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QUALITY EVALUATION OF MIXED FRUIT JUICE PRODUCED FROM AFRICAN BUSH MANGO, PINEAPPLE AND ORANGE

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ABSTRACT
This study was aimed at production and quality evaluation of mixed fruit juice from lesser known fruit African bush mango (Irvingia gabonensis) and known fruits of pineapple (Ananas comosus) and orange (Citrus sinensis).African bush mango, pineapple and orange juices were blended to produce different mixed juice samples. The proximate composition, physicochemical, anti-nutrient and sensory qualities of the juice blends were evaluated. The protein content of the juice blends ranged from 0.76 to 0.93 %; moisture 70.05 to 80.45%; carbohydrate 16.95 to 26.95%. The pH of the juice blends were in the range of 4.89 to 5.55 while the brix ranged from 10.10 to 10.88%. The total titratable acid were in the range of 0.16 to 0.25mg/l. The saponin and tannin contents of the juice blends were low and within tolerable limit safe for consumption. The sensory scores obtained showed that the juice samples were accepted following the organoleptic ratings.
Keywords: African bush mango, Pineapple, Orange, Juice, Quality evaluation.

INTRODUCTION

Fruits are good sources of essential elements which are very important for our body to function properly (Dosumu *et al*., 2009). Due to the high perishability nature of fruits, they rotten quickly and preservation becomes highly essential to make them available for a long period of time (Begum et al., 2018). Fruits can be preserved as beverages such as fruit juice (orange, apple, grape juice etc) or alcoholic beverage such as wine, brandy or vinegar. Fruit juice is the unfermented but fermentable liquid obtained from the edible part of sound, appropriately mature and fresh fruit or of fruit maintained in sound condition by suitable means including postharvest surface treatments applied in accordance with the applicable provisions of the Codex Alimentarius Commission (CODEX STAN 247-2005). Fruit juices can be prepared by squeezing fresh fruits mechanically or by enzymatic extraction process. Fruit juices are less fatty, nutrient dense beverages rich in vitamins, minerals and naturally occurring phytonutrients that contribute to good health. Fruit juices promote detoxification in the human body (Minich and Bland, 2007, Begum *et al*., 2018).

There are many underutilized indigenous crops that contribute to food security and play important roles in the nutrition of the people in Nigeria and other African countries. Among these is a wide variety of wild indigenous fruits and vegetables that enrich the diet of the rural populace (Aworh, 2015). Some of these lesser-known crops include the African bush Mango, African Pear, African Star Apple and these fruits when consumed in their fresh state are rich sources of nutrients including ascorbic acid, provitamin A carotenoids, minerals and nutraceuticals with health-promoting benefits (Aworh, 2015).

African bush mango (*I. gabonensis)* is an economic food tree of West and Central Africa (WCA) with on-farm food production potential. This food tree is a source of financial revenue for rural farmers, wholesale traders and can help in achieving long term food security (Sunderland et al., 2013; Kengni *et al*., 2017). African bush mango belongs to the family*Irvingiaceae* (Lesley and Brown, 2004)and is found throughout the tropical forest of Africa. It is widely cultivated in Central and Western Africa (Kengni *et al*, 2011; Kengni *et al*., 2017). It is called bush mango or African mango because the trees bear mango-like fruits (Adegbehingbe *et al*., 2017). The *Irvingia* species exist in two varieties as *I. gabonensis* and *I.excelsa*. *I. gabonensis* var. *gabonensis*, commonly known as African bush mango or wild mango is native to most tropical forests in the West and Central Africa (Arogba, 2011).

In West Africa, *I. gabonensis* tops the list of non-timber forest products and isbeing clamored for domestication (Ekpe *et al.,* 2007).The fruits are broadly ellipsoid, about 4-7cm long, green when unripe and yellow when ripe with fleshy mesocarp (Arogba, 2011). The fruit pulp isjuicy and the taste varies between sweet and bitter (Etebu,2012). The fruit is rich in vitamin C, minerals and phytochemicals such as flavonoids, alkaloids and tannins (Manach *et al*., 2004).The tasty mesocarp is widely consumed raw as dessert fruit or snack throughout Western and Central Africa for its health promoting potential (Manach *et al*., 2004).Apart from the common use of the kernels assoup thickener in West Africa, the kernel oil and meal are potential materials for drug binding, confectionery edible fat and cosmetics (Ngondi *et al*., 2005).

Pineapple (*Ananas comosus* L.) is one of the most appreciated tropical fruits around the world. It is rich in vitamins and other nutrients. A fresh and ripe pineapple can supply about 116.2% of the daily requirement forvitamin C (Shamsudin *et al*., 2007). Juice extracted from pineapple can be processed into many forms such as concentrated juice, mixed juice and single strength juice (Begum et al., 2018). Sweet orange is the citrus fruit (*Citrus sinensis*).The fruit of *Citrus sinensis* is called sweet orange to distinguish it from *Citrus aurantium*, the bitter orange. It is the most commonly grown tree fruit in the world, primarily in Brazil and the US states of California and Florida (Idise, 2012). Orange trees are widely cultivated in tropical and subtropical climates for sweet fruit, which is peeled or cut (to avoid the bitter rind) and eaten whole, or processed to extract orange juice. It is rich source of Vitamin C, foliate and flavonoids and improves blood lipid profiles in hyper medicines as a stimulant and appetite suppressant (Begum *et al*., 2018). Orange juice is more nutrient dense than many commonly consumed 100 percent fruit juices, such as apple, grape, pineapple and prune (Rampersaud, 2007).

Many fruits and vegetables (including African bush mango, pineapple, orange)are seasonal in nature and are available in large quantity in peak season. But due to inadequate and improper postharvest handling, processing and preservation facilities of these fruits, every year a substantial quantity is wasted. Poor postharvest handling practices of fruits and vegetables lead to considerable postharvest losses thereby reducing their contribution to food security (Aworh, 2015). There is therefore the need for value-added processing of these lesser-known fruits with other known fruits into shelf-stable products to reduce postharvest losses and promote their utilization and cultivation. The present study was undertaken to find out an acceptable formulation of mixed fruit juice using African bush mango, pineapple and orange juice as well as to analyze the nutrient composition of the mixed juice samples.

MATERIALS AND METHODS

Sources of Raw Materials

Wholesome, matured and ripe African bush mangoes (*I. gabonensis*), pineapples (A*nanas comosus*) and oranges (*Citrus sinensis*) used for this work were purchased from Ubani main market Umuahia, Abia state. Other materials and apparatus used were gotten from Central Laboratory National Root Crops Research Institute, Umudike Abia State.

Sample Preparation

Production of African bush mango, pineapple and orange juice blends

The juice blends were produced using the method described by Akubor (2017) with little modification. The wholesome fruits were individually prepared. The fruits were washed, peeled, chopped, weighed and divided into 8 portions, each of the portion was crushed in a blender to obtain a homogenous mass. Two (2) ml of water was added in the blender. The juice was extracted by pressing through a muslin cloth sterilized in hot water for 15 minutes. The resulting juices were filtered and pasteurized at 92^0C for 10 minutes. The pasteurized juices were cooled and 2g of lemon juice was added as preservative. The juices were filled into sterilized plastic bottles and then stored.

Chemical Analysis

Proximate Composition

The Proximate compositions(moisture, ash, crude fiber, protein (N x 6.25) and crude fat) of the juice samples were determined using the standard procedures of Association of Official Analytical Chemists (AOAC, 2010) while the carbohydrate content was determined by difference.

Physiochemical Analysis of the Juice

Determination of Total Solids

The total dissolved solids were determined by using TDS meter as described by Bradley (2010).

Determination of Total Titratable Acidity

The total titratable acidity was determined using the method of AOAC (2010).

Determination of Total Sugar (Brix^o)

The total sugar was determined using the refractometer.

pH Determination

The pH of the juice samples were determined using apH meter(R1 – 02895 HANNA / Italy).

Determination of Tannin and Saponin

The tannin and saponin contents of the sample were determined using the method described by AOAC(2010).

Sensory Evaluation

Sensory evaluation was conducted using the method described by Iwe (2002).A nine 9-point hedonic scale was used with one denoting extremely disliked and nine extremely liked. Twenty member panel that were already used to the taste of the three fruits were selected. The quality attributes tested for the samples include appearance, flavour/aroma, mouth feel, taste and general acceptability. This was done to determine the consumers' acceptance of the samples.

STATISTICAL ANALYSIS

The data analysis was done using Analysis of Variance (ANOVA) and mean separation using Duncan's multiple range test.

RESULTS AND DISCUSSION

Proximate Composition of the Mixed Juice Samples

The result presented in Table 1 reveals the blend compositions of the juice samples. The moisture content of the samples ranged from 70.05 to 80.45%, with sample containing African bush mango- pineapple- orange in the ratio 90:05:05 having the highest moisture content of 80.45% and sample 50:25:25(African bush mango: pineapple: orange) having the least moisture content of 70.05%. The moisture contents of all the samples were significantly different ($p<0.05$). The high moisture content of the products could be as a result of reconstitution of juice blends from different fruits. Thus, excess moisture content may influence the quality and shelf life of the food product. The moisture content values 70.05 to 80.45% are similar to those reported for juice samples from pineapple, apple, orange and pawpaw (Akubor, 2011). Mbaeyi-Nwaoha and Okorie (2016) reported moisture content of 90.91 to 93.25% in the storage studies of table wine produced from African bush mango (I*. gabonensis*) and watermelon (C*itrullus lanatus*) blends. Akubor (2017) reported moisture content of 88% in the African bush mango juice.The results represented in Table 2 also reveals that the ash, fiber, fat and protein contents of the juice samples were significantly ($p<0.05$) low. Low crude fiber contents (0.37 to 0.63%) were observed from the study. These results also agree with the observation of Cheeseman and Lean (2000) that generally beverages and other water based products have poor fiber level. Akubor (2017) in his study on the evaluation of the quality of juice prepared from African bush mango fruit pulp reported crude fiber content of 0.98% in juice produced from African bush mango.

The protein contents of the mixed fruit juice samples ranged from 0.76 to 0.93%. The sample containing 100% African bush mango juice (sample 100:0:0) had the highest protein content of 0.93%. Akubor (2017) reported protein content of 1.1% in African bush mango juice. Fruits are known to be high in soluble fiber than insoluble fiber(Onimawo and Akubor,2012). The carbohydrate contents were in the range 16.95 to 26.95%. The carbohydrate contents increased as the proportion of the African bush mango gradually decreased. This might be as a result of different ratios in the juice blends. Carbohydrate is a major constituent of most beverages.

Physicochemical properties of the mixed juice samples

The results presented in Table 3 reveals the physicochemical properties of the mixed juice samples. The total titratable acid value (0.25%) of sample 100:0:0 (African bush mango) was the highest while those of sample60:20:20 (0.17%) and sample 50:25:25 (0.16%) were the least. The total titratable acid value of sample 100:0:0 ((African bush mango) was significantly different ($p<0.05$) from other samples. This result did correspond with the findings of Islam *et al.* (2014) reported that the mixed fruit juice from orange and pineapple fruits had a titratable acidity range of 0.62 to 0.78%.This might be attributed to the addition of bush mango in the blend which was not added in the previous study. Onimawo *et al.*(2003) in their study of the physicochemical and nutrient evaluation of African bush mango seeds and pulp reported titratable acidity of $0.112cm^3$ in the pulp of African bush mango. The total titratable acidity (TTA) measures the ionic strength of a solution which in turn determines the rate of chemical reaction.

The result of the pH values shows that the sample containing 100% African bush mango juice recorded the highest pH value of 5.55. There were no significant differences in the pH values in samples 70:15:15, 60:20:20, 50:25:25 (African bush mango: pineapple: orange) respectively. The pH value of 4.0 was reported by Akubor (2017) in his study of evaluation of the quality of juice prepared from African bush mango fruit pulp. Adebofuor *et al.* (2010) recorded 4.78 to 4.99 for juice produced from orange, tomatoes and carrots. This difference could be attributed to the variations in the raw materials used in producing the individual juices.

The pH measures the acidity or alkalinity of medium which is usually expressed as the hydrogen ion concentration. Solutions are described as acidic if the hydrogen ion concentration is less than 7 and it can be classified as basic when the pH is greater than 7.0.Excellent keeping quality of fruits and soft drinks is due to low pH (Al-Jedah *et al.*, 2003). The acids present in food not only improve its palatability but also influenceits nutritive value (Akubor, 2017).

The result of the total dissolved solids were in the range 1800.5 to 2011mg/I. There was no significant difference ($p<0.05$) in the total dissolved solid content of samples 60:20:20 and 50:25:25 (African bush mango: pineapple: orange), which were found to be highest (2002.50 mg/l and 2011.00 mg/l respectively). Sample 100:0:0 (African bush mango) had the least total dissolved solid content (1800.50 mg/l), which was significantly different from other samples. This difference could be attributed to the variations in the ratio of each raw material in the juices. Soluble solids content is one of the most important quality parameters in fruit processing. Most soluble solids in food products are sugars and the amount influences the organoleptic qualities of fruit andfruit products (Akubor, 2016). The moderate soluble solids for the juices are desirable as responses for much sweetened beverages are usually low (Akubor, 2011).

The Brix values were in the range of 10.10 to 10.88%. Sample 50:25:25 (African bush mango: pineapple: orange) had the highest Brix value of 10.88%. This result is in agreement with values obtained by Akubor (2017) who reported 10% level of sugar in the evaluation of the quality of juice from African bush mango fruit pulp. High level of sugar consumption has beennotably linked to dental caries, obesity, diabetes, hypertension, hypoglycemia and heart disease(Obadoni and Ochuko, 2001).

Anti-nutrient composition of the mixed juice samples

The results presented in Table 4 shows the anti-nutrient composition of the mixed juice samples. The tannin contents ranged from 0.36 to 0.43mg/100g.The sample containing 100% African bush mango had the highest tannin content of 0.43mg/100g while sample 50:25:25 (African bush mango: pineapple: orange) had the least tannin content of 0.36mg/100g. Tannins are considered bitter plant polyphenolic compounds; they may precipitate protein from aqueous solution by inhibiting digestive enzyme and have been found to interfere with digestion by displaying anti-trypsin and anti-amylase activity (Soetan and Oyewole, 2009). Tannins also chelate iron and zinc irreversibly and interfere with their absorption (Soetan and Oyewole, 2009). The saponin contents were in the range of 0.06 to 0.12mg/100g. The saponin content which was observed to be highest in the sample containing 100% African bush mango 0.12mg/100g was significantly different from the other juice samples. Saponins cause haemolysis of blood; they possess bitter and acid taste thereby causing irritation to mucous membranes (Kar, 2007). Saponins also disrupt epithelial function and create other digestive issues. They damage red blood cells, inhibiting enzymes and interfering with thyroid function (Kar, 2007).

Sensory evaluation of the mixed juice samples

The result of the sensory scores are presented in Table 5. There was significant difference ($p<0.05$) in the appearance of the juice samples. Sample 70:15:15(African bush mango: pineapple: orange) had the highest rating 7 which translates to like moderately in the 9-point hedonic scale, while the sample containing 100% African bush mango was the least preferred in the appearance rating of 5 which represents neither like nor dislike in the 9-point hedonic scale. The sensory scores of 5 to 7 obtained in appearance were slightly higher than the values of4 to 7 reported by Akande and Ojekemi (2013) in their study of watermelon and pineapple juice blends. The results showed that the aroma of the juice samples slightly differ significantly ($p<0.05$). Samples 70:15:15 and 60:20:20(African bush mango: pineapple: orange)were equal in rating and had the highest aromascore of 6 which translates to slightly liked, while sample 100:0:0 (African bush mango) had the least aroma score of 4 which translates to dislike slightly.

The result for sensory score for taste of various juice samples ranged from 4 to 6, with samples 80:10:10,70:15:15 and 60:20:20 (African bush mango: pineapple: orange) having the highest rating score of 6 (slightly liked), while sample 100:0:0 (African bush mango) had the smallest rating of 4 (slightly disliked).The overall acceptability results showed that samples 100:0:0 and 90:05:05 (African bush mango: pineapple: orange) had significantly lower rating (4- slightly liked) compared to samples 80:10:10, 70:15:15, 60:20:20 and 50:25:25 (African bush mango: pineapple: orange)with score of 6 which translates to like slightly. Most of the samples were slightly liked by the members of the panel.

Table 1. Blend formulation for the juice blends

Sample codes	African bush mango	Pineapple	Orange
100:0:0	100	-	-
90:05:05	90	5	5
80:10:10	80	10	10
70:15:15	70	15	15
60:20:20	60	20	20
50:25:25	50	25	25

Ratios are in the form; African bush mango : pineapple : orange juice

Table 2: Proximate composition of African bush mango-pineapple – orange juice blends (%)

Sample	Moisture	Ash	Fibre	Fat	Protein	Carbohydrate
100:0:0	78.95^{b}±0.21	0.78^{d}±0.02	0.37^{e}±0.01	0.73^{a}±0.01	0.93^{a}±0.01	18.26^{e}±0.25
90:05:05	80.45^{a}±0.21	0.85^{c}±0.01	0.53^{d}±0.01	0.37^{f}±0.01	0.76^{e}±0.01	16.95^{f}±0.07
80:10:10	75.65^{c}±0.07	0.87^{c}±0.00	0.55^{cd}±0.00	0.39^{e}±0.01	0.82^{d}±0.01	21.73^{d}±0.06
70:15:15	73.30^{d}±0.14	0.91^{b}±0.01	0.58b^{c}±0.01	0.41^{d}±0.01	0.87^{c}±0.01	23.98^{c}±0.13
60:20:20	71.55^{e}±0.07	0.91^{ab}±0.01	0.59^{b}±0.01	0.43^{c}±0.01	0.88^{c}±0.01	25.63^{b}±0.06
50:25:25	70.05^{f}±0.07	0.95^{a}±0.01	0.63^{a}±0.03	0.46^{b}±0.01	0.89^{b}±0.01	26.95^{a}±0.08

Means in the same column with different superscript are significantly different ($p<0.05$).
Ratios are in the form; African bush mango : pineapple : orange juice

Table 3: Physicochemical properties of African bush mango-pineapple – orange juice blends

Sample	Total Titratable Acidity (%)	pH	Total Dissolved Solids (mg/l)	BRIX (%)
100:0:0	0.25^{a}±0.01	5.55^{a}±0.07	1800.50^{e}±0.71	10.10^{d}±0.14
90:05:05	0.22^{b}±0.00	5.35^{b}±0.07	1955.00^{d}±7.07	10.32^{c}±0.01
80:10:10	0.21^{b}±0.01	5.20^{c}±0.00	1982.50^{c}±3.54	10.46^{c}±0.01
70:15:15	0.19^{c}±0.01	4.95^{d}±0.07	1992.50^{b}±3.54	10.61^{b}±0.01
60:20:20	0.17^{d}±0.01	4.95^{d}±0.01	2002.50^{a}±3.54	10.69^{b}±0.01
50:25:25	0.16^{d}±0.01	4.89^{d}±0.01	2011.00^{a}±1.41	10.88^{a}±0.04

Means in the same column with different superscript are significantly different ($p<0.05$).
Ratios are in the form; African bush mango : pineapple : orange juice

Table 4 : Anti-nutrient composition of African bush mango-pineapple – orange juice blends (mg/100g)

Sample	Tannin	Saponin
100:0:0	0.43^{a}±0.01	0.12^{a}±0.01
90:05:05	0.41^{b}±0.00	0.11^{ab}±0.00
80:10:10	0.41^{b}±0.01	0.10^{b}±0.00
70:15:15	0.39^{c}±0.01	0.09^{c}±0.01
60:20:20	0.37^{d}±0.00	0.08^{c}±0.01
50:25:25	0.36^{e}±0.01	0.06^{d}±0.00

Means in the same column with different superscript are significantly different ($p<0.05$).
Ratios are in the form; African bush mango : pineapple : orange juice

Table 5: Sensory evaluation of African bush mango-pineapple – orange juice blends

Sample	Appearance	Aroma	Taste	Mouth feel	Overall acceptability
100:0:0	5.00^{c}±2.24	4.00^{b}±1.77	3.00^{c}±1.76	4.00^{c}±2.23	4.00^{b}±1.93
90:05:05	6.00^{bc}±2.06	5.00^{ab}±1.77	4.00^{bc}±1.95	5.00^{bc}±2.20	4.00^{b}±1.69
80:10:10	6.00^{ab}±1.42	5.00^{ab}±1.59	6.00^{a}±1.21	6.00^{ab}±1.74	6.00^{a}±1.41
70:15:15	7.00^{a}±1.12	6.00^{a}±1.60	6.00^{a}±1.58	6.00^{a}±1.53	6.00^{a}±1.61
60:20:20	6.00^{ab}±1.47	6.00^{a}±1.41	6.00^{a}±1.57	6.00^{a}±1.27	6.00^{a}±1.43
50:25:25	6.00^{bc}±1.48	5.00^{ab}±1.57	5.00^{ab}±1.81	6.00^{ab}±1.74	6.00^{a}±1.74

Means in the same column with different superscript are significantly different ($p<0.05$).
Ratios are in the form; African bush mango : pineapple : orange juice

CONCLUSION

Quality fruit juice can be produced from lesser known fruit from African bush mango mixed with known fruits from pineapple and orange using simple technologies suitable for small-scale commercial production. Ensuring the production of these mixed juice products would reduce postharvest losses, increase utilization and cultivation of these indigenous fruit trees thereby contributing to food security.

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