International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 4, No. 2, p. 21-29, 2014

INNSPUB

RESEARCH PAPER OPEN ACCESS

Proximate composition and some physical attributes of three mango (*Mangifera indica* L.) fruit varieties

S. T. Ubwa[1*], M. O. Ishu[2], , J. O. Offem[1], , R. L. Tyohemba[1], G. O. Igbum[1]

[1]*Department of Chemistry, Benue State University, Makurdi-Nigeria*

[2]*Department of Physiology, Pharmacology & Biochemistry, Federal University of Agriculture, Makurdi-Nigeria*

Article published on February 25, 2014

Key words: Mango, proximate, analysis, sensory, nutritional.

Abstract

The proximate composition and some physical parameters of three mango (*Mangifera indica L.*) fruit varieties; {'Hindi' mango (HM), 'Julie mango (JM) and Local mango (LM)} were determined. Ripe fruits were pretreated and analysed for moisture; protein; crude fibre; crude fat; ash; carbohydrate; nitrogen free extract (NFE); pH; total soluble solids (TSS); reducing sugars; vitamin C and sensory using standard methods. The results expressed as means of triplicate determinations ± standard deviation: were as follows; moisture content: HM (78.41 %), JM (77.85 %), LM (82.22 %); Protein (g/100g): HM (1.38), JM (1.65), LM (1.30); crude fat (g/100 g): HM (0.16), JM (0.06), LM (0.072); carbohydrates (g/100 g): HM (19.60), JM (19.78), LM (16.25); Vitamin C (g/100 g): HM (7.24), JM (11.23), LM (6.04); ash (g/100 g): HM (0.45), JM (0.66), LM(0.31); crude fibre (g/100 g): HM (0.84), JM (1.11), LM (0.94); Reducing Sugars (g/100 g): HM (6.38), JM (6.20), LM (6.04); NFE (g/100 g): HM (18.68), JM (18.75), LM (15.31); TSS (Brix): HM (20.75), JM (18.8), LM (17.31); pH: HM (5.62), JM (5.22), LM (4.72). Sensory analysis of the parameters tested; appearance, odour, taste, texture and over all acceptability showed that only the taste of the mango fruit varieties was significantly different. The dietary parameters of the mango fruit pulps in this study were compared with benchmark for fruit groups and found to meet local and international requirements recommended by EU/WHO and National Agency for Food and Drug Administration and Control (NAFDAC, Nigeria). The Julie mango variety (JM) was found to have higher nutritional quality and most acceptable from sensory evaluation. The results showed that these mango fruit varieties are of high nutritional quality and will compete favourably in the international market.

* **Corresponding Author:** Ubwa, S. T. ✉ drsimonterverubwa@gmail.com

Introduction

Mango (*Mangifera indica* L.), is an Indian or a tropical evergreen(deciduous) tree which produces green fruits when unripe but green to light green or yellowish to reddish (sweet, juicy and succulent) fruits when ripe (Seifu, 2010; Bally, 2006 & Morton, 1987). *Mangifera indica* is the most economically important fruit in the Anacardiaceae family (Seifu, 2010; Bally, 2006). The genus *Mangifera* contains several species that bear edible fruits. Most of the fruit trees that are commonly known as mangos belong to the species *Mangifera indica* L. There are other edible *Mangifera* species that generally have lower quality fruits that are commonly referred to as wild mangos (Bally, 2006).

The mango is known to have originated about 4000 years ago in Asia and the trees are favored by tropical and subtropical climate. They grow to about 18m (or even more) and bear fruits four to six years after planting. Among internationally traded tropical fruits, mangos rank second only to banana both in quantity and quality and fifth in total production among major fruit crops worldwide (Seifu, 2010; FAO, 2004). World production of mangoes is estimated to be over 26 million tons per annum and India ranks first among the world's producing countries, accounting for 54.2% of the total mangos produced worldwide. It is commercially the most important fruit crop in India with more than a thousand varieties known to date. The other prominent mango producing countries are China, Thailand, Mexico, Pakistan, Indonesia, Philippines and Nigeria (Morton, 1987; FAO, 2004).
Among the major producers of mango in the World, Nigeria ranks 8th (Morton, 1987; FAO, 2004; Yusuf & Salau, 2007), and Benue ranks first (1st) in the league of states that produce mangos in Nigeria (Yusuf & Salau, 2007). The other mango producing states in Nigeria include; Jigawa, Plateau, Kebbi, Niger, Kaduna, Kano, Bauchi, Sokoto, Adamawa Taraba and the Federal Capital Territory (FCT) (Yusuf & Salau, 2007). In Nigeria, the Hausas in the North call it 'mangoro' (FAO, 2004) while the Tivs in North-Central (Benue state), where it is mostly cultivated, call it 'mongo'.

The mango fruit is classified as a drupe (fleshy with a single seed enclosed in the endocarp) (Seifu, 2010; Bally, 2006). The mesocarp is the fleshy, edible part of the fruit that usually has a sweet and slightly turpentine flavor when ripe. Its colour varies from yellow to orange and its texture from smooth to fibrous (Bally, 2010; Morton, 1987). Blessed with all the natural ingredients, mango fruit juice possesses salient properties such as detoxification, energizing of human body, improving human complexion. It also contains tryptophan, the precursor for seratonin; the "happiness hormone" alongside Glutamine, known to be an important protein that enhances concentration in humans as well as memory gain. This has underscored its overwhelming acceptability and consumption worldwide. It is also medicinal, a natural antioxidant and a very good source of both vitamin A and vitamin C (Ajila *et al.,* 2007; Criqui and Ringel, 1994; Hertog *et al.,* 1993). The ripe pulp may be spiced and preserved in Jars. Ripe mangoes are sometimes peeled, sliced and canned in syrup, or made into jar, marmalade, jelly or nectar (Morton, 1987). The extracted pulpy juice of fibrous types is used for making mango halva and mango leather. Mango juice may be sprayed, dried, powdered and used in infant foods as well as foods for the physically challenged and invalid foods, or reconstituted and drunk as a beverage. The dried Juice, blended with wheat flour has been made into "cereal" flakes. A dehydrated mango custard powder has also been developed in India, especially for use in baby foods (Morton, 1987).

Although Benue state has contributed greatly in the production of mangoes which has earned Nigeria its 8th position on the chart of mango producers in the world, there has not been significant economic benefit resulting from this production. A greater part of the mangoes produced in Benue State is lost to poor post-harvest management and lack of good preservation techniques. Lack of adequate data on the chemical profile of the different varieties of mango fruits produced in Nigeria and absence of good market strategies have deprived Nigeria of trading this

important commodity in the international market. This informed the present study and subsequent ones. The study area was chosen because of the high preponderance of mango fruits produced therein. The study evaluates the nutritional quality of these abundant fruits and compares their chemical and physical properties with those in the international market.

Material and methods

Study area

Yandev is a town located in the Northeastern part of Gboko Local Government area of Benue state. Its centre lies at latitude 7°22′N and longitude 9°03′E and it has an elevation of 223 metres above sea level with an estimated population of 7750 (MONGABAY, 2013). The people are predominantly farmers and the presence of a College of Agriculture in the area must have played a significant role on their occupation. Fruit production is very eminent in the area with citrus, tomatoes, pepper and mangoes being the most cultivated.

Sample collection

Five mango trees of each of the studied varieties (Hindi, Julie and Local mango) were selected for sampling at an orchard in Tse-Apev compound in Yandev the study location. From each of the mango trees, fruits of appreciably even level of ripening were carefully hand plucked, labeled according to the trees of origin and transported to the laboratory for storage in the refrigerator at 15°C.

Sample preparation

Five, fully matured ripe mango fruits from each of five trees of each variety were randomly selected, thoroughly washed in warm water, to remove gummy sap or other materials. With the aid of a clean sharp knife, the peels, pulp and seed (kernel) of the mango fruits were removed. The average weight of the peel, pulp and kernel for each fruit was recorded before pooling each component together to form composite sample for each tree. This means that each variety had five samples giving a total of fifteen (15) samples in all. The pulps from each batch of five fruits were fed into a blender (Sharp blender model; EM-11) and homogenized. The speed switch was set to number II and the pulp blended for five (5) minutes. The resulting pulp here-in referred to as the juice was introduced into plastic bottles and preserved in a refrigerator at 15°C until required for analysis.

Determination of proximate composition

The proximate parameters viz; crude protein, crude fiber, moisture content, pH, fat content, carbohydrate content and vitamin C of the study mango variety samples were determined using the standard analytical method of Association of Official Analytical Chemists, AOAC (2000). All measurements were in triplicate and reagents used were Analar grade.

Sensory analysis

A method similar to that reported by Iwe (2002) was adopted for the sensory evaluation. A panel of ten (10) semi-trained members (from the Department of Food Science and Technology, University of Agriculture Makurdi, Benue State) of which three (3) were female and seven (7) male was used to judge the quality of the mango fruits. Panelists were asked to give acceptance score for four attributes; colour, aroma, taste and overall acceptability using a 5 point hedonic scale from 1 to 5 as follows: 1: Extremely dislike; 2: Dislike; 3: Neither like nor dislike; 4: Like and 5: Extremely like. The juice from the mango fruits were placed in three (3) glasses which were given codes and subsequently served randomly to each panelist.

Results and discussion

Three mango varieties comprising two improved varieties; [Hindi mango (HM) and Julie mango (JM) and one local variety 'Ichul Kpev' (LM)] were investigated for their proximate composition, sensory evaluation and some physical properties.

Physical characteristics of the components of the studied mango fruits

Results in table 1 show the mass of the fruit varieties and their percentage composition. For fruit mass, the highest value was recorded in JM (264.82±0.02 g),

followed by HM (264.82±0.02 g) and LM (234.16±0.02 g). Percentage peel component of the fruits was in the order JM (26.11 %), HM (19.74 %) and LM (17.83 %). In the pulp components, highest value was also recorded in JM (66.23 %), followed by LM (65.65 %) and HM (62.01 %). HM had the highest seed component (18.10 %), LM (15.91 %) and the least

Table 1. Mass of Mango fruits varieties vs. percentage by mass of fruits components.

Variety	Mass of fruit (g)	% mass of peel	% mass of seed	% mass of pulp
HM	239.58±0.02	19.74±0.01	18.10±0.01	62.01±0.01
JM	264.82±0.02	26.11±0.01	7.46±0.01	66.23±0.01
LM	234.16±0.02	17.83±0.00	15.91±0.02	65.65±0.01

HM: Hindi Mango fruits, JM: Julie Mango fruits, LM: Local Mango fruits.

Table 2. Result of the proximate composition of the pulp of mango fruit varieties.

Sample →	HM	JM	LM
Moisture Content (%)	78.41±0.02^{a}	77.85±0.02^{b}	82.22±0.02^{c}
Crude Protein (g/100g)	1.38±0.02^{a}	1.65±0.01^{a}	1.30±0.02^{a}
Crude Fat (g/100g)	0.16±0.01^{a}	0.06±0.00^{a}	0.072±0.00^{a}
Carbohydrates (g/100g)	19.60±0.02^{a}	19.78±0.02^{a}	16.25±0.02^{a}
Vitamin C (g/100g)	7.24±0.02 ^{a}	11.23±0.01^{a}	6.04±0.01^{a}
Crude Ash (g/100g	0.45±0.01^{a}	0.66±0.01^{b}	0.31±0.00^{c}
Crude Fibre (g/100g)	0.84±0.01^{a}	1.11±0.01^{a}	0.94±0.01^{a}
Reducing Sugar (%)	6.38±0.00^{a}	6.20±0.00^{b}	6.04±0.01^{c}
NFE (g/100g)	18.68±0.01^{a}	18.75±0.02^{a}	15.31±0.01^{a}
TSS (^{o}Brix)	20.75±0.0^{a}	18.8±0.01^{a}	17.31±0.1^{a}
pH	5.62±0.0^{a}	5.22±0.0^{a}	4.72±0.0^{a}

Means within the same row having the same superscripted letters are not significantly different (P≥0.05) according to the Duncan multiple range test. HM: Hindi Mango fruits; JM: Julie Mango fruits; LM: Local Mango fruits; NFE: Nitrogen free extract; ND: Not Detected.

seed component was observed in JM (7.46 %). Statistical Analysis of Variance (ANOVA) showed a significant difference between the masses of peels, seeds and pulps of these varieties (p≥0.05). The data obtained for seed and peel mass are comparatively higher than the 10.53 % to 10.70 % and 7.0 % to 7.9% recorded by Abdualrahman (2013) while the percentage pulp composition recorded in the present study (62.01 to 66.23 %) are lower than the same varieties of mangoes fruits in Southern Drafur, Sudan (Abdualrahman, 2013).

Proximate Composition of the mango fruit varieties

Results

Result of the proximate composition for the pulps of the mango fruit varieties are presented in table 2. The local mango variety (LM) was observed to have the highest moisture content (82.22±0.02%) and Julie mango variety (JM) had the lowest moisture content in its pulp. There was a significant difference between the moisture content of the fruit samples (p≤0.05). The lowest amount of protein was observed in LM (1.30±0.02 g/100g) and the highest in JM (1.65±0.01 g/100g). Crude fat content varied from 0.06 g/100g to 0.16 g/100g. The highest amount of crude fat (0.16±0.01 g/100g) was recorded in the pulp of the 'Hindi' variety (HM) and the lowest (0.06±0.00 g/100g) in JM. The carbohydrate content of JM (19.78±0.02 g/100g) and HM (19.60±0.02 g/100g) were observed to be higher than LM (16.25±0.02 g/100g). A similar trend was observed in the ascorbic acid content of mango fruit pulp samples. JM recorded the highest ascorbic acid content (11.23±0.01 g/100g) followed by HM and LM. There was a statistically significant difference in the ash content of the samples (p≤0.05). The lowest ash

content was observed in LM (0.31±0.00 g/100g) while JM and HM had higher values of (0.66±0.01 g/100g and 0.45±0.01 g/100g) respectively. Statistical analysis showed no significant variation in the crude fibre content of HM, JM and LM. However, JM recorded the highest crude fibre content (1.11±0.01 g/100g) and the lowest crude fibre content (0.84±0.01 g/100g) was observed in HM. Reducing sugars in the fruits pulp samples ranged between 6.04±0.01 to 6.38±0.00 %. The highest concentration (6.38±0.00 g/100g) was observed in HM and lowest concentration in LM (6.04±0.01) table 2. There was a significant difference between the mean values of reducing sugars in the fruits' pulp samples. Fruits with higher Nitrogen free extract (NFE) are JM with (18.75±0.02 g/100g) and HM with (18.68±0.01 g/100g) while the lowest content of NFE was observed in LM (15.31±0.01 g/100g). Total soluble solids (TSS) and pH of fruit pulp samples showed a similar trend; (20.75, 18.8 ^{o}Brix and 5.62, 5.22) being recorded in HM and JM while lower values of 17.31 ^{o}Brix and 4.72) were observed in the LM. Statistical analysis showed no significant difference in the TSS and pH of the fruits' pulp samples.

Discussion

The high moisture content of 77.85% to 82.22 % observed in the fruits pulp implies that the fruits pulps have a short shelf life (Nwofia, *et al.*, 2012). From the results obtained in this study, the fruits would need to be stored in a cool condition if they are to be kept for a long period or would be needed to be processed as quickly as possible to avoid microbial spoilage (Nwofia, *et al.*, 2012; Abulude, *et al.*, 2006). The moisture content of the pulp of mango fruit varieties was found to be at par with those reported by (Mohammed & Yakubu, 2013; Abdualrahman, 2013; Arumugan & Manikandan, 2011; Gopalan *et al.*, & Rathore, 2009) for mango fruits in Kaduna, Northern Nigeria, Drafur in Sudan, Ethiopia and India but lower than the upper limits of (86.1 and 84.12) % earlier reported by (Othman & Mbago; Wenkam & Miller, 1965) for mango fruit varieties in Tanzania and Hawaii.

The crude protein content in the pulps of the mango fruits reported in this study were above the EU/WHO (2000) recommended limits of 1 g/100g for fruit groups but are within the same range of (1.97 to 2.16) earlier reported by Mohammed & Yakubu (2013) in mango fruit varieties in Kaduna, Nigeria but higher than values obtained from similar studies on mango fruits in Sudan, India and Hawaii (Abdualrahman, 2013; Gopalan *et al.*, Wenkam & Miller, 1965). However, the values reported in this study are far below the 7.96 % protein reported by Arumugan & Manikandan, (2011) for mango fruits varieties in Ethiopia. The difference in nutritional content of these studies could have arisen from environmental factors and cultural practices (Ishu, 2013). Earlier reports by Ene-Bong (1992) indicate that diet is nutritionally satisfactory, if it contains high calorific value and a sufficient amount of protein. It has been shown that any plant foods that provide about 12% of their calorific value from protein are considered good sources of protein (Ali, 2010; Effiong *et al.*, 2009) an observation which is similar to the recommendations of the National Agency for Food and drug Administration and Control (NAFDAC), 2010 in Nigeria. The implication is that mango fruits are generally not a rich source of protein.

The values of crude fat obtained for the pulps of the mango fruit varieties (table 2) are lower than the 0.5 g/100g maximum limit recommended by NAFDAC for fat free foods and the 0.25 g/100g values recommended by EU/WHO for fruit groups. However, the values of crude fat reported in this study are relatively lower than the values reported by Mohammed & Yakubu, 2013 and Arumugan & Manikandan, 2011 but HM had crude fat in amounts higher than the values reported by Othman & Mbago, 2009; Wenkam & Miller, (1965) for mango fruits in Tanzania and Hawaii. Nwofia *et al.*, (2012) have earlier reported that low lipid concentration in fruits indicates that the lipids are mobilized and stored in the seeds thereby making the fruits a good food for people suffering from obesity. Thus the mango fruit varieties can be recommended for people suffering from this ailment. The carbohydrate content in the

pulps of the studied mango fruit varieties (table 2) is higher than 15 g/100g minimum requirement for fruit groups recommended by EU/WHO and is also in favourable agreement with values reported for similar studies on mango fruits in Kaduna in Nigeria, other parts of Africa, Hawaii and India (Mohammed & Yakubu, 2013; Abdualrahman, 2013; Arumugan & Manikandan, 2011; Othman & Mbago; Wenkam & Miller, 1965; Rathore, 2009). Notwithstanding, the

Appendix I: Results from similar studies on mango fruits

	Mohammed & Yakubu, 2013 (Kaduna-Nigeria)	Abdualrahman, 2013 (Drafur-Sudan)	Othman & Mbogo, 2009 (Tanzania)	Arumugam & Manikandan, 2011 (Ethiopia)	Gopalan *et al*, 2000; Rathore, 2009 (India)	Wenkam & Miller,1965 (Hawaii)
Moisture Content (%)	72.04-79.76	77.40-78.70	56.3-86.1	81.26	79.9-81.71	79.97-84.12
Crude Protein (g/100g)	1.97-2.16	0.74-0.82	-	7.96	0.51	0.39-0.55
Crude Fat (g/100g)	1.52-1.89	0.29-0.38	0.20-0.22	1.48	-	0.02-0,20
Carbohydrates (g/100g)	7.16-16.59	14.10-15.40	-	-	17.00	15.05-18.92
Vitamin C (g/100g)	34.12-35.20	-	5.0-25.2	-	27.7	15.0-15.1
Crude Ash (g/100g	6.40-9.81	1.35-1.70	0.55-0.57	6.24	-	0.42-0.37
Crude Fibre (g/100g)	-	4.20-4.50	0.85-0.87	23.07 (as TDF)	0.70	0.54-0.70
Reducing Sugar (%)	-	-	9.6-24.2	-	ND	-
NFE (g/100g)	-	-	-	-	-	-
TSS (^{o}Brix)	-	66.80-67.00	14.5-30.0	-	-	-
pH	-	3.40-3.60	-	-	-	-

values in the present study are above the earlier studies reported in appendix I.

The Vitamin C values in the pulps of our mango fruit varieties imply that they are good sources of the vitamin with JM being of the highest source. The fruit pulps meet the minimum Vitamin C requirement of (15 mg/100g and 80 mg/100g) recommended by EU/WHO and NAFDAC for fruit groups. However, the ascorbic acid content of the mango fruit varieties in this study are lower than the amounts reported by Mohammed & Yakubu (2013) in Kaduna and other authors (Rathore, 2009; Wenkam & Miller, 1965) in India and Hawaii but at par with similar studies on mango fruits varieties in Tanzania (Othman & Mbago, 2009). Vitamin C plays an active role in human health and welfare mostly as an antioxidant (Nwofia *et al.*, 2012). It is also generally used for protein metabolism and collagen synthesis (Vunchi *et al.*, 2011). The proportion of ash in any food is a reflection of its mineral content (Vunchi *et al.*, 2011., Omotosho, 2005 & Nnamani, *et al.*, 2009). Thus this study suggests that JM fruits have higher deposits of mineral elements than HM and LM fruits. Mohammed & Yakubu (2013) found higher ash content in JM fruit variety in Kaduna compared to 'Peter' Variety but lower in the 'Durshea variety. Our results for ash content are in agreement with 0.42 to 0.37 % and 0.55 to 0.57 % recorded for mango fruit varieties in Hawaii and Tanzania (Wenkam & Miller, 1965; Othman & Mbago, 2009). However, the ash content values of our fruits are lower than those reported by in Kaduna, Sudan and Ethiopia (Mohammed & Yakubu (2013); Abdualrahman, 2013; Arumugan & Manikandan, 2011).

Crude fibre content of the mango fruits pulp is relatively low in comparison to NAFDAC minimum requirement of 3 g/100g for source of fibre and the EU/WHO recommended limit of 2.5 g/100g for fruit

groups. The crude fibre content of fruit pulps in the present study are also lower than those recorded in studies elsewhere. Arumugan & Manikanda (2011) have reported total dietary fibre content as high as 23.07 % in mango fruit pulp in Ethiopia. Crude fibre content in the range of 0.85 to 0.87 g/100g reported by Othman & Mbago (2009) are in agreement with the present study but the values reported elsewhere (WHO/EU (2000) & Effiong *et al.*, 2009] are lower. Dietary fibre helps to maintain the health of gastrointestinal track but, in excess, may bind trace elements, leading to deficiencies of some of these micro nutrients in the body (Siddhuraju *et al.*, 1996). Table 2 also shows that HM recorded the highest amounts of reducing sugars in its pulp while the least amount was found in LM. The amount of reducing sugars in these samples is slightly above the NAFDAC recommended limit of 5 g/100g for low sugar foods. The total soluble solids of the HM is above the 20 % minimum requirement for mango beverage recommended by NAFDAC (2013) while JM and HM had their TSS values slightly below the local regulatory standard. TSS content of the mango fruits pulps are higher than the lower limit of 14.5 earlier reported by [19] in mango fruit varieties in Tanzania but lower than the range of 66.8 to 67.00 ^{o}Brix reported by Abdualrahman (2013). TSS in fruit is an index used to determine the maturity of fruits and it is a strong indication of the harvesting time. Differences in the TSS content of fruits could result from the differences in varieties and climatic conditions (Rahman, *et al.*, 2010).

Van Soest & Wine (1967) has reported that nitrogen free extract content of food represents the highly digestible carbohydrates. The result from the present study (table 2) showed lower values than those obtained by Arumugan & Manikandan (2011) for *Opuntia ficus-indica*; a fruit used as a livestock feed in Ethiopia. Not much work have been done to determine nitrogen free extract of mango fruits pulp but the result from this study shows an appreciable level of highly digestible carbohydrates in the mango fruit which is a good index in diets. Studies for the pH content of the mango fruit pulp as presented in table 2 are less acidic than the 3.40 to 3.60 reported for mango fruit pulp in Drafur region of Sudan (Abdualrahman, 2013). Again, differences in pH values can be attributed to species or variety differences as well as environmental factors. The LM variety is found to be more acidic than HM and JM which are improved varieties although statistical analysis of variance indicated no significant difference in the pH content of the fruits pulp.

Table 3. Sensory scores of Hindi, Julie and Local mango varieties

Parameter	HM	JM	LM	LSD
Appearance	7.50^{a}	7.00^{a}	7.50^{a}	1.48
Odour	6.80^{a}	7.40^{a}	7.10^{a}	1.38
Taste	7.30^{a}	7.80^{a}	6.20^{b}	1.84
Texture	7.50^{a}	7.30^{a}	7.20^{a}	1.64
Acceptability	7.40^{a}	7.80^{a}	7.00^{a}	1.55

Sensory analysis

The scores for sensory evaluation presented in table 4 showed that Julie mango variety (JM) had the highest acceptability by the panelists. Statistical analysis also showed a significant difference between the taste of the Local mango variety (LM) and the other varieties but not between JM and HM. No statistically significant differences were found in the other sensory parameters alongside their high scores. This is an indication of how appealing the mango fruits were found to be by the panelists.

Conclusion

The study has shown that the improved mango varieties (JM and HM) have both excellent eating and nutritional qualities when compared to the local variety (LM). The dietary parameters of the mango fruit pulps in this study; protein content, crude fat, carbohydrate content, sugars, ascorbic acid content and TSS on the average, meet local and international requirements recommended. The Julie mango variety (JM) was adjudged to have higher nutritional quality being found to contain the highest amount of nutritional parameters investigated and being the most acceptable from the sensory evaluation. The mango varieties in this study were also found to be at par with studies in other parts of Nigeria, Africa and

Asia in terms of some of their nutritional qualities and hence they will compete favourably in the international market.

Reference

Abdualrahman, MAY. 2013. Physico-chemical characteristics of different types of mango (*Mangifera indica L.*) fruits in Drafur region and its use in jam processing. Science International **1**(5), 144-147.

Abulude, FO, Eluyode OS, Adesanya WO, Elemide, OA, Koumah T. 2006. Proximate and selected mineral composition of *Mangifera indica* and *Persia americana* seeds found in Nigeria. Agricultural Journal **1**, 72-76.

Ajila CM, Naidu SG, Bhat SG, PrasadaRao UJA. 2007. Bioactive compounds and anti-oxidant potential of mango peel extract. Food chemistry **105**(3), 982 988.

Ali A. 2010. A comparative study of nutrients and mineral molar ratios of some plant foods with recommended dietary allowances. Journal of Food Science and Technology **2**, 104-108.

AOAC. 2000. Association of Official Analytical Chemists. Official methods of analysis, (Vol.II, 17th edition) of AOAC international, Washington DC, USA.

Arumugan R, Manikandan M. 2011. Fermentation of pretreated hydrolyzates of banana and mango fruit wastes for ethanol production. Asian J. Exp. Biol. Sci., **2**(2):246-256.

Bally, ISE. 2006. *Mangifera indica* (Mango) Ver, 3.1. In: Elevitch, C.R. (ed). 'Species profiles for pacific Island Agroforestry'. Permanent Agricultural Research (PAR). Holualoa, Hawaii. Retrieved from http//www.traditionaltree.org.

Criqui, MH, Ringel, BL. 1994. *Does diet or alcohol explain the French Paradox?* Lancet **344**, 1719 – 1723.

Effiong GS, Ibia, TO, Udofia, US 2009. Nutritive and energy values of some wild fruit spices in South Eastern Nigeria. *Electron.* Electronic Journal of Environmental, Agricultural and Food Chemistry **8**, 917-923.

Ene-Bong HN. 1992. Nutritional evaluation, composition pattern and processing of underutilized traditional foods with particular reference to the African yam beans (*Sphenostylis sternocarpa*). Ph.D Thesis, University of Nigeria Nsukka.

FAO. 2004. FAO Products Year report. Food and Agricultural Organization, Rome.

Gopalan C, Ramasastri BV, Balasubramanian SC. 2010. Proximate principles: Common foods. In. B.S. Narasinga Rao, K.C. Pant, and Y.G. Deosthale (Eds.), Nutritive value of Indian foods (Revised and updated edition). (pp53-55). Hyderabad, India: National institute of Nutition, ICMR.

Hertog, MGL, Feskens, EJM, Hallman PGH, Katan MB, Kromhout D. 1993. Dietary antioxidant flavonoids and risk of coronary heart disease:The Zutphen elderly study. Lancet: 1007 – 1014.

Ishu MO. 2013. Comparative proximate composition of the fruits juice of three varieties of *Mangifera indica* L. (mango). M.Sc Dissertation, Benue State University, Makurdi, Nigeria.

Iwe, MO. 2002. Handbook of sensory methods and analysis. 1st ed. Rejoint communication services Ltd., Enugu, Nigeria.

Mohammed SSM, Yakubu A. 2013. Comparative analysis of nutritional and anti-nutritional contents of some varieties of mango (*Mangifera indica*) in Kaduna metropolis-Nigeria. Research Journal of Applied Sciences, Engineering and Technology **5**(4), 387-391.

MONGABAY. 2013. Population of Yandev, Nigeria. Retrieved from www. Population.mong abay.com/population/Nigeria/2318374/yandev, 12/12/2013.

Morton, JF. 1987. 'Fruits of warm climate' (mango) 221-239. Miami Webster.

NAFDAC (National Agency for Food & Drug Administration & Control). 2013. Minimum Requirement for Analysis of Finished Product. Summary of Current Food standards as of 04 april, 2013.

NAFDAC (National Agency for Food & Drug Administration & Control). 2010. Nutrition, Health and other Claims on Food Regulations 2010.

Nnamani CV, Oselebe HO, Agbaufu A. 2009. Assessment of nutritional values of three underutilized indigenous leafy vegetables of Ebonyi State, Nigeria. African Journal of Biotechnology **8**, 2321-2324.

Nwofia GE, Nwogwu N, Nwofia KB. 2012. Nutritional variations in fruits and seeds of pumpkins (Cucurbita Spp); Accessions from Nigeria. Pakistanian Journal of Nutrition **11**(10), 848-858.

Omotosho OT. 2005. Nutritive quality, functional properties and anti-nutritive composition of the Larva of *Cirinda forda* (westwood) (*Lepidoptera saturniidae*) **7**, 51-55.

Othman OC, Mbago GP. 2009. Physico-chemical characteristics of storage ripened mango (*Mangifera indica* L.) fruits varieties of Eastern Tanzania. Tanzania Journal of Science **35**, 57-66.

Rahman MM, Fakir MSA, Rahman MM. 2010. Fruit growth of china cherry (*Muntinga calabura*). Bot. Res. Intl., **3**(2), 56-60.

Rathore M. 2009. Nutrient content of important fruit trees from arid zone of Rajasthan. Journal of Horticulture and Forestry **1**(7), 103-108.

Seifu Z. 2010. 'Production and quality evaluation of spray dried fruit products'. A Master of Science thesis Presented to the School of Postgraduate Studies, University of Addis Ababa, Ethiopia.

Siddhuraju P, Vijayakumari K, Janardhanan K. 1996. Chemical composition and nutritional evaluation of an under exploited legume, *Acacia nilotica* (L.) Del. Food Chemistry **57**(3), 385-391.

Van Soest PJ, Wine RH. 1967. Use of detergents in the analysis of fibrous feeds. IV. Determination of plant cell-wall constituents. Journal of the Association of Official Analytical Chemists **50**, 50-55.

Vunchi MA, Umar AN, King MA, Liman, AA, Jeremiah G, Aigbe, CO. 2011. Proximate, vitamins and mineral composition of *Vitex doniana* (black plum) fruit pulp. Nigerian Journal of Basic and Applied Sciences **19**(1), 97-101. J. Zhejiang univ. Sci.

Wenkam, NS, Miller CD. 1965. Composition of Hawaii fruits. University of Hawaii College of Tropical Agriculture, Hawaii Agricultural experiment station Honolulu, Bulletin No. 135.

World Health Organization/Europe. 2000. CINDI dietary guide. WHO Regional Office for Europe, Copenhagen, Denmark.

Yusuf, SA, Salau AS. 2007. *Forcasting Mango and Citrus Production in Nigeria*. Munich Personal RePEc Archive. Retreived from http//mpra.ub.unimuenchem.de/2691/MPRA paper No. 2691.