Physico-Chemical and Nutritional Composition of Mango

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Abstract

The study of physico-chemical and nutritional composition of mango varieties in different regions is of great importance, due to the existence of enormous genetic diversity and differences in soil and climatic conditions.The aim of this study was, therefore to evaluate the physico-chemical and nutritional characteristics of mango fruits from central rift valley area of Ethiopia. Four mango varieties, namely Tommy Atkins, Apple, Kent were evaluated for physical (fruit weight, fruit length and juice volume) and chemical parameters (pH, total soluble solid (TTS), titrable acidity (TA), TSS/TA, total carotenoid and vitamin C) and proximate composition using standard laboratory procedures. The results showed that, variety Keitt had higher physical quality asevaluated by fruit weight, fruit length and juice volume.Chemical characteristics of mango fruitssuch as pH, TSS,TA, TSS/TA, total carotenoid and

higher chemical quality, which was observed from the values of pH, TSS and carotenoid content, whereas Keitt mango was better in vitamin C content (ascorbic acid) and citric

proximate composition as evaluated by fruit moisture, ash, crude fat,crude fiber, crude protein and carbohydrate contents and food energy value.Therefore, it was concluded that the four mango varieties differ from each other in physical, chemical and nutritional characteristics.

Introduction

Mango Mangifera Indica L.) (referred to as “The king of fruits”, is one of the delicious tropical seasonal fruit and believed to be originated in the sub-Himalayan plains of Indian subcontinent.Mangois one of the nutritionally rich fruits with unique flavor, fragrance,tasteand,thus,provide health benefits to humans (http://www.fruitsinfo.com/mango-health-benefits-nutrition-values.php). Mango is not only delicious but also rich in prebiotic dietary fiber, vitamins, minerals and polyphenol, flavonoid and antioxidant compounds. It is also medicinal, a natural antioxidant and very good source of both vitamin A and vitamin C (Criquiand Ringel, 1994; Ajila *et al*., 2007). Mango is mostly eaten fresh as dessert and processed as juices, jams, jellies, nectarsas well as crisp mango chips (Hamdard et al., 2004). The fruit should be mature enough and ripen very well to have the necessary nutritional value. The main physico-chemical attributes related to ripening quality of mango fruit include firmness, flesh color (sometimes peel color), total soluble solids content, titratable acidity and aroma volatiles (Lalel*et al*.,2003; Yashoda *et al*., 2006). Accurate

determination of fruit ripening stage is important for fresh cut products to provide a consistent supply of good quality fruit for retail marketing (Saranwong et al., 2004).

In Ethiopia, there are four varieties of mango namely Kent, Keitt, Apple and Tommy Atkin and greatly distributed in major mango producing areas, such as central rift valley and Assosa. The nutritionalvalue of mango varies depending oncultivar (Othman and Mbogo, 2009; Rodriguez-Amaya, 1998), cultivation practice (Hofman*et al*., 1995), climatic conditions (Léchaudel and Joas, 2006), ripeness at harvest (Lalel*et al*., 2003; Jacobi*et al*., 1995), and postharvest storage and treatment of the fruit (Nunes *et al*., 2007; Hofman*et al*., 1997).

Physico-chemical, nutritional and sensory profile of mango cultivars constitutes 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, but in Ethiopia there is no as such comprehensive evidence.So, the present research work was carried out to assess different physico-chemical and nutritional characteristics of fruits of four mango cultivars grown in central rift valley of Ethiopia.

Materials and Methods

Sample collection

The study was conducted in Food Science and Postharvest Technology Research Laboratory of Melkassa Agricultural Research Center (MARC), Ethiopia.Fruits of four mango varieties (Apple mango, Tommy Atkins, Keitt, and Kent) at similar stage of maturity were collected from different trees. Each sample was collected from ten mango trees randomly selected from each variety grown at MARC horticultural research plot in central rift valley of Ethiopiain the year 2015. The selected fruits were free from mechanical damage, insect and disease infestation and physiological disorders and stored at 12 ^{0}Cprior to analysis.

Sample preparation

Fruits collected from each variety were washed with deionized water to remove surface dust particles and the water stains was removed quickly with a blotting paper.The peels, pulp and seed (kernel) of the fruits were removed using clean sharp knife and the flesh homogenized. Some parameters were measured using parts of the fleshes of the mango fruitsand the remaining parts were lyophilized for further analysis.Each parameter was determined in triplicate.

Fruit physical characteristics

Each fruit was weighed usingsensitive balance to determine fruit weight. Digital caliper was used for measuring fruit width and fruit length. Color of skin and pulp was determined using color chart. The average value of samples taken from ten mango trees was calculated to determine each physical parameter of the fruits.

Physico-chemical characteristics

pH was measured by immersing electrode of the pH meter(Type H1 98106, HANNA) in mango juice sample in 50 ml beaker.Titratable acidity was determined using AOAC (2000),where 0.01M NaOH was titrated against 10ml of the mango juice filtrate using digital burette in the presence of phenolphthalein indicator. The end of the titration was indicated by a change in color of the sample to pink. The amount of acid in milligram per hundred grams (mg /100g) was calculated as

Where:TA = Titrable acidity, molarity of NaOH = 0.01, 0.22= conversiontoect,ot,acle ac,am

Total Carbohydrate (%) =100 - {Moisture (%) +Protein (%) + Fat (%) + Ash (%)}

Statistical analysis

Statistical analysis of the data was carried out using analysis of variance (ANOVA) techniquefor Completely Randomized Design (CRD) and pairwisecomparisons test with the Least Significant Difference (LSD) test was used for comparison of the treatment means at $P \leq 0.05$.

Results and Discussion

Physical properties of mango fruit

There was varietal difference for physical characteristics of mango fruits. Accordingly, the highest average fruit weight (727.35 g) was observed for Keitt, followed by Tommy Atkins (466.88 g); while the lowest value was recorded for Apple (433.52 g) (Table 1). The average fruit weight obtained in this study was similar with the result reported by Souza *et al.* (2018). Except fruit width, all other physical parameters, including fruit weight, length and juice volume were significantly different ($P \leq 0.05$) among the varieties (Table 1).

Physio-chemical characteristics

It has been well documented that fruit weight is related to the genetic factors of each cultivar, as large fruits with average weight of up to 510 g (Schnell et al., 2006) characterize variety Keittfrom a genetic improvement program in Florida (USA). Besides, fruit weight is directly affected by climatic factors; especially precipitation and water supply are of prime importance, during fruit development, as growth is the result of cell elongation that depends on the water content within the cell (Souza *et al.*, 2018). Furthermore, variety Keittexhibited the highest juice volume, which is interesting quality for industry**.**

Table 1: Physical characteristic of fruits of different mango varieties

Variety	Skin color	Flesh color	Fruitweight /1 fruit (g)	Fruit Width /1fruit(mm)	Fruit length /1fruit(mm)	Juice volume /1 fruit (ml)
Apple	Yellow with red	Yellow	433.52^{b}±99.5	91.157^{a}±9.5	93.225^{b}±7.1	316.50^{b}±59.7
Keitt	Pink with red	Golden-yellow	727.35^{a}±50.6	93.786^{a}±3.6	137.30^{a}±17.9	540.00^{a}±13.9
Kent	Yellow with red	Orange-red	458.90^{b}±62.9	96.693^{a}±4.8	99.828^{b}±5.2	368.25^{b}±20.1
Tommy Atkins	Red purple	Yellow orange	466.88^{b}±51.5	87.705^{a}±6.9	108.64^{b}±5.3	333.75^{b}±25.6
Mean			521.66	92.335	109.75	389.63
CV			13.23	7.09	9.40	8.90
LSD			106.36	10.09	15.89	53.44

Means followed by different superscripts within a column are significantly different at (P

pH value of the varieties showed significant difference (P≤0.05), and the highest pH was recorded for Tommy atkin, while the lowest value was for Apple mango (Table 2). The pH of all the varieties was found to be below 4.7, which indicate that they are acidic.As reported by Souza *et al.*, (2018), fruits of different mango cultivars had an average pH of 4.0, which is lower than the values recorded in the present experiment. pH in the fruit pulp plays an important role in flavor promotion and as a preservation factor (Cruess, 1948). The highest average citric acid content, as evaluated by titerable acidity,was recorded for Apple (6.7mg/100g), followed by Kent, Tommy atkin and Keitt with values of 3.84,3.54 and 3.48 mg/100g, respectively (Table 2).This result was in agreement with some previous findings for some varieties (Souza *et al*, 2018). In line with this, it has been reported that fruit acidity is directly related to the genetic makeup of mango germplasm and climate conditions under which the plant grown (Kaur *et al*., 2014).

Total soluble solids (TSS) content in fruit pulp of mango was significantlyaffected (P≤0.05) by variety. The maximum TSS content was detected in the pulp of Kent (18.97°Brix),followed by Apple mango (18.07) and the minimum value (13.60) was recorded for Keitt (Table 2).TSS in fruit is an index used to determine its maturity and is a strong indication of the optimum harvesting time. As observed in the present study, differences in the TSS content of fruits could be attributed to genetic differences among varieties and variations in climatic conditions.

Although different studies have shown different TSS values for mango, Othman and Mbogo, (2009) have reported that the range was 14.5-30.0, which accommodates the value for three of the varieties, except for Keitt in the present study.

Table 2: Physio-Chemical characteristics of fruits of different mango varieties

Variety	pH	TSS (brix)	TA (citric acid) mg/100g	Sugar /Acid Ratio	Total carotenoid (µg/g)	Vitamin C (mg/100g)
Apple	3.86^{d}	18.07^{b}	6.40^{a}	28.45^{c}	27.20^{a}	27.47^{c}
Keitt	4.00^{c}	13.60^{d}	3.48^{b}	39.44^{b}	15.57^{b}	36.40^{a}
Kent	4.29^{b}	18.97^{a}	3.84^{b}	49.62^{a}	3.09^{c}	32.79^{b}
Tommy atkin	4.73^{a}	15.03^{c}	3.54^{b}	42.51^{b}	13.18^{b}	14.19^{d}
Mean	4.22	16.42	4.31	40.01	14.76	27.72
CV	0.69	1.72	9.6	9.18	10	6.41
LSD	0.05	0.53	0.78	6.92	2.78	3.35

Means with different superscripts within a column are significantly different (P 0.05).

Soluble solid to titerable Acidity Ratio or sugar to acid ratio was significantly (P ≤ 0.05) higher for Kent (49.62) and the least value was recorded for Apple mango (28.45). TSS to TA ratio indicates the degree of sweetness of the fruit or its product, providing information about the predominant flavor, whether sweet or sour or a balance of the two. This ratio is one of the most used parameters to evaluate taste, being more representative than the independent measurement of sugars or acidity.

Apple mango had significantly greater total carotenoid content (27.20), while Kenthad the least value (3.09) (Table 2). Generally, all the four varieties of mango were significantly different ($P \leq 0.05$) for carotenoid content. It has been reported that carotenoids are bioactive substances in food with powerful antioxidant activity and play vital role in enhancement of the immune response and reduction of the risk of degenerative diseases, such as cancer, cardiovascular diseases and muscular degeneration. Hence, the two mango varieties (Apple and Keitt) in this study seem to have more nutritional value and similar results also reported by Melo *et al*. (2006.).

There was a significant ($P \leq 0.05$) difference among varieties for vitamin C (ascorbic acid content). The highest vitamin C content was obtained from pulp of Keitt (36.40 mg/100g) and the lowest value was recorded for Tommy atkin (14.19mg/100g) (Table 2).Hence, the fruit pulps meet the minimum Vitamin C requirement of 15 mg/100g to 80mg/100g as recommended by EU/WHO and NAFDAC for fruit groups (Ellong *et al*., 2015). Based on this requirement, except Tommy atkin, the other three mango varieties appear to be good source of vitamin C.

Proximate composition

Moisture content of mango varieties ranged from 77.85% to 82.22 %.The highest moisture or lowest dry mater content was recorded for Tommy atkin, while the lowest moisture or higher dry mater content was recorded for Keitt (Table 3), and varietal differences were significant ($P \leq 0.05$). Statically there was a significant difference among the fruit sat ($p \leq 0.05$). In agreement with this result, (Nwofia *et al*., 2012) have reported that moisture content of fruit pulps ranged from 77.85 to 82.22 % and this showed that the fruits have a short shelf life. Total mineral content (ash) varied from 2.78 to 1.75% and except for Apple mango, the difference between varieties was non-significant, Although Keitt had the highest and Apple mango hadthe lowest values (Table 3). Crude fat content of the varieties ranged from 0.76 to 2.29% and crude fiber was in the range of 0.81 to 2.74%, where varietal difference was significant for both parameters (Table 3). Similarly, total protein content was found to be in the range of 1.75 to 2.74% and total carbohydrate content and food energy value ranged between 77.31-71.66% and 326.55-312.87 Kcal/100g, respectively, with significant differences at ($P \leq 0.05$) for mango varieties (Table 3).

Variety	Moisture (%)	Dry Matter (%)	Ash (%)	Crude Fat (%)	Crude Fiber (%)	Protein (%)	CHO (%)	Food Energy (Kcal/100g)
Apple	82.49^{ab}	17.51^{bc}	1.75^{b}	1.67^{b}	1.94^{b}	1.75^{c}	77.31^{a}	323.56^{ab}
Keitt	79.48^{c}	20.51^{a}	2.78^{a}	2.29^{a}	0.81^{c}	2.74^{a}	71.66^{b}	315.04^{bc}
Kent	81.39^{b}	18.61^{b}	2.35^{a}	0.77^{c}	1.79^{b}	2.04^{b}	76.23^{a}	312.87^{c}
Tommy atkin	83.61^{a}	16.38^{c}	2.40^{a}	2.53^{a}	2.74^{a}	1.76^{c}	76.92^{a}	326.55^{a}
Mean	81.74	18.25	2.32	1.82	1.82	2.07	75.53	319.5
CV	1.16	5.18	12.33	11.9	14.95	0.54	1.54	1.44
LSD	1.78	1.78	0.54	0.41	0.51	0.02	2.19	8.67

Table3: The proximate composition of fruits of four mango varieties (in dry matter basis)

Means with different superscripts with in a column are significantly different at P 0.05

Conclusion

The physical and physico-chemical characteristics and proximate compositions of four mangovarieties, namely, Tommy Atkins, Apple, Keit,t and Kent from Melkasa Agricultural research center, central rift valley of Ethiopia was determined.The results showed that variety Keitt was good in physical quality attributes,such as fruit weight and juice volume which are desirable for juice industry. In addition, Keitt was better than others were for its vitamin C, total carotenoid (precursor of Vit A) and citric acid levels. Generally, there was appreciable variation among the four mango varieties for physical and chemical characteristics. Therefore, these data would serve as baseline information for both researchers and growers and traders toselect varieties with better quality for consumption, industrial use and export.

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