Asian Research Journal of Agriculture

6(4): 1-9, 2017; Article no.ARJA.36476
ISSN: 2456-561X

Evaluation of the Quality of Juice Prepared from African Bush Mango (*Irvingia garbonensis* Var. *garbonesis*) Fruit Pulp

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/ARJA/2017/36476
Editor(s):
(1) Nndamuleleni Murovhi, Agricultural Research Council, South Africa.
Reviewers:
(1) Mingyuan Wang, Huaqiao University, China.
(2) Uttara Singh, Government H.Sc. College, Panjab University, India.
Complete Peer review History: http://www.sciencedomain.org/review-history/21511

Original Research Article

Received 29th August 2017
Accepted 26th September 2017
Published 23rd October 2017

ABSTRACT

Aim: The study investigated the quality of juice prepared from African bush mango fruit pulp.
Study Design: The study was carried out in three replications and the data were analyzed using analysis of variance in completely randomized design.
Place and Duration of Study: The study was carried out at University of Nigeria Nsukka in 2014.
Methodology: African bush mango pulp was blended with hot water at 1:5 dilution and the slurry was filtered through double folded muslin cloth. The juice was ameliorated with 8% (w/v) sucrose and then pasteurized at 65°C for 30 min. The juice was treated with 0.1% (w/v) sodium benzoate. The pulp and the treated juice were analyzed for the chemical composition, mineral and phytochemical contents. The sensory properties of the untreated and the sodium benzoate treated juices were determined.
Results: The pH of the treated juice and pulp were 4.0 and 4.8, respectively. The juice contained 10°brix soluble solids while that of the pulp was 8°brix. The protein contents decreased from 4.8% in the pulp to 1.1% in the juice. Similarly, the carbohydrate contents decreased from 80.8% in the pulp to 7.72% in the juice. The juice contained lower energy content (41.58 Kcal/100 ml) than the pulp (355 Kcal/100 g). The vitamin C contents of the pulp and juice were 78 mg/100 g and 67 mg/100 ml, respectively. The Mg, Fe and Zn contents of the pulp were 104, 2.5 and 3.0 mg/100 g,

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respectively while the Mg, Fe and Z contents of the juice were 97, 1.3 and 1.9 mg/100 mg, respectively. The juice contained 272 mg/100 ml phenols, 1056 ug carotenoids, 395 mg/100 ml flavonoids and 43. 4 mg/100 ml anthocyanins. These phytochemicals were higher in the pulp than in the juice. The African bush mango juice and the sodium benzoate treated juice were not significantly different (p>0.05) in all the sensory properties evaluated. The juices were generally accepted by the panelists.

Conclusion: Accepted juice could be prepared from African bush fruit at 1:5 pulp to water dilution with 8% (w/v) sucrose addition. The juice was rich in vitamin C, essential minerals and phytochemicals.

Keywords: African bush mango; juice; phytochemical; sensory properties; chemical composition; fruit pulp.

1. INTRODUCTION

There are different varieties of wild fruit that are in abundance in Nigeria that could be of health benefit (Thompson, 2003). These fruits are seasonal and harvested for consumption on site or for sale in the urban centers .However, lack of information on the chemical composition, processing and health promoting potentials limit the maximum utilization of these fruits [1,2]. One of such fruit is African bush mango.

Irvingia gabonensis belongs to the family Irvingiaceace. The Irvingia species exists in two varieties as *Irvingia gabonensis* and *Irvingia excelsa*. *Irvingia gabonensis* var. *gabonensis*, commonly known as African bush mango or wild mango because the tree bears mango-like fruit is native to most tropical forests in the West and Central Africa [3]. It is locally known as *egili* among the *Igalas* of Kogi State, *oro, oba* among the Yoruba and *oghi* in *Etsako* of Edo State, Nigeria. The fruits are broadly ellipsoid, about 4-7cm long, green when unripe and yellow when ripe with fleshy mesocarp [3]. The fruit pulp is juicy and the taste varies between sweet and bitter [4]. The fruit is rich in vitamin C, minerals and phytochemicals such as flavonoids, alkaloids and tannins [5]. In West Africa, *I. gabonensis* tops the list of non-timber forest products and is being clamored for domestication [6]. The tree has high utility value for the leaves, fruit, bark, hardwood and root have several medicinal, food and industrial applications. The kernel is ground and used, often in conjunction with okro and vegetable for soup preparation as condiment [3]. The tasty mesocarp is widely consumed raw as dessert fruit or snack throughout Western and Central Africa for its health promoting potential [5]. Apart from the common use of the kernels as soup thickener in West Africa, the kernel oil and meal are potential materials for drug binding, confectionery edible fat and cosmetics [7]. The plant and the edible fruit are largely used in traditional and modern medicines for the treatment of several illnesses [3]. The leaves and the fruits are mixed with other herbs and used as drugs for the treatment of malaria. The fruit pulp is also combined with honey and used for treatment of dry cough, nervous activation for sexual feelings, sexual fragility in women and depressed libido in men [7]. African mango pulp has been used in the treatment of and management of obesity as well as analgesic, antimicrobial, antioxidants and gastrointestinal activity [7]. The health promoting property is due to the flavonoids in the pulp [7]. Flavonoids protect gastrointestinal tract, having antispasmodic, antidiarrheal, antibacterial, antisecretory and antiulcer properties as well as strong antioxidant capacities [8]. The health enhancing potential of flavonoids contribute to the health of locals in the villages across Nigeria who regularly eat fresh Irvingia fruits as snack [4,9].

In Nigeria, although, the pulp is consumed to a considerable extent among the locals in the rural areas, large quantities are usually wasted because of poor storage facilities, poor road network and inadequate processing and preservation capacity [10]. In Nigeria, no commercial value is attached to the fruit pulp. The common practice of processing the fruit by majority of the locals is to split the fruit manually with sharp cutlass. The kernel is then removed while the fleshy pulp (mesocarp) is thrown away and left to rot [4]. In some places, the fresh fruits are heaped in piles and fermented for few days. The rotten pulp is then washed away with water to obtain the nuts which are sun dried. The dried nuts are cracked to obtain the kernels. The fruit pulp which is usually washed away in these processes has the potential for preparation of juices, jams, jellies and wine [11]. However, the only extensive work done so far on the use of the pulp was that of Ogbona et al. [9] who explored the possibility of using it for the production of wine. The presence of flavonoids and dietary fiber makes African bush mango fruit pulp good candidate for juice preparation [10]. The trade in African bush mango kernel is on the increase [12] and thus, there is need to find processing applications for the fruit pulp. The processing of the fruit into juice will preserve the fruit, reduces post harvest losses and equalize availability in between seasons in addition to providing essential vitamins, minerals and phytochemicals to diets. Therefore, the objective of this study was to evaluate the quality of juice prepared from African bush mango fruit pulp.

2. MATERIALS AND METHODS

2.1 Preparation of African Bush Mango Juice

Mature, ripe and healthy African bush Mangoes were purchased from a local farm in Idah Township, Kogi State, Nigeria. Idah is located in the Eastern part of Kogi State in the Guinea savanna region of Nigeria. The mangoes were washed in a basin of tap water and stored in refrigerator (4°C) until used. The cleaned mangoes were peeled manually with sharp stainless knife. The pulp was then scraped from the kernel with the sharp knife. The pulp water were mixed at various rations of 1:1, 1:2, 1:3, 1:4, 1:, 1:5, 1:6, 1:7, 1:8, 1:9, 1:10 and 1:11. By sensory evaluation, as described later, the optimal pulp/water ratio for preparation of acceptable juice was determined at the ratio 1:5 (pulp: water). The pulp was blended with 100°C hot water (1:5, pulp: water) in Kenwood food processor operated at full speed (1200 rpm) for 10 min. The resulting slurry was screened through a double folded muslin cloth. Sucrose levels at 1-10% (w/v) were added to the juice and evaluated for sweetness. Sucrose at 8% (w/v)) based on sensory evaluation and 0.1% (w/v) sodium benzoate were added to the juice and thereafter, pasteurized at 65°C for 30 min in sterile bottles in water bath. The juice samples were stored in a refrigerator until required for analysis.

2.2 Evaluation of Chemical Composition

Moisture, ash, crude fiber, fat (solvent extraction) and protein (micro-Kjeldahl) contents were determined using the methods described by AOAC [13]. Carbohydrate was calculated by difference [13]. The calorie content was calculated by using Atwater factors (4 X % Protein, 4 X % Carbohydrate and 9 X % Fat), Vitamin C was determined by the 2, 6-dichlorophenol indophenol titration method described by AOAC [13]. The pH was measured with digital pH meter (Top tronic Milano, Italy) at 30°C as described by the AOAC [13] method. The titratable acidity (% lactic acid) was determined by titrating sample against 0.1 M NaOH to phenolphthalein end point. The volume of 01 N NaOH consumed for the titration was converted as percentage of lactic acid. Soluble solids (°brix) were determined using Abbe refractometer.

2.3 Evaluation of Mineral Composition

Sodium and potassium were determined by flame photometry [13]. Calcium, iron, magnesium and zinc were determined using atomic absorption spectrophotometer (AAS model 707, 11TA) following the methods described by the AOAC [13].

2.4 Evaluation of Phytochemical Composition

The carotenoids and flavonoids contents were determined using the methods of Obadoni and Ochuko [14]. The total phenol and anthocynanins contents were determined using the methods described by Onimawo and Akubor [8].

2.5 Sensory Evaluation

A 20 member trained panel consisting of staff and students (10 males and 10 females) of the Department of Food Science and Technology, University of Nigeria Nsukka, Nigeria, was recruited based on their familiarity with quality attributes of juice. The evaluation was carried out in a sensory evaluation laboratory under controlled conditions of lighting and ventilation. The panelists were served the samples in 3-digit coded transparent plastic bottles. The order of presentation of the samples to the panelists was randomized. Panelists were instructed to evaluate the color, flavor, taste, texture and overall acceptability of the samples. A six point Hedonic scale was used with 1=dislike extremely and 6=like extremely to evaluate the juices [15]. Clean tap water was provided for the panelists to rinse their mouths between consecutive samples. The panelists were guided on how to carry out the tests.

2.6 Experimental Design and Statistical Analysis

The experiment was laid out in completely randomized design. All determinations were replicated three times. Analysis of variance of the data was performed using Statistical Package for Social Sciences (SPSS) version 17. Means where significantly different were separated using least significant difference (LSD) test [16]. Significance was accepted at $p<0.05$.

3. RESULTS AND DISCUSSION

3.1 Preliminary Studies

The extraction method employed in this study extracted 85% of the African bush pulp as juice. The incorporation of varied levels of sugar (1-10%) resulted in significant ($p<0.05$) taste differences. Sucrose added at 8% (w/v) gave the most preferred taste. The taste of the juice was contributed by the amount of sugar contained in the pulp and the added sucrose.

The mean scores for the sensory attributes of the bush mango juices were affected by the pulp to water ratio (Table 1). The 1: 5 dilution had higher scores than the other dilutions for all the sensory attributes studied. There were difficulties of mixing and/or filtration at above and below this ratio. The acceptability of fruit and fruit products is influenced by their taste and aroma [17].

3.2 Physicochemical Properties

The pH of the pulp and treated juice were 4.0 and 4.8, respectively. The low pH of the African bush mango juice would not create favorable conditions for many organisms to sporulate and multiply [18]. This would enhance the storage stability of the juice [18]. The titratable acidity of the juice averaged 0.04%.

The value for the titratable acidity was similar to that reported previously for bush mango juice of similar dilution (1:5, pulp: water [9]. The pH of all the pulp and juice indicated that they were slightly acidic. The low pH and high acidity for these products was due to the organic acids in the fruit pulp [10]. These properties would confer long shelf life on the products by hindering proliferation of undesirable microorganisms [8]. Excellent keeping quality of fruits and soft drinks is due to low pH [19]. The acids present in food not only improve its palatability but also influence its nutritive value [18]. The acids influence the flavor, brightness of color, stability, consistency and keeping quality of food products [20]. The soluble solids significantly ($p<0.05$) increased from 8 ^{o}brix in the pulp to 10 °brix in the juice, due to the sucrose added. Soluble solids content is one of the most important quality parameters in fruit processing. Most soluble solids in food products are sugars [21,22] and the amount influences the organoleptic qualities of fruit and fruit products. The moderate soluble solids for the pulp and juices are desirable as responses for much sweetened beverages are usually low [23]. High level of sugar consumption has been notably linked to dental caries, obesity, diabetes, hypertension, hypoglycemia and heart disease [14].

3.3 Chemical Composition

The chemical composition of the untreated bush mango juice is shown in Table 3. The protein content decreased from 4.8% in the pulp to 1.1% in the juice, probably due to the incomplete

Table 1. Mean sensory scores of bush mango juice as affected by pulp to water dilution

Pulp: Water	Color	Taste	Flavor	Mouthfeel	Overall acceptability
1:3	3.8^d	4.0^a	3.3^a	2.8^d	3.3^d
1:4	4.9^b	3.9^a	3.3^a	3.9^c	3.8^c
1:5	5.7^a	3.8^a	3.8^a	4.5^a	4.5^a
1:6	4.2^c	3.3^b	3.6^a	4.0^b	4.0^b
1:7	4.0^c	3.2^b	3.4^a	3.4^d	3.0^d
1:8	4.4^c	3.1^b	3.2^a	2.9^e	2.9^d
1:9	3.9^c	2.6^d	3.1^a	2.7^d	2.9^d
1:10	3.0^e	2.2^d	3.0^a	2.7_d	2.7^d
1:11	2.8^e	2.1^d	2.9^a	2.6^d	$2.5d^c$
LSD	0.5	0.4	1.0	0.3	0.4

Means (n=20) within a column with the same superscript were not significantly different (p>0.05). Juices were evaluated on 6-point Hedonic scale (1=disliked extremely and 6=liked extremely).
The juices were not treated with sodium benzoate

extraction of protein [10]. The pulp is not a good source of protein as the protein is concentrated in the seed [24]. The protein of the bush mango juice was lower than 2.92% reported for cashew juice [25] and 1.4% for pineapple juice [22,26] but higher than 0.2% reported for pawpaw juice [27]. The juice had low fat content of 0.7%, a value which was, however, higher than 0.3% reported for pawpaw juice [9]. Fruits are generally low in fat and protein contents [26]. The juice (0.5%) had slightly lower ash content than the pulp (0.8%). The ash content of the juice was comparable to that of the pineapple juice (0.53%) [26] but higher than the 0.31 % reported for cashew juice [19]. This is indicative of the high mineral content of the bush mango juice.

Table 2. Physicochemical properties of African bush mango pulp and juice

Property	Pulp	Juice
PH	4.8^a	4.0^a
Titratable acidity (%)	ND	0.04
Soluble solids (^{o}brix)	8.0^b	10.0^a
Specific gravity	ND	1.038

Values are means of 3 replications. Means within a row with the same superscript were not significantly different (p>0.05). ND, Not determined

Table 3. Chemical composition of African bush mango pulp and juice

Composition	Pulp	Juice
Moisture (%)	8.4^b	88.0^a
Protein (%)	4.8^a	1.1^a
Fat (%)	1.4^a	0.7^b
Ash (%)	2.1^a	1.5^b
Crude fiber (%)	2.5^a	0.98^b
Carbohydrate (%)	80.8^a	7,72a
Calorie (Kcal/100 ml)	355^a	41.58b
Ascorbic acid (mg/100 g)	78.0^a	67.0^b

Values are means of 3 replications. Means within a row with the same superscript were not significantly different (p>0.05)

The moisture content of the bush mango juice was 88%. This value was similar to those of the pineapple (87 %) and apple (86%), orange (88%) and pawpaw (89%) [23]. The African bush mango juice would not be microbiologically stable at this moisture content as it would allow the proliferation of microorganisms. This necessitated the addition of sodium benzoate to the juice to preserve the juice in the present study. The crude fiber contents of the pulp and juice were 2.5 and 0.98%, respectively. The low crude fiber content of the bush mango juice relative to the pulp makes it digestible beverage for children [17]. Fruits are known to be high in soluble fiber than insoluble fiber [8]. Insoluble and soluble fibers are of great importance in the well being of the body [28]. Insoluble fibers provide roughages that speed up the elimination of faeces (excreta), thus. decreasing the time the body is exposed to harmful substances [29]. Soluble fiber mixes with food in the small intestine of potentially dangerous substances from food [29]. Soluble fibers also bind dietary cholesterol and carry it out of the body thereby preventing it from accumulating in the inner walls of the arteries where it may set the stage for high blood pressure, heart diseases and stroke [29]. The carbohydrate content decreased from 80.8% in the pulp to 7.72 in the juice due to dilution effect. The energy content decreased from 355 Kcal/100 g in the pulp to 41.58 Kcal/100 g in the juice. The high fat and carbohydrate contents of the pulp relative to the juice contributed to the higher energy content of the pulp. The carbohydrate majorly contributed to the energy content of the juice. The vitamin C content of the bush mango juice was 67 mg/ 100 ml. This value was lower than that of the pulp which was 78 mg/100 g but higher than those of banana (9 mg/100 ml), avocado (18 mg/100 ml), orange (46 mg/100 ml), pawpaw (52 mg/100 ml) and pineapple (54 mg/100 ml) but lower than those of guava (300 mg/100 ml) and cashew apple(250 mg/100 ml) juices reported previously by Ogbonna et al. [9]. The whole of the vitamin C was not probably extracted into the juice. The heat treatment used in the preparation of the juice probably oxidized the juice [8]. However, bush mango juice could be considered as a fairly good source of vitamin C. The importance of vitamin C in human nutrition is well established. A study has demonstrated that less than 50mg of vitamin C per day significantly increased the absorption of non heme iron [30]. The high level of vitamin C in the bush mango juice is desirable as this vitamin is vital in iron metabolism as well as formation of intracellular protein collagen [8]. Vitamin C is essential for the body to form cartilage, muscle and blood vessels [30]. Studies have indicated possible role of vitamin C in the protection of certain types of chronic diseases including certain types of cancer [30]. Vitamin C acts as an antioxidant in the blood and other body fluids. It regenerates the active antioxidants form of vitamin E and enhances non haem iron absorption by keeping iron in its more readily absorbable forms [30]. Simultaneous presence of iron and vitamin C in the gut has been reported to improve bioavailability of iron from non- haem foods [30]. The energy content of the pulp was 57.8 Kcal/100 g and increased to 81.5 kcal/100 g for the juice probably due to the higher carbohydrate content of the juice [28].

3.4 Mineral Composition

The mineral composition of the pulp and juice is presented in Table 4. The amounts of the minerals were lower in the juice probably the minerals were not completely extracted into the juice. Some of the minerals may have bound by some of the antinutritional factors such as phytates and oxalates in the pulp [8,18]. The levels of Ca in the pulp and juice were 190 and 160 mg/100 g, respectively. The K content reduced from 620 mg/100 g in the pulp to 598 mg/100 g in the juice. Similarly, the sodium contents of the pulp reduced from 50 mg/100 g in the pulp to 39 mg/100 g in the juice. The levels of potassium and sodium in the juice agreed with the report that potassium is the major mineral in most root crops while sodium tends to be low in food crops [31] The Mg, Fe and Zn contents of the pulp were 104, 2.5 and 3.0 mg/100g, respectively. The Mg, Fe and Zn contents of the juice were 97, 1.3 and 1.9 mg/100 mg, respectively. The juice is a good source of these minerals which are useful for the proper functioning of the body [8] Magnesium is an essential constituent of all cells necessary for the functioning of enzymes involved in energy utilization and it is present in the bone [29]. The US RDA for iron is 10-15mg per day [30]. The level of iron lends African bush mango juice as a good source of iron. Iron is very important in blood building. Deficiency of iron is the most common nutritional disorder in the world, causing anemia that affects more than 3.5 million people in the developing world [31].

Table 4. Mineral composition of African bush mango pulp and juice

Composition (mg/100 ml)	Pulp	Juice
Ca	190.0^{a}	160.0^{b}
K	620.0^{a}	598.0^{b}
Na	50.0^{a}	39.0^{b}
Mg	104.0^{a}	97.0^{b}
Fe	2.5.0^{a}	1.3.0^{b}
Zn	3.0^{a}	1.9.0^{b}

Values are means of 3 replications. Means within a row with the same superscript were not significantly different (p>0.05). The juice was treated with sodium benzoate

Zinc is needed by over 300 enzymes, some of which are involved with metabolism of blood sugars [8]. Zinc is so important that lack of it causes Types 1 and Type II diabetes [29]. Meals rich in zinc protect the body from inflammatory signals that damage beta cells [29]. The RDA for zinc for all groups is 15mg, thus, consuming 200 g of the juice would provide the RDA for zinc [30].

3.5 Phytochemical Composition

The African bush mango pulp contained significantly higher ($p<0.05$) amount of flavonoids (430 mg/100 g) than the juice (395 mg/100 g) probably due oxidation of the flavonoids during the preparation of the juice [8]. These values were higher than 8.92 mg/100 g reported for African locust bean pulp [11].

Table 5. Phytochemical composition of African bush mango and juice

Composition	Pulp	Juice
Phenols (mg/100 g)	300.0^{a}	272.0^{b}
Carotenoids (ug/100 ml)	1267.0^{a}	1056.0^{b}
Flavonoids (mg/100 g)	430.0^{a}	395.0^{b}
Anthocyanins (mg/100 g)	50.0^{a}	43.4^{b}

Values are means of 3 replications. Means within a row with the same superscript were not significantly different (p>0.05)

Phytochemical composition is influenced by type or variety of the plant, species, environmental conditions as well as the type of soil, climate, post harvest conditions, fertilizer applied etc. [24]. These factors probably explain the differences in the flavonoids contents of fruits. It was suggested that fresh African bush mango fruit for juice making should not be stored for more than 7 days (preferably 3 – 5 days) after harvest to maintain relatively high amount of flavonoids in such fruit drinks [14]. Flavonoids have antioxidant properties that play protective role in the development of cardiovascular diseases, atherosclerosis, hypertension, ischemia / reperfusion injury, diabetes mellitus, neurodegenerative diseases (Alzheimer's disease and Parkinson's disease), rheumatoid, arthritis and aging [8]. The carotenoids contents of the pulp and the juice were 1267 and 1039 mg/100 g, respectively. The water used in the blending of the pulp was not able to extract all the carotenoids in the pulp because carotenoids are largely soluble in fat and not in water [8]. This explains the lower content of carotenoids in the juice. Carotenoids have been reported to be stable to light in the absence of air but fade rapidly when exposed to both light and air [5].

Table 6. Mean sensory scores of African bush mango juices

Juice	Color	Taste	Flavor	Mouthfeel	Overall acceptability
ABMJ	5.3[a]	5.4[a]	4.0[a]	4.2[a]	5.5[a]
SBT-ABMJ	5.0[a]	5.0[a]	4.0[a]	4.0[a]	5.5[a]
Lsd	0.8	0.9	0.3	0.4	0.3

Means (n=20) within a column with the same superscript were not significantly different (p>0.05). Juices were evaluated on 6-point Hedonic scale (1=disliked and 6= liked extremely. ABMJ, Untreated African bush mango juice; SBT-ABMJ, Sodium benzoate treated African bush mango juice

This also may account for the low contents of carotenoids in the juice relative to the pulp. The high contents of carotenoids in the pulp and juice suggest that consumption of these products would provide some health benefits. Carotenoids are powerful antioxidants which protect the cell by reacting with oxidizing factors and neutralizing their effects [5]. Carotenoids are effective in preventing cancer and other degenerative diseases [7]. The phenol content decreased from 300 mg/100 g in the pulp to 272 mg/100 g in the juice. Phenolic compounds possess significant antioxidant activity due to their ability to adsorb, neutralize and quench free radicals [8]. Their ability as free radical scavenger is attributed to their redox properties, the presence of conjugated ring structures and carboxylic group which are reported to inhibit lipid peroxidation. Tannins, a class of phenols, hasten the healing of wounds and inflamed mucus membrane [8]. The binding of iron by tannins and phytate prevents them from generating free radicals and thus, have protective effect against cancer [5] .The African bush mango pulp and juice contained 50 and 43, 4 mg/100 g of anthocyanins, respectively. Anthocyanins are a group of flavonoids that are water soluble. They are glycosides and on hydrolysis yield sugar and aglycone called anthocyanidine [8]. The carbohydrate residues of anthocyanins are glucose, rahamnose, galactose, xylose and arabinose [20]. These residues may be responsible for the sweetness of African bush mango pulp.

3.6 Sensory Evaluation

The selected sensory attributes of the untreated bush mango juice and the sodium benzoate treated juice are presented in (Table 6 above). There were no significant differences (p>0.05) between the treated and untreated samples for all the sensory quality attributes evaluated. Both juices were generally accepted by the panelists. The taste of the juice was contributed by the sugar contained in the pulp and the added sucrose.

4. CONCLUSION

Acceptable juice was prepared from African bush fruit at 1:5 pulp to water dilution and 8% (w/v) sucrose addition. The juice was rich in vitamin C, essential minerals and phytochemicals. Commercial production of this juice would depend on availability of the raw material. The existing bush mango trees do not grow rapidly and are of the poor yielding varieties. If the potential of this tree is to be fully utilized, the need to improve on the existing varieties cannot be over stressed .In the subsequent work, the effect of storage on the quality of African bush mango juice and the nutraceutical potential of the juice will be assessed.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Jain PK, Nema PK. Processing of pulp of various cultivars of guava (*Psidium guavava)* for leather production. Agricultural Engineering International. 2007;9:34-45.
2. Off-Olua B, Ehwunife OA. Production and evaluation of the physicochemical and sensory qualities of mixed fruit leather from apple (*Musa pumila*), banana (*Musa sapientum)*, pineapple (*Ananas comos*). Nigerian Food Journal. 2015;33:23-28.
3. Arogba SS. The effect of testa on the physicochemical properties, browning index and functional properties of wild mango (*Irvingia gabonensis* var. *gabonensis* kernel flour. International World Journal of Science and Technology. 2011;1:178-185.
4. Etebu E. Postharvest pathology and phytcohemicals of *Irvingia gabonensis* (Aubry-lecomte ex O'Roke) fruits and wastes. Agricultural Science Research Journal. 2012;26(6):285-294.

5. Manach C, Scalbert A, Morand C, Rémésy C, Jiménez L. Polyphenols: Food sources and bioavailability. American Journal of Clinical Nutrition. 2004;79:727-747.
6. Ekpe OO, Umoh IB, Eka OU. Effect of typical rural processing method on the proximate composition and amino acid profile of bush mango seed (*Irvingia gabonensis*). Food, Agriculture, Nutrition and Development. 2007;7(1): 28-35.
7. Ngondi JL, Oben JE, Minka SR. The effect of *Irvingia gabonensis* seeds on body weight and blood lipids of obese subjects in Cameroon. Lipids Health and Disease. 2005;4:12-15.
8. Onimawo IA, Akubor PI. Food chemistry (integrated approach with biochemical background). 2nd Edn. Joytal Printing Press. Ibadan, Nigeria; 2012.
9. Ogbonna AC, Abuajah CI, Ekpe GE. A comparative study of the nutritive factors and sensory acceptance of juices from selected Nigerian fruits. Croatian Journal Food Technology, Biotechnology and Nutrition. 2013;8(1-2):45-51.
10. Onimawo IA, Oteno I, Orokpo G, Akubor PI. Physicochemical and nutrient evaluation of African bush mango (*Irvingia gabonensis*) seeds and pulps. Plant Foods for Human Nutrition. 2003;3(2)58:1-6.
11. Leakey RRB, Temu AB, Melnyk M, Vantomme P. Non-timber forest products paper 9, FAO Rome; 2003.
12. Ogunsina BS, Bhatnagar AS, Indira TN, Radha C. The proximate composition of african bush mango kernels and characteristics of its oil. Ife Journal of Science. 2012;14(1):177-182.
13. AOAC. The official methods of analysis. 19th edition. Washington, D.C.; 2010.
14. Obadoni BC, Ochuko PO. Phytochemical and studies and comparative efficacy of the crude extracts of some home static plants in Edo and Delta States of Nigeria. Global Journal of Pure and Applied Science. 2001;8:203-208.
15. Lawless HT, Heymann HI. Sensory evaluation of food: Principles and practices. 2nd Edn, Springer, New York; 2010.
16. SPSS. Statistical package for social sciences (SPSS). Version SPSS 16.0. SPSS Inc., Chicago, IL, USA; 2008.
17. Nnam NM, Njoku IE. Production and evaluation of nutrient and sensory properties of juices made from citrus fruits. Nigerian Journal of Nutritional Sciences. 2009;26(2):62-66.
18. Akubor PI. Characterization of fruit wines from baobab (*Adansonia digitata)*, pineapple (*Ananas sativus*) and carrot (*Daucus carota*) tropical fruits. Asian Journal of Biotechnology and Bioresource Technology. 2017;1(3):1-10.
19. Al-Jedah JH, Robinson RK. Nutritional value and microbiological safety of fresh fruit juice sold through retail outlets in Qatar. Pakistan Journal of Nutrition. 2003; 2:79-81.
20. Ewere NJ, Ntuen IG. Effect of ripe fruit pulp on the sensory and nutritive quality of ready-to eat breakfast cereal produced from maize and soybean flours and cassava starch blends. International Journal of Food Science and Nutrition. 2005;56(1):35-44.
21. Matos L, Nzikou JM, Matouba E, Pandzou-Yembe VN, Mapepoulou TG, Linder M, Desobry S. Studies of *Irvingia gabonensis* seeds kernels: Oil technological applications. Pakistan Journal of Nutrition. 2009;8:151-157.
22. Akubor PI. Quality evaluation and storage properties of yogurt supplemented with pineapple juice. International Journal Science and Knowledge. 2016;5(1):23-31.
23. Akubor PI. Physicochemical, microbiological and sensory properties of yoghurt supplemented with carrot juice. Nigerian Journal of Nutritional Science. 2011;32(1): 15-20
24. Etukudo I. Forests our divine treasure. Dorand Publishers Fajimi O, Sarumi MB, Olayode MN, Gamra EO and Sanusi SI (2007). *In-vitro* propagation of *Irvingia gabonensis.* African Journal of Biotechnology. 2001;6(8):976-978.
25. Thompson AK. Friuts and vegetables. Harvesting and storage, 2nd edn; 2003
26. Akubor PI, Onimawo IA. Nutrient content, physicochemical and sensory properties of pineapple-coconut food drink. Nigerian Journal of Nutritional Sciences. 2005; 26(2):76-80.
27. Chikwendu JN, Ayogu RND. Nutrient and antinutrient composition of unripe mature paw fruit juice. Nigerian Journal of Nutritional Sciences. 2005;30(2):123-126.
28. Onimawo IA. Proximate composition and selected physicochemical properties of the seed, pulp and oil of sour sop (*Annonu*

muricata). Plant Foods Human Nutrition. 2002;57:165-171.

29. Wardlaw HM, Hampin JJ. Perspectives in nutrition. 7th Edn. New York. McGraw Hill; 2007
30. WHO/FAO. Diet, nutrition and the prevention of chronic diseases. Report of a WHO/FAO Epert consultant World Health Organisation Technical Report series. 910 WHO Geneva; 2003.
31. Olusegun PI. The determination of lead, arsenic, mercury and cadmium contents in some edible fish species retailed in Ibadan, Nigeria. Nigerian Journal Nutritional Science. 2011;32(1):9-14.

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