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Research Article

Quality and Sensory Evaluation of Mango (*Mangifera Indica*) Squash as Influenced by Different Storage Conditions

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ABSTRACT

Mango (*Mangifera indica*) is one of the most important tropical and sub-tropical fruit. Most of the mango growers use traditional techniques of harvesting in the study area. Such technique causes fruit to damage and initiates the postharvest quality loss. The huge quality loss causes fruit to unacceptable and reduces the marketability and causes economic & nutritional impact on stakeholders. Utilization of such low market value mango fruits for developing value added product like squash can be of a great interest. The present study was conducted to standardize the production techniques of mango squash and evaluate its consumer acceptance. The experimental trail were laid in (2*3*3) two types of mango fruits (marketable and unmarketable), three types of storage temperatures (room temperature, refrigeration and incubator); and three level of storage periods (30, 60 and 90) days having with triplications and arranged in (CRD). The treatment at first day stored under room temperature was considered as a control. The data obtained were analyzed by using SAS version 9.1. The mean comparisons were done by using Duncan's Multiple Range Test at 5 percent. The result revealed that the preliminary test of sensory attributes was selected the 1:1 ratio of sugar to mango pulp for both mango fruit types. In the first day sensory score of color, flavour, consistency and overall acceptance was ranged between 7.54-7.93, 6.80-7.50, 7.42-7.83 and 7.64-8.54 respectively; however at the end of storage period it was recorded 6.12-7.32, 6.04-7.00, 6.04-7.13 and 6.66-7.75 respectively. The ranged value of vitamin C content was fall between 11.63-24.40 mg/100 g. Beta carotene content of mango squash made from both mango types was ranged from 4.11-5.72 mg/100 g. The range of selected mineral contents was fall between 27.50-33.59mg/100 g, 28.50-37.59 mg/100 g and 2.14-2.65 mg/100 g for calcium, potassium and iron respectively.

Keywords: Mango; Squash; Quality; Sensory evaluation; Storage conditions

INTRODUCTION

Mango (*Mangifera indica L.*) is one of the most important tropical and sub-tropical fruits. It is originated in India, Assam-Burma region; and has been cultivated for more than 4000 years [1]. The mango trees grow from the sea level up to altitude of 1500 m, withstand dry conditions and heavy rain fall but severe frosts during winter may endanger the tree. Mango tree is an erect branched evergreen plant reaching about forty-meter-high and may live up to hundred years, [4]. Ethiopia has diverse agro climatic conditions which are conducive for growing wide range of horticultural crops. Fruits like banana, mango, papaya, avocado, citrus fruits etc. are grown in the country. Mango is one of the main horticultural crops grown in the country. Out of 47,000 hectare of land is under fruit production in Ethiopia, mango is cultivated in about 12.61% of the area which was around 5926.7 hectares of land [5]. Total fruit production in Ethiopia is about 500,000 tones. In the previous study, it was estimated that as much as 28% of the mangoes sold in the capital city of Ethiopia, Addis Ababa, were grown in the Arba Minch Southern Ethiopia [18].

Mango production covers 35 percent of the total acreage allotted for fruit production in Harari and Assosa. In Ethiopia mango is

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produced mainly in west and east of Oromia, SNNPR, Benishangul and Amhara [6]. But, according to [5] cropping season mangoes contributed about 14.21% of the area of land allocated for fruit production and holds 14.55% of fruits produced in the country. Mango is grown in many parts of the country, especially in the Rift Valley, western and south western parts of the country. The national research system has developed a number of varieties but are not widely spread [5]. Mango is one of the most important tropical fruits, for processing industry. Beside the fresh fruit, processed mango products such as juices, nectars, jelly powders, fruit bars, flakes, dried fruits and squash have become increasingly popular in Europe [1,12]. The phenolic compounds have an important impact on the flavor of mango fruits, which is mainly due to astringency of their tannins content. The vitamin content of the fruits varies from variety to variety depending on their origin [16]. The vitamins that were determined in mango fruits are pro vitamin A, vitamin C and small amounts of vitamin B group. The principal minerals of mango fruits to be considered are calcium, sodium, and potassium magnesium. Very little is known about the lipids substances of mango fruits. Fatty acid composition of the acid from ripe mango pulp mainly consists of meristic, palmitic, stearic, linoleic and linolenic acid [16].

Arba Minch is a sub-tropical area, and is known for production of many fruits such as mango, avocado, banana etc. Mango is one of perishable climacteric fruit and most farmers in the area harvest the fruits in a traditional manner by beating the branches of the trees, with a long hand stick. This makes the beginning of post-harvest deterioration. Improper post-harvest handling methods also lead to deteriorations of the fruit. Substantial quantities of mango fruits are sorted because of defects, mechanical damages, and pest damages, bruised and partially spoiled fruits and are discarded as unmarketable by the farmers and traders in the production area. Thus a substantiated quantity of fruit becomes unmarketable. Huge quantities of fruits are segregated as unmarketable fruit. Once the fruit is being graded for packing, the traders genuinely expect that packing such fruit will causes additional spoilage and as such discard such fruit. Such huge quantities of waste not only result in economic and food losses, but also cause environment pollutions. Unmarketable fruit not only results in wastage of food and nutrition but also causes a great environmental pollution and a heavy financial loss to the growers and traders. As such there is an urgent need to address this problem. Therefore this study was conducted to address the goal of mango product (squash) standardization procedure of mango pulp to sugar ratio for sensory evaluation acceptability and to evaluate the selected minerals and vitamins content of product from both marketable and unmarketable fruit. Thus the findings of this study were expected to help in utilizing substantial quantities of unmarketable mangoes for developing value added products.

MATERIALS AND METHODS

Description of the study area: The study was conducted in Department of Chemistry, College of Natural Sciences, and Arba Minch University. It is located in Southern Ethiopia, Arba Minch town about 505 km far away from capital city of Ethiopia, Addis Ababa. Lante kebele is the sample collection targeted location, which is sub-district of Arba Minch Zuria woreda and was located at 6° 2'N Latitude and 37° 33' E Longitude and have an altitude of 1,200 m.a.s.l with its average temperature and rain fall of 29°C and 900 mm respectively.

Material collection: Mango fruits were collected from Lante kebele in Arba Minch district. Both marketable and unmarketable mangoes were selected on basic criteria's for marketable and unmarketable fruits as reflected here. Marketable mangoes based on healthy mangoes at proper stage of maturity without any blemishes, defects, having similar variety, defined size, color, and shape and without any injuries were selected for procurement studies, however unmarketable mangoes were collected through considering the mangoes discarded by traders and growers due to their inferior qualities which included heavily injured fruits, infected with birds, bruised, partially rotten and other such factors. Such fruit was being discarded by farmers or traders during grading of mangoes for dispatches of fresh fruit to market.

Pulp preparation: Fruits of both the lots (marketable and unmarketable mango) fruits were washed thoroughly in tap water to remove the foreign materials and to reduce the microbial load. The rotten and bruised portion of the unmarketable mangoes separated with the stainless steel knife and the healthier part of the fruit were peeled and sliced into pieces. The flesh portion of both marketable and unmarketable mango was separately autoclaved at 10 psi for 15 minutes separately. Autoclaved mango slices from both marketable and unmarketable mango were pulped separately using Juice extractor model JX-909 (lumnix-juice maker) to converting the slices into pulp in a blender, then packed, labeled and stored in refrigerator for further use. Both the marketable and unmarketable lots were kept separate and details of stone; rotten portion etc. had recorded to work out the per cent age pulp yield from marketable and unmarketable fruits.

Preparation of squash: The measured amount of sugar dissolving with water and boiling through continuous stirring with wooden spoon until the sugar syrup reach around 65°Brix then the syrup was filtered via a muslin cloth to remove impurities. Sugar syrup was added to kettle and placed on the heating plate and measured quantity of fruit pulp used taken and added to filtered sugar syrup the total soluble solid of sugar syrup falls from 65-21°Brix because of addition of pulp. Then the remaining sugar to the boiling pulp and heating continued with continuous stirring of the product to ensure that the sugar is dissolved properly. Continued boiling and stirring until the volume of the pulp was reduced and check the soluble solid by using digital hand refract meter to decide the end point. Citric acid was dissolved in a small quantity of water and added to the product. While continuing cooking the temperature was raised to about 105°C and TSS of 45Brix was attained. The end point was assessed by noting TSS. The TSS was recorded by digital hand refractor meter. If the TSS of the product attained 45°Brix it indicates the end point of squash. The heating was stopped and the time froth at surface was removed. The product was cooled to about 82°C and filled into free sterilized jars and

closed after heat vaporized from squash to come out of jar. Lid of the jar was closed properly leaving no chance for any gaseous exchange and having one inch head space. The jar was cooled room temperature by immersing in normal cool potable water. The jars were dried and labeled. A product was analyzed for various quality parameters and sensory evaluation at room temperature.

Experimental design: The trial was laid out in completely randomized design (CRD) with three replications in 2*3*3 factorial experimental combinations. Totally thirty six observations were laid in two types of mango (marketable and unmarketable), three types of storage temperatures (room temperature, refrigeration and incubator) and three different storage durations of (30, 60 & 90) days.

Chemical composition analysis

Determination of vitamin C: Vitamin C for marketable and unmarketable mango was determined by using method of [3]. Under this method, titration was performed in the presence of phosphoric acid/acetic acid solution to maintain proper acidity (1-3) pH for titration and to inhibit oxidation of the acid whereby 5 g of grinded mango squash sample were taken into 250 ml Erlenmeyer flask. 50 ml of Ortho-phosphoric acid were added to extract, to lower pH as well as to de-proteinase the sample. The extracted samples were then filtered and titrated against standardized dichlorophenol indophenols until pink color which is the end point of the reduction process was observed. The volume of Dichlorophenol indophenols used was recorded and vitamin C content in samples was calculated as (X-B) x () x (). Where, X is titre value, B is blank, F is mg of ascorbic acid equivalent to 1.0 ml indophenols, E is number of ml assayed, V is initial assay solution volume and Y is volume of sample aliquot titrated.

Beta carotene determination: Beta carotene determination was done using a modified chromatographic procedure [9]. A sample of 20 g was homogenized. A spatula of hydro florosupercel was added and extraction done using 50 ml of acetone until the residue became white. Partitioning was done using 25 ml of petroleum ether in a separating funnel. Saponification was carried out by adding an equal amount of extract in 3 ml of 10% KOH in methanol and a few drops of 0.1% butylated hydroxytoluene in petroleum ether. The sample was kept in the dark for 16 hours followed by washing with water in a separating funnel until it became clear. Anhydrous sodium sulphate was added to remove water and further concentration done using a rotary evaporator. The HPLC (Model LC-10), which had the following conditions was used: Mobile phase (acetonitrile: Methanol: Dichloromethane=70:10:20), flow rate of 1 ml/min, column ODS 150, injection volume 10 µL, oven temperature 35°C.

Determination of minerals: Mineral content of marketable and unmarketable mango squash was determined by using atomic absorption spectrophotometer (AAS), U.K method described in [3]. Test portions were dried and then ash at 550. The obtained ash from ash determinations were used for analysis of minerals according to the [2] procedures.

The ash was dissolved in 20 ml of 1 N HCl and heated for 5 minutes at 70°C. The solute was then transferred quantitatively to a 100 ml volumetric flask and made up to volume with distilled water. Mineral content (Ca, Fe & K) were determined by AAS through absorbance of sample and standard solutions was carefully recorded. The standard curve plot of absorbance against the known concentration of standard solutions was used to determine the concentration of minerals.

Sensory evaluation: Sensory evaluation of mango squash prepared from different mangoes were conducted the sensory evaluation of color, flavor, consistency, and overall acceptability for both preliminary test and shelf-life study by 20 semi-trained test panelists.

The sensory evaluation was carried out using semi trained sensory panelist's consisting of students and staff from the department of Food Science and Postharvest Technology, Arba Minch University. Each panelist received samples labeled with reference and code numbers. A 9-point Hedonic test scales were used to analysis the sensory attributes. The panel members were selected on the basis of their ability to discriminate and scale a broad range of different attributes of squash prepared from marketable and unmarketable mango fruit. Finally, the average value of each sensory attributes was analyzed using Statistical analysis software (SAS) version 9.1.

Data analysis: The data obtained for each parameter was subjected to statistical analysis software (SAS) version 9.1. All the experiments were conducted in triplicate and the mean were taken for statistical changes. The Analysis of Variance (ANOVA) was analysed to determine the level of significance. The least significant differences among means at ($P<0.05\%$) were further compared through Duncan Multiple Range Test [19].

RESULT AND DISCUSSION

The pulp yield of marketable and unmarketable mango fruit was carefully measured and recorded as the following for yield of pulp, peel, and stone weight, weight of fruit and percentage yield of pulp.

The weights of pulp peel and stone were recorded by taking the average weight of four fruits of each type. The average weight of mango fruits was recorded as 345 g and 342 g for marketable and unmarketable mango fruit respectively.

The weight of 281.2 g, 38.98 g and 23.8 g were recorded for pulp, peel and stone for marketable mango, whereas for unmarketable mango it was recorded as 228.45 g, 53.01 g and 23.6 g respectively.

Table 1: Preliminary test ratios of sugar to mango pulp for preparation of squash.

Squash source	Pulp to sugar ratio (kg)	Preliminary test			
		Color	Flavor	Consistency	Overall acceptance
Marketable mango	01:01.3	7.25	6.5	7.25	7.16
	01:01	7.5	7.15	7.5	7.43
	01:00.7	7	7	7	6.79
Unmarketable mango	01:01.3	7.5	7	7.25	7.37
	01:01	7.5	7.25	7.25	7.45
	01:00.7	7.25	7	7.25	6.87

Source: Panelist test result of preliminary trial (2021)

As depicated in the product acceptability test of squash from both marketable and unmarketable mango were almost same in the two products developed from unmarketable mango fruit pulp to sugar ratio of (1:1) had the highest consumer acceptability as in depicted in Table 1 followed by product developed from marketable mango with ratio (1:1) of pulp to sugar. Based on the high consumer acceptability of the products, the products were produced with the same procedure and stored for further analysis. The major observation reached while preparing the squash was as under proper condition and its end point was achieved by measuring the TSS of 68rix and stored at a temperature of 105°C.

Vitamin C: Vitamins C content of the squash prepared from marketable and unmarketable mangoes are presented in Table 2. Vitamin C content of 24.59 mg/100 g was observed in the squash prepared from unmarketable mango fruit storage time and temperature had a significant effect on vitamin C content of the mango squash. Vitamin C content of mango squash ranged from 17.66-24.59 mg/100 g of the product during storage. The lowest value of 17.66 mg/100 g vitamin C was observed in the product stored for 90 days at incubator. Perianal of the date reveals that the loss of vitamin C has been observed maximum at incubator. Higher storage temperature causes more losses of vitamin C. This was also reported by earlier writers of [17]. Vitamin C content of 11.63-24.40 mg/100 g in fruit squash was also reported by [17]. It is ranged from 17.66-24.59 mg/100 g which was in line with the values of vitamin C content ranged from 11.63-24.40 mg/100 g reported by [17]. It is the least stable of all vitamins and will easily be destroyed during processing and storage, thus the exposure to oxygen; light and prolonged heating in the presence of oxygen during processing will decrease the vitamin C content of foods [7]. The low contents of vitamin C content squash could be linked to the destructive nature of squash making process. Processing of fruits into squash has been revealed to be most damaging towards vitamin C [21] which explains low vitamin C content in squash. As report of vitamin C is integral in biochemical process in human body.

Table 2: Effect of storage temperature and time on vitamin C and beta carotene of mango squash (mg/100 g).

Storage	Mango	Vitamin C			Beta carotene		
period	types	Refr	RT	Inc	Refr	RT	Inc
1 day	Mm	24.59	24.59	24.59	5.72	5.71	5.67
	Umm	24.59	24.59	24.59	5.72	5.52	5.62
30 days	Mm	22.4	23.19	23.16	5.63	5.22	4.75
	Umm	20.77	23.53	23.43	5.18	4.85	4.65
60 days	Mm	20.77	22.36	22.36	5.33	4.83	4.45
	Umm	18.52	22.35	22.65	5.37	4.42	4.35
90 days	Mm	18.52	21.34	21.37	4.87	4.44	4.11
	Umm	17.66	22.46	21.19	4.93	4.29	4.11

CV%	1.38	2.65
LSD(5%)	0.5066	0.2174

Where:- Mm: marketable mango; Umm:Unmarketable mango; Refer: refrigerator, RT: room temperature, Inc.: incubator CV: coefficient of variation and LSD: least significant difference.

Beta carotene: There was a decrease in the beta carotene content during storage of the product. Higher losses were observed at higher storage temperature. Earlier researches have also reported similar observations in various fruit products. In all treatments beta carotene content was ranged from 4.11-5.72 mg/100 g. This study is similar to the report of [14] who reported that the beta carotene content of mango squash stored under room temperature and refrigerator range from 4.70-5.73 mg/100 g. Beta carotene content of all different storage temperatures has observed the same mean value at first day, but when the storage period was increasing the content of beta carotene was decreased. The highest reduction of beta carotene content was observed in room temperature and incubator. This could be due to the oxidation of pigments during storage may be responsible for loss of beta carotene content and also may be due to metabolic pathways affected at high temperature.

Table 3: Effect of storage temperature and time on selected minerals of mango squash (mg/100 g).

Storage	Mango	Calcium			Potassium	Iron				
period	types	Refr	RT	Inc	Refr	RT	Inc	Refr	RT	Inc
1 day	Mm	33.59	33.59	33.45	37.42	37.49	37.56	2.64	2.58	2.58
	Umm	33.42	33.49	33.45	37.52	37.52	37.59	2.48	2.48	2.58
30 days	Mm	32.49	32.51	33.57	34.42	35.47	36.51	2.47	2.41	2.49
	Umm	32.54	32.54	31.54	33.45	37.49	35.52	2.56	2.17	2.56
60 days	Mm	31.51	31.42	32.55	32.58	34.58	34.56	2.52	2.42	2.45
	Umm	30.35	32.52	30.56	31.43	35.54	33.39	2.34	2.46	2.42
90 days	Mm	30.45	32.46	31.47	30.57	33.17	32.46	2.44	2.42	2.65
	Umm	28.42	32.54	27.5	28.5	33.59	31.53	2.14	2.61	2.53
CV %		1. 26	1.27	4.16						
LSD(5%)		0.664	0.7218	0.1696						

Where: Mm: marketable mango; Umm:Unmarketable mango; Refer: refrigerator, RT: room temperature, Inc.: incubator CV: coefficient of variation and LSD: least significant difference.

Calcium: The calcium content of the squash prepared from marketable and unmarketable mango fruit was ranged from 27.5-33.59 mg/100 g of the product during storage. The highest calcium content of 33.59 mg/100 g was observed in squash prepared from unmarketable mango fruit initially, whereas the lowest calcium content of 27.50 mg/100 g was observed in squash prepared from unmarketable mango fruit after 90 days storage at incubator. The different storage temperature and time of the product was presented in Table 3. A study of earlier reports also shows similar results of calcium content in mango squash of 33.95 mg/100 g reported by [17]. The present findings were in line with the mango squash of calcium content as reported by [17]. It is also slightly similar study as recommended by [20] calcium content of mango squash.

Potassium: Potassium content of the squash prepared from marketable and unmarketable mangoes were presented in Table 3. The potassium content of 37.49 mg/100 g was recorded in the squash prepared from marketable mango fruit; whereas it was observed 37.52 mg/100 g in squash prepared from unmarketable mango fruit in initially. The potassium content of squash prepared from both marketable and unmarketable mango fruit that stored under refrigerator, room temperature and incubator at initial day were observed whereas, the lowest potassium content of 30.57 mg/100 g was recorded in squash prepared from marketable mango stored under refrigerator at 90 days followed by 31.43 mg/100 g for squash prepared from unmarketable mango that stored under refrigerator at 90 days. The overall ranged value from 30.57-37.59 mg/100 g was recorded. This result has acceptable potassium content of the recommended by [20] potassium content in quality mango squash and it is in line with the study of [17] who reported that the potassium content of 37.88 mg/100 g mango squash.

Iron: Iron content of the marketable and unmarketable mango squash is presented in Table 3. The iron content of 2.58 mg/100 g on fresh weight was observed in squash prepared from marketable mango in first day storage under room temperature, whereas it was recorded 2.48 mg/100 g for squash prepared from unmarketable mango fruit in first day storage under room temperature. The highest iron content of 2.65 mg/100 g was observed in squash prepared from marketable mango fruit

which was stored under incubator at 90 days followed by 2.64 mg/100 g in squash prepared from marketable mango in first day storage under refrigerator, whereas the lowest iron content of 2.14 mg/100 g was recorded in squash prepared from unmarketable mango at 90 days under incubator. The iron content is gradually decreasing in all treatments when the storage time and temperature is increasing. This could be due to the movable nature of metals iron and zinc in temperatureduring storage period. The range value of iron was fall from 2.14-2.65 mg/100 g. This is closed study with the result of iron content of 2.62 mg/100 g mango squash reported by [17] and also similar result with the recommended value of quality mango squash iron content by [20].

Table 4: Effect of storage temperature a nd time on sensory evaluation of mango squash (mg/100 g).

Storage	Mango	Colour			Flavour	Consistency	Overall acceptance						
period	type	Refr	RT	Inc	Refr	RT	Inc	Refr	RT	Inc	Refr	RT	Inc
1 day	Mm	7.86	7.75	7.64	7.43	7.5	7.43	7.43	7.63	7.76	8.18	8.54	8.13
	Umm	7.84	7.93	7.54	7.43	7.43	6.8	7.85	7.65	7.42	8.5	8.47	7.64
30 days	Mm	7.54	7.75	7.75	7	7.29	7.12	7	7.22	7.24	7.39	8.11	8.13
	Umm	7.67	7.75	6.67	7.12	7.19	6.67	7.14	7.74	7.15	8.22	8.3	7.36
60 days	Mm	7.13	7.54	6.84	6.39	6.95	6.78	6.39	6.87	7.24	7.23	7.87	7.66
	Umm	7.35	7.95	6.24	6.77	7.25	6.69	7.23	7.85	6.75	7.56	8.47	7.35
90 days	Mm	6.65	7.32	6.52	6.04	6.93	6.44	6.04	6.42	6.84	6.66	7.75	7.34
	Umm	6.67	7.2	6.15	6.45	7	6.53	6.65	7.13	6.64	7.23	7.53	6.75
CV%		2.08	3.28	1.48	2.28								
LSD(5%)		0.2498	0.3745	0.1748	0.2918								

Sensory Evaluation: The mango squash prepared from marketable and unmarketable mango fruit, treated with specified treatments and stored for 90 days under refrigerator, room temperature and incubator was assessed for sensorial quality parameters at a frequent interval of 30 days. The first day sensory attribute score of color 7.75, flavour 7.50, consistency 8.16, and overall acceptance 8.54 were recorded in squash prepared from marketable mango fruit, whereas it was observed in the squash prepared from unmarketable mango was at initial day storage under room temperature 7.93 colour, 7.43 flavors, 8.16 consistencies, and 8.47 overall acceptances. The colour recorded of squash prepared from marketable mango ranged from 6.52-7.86 whereas it was ranged from 6.15-7.93 in squash prepared from unmarketable mango. Maximum score of colour 7.95 was observed in squash prepared from unmarketable mango after 30 days under room temperature, whereas the minimum score of 6.15 was recorded for squash prepared from unmarketable mango after 90 days under incubator. The score of colour value was gradually decreasing during storage time increasing in all treatments. The reduction in colour scores might be due to superimposition of intermediate colour developed due to mail lard reaction accelerated between reducing sugars and amino acids during storage. The flavour score of 7.5 of the squash prepared from marketable mango was recorded first day under storage of room temperature, whereas it was recorded 7.43 in squash prepared from unmarketable mango at first day under room temperature. The ranged value of flavour 6.04-7.5 in squash prepared from marketable mango, whereas it was ranged from 6.53-7.43 in squash prepared from unmarketable mango. The maximum flavor score of 7.50 was recorded in squash prepared from marketable mango at first day under room temperature, whereas the minimum flavor score of 6.04 was recorded in squash prepared from marketable mango after 90 days both under refrigerator and incubator. The reduction of flavour could be due to that unmarketable mango fruit has high content of sugar due to its ripening process conversion of organic acid to simple sugar like fructose [13].

Interestingly, a great variability in the scores for overall acceptability of these twenty four mango squash was observed. Squash from marketable mango in firs day under refrigerator, squash from marketable mango in first day under room temperature, squash from marketable after 30 day under room temperature, squash from marketable mango in first day under incubator, squash from marketable mango after 30 day under incubator, squash from unmarketable mango in first day under refrigerator, squash from unmarketable mango after 30 days day under refrigerator, squash from unmarketable mango in first day under room temperature and squash from unmarketable mango after 30 day under room temperature rated as best by the judges suggesting that no particular treatment could be regarded the best from all samples (Table 1). Degree of ripeness at which a fruit is tested, plays a major role in the assessment of its sensory qualities and acceptability [15]. 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, phenolic and a number of volatile compounds. All these changes lead to ripening of fruit with softening of consistency to acceptable quality. These factors predominantly contribute towards developing a total sensory profile of the mango products [10].

CONCLUSIONS AND RECOMMENDATIONS

From the results obtained in this study the following points can be concluded: The squash prepared from unmarketable mango has similar results to squash prepared from marketable mango. The squash prepared from unmarketable mango is rich in the mineral elements (Ca, Mg and Fe) relative to the reference squash prepared from marketable mango. The squash prepared from unmarketable mango has shown to be accepted by consumers. When compared with squash prepared from marketable mango there was no significant differences between the two squash in sensory attributes. It is an opportunity for exploring the possibility of producing other value added food products in order to preserve the fruit during off seasons and also to reduce postharvest losses.

The two treatments namely (squash prepared from marketable mango after 90 days under refrigerator and squash prepared from unmarketable mango after 90 days under incubator) were recognized to be relatively inferior but the judges did not reject this treatment for overall acceptability. The squash prepared has been well accepted however some improvement should be made to make it more attractive to consumers. The flavour of squash made from both mango types should be improved to make it more acceptable. Because of its highly perishable in nature, to preserve the unmarketable mango for longer period should be promoted through production of many other value added food products such as jelly, juice, candy bar, mango chips, fruit preserves all these can be processed by simple techniques so as to reduce postharvest losses and can be sold in domestic as well as external market to increase income. Government through extension workers and NGOs should promote the utilization of such lots into value added products to generate income for farmers, traders, small scale business owners and enterprises in order to increase farmers' income and improve their livelihood. A regular training of the small scale farmers and entrepreneurs and other stakeholders on how to procedures of processing operation on utilizing such unmarketable mango by simple technologies and its advantages in order to allow them have a full knowledge of the technology that will always strengthen their economic status by creating employment for them. Further research is needed in order to understand more about unmarketable mango fruit to produce squash because it has many defects so one can identify which type of defects are good for developing specific processed food products which are of health benefits potential. Advantage should be taken of the utilization of this fruits which is rich in many important nutrients.

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