Physicochemical and Sensorial Quality of Released Papaya Varieties in Ethiopia

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Abstract

The study was carried out to investigate the physic-chemical, nutritional, and sensorial qualities of released papaya varieties, namely, KK-103, MK-121, and CMF-078, which are widely grown in Ethiopia. The results showed that maximum fruit weight was observed for variety MK-121 and the lowest value was for CMF-078. It was also found that total soluble solids (TSS), citric acid, total 1carotenoid and vitamin C contents ranged between 10.287 and 12.620 Brix, 1.455 and 1.978 g/l, 13.670 and 18.912 µg/g and 30.854 and 36.507 mg/100g respectively. Results of proximate analysis of the pulp showed crude protein, crude fat, and fiber contents of 0.200- 0.907%, 0.215-0.293%, and 0.732-0.995% respectively. In general, the results indicated that a significant difference between the papaya varieties. In addition, it was also observed that papaya fruits had high moisture content (>85.5%), low acidity (>5.3 pH), low crude fat and crude fiber, and moderate ascorbic acid contents. The sensory evaluation results showed that variety MK-121 exhibited significantly higher values for color, flavor, sourness, and sweetness than did the other two varieties,howeve variety CMF-078 had higher acceptability than other varieties.

Keywords: physiochemical composition, and proximate analysis, sensory evaluation.

Introduction

Papaya (*Carica papaya* L.) is one of the important and versatile fruits of the family Caricaceae and grown worldwide in the tropics and subtropics, including India, Bangladesh, Malaysia, Australia, Hawaii, Philippines, Sri Lanka, South Africa and other countries in tropical America (Anuar *et al.*, 2008). Papaya has been ranked as one of the tops for nutritional value among 38 common fruits (Ming *et al*., 2008). It is available year round; therefore, ripe papaya is consumed as fruit and green papaya as a vegetable. Besides, it has medicinal properties and has been used against diseases for many years (Mello *et al*., 2008). Practically, every part of the fruit is used for a variety of medical purposes (Silva *et al.,* 2010). It has been argued by scientists that all parts of papaya, including seeds, roots, rinds, and fruits have positive effects on general health preventing diseases (Seigler *et al.,* 2002).

Fruit quality is one of the most important themes of the fruit industry, especially for juice and pulp processing, as it has a direct impact on the use of additive

synthetic products such as acidifiers, colorants, and sugars. The physical and chemical parameters of fruits are important indicators of their maturation and internal and external quality and, hence, affect market demands (Abbott, 1999). Fruit quality of papaya is affected by the ripening process (Chonhenchob and Singh, 2005), as quality is defined as the absence of defects or degrees of excellence and includes appearance, color, shape, flavor, taste, aroma, nutritional value and safety for the consumer (Chonhenchob and Singh, 2005). Due to higher market exigency for high-quality products, juice, and pulp industries are looking for fruits with better internal and external features, including fruit length and width, fruit weight, pulp, seed and peel percentages per fruit, seed size, peel diameter, soluble solids, titratable acidity and vitamin C contents, pulp pH and soluble solids to titratable acidity ratio (Abbott, 1999).

Papaya is a good source of many vitamins, such as vitamin C, and it contains vitamin E, pectin, and carotenoids (Zaman *et al.*, 2006). Despite its economic importance and nutritional value, quality parameters of papaya varieties grown in Ethiopia have not been well studied. Hence, full characterization and comparison of the quality attributes of released papaya varieties need research attention. Physic-chemical characteristics are important qualitative indixes of any fruit for fresh consumption. Hence, the main objective of the present study was to conduct a detailed analysis of variations in fruit physicochemical

Fruit weight: Fruit weight was determined using a sensitive balance.
Fruit width, length, and diameter: Fruit width, length, and diameter were determined by using a digital caliper.
Juice pH: it was measured by taking a sufficient quantity of juice sample in 50 ml clean beaker and using pH meter (Type H1 98106 by HANNA).

Total Soluble Solid (TSS): TSS content of the fruit was determined using a pre-calibrated Atago hand refractometer (Type ATAGO, Model-9099). A drop of homogenized papaya pulp was placed at the prism of the refractometer and the lid was closed and TSS reading was directly taken from the digital scale at 20°C±1 and results were expressed in Brix.

Titerable acidity (TA): Titerable acidity value was calculated through the standard method (AOAC, 2000). Zero point zero one molar (0.01M) NaOH was titrated against 10ml of the filtrate using phenolphthalein indicator. The end of the titration was indicated through a change in the color of the sample to pink. The amount of acid in milligram per hundred gram (mg /100g) was calculated as follows.

$$\text{Titratable acidity} = \frac{0.01 \times 0.0064 \times T \times 10 \times 10}{Ft \times S}$$

Where 0.01M = morality of NaOH used, 0.0064= conversion factor for citric acid, which it is present in papaya fruits, T = titer value, Ft = quantity of filtrate used, S = quantity of sample weighed and 10 = dilution factor, and 1000 = conversion to mg/100g

Ash (Total Mineral): Ash content of the samples was determined following the standard method described by AOAC (2000). Two gram of dry ground sample was weighed into a clean crucible of predetermined weight. The sample was burnt in the muffle furnace at $550^{o}C$ until the color was changed to grey/white. The crucible was removed with a tong and allowed to cool in a desiccator for 30 minutes before reweighting the crucible with the sample. Then, ash content of the sample was calculated using the following formula.

Crude Fat: It was determined through the Soxhlet extraction method as described by AOAC(2000).Five gram of dry papaya powder was weighed into an extraction thimble. The mouth of the thimble was plugged with fat-free absorbent cotton wool. The receiver flask of the soxhlet was cleaned, dried, and weighed accurately before the thimble with the sample was introduced into the soxhlet extractor. The apparatus was assembled and filled with petroleum spirit to half capacity 501(a)] u0T1 (a)

$$\text{Crude fat (\%)} = \frac{(WF - W)}{S} \text{x } 100$$

Where WF = weight of the receiver flask and fat deposits, W = weight of empty receiver flask and S = Weight of sample used.

Crude Fiber content: It was determined according to the standard method mentioned by AOAC (2000). Two grams of dry papaya samples were defatted using a soxhlet extractor. The fat-free sample was transferred into a one-liter beaker. Boiling water was added to it and mixed with 25ml of 2.5M H_2SO_4 and the volume was raised up to 200ml level. Then, the mixture was boiled for 30 min and filtered using suction filtration through the butcher filter. The residue was washed twice with boiling water and transferred into the beaker. Then, 25ml of 2.5M NaOH was added and diluted to a 200ml mark. The beaker was heated and boiled for 30min and filtered gain. The resulting residue was transferred to a porcelain crucible. Finally, the fiber cake was extracted and dried by moisturizing with a small amount of ethanol. The extracted fiber cake was dried with crucible at 100^0C to a constant weight, cooled and weighed (W1) and, then, the dried content of the crucible was incinerated at 600^0C for 3hrs in a muffle furnace until all the carbonaceous matter was burned out. The crucible was cooled in the desiccator and weighed (W2) and, finally, the crude fat content was calculated as follows:

$$\text{Crude fiber (\%)} = \frac{(W1 - w2)}{w} * 100$$

Where, W1 = weight in a gram of porcelain crucible and content before ashing, W2 = weight in a gram of porcelain crucible containing ash and W = weight of sample in gram

Crude protein content: Crude protein content was determined according to the procedure mentioned by AOAC (2000) using the Kjeldahl method. Fresh samples of 0.5g were taken in a test tube and 6ml of concentrated sulfuric acid was added and mixed, and 3.5 ml of 30% hydrogen peroxide was added step by step. Three grams of catalyst mixture (powdered 0.5 g of selenium metal with 100 g of potassium sulfate) was added into each tube and allowed to stand for about 10 minutes. When the violet reaction was terminated, the tubes were shaken and placed back to the rack. After the temperature of the digester reached 370 ^{O}C, the tubes were lowered into the digester. The digestion was allowed to continue until a clear solution was obtained after about 4 hours. The tubes in the rack were cooled in a fume hood and 25 ml of de-ionized water was added and shaken to avoid precipitation of sulfate in the solution. A 250ml conical flask, containing 25 ml of boric acid, 25 ml of de-ionized water, and an indicator solution was placed under the condenser of a distiller with its tips immersed into the solution. The digested solution was transferred into the sample compartment of the distiller. Sodium hydroxide solution (40%) was added (40 mL) into the digested and diluted solution. The distillation process was continued for some minutes until a total

volume reached 250 ml. The tip of the distiller was rinsed with a few milliliters of water before the receiver was removed. Finally, the distillate solution was titrated using 0.1N hydrochloric acid until reddish color appeared. Then, crude protein content was determined using the following formula.

$$\%N = \frac{(V\ HCl\ sample - V\ HCl\ blank) \times N\ HCl \times 14.0}{Weight\ of\ sample(Wt.)} \times 100$$

%Protein = %N X 6.25

Where: % N= percent nitrogen, N = normality of HCL (0.1N), Wt. = weight of sample in gram, 14.0 = molecular weight of nitrogen, V HCl sample = volume consumed by the sample to the endpoint of the titration and V HCl blank = Volume consumed by the blank (without sample)

Total Carotenoid content: Total carotenoid content of the sample was determined spectrophotometrically through harvest plus crops method as described by Rodriguez-Amaya and Kimura (2004). About 5 g of papaya flesh sample and 3 g of hyflosupercel (Celite) were weighed and transferred into a mortar and the mixture was ground with a pestle by adding 50 ml of cold acetone and filtered with suction filtration methods using a Buchner funnel with filter paper. Then, the extract (liquid) sample was put into a 500-ml separator funnel and 40 ml of petroleum ether was added and mixed with the extract. Then, 300 ml of distilled water was added slowly and allowed to flow along the walls of the funnel. The upper phase left in the funnel was washed three to four times with 200 ml distilled water. The petroleum ether phase was collected in a 50-ml volumetric flask, making the solution pass through a small funnel containing about 15 g of anhydrous sodium sulfate to remove residual water. The sample voloume was adjusted to ml by adding petroleum ether and the absorbance was read at 450 nm using UV-spectrophotometer. The total carotenoid content was calculated with the following formula.

Total carotenoid (µg/g) = [A × volume (ml) × 104] / [A1% 1cm × sample weight (g)]

Where A = absorbance; volume = total volume of extract = 50 mL and A1% 1cm = absorption coefficient of β-carotene in petroleum ether (2592).

Vitamin C (Ascorbic Acid) content: Vitamin C content was determined using the method developed by Horwitz (2000). Precisely, a 5g fresh papaya sample with 100ml of 6% trichloroacetic acid was extracted using mortar and pestle. In the extracted sample 2 drops of saturated bromine solution were added and then 10ml aliquot was taken and mixed with 10ml of 2% thiourea. From the mixture (10 ml extracted and 10ml of 2% thiourea) 4 ml taken into two different test tubes and one as a blank. To each tube, 1ml of 2,4-DNPH was added and put in a water bath at 37 ^{0}C for 3 hours and then added slowly 5ml 85% H_2SO_4 while the tubes are in an ice bath. Added 1ml of 2% DNPH to the blank and mix all tubes and then

standing all tubes at room temperature for 30 min. Read the absorbance of the standards, blank and test samples at 515 nm.

$$\text{Ascorbic Acid (mg/100g)} = \frac{[(As - Ab) * 10]}{[A10\mu g\ Std - Ab]}$$

Where: As=Absorbance of samples; Ab = Absorbance of blank; A_{10} µg Std. = The absorbance of $_{10}$ µg AA standard

Sensory analysis

Sensory analysis was conducted by semi-trained panelists of Melkassa Agricultural Research Center staff members following the standard procedures of a hedonic (1-5) scale scoring (1- indicates dislike very much and 5- indicates like very much). Samples were evaluated for sweetness, color, flavor, sourness, and overall acceptability by 10 semi-trained panelists.

Statistical analysis

Statistical analysis of the data was carried out using analysis of variance (ANOVA) procedure for completely randomized design (CRD)and pairwise comparison test was carried out, whereas, Tukeys HSD was used for comparison of the treatment means at $p<0.05$.

Results and Discussion

Physical properties of papaya fruit

Papaya varietiesshowed significant differences for fruit weight, length, width and diameter (Table 1). The highest fruit weight (1083 g) was recorded for variety MK-121 and the lowest (356 g) was for CMF-078. Similarly, the maximum fruit diameter was recorded for variety MK-121 and the lowest was for CMF-078. Variety MK-121 also showed maximum fruit length and width. The skin and flesh colors were the same for variety MK-121, while the rest two varieties of papaya showed different skin and flesh colors. In general, fruits of the three papaya varieties showed different physical characteristics such as length, weight, and diameter (Table 1).

Table 1: Fruit physical parameters of papaya varieties

Variety	Length (mm)	Width (mm)	Weight (gm)	Diameter (mm)	Flesh Color	Skin Color
KK-103	186.72^{b}	82.782^{b}	538.92^{b}	38.900^{b}	Reddish orange	Yellowish green
MK-121	250.07^{a}	105.38^{a}	1082.6^{a}	44.182^{a}	Bright yellow	Bright yellow
CMF-078	138.76^{c}	77.870^{b}	355.72^{c}	29.957^{c}	Reddish orange	Yellow
Mean	191.85	88.678	659.08	37.680		
CV	4.03	6.610	9.750	4.530		
LSD	47.96	4.912	183.20	5.282		

Means followed by the same letter within a column are not significantly different at P≥0.05

Chemical parameters of papaya fruit

Fruit pH of the three varieties was not significantly different. But, total soluble solids (TSS) content of the significantly varied from 10.287 to 12.620 Brix, where variety KK-103 showed higher value than did the other two varieties (Table 2). The TSS values of papaya in the present study were similar to those which have been reported by Tekliye, (2016) and Zaman *et al*., 2006). The difference between varieties was significant for fruit acidity (as citric acid) which ranged from 1.454 g/l for variety MK-121 to 1.978 g/l for CMF-078. Fruit acidity values observed in the present study were in agreement with the findings of Tekliye (2016) and Zuhair etal., (2013). Variety MK-121 had significantly higher (18.912µg/g) total carotenoid content as compared with the other two varieties. Vitamin C (Ascorbic Acid) content of the pulp ranged from 30.854 to 43.407mg/100g. A significantly higher value of ascorbic acid/vitamin C content was recorded for variety MK-121, while the lowest value was recorded for variety CMF-078 (Table 2).

Table 2: Fruit chemical properties of papaya varieties

Varieties	PH	TSS (Brix)	Citric Acid(g/l)	Total Carotenoid (µg/g)	Vitamin C(mg/100g)
KK-103	5.667^{a}	12.620^{a}	1.6043^{b}	13.847^{b}	36.507^{b}
MK-121	5.520^{a}	11.493^{ab}	1.4547^{b}	18.912^{a}	43.407^{a}
CMF-078	5.284^{a}	10.287^{b}	1.9787^{a}	13.699^{b}	30.854^{c}
Mean	5.49	11.47	1.68	15.49	36.922
CV	3.78	5.89	8.03	8.80	4.21
LSD	0.52	1.69	0.34	3.42	3.8924

Means followed by the same letter(s) within a column are not significantly different at p ≥0.05

Sensory evaluation

Most of the studies on fresh-cut fruits have been concerned with the objective and subjective evaluation of market quality by color, sensory and texture measurements (Ahvenainen, 1996). The results also showed that color; flavor and sourness values were significantly higher for variety MK-121 than for the other two varieties, variety CMF-078 showed higher value for sweetness. Color, flavor, and sourness values were statistically similar for variety CMF-078 and KK-103. According to the panelists mean evaluation, overall acceptability of variety CMF-078 was found to be significantly higher than other varieties (Table 3).

Table 3: Fruit sensorial quality attributes of papaya varieties

Varieties	Color	Flavor	Sourness	Sweetness	Overall acceptability
KK-103	3.4867^{b}	3.229^{b}	3.0383^{b}	2.8897^{b}	2.9997^{c}
MK-121	4.4133^{a}	4.594^{a}	4.1537^{a}	3.9980^{a}	3.9623^{b}
CMF-078	3.2300^{b}	3.3083^{b}	3.4557^{b}	4.1280^{a}	4.7457^{a}
Mean	3.71	3.71	3.55	3.67	3.90
CV	5.92	3.25	4.99	4.02	2.83
LSD	0.55	0.30	0.44	0.37	0.28

Means followed by the same letter within a column are not significantly different at P≥0.05
Score value respresent; 1 = Dislike Very Much, 2 = Dislike, 3 = neither like nor dislike, 4 = Like, and 5 = Like very much.

Proximate compositions of papaya fruit

Fruit moisture content of the three papaya varieties was significantly different at ($p \leq 0.05$) and ranged from 87.787 % to 90.857 %. Variety KK-103 showed higher value as compared to the values recorded for the other two varieties. Fruit ash content ranged from 0.476 % for variety CMF-078 to 0.552 % for MK-121and showed a significant difference among varieties. Although protein, fat, and fiber contents are not a big deal in fruits and vegetables except for some fruits, protein content was higher for variety KK-103, while variety CMF-078 exhibited significantly higher fat and fiber contents (Table 4). Carbohydrate content and energy value were significantly higher for variety MK-121, but the difference between the rest two varieties was not significant for these parameters.

Table 4: Proximate compositions of papaya fruits

Varieties	% Moisture	%Ash	%Protein	%Fat	%Fiber	CHO %	Energy(kcal/g)
KK-103	90.857^{a}	0.485^{b}	0.907^{a}	0.215^{b}	0.732^{c}	7.543^{c}	32.744^{b}
MK-121	87.787^{c}	0.552^{a}	0.866^{a}	0.238^{b}	0.888^{b}	10.556^{a}	44.280^{a}
CMF-078	89.704^{b}	0.476^{b}	0.200^{b}	0.293^{a}	0.995^{a}	9.327^{b}	36.765^{b}
Mean	89.45	0.50	0.67	0.25	0.87	9.14	37.93
CV	0.51	1.85	3.18	4.68	2.89	4.97	4.92
LSD	1.14	0.023	0.05	0.03	0.06	1.14	4.68

Means followed by the same letter within a column are not significantly different at $p \geq 0.05$

Conclusions

Fruit physicochemical parameters significantly differed with variety, which could probably be due to differentces in genetic make-up of the varieties. Nevertheless, the results of the present study indicated that fruits of papaya variety CMF-078 exhibited higher overall acceptable value with higher customer preference. On the other hand, variety MK-121 had higher carbohydrate content and energy value than did the other two varieties. It had also a better vitamin C and total carotenoid contents. Therefore, it was recommended that fruits of variety MK-121 could be used for fresh consumption as well as for processing purposes.

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