with the findings of Sardar *et al*., (1998) who reported highest sugar contents in Langra cv. TSS in fruit juices contains different soluble solids such as acids, minerals, sugar, vitamins and proteins etc. (Khan *et al*., 2013). The present findings partially agreed with the results of Bhuyan & Guha, (1995) who found 16.22 to 24.14% TSS in 14 mango germplasms under the climatic conditions of Rajshahi. Rajwana *et al*., (2011) partially supported the results of present study who observed maximum TSS in Black Chaunsa (Late).

The protein content of Langra and Samar Bahisht Chaunsa is 0.64% and 0.58%, respectively. Similar results were obtained by the studies conducted by Mukherjee (1953) also reported that mango fruits contained 0.5% protein. Sarkiyayi *et al*., (2013) reported the protein contents range 1.97- 2.16% among three mango cultivars. The low levels of fat in mango fruits show that these fruits are not good sources of energy (Samson, 1986). In our study, cv. Langra is comparatively less source of energy comparable to other selected mango cultivars.

Sensory attributes like color, flavor and taste plays imperative position in acceptability of mangoes by consumers. According to Aina & Oladunjoye, (1993); Tucker & Grierson, (1987) color changes are attributed with biochemical changes like degradation and accumulation of various carotenoids pigments such as esters, lycopene, β-carotene and xanthophylls. The overall flavor impression is the result of taste perceived by taste buds. Anwar Ratual attained highest score for flavor followed by Samar Bahisht Chaunsa. These results are in agreement with the finding of Akhtar *et al*., (2009) who reported highest score for Anwar Ratual. Flavor intensity might be correlated with various components like palmitoleic acid, cis-ocimene and β-myrecene of mango during ripening (Engel & Tressl, 1983; Gholap & Bandyopadhyay, 1975). Similarly the Anwar Ratual found to be the best for taste followed by Samar Bahisht Chaunsa. Similar results were also reported by Akhtar *et al*., (2009). Organic acid and sugars ratio mainly creates a sense of taste. Hence, sweetness due to sugar and sourness from organic acids are principal components in the taste of many fruits (Kays, 1991). Sensory evaluation was also checked by "after taste and mouth feel" parameters. Anwar Ratual and Chaunsa achieved highest scores. Regardless of taste, flavor, color and other sensory parameters two cultivars *viz*., Samar Bahisht Chaunsa, and Anwar Ratual were equally acceptable to the panelists and declared excellent. According to Mtebe *et al*., (2006) fruit ripeness phase, plays a key role in the judgment of sensory attributes and acceptability. Ripening of mango involves various metabolic changes *viz.* ethylene production, softening, increased respiration, breakdown of chlorophyll and conversion of starch into sugars etc which contribute towards build up of sensory profile of the mango (Herianus *et al*., 2003).

The present study facilitates mango growers and consumers to choose top quality mango cultivars that impart remarkably acceptable sensorial attributes for both export promotion and local consumption.

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