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Nutritional, functional and sensory attributes of jam from velvet tamarind pulp

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Velvet tamarind pulp of *Dialium guineense* have been used as medicinal remedies, as source of vitamin C and as flavour in snacks and non-alcoholic beverages. The nutritional, functional and sensory attributes of velvet tamarind pulp jam was assessed. Proximate, mineral profiles, beta-carotene, riboflavin, niacin, thiamin, ascorbic acid and phytochemical profiles in jam samples were determined. Sensory evaluation of the jam samples was carried out using a 7-point hedonic scale. Moisture content of the jam was 74%, fat 0.47%, protein 2.3% and ash 0.85%. Some essential elements including Ca (0.97 mg/100 g), Mg (1.04 mg/100 g), K (1.44 mg/100 g), Na (0.21 mg/100 g) and P (0.35 mg/100 g) were contained in the velvet jam, while energy value was 499 KJ/100 g. The results indicated that the velvet tamarind jam would provide essential valuable minerals, energy and vitamin C, needed for good body development.

Key words: Velvet pulp, jam, vitamin C, proximate composition, overall acceptability.

INTRODUCTION

Dialium guineense Wild with English name black velvet or velvet tamarind tree is commonly called 'Awin' among the Yorubas, and icheku by Igbos. The fruit pulp which is red, with a sweet-sour, astringent flavour similar to baobab, but sweeter, is eaten raw when dry by man and animal (Matsuda, 2006).

Velvet tamarind is an important multipurpose agroforestry crop (Nwaoguala et al., 2007). It is made up of two species (*Dialium indium* or *Dialium cochichinense* and *D. guineense* wild) (Ubbaonu et al., 2005). *D. guineense* commonly known as African black velvet tamarind, is a large tree found in many parts of Africa, such as West Africa, Central African Republic and the Chad. The tree belongs to the family *Fabaceae*-caesalpinioidaea, it is 30 m high, with a densely leafy crown, but often shrubby. The leaves are finely hairy, broadly elliptic, blunt at the apex, leathery and are a sunken midrib. Its flowers appear whitish and the branches are horizontally spread (Szolnok, 1985).

Fruits are usually circular and flattened, black in colour with stalk 6 mm long, a little collar is seen near the apex and a bristle shell encloses one or two seeds embedded in a dry, brownish edible pulp (Hong et al., 1996). Wild fruits are dietary supplement for rural dwellers in Nigeria during the - dry season when fruits are scarce (George Mateljan Foundation, 2011). The fruits are

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used as source of vitamin C, as flavour in snacks and non-alcoholic beverages (Effiong et al., 2009; Adame, 2002).

Fruit pulps supplies high amount of micronutrients like sodium, magnesium and potassium. Bark and leaves are used against several diseases such as malaria (Effiong and Udo, 2010). Velvet tamarind is a tall, tropical, fruit bearing tree which belongs to the leguminosae family that has small and grape-sized edible fruits with brown hard inedible shells. It grows in savanna regions of West Africa and widely spread in Nigeria (Ogungbenle and Ebadan, 2014). The fruit is used as a candy-like snack food in Thailand, often dried, sugar coated and spiced with chilies.

Awin, as this fruit is called by the Yoruba people of Nigeria, has an orange coloured pulp which has a sweet and sour taste and a dry powdery texture. The fruit is also called *Icheku* by the Igbos, *Tsamiyarkurm* by the Hausas (Gbile, 1980; Burkill, 1985). The fruit is rich in minerals (magnesium, sodium, iron, potassium and beta-carotene (Vitamin A), copper, sugars and tartaric acid, citric acid, malic acid, ascorbic acid and Niacin. As anticipated, this fruit also has high levels of anti-oxidants. The pulp is believed to improve appetite and is used as a gargle for sore throats, dressing of wounds and is said to aid the restoration of sensation in cases of paralysis. The unique sweet/sour flavor of the pulp makes it popular in domestic cooking and flavorings. The thirst quenching, refreshing fruit pulp can also be soaked in water and drank as a beverage and also provides chewing sticks, jams and jellies (FAO, 2004).

In Nigeria, however, velvet tamarind pulp is normally consumed fresh; which could be the reason why at its peak period, the surplus fruit suffers post-harvest losses due to poor handling and weevil infection (CTA, 2012). There is urgent need to explore an affordable and easily adoptable food processing method that can be used to convert the surplus fruits into shelf stable products like juices, jams and jellies which are easy, cheap and economically reliable alternative that will reduce post-harvest losses and in the long run reduce vitamin C deficiency in individuals.

This study was conducted to investigate the potential of velvet tamarind pulp in jam production with a view to improving utilization efficiency of the fruits pulp; thereby, adding value to the tree and encouraging its cultivation and sustainable management.

This study was therefore designed to develop jam from velvet tamarind pulp.

MATERIALS AND METHODS

Velvet tamarind fruit source

The velvet tamarind (*D. guineense)* fruits used for the present work were purchased from three different markets (Ndioru, Orie-Ugba and Ubani) in Abia State, Nigeria.

Sample preparation

The fruits were washed thoroughly in tap water to remove extraneous materials. The fruits were then air-dried. Bruised and spoilt fruits were discarded. A randomly selected clean sample of the fruit pulp was extracted from the fruits by soaking in clean water for 20-30 min. The pulp was separated from the seeds by sieving. Samples were pooled to obtain the sample for the preparation of the jam. The pulp was separated from the shell and seed. Potable water (1125 ml) was added to 400 g de-hulled fruit and allowed to rest for 1 h at room temperature (29-30°C) to dissolve the pulp. A sieve (5 mm) was used to separate the pulp from the seed.

The jam preparation process

The jam was produced by using the open kettle process. Sugar (200 g) was added gradually as boiling continued and twenty milliliters (20 ml) of lemon juice to enhance gel formation, improve colour and flavor of the jam. The jam produced was then cooled at 80°C before pouring into bottles. The jam was stored under refrigeration condition (12^{o}C) for further analysis.

Chemical analyses

The proximate compositions of the sample were determined using AOAC (2006) methods. Moisture content of the jam was determined gravimetrically. The protein content was determined by micro-Kjeldahl method, using 6.25 as the nitrogen conversion factor. The fat content was determined by Soxhlet extraction method using petroleum ether. The ash content was determined by incinerating the samples at 600°C in a muffle furnace. Carbohydrate was obtained by difference, while gross energy (KJ and Kcal per 100 g) was calculated based on the formula by Eknayake et al. (1999). Gross energy (Kcal per 100g dry matter) = (crude protein x 17) + (crude lipid x 37) + (crude carbohydrate x 17) for protein, carbohydrate and lipid, respectively.

Mineral elements were determined using wet-acid digestion method for multiple nutrients determination as described by the method of AOAC (2006). About 0.2 g of the processed sample material was weighed into a 150 ml Pyrex conical flask. Five milliliters (5 ml) of the extracting mixture (H_2SO_4 – Sodium salicylic acid) was added to the sample. The mixture was allowed to stand for 16 h. The mixture was then placed on a hot plate set at 30°C and allowed to heat for about 2 h. Five milliliters (5 ml) of concentrated perchloric acid was introduced to the sample and heated vigorously until the sample was digested to a clear solution. Twenty milliliters of distilled H_2O was added and heated to mix thoroughly for about a minute. The digest was allowed to cool and was transferred into a 50 ml volumetric flask and made up to the mark with distilled water. The digest was used for the determinations of calcium (Ca) and magnesium (Mg) by the ethylenediamine ditetraacetic acid Versanate Complexiometric titration method (AOAC, 2006). AOAC (2006) method was used to determine sodium (Na) and potassium (K) by using a flame photometer (model PFP7 Digital, Jenway, UK). All other minerals were determined by atomic absorption spectrophotometer (model 3030, Perkin Elmer, Norwalk USA)

The β-carotene, riboflavin, niacin and thiamin of the products were determined spectrophotometrically as described by AOAC (2006). Ascorbic acid was determined using titration method as described by AOAC (2006). Gravimetric method (Harborne, 1973) was used to determine alkaloids. Saponin was determined by gravimetric oven drying method as described by the method of AOAC (2006). Tannin content of the sample was determined spectrophometrically as described by Kirk and Sawyer (1991). Phenol was determined by the Folin-Ciocalteu method (AOAC

Table 1. Energy and proximate composition of velvet tamarind (*D. guineense)* jam (dry basis).

Nutrient	Velvet jam
Moisture (%)	74.4±0.67
Protein (%)	2.3±0.08
Fat (%)	0.47±0.03
Ash (%)	0.85±0.01
Crude fiber (%)	0.66±0.04
CHO (%)	21.3±0.51
Energy(KJ/100 g)	136.38/499

Values of means ± standard deviation of duplicate determinations.

2006). Flavonoid was determined by gravimetric oven drying method as described by Harborne (1973).

Sensory evaluation

Twenty member panels of assessors with two jam samples were used. Panelists were asked to score samples based on the intensity of organoleptic quality attributes of appearance (colour), flavor, consistency and overall acceptability using the 7-point hedonic scale where 7 = like very much and 1 = dislike very much (Iwe, 2002).

Statistical analysis

Data were expressed as means ± standard deviation (SD) of two replications, and one factor ANOVA was used for the statistical analysis using SPSS program (version 20 SPSS Inc., USA). The values of sensory evaluation were considered to be significantly different when $P<0.05$.

RESULTS AND DISCUSSION

Energy and proximate composition of jam developed from velvet tamarind (*Dialium guineense)*

The proximate composition of velvet tamarind is presented in Table 1. The moisture obtained for velvet jam was 74.4%. When compared with other work, the value of moisture in this study was lower than the value (96.3%) reported for commercial orange jam (Tanwar et al., 2014). The moisture content of any food is an index of its spoilage (Dewole et al., 2013); this implies that velvet tamarind jam may have a longer shelf life than orange jam. The total ash (0.85%) was found to be lower than those of velvet tamarind pulp (1.47%) (Niyi, 2015). Ash value has been regarded as an indicator for food quality evaluation. The crude fiber (0.66%), and crude fat (0.47%) obtained for velvet tamarind jam were lower than the crude fiber and crude fat values (2.2 and 3.4%) reported for pineapple jam, but the crude protein (2.3%) obtained for velvet jam was higher than the value of crude protein (0.8%) reported for pineapple jam (Aina et al., 2015). Protein has been identified as one of the deficit nutrient in the developing countries; this implies that consuming velvet jam along with other protein food sources will increase protein intake. Protein malnutrition is one of the serious challenges in Africa continent especially Nigeria.

The carbohydrate and energy obtained for velvet jam were 21.3 g/100 g and 499 KJ, respectively. The calorific value of the sample was fairly high. The human body needs considerable energy when at rest. The amount required has been determined to be about 1 Kcal per kg of body weight per hour or 1,500 to 2,000 Kcal per day. This depends on the individual's metabolism. The largest part of human energy consumption via food is used for manufacturing essential life processes and body temperature (Osborne and Voogt, 1978). The energy that the body derived from food is lower than the amount of energy produced when food is burned or completely oxidized in a bomb calorimeter. This is due to calorie producing nutrients, which are mainly protein, fats and carbohydrates that are not completely digested, absorbed or oxidized to yield energy in the body (Akubugwo et al., 2007). The present value was lower than those of velvet tamarind pulp (761.4 KJ/100 g) (Niyi, 2015). Based on the required amount per day recommended (1,500 - 2,000 Kcal per day) (Osborne and Voogt, 1978), velvet tamarind may only supply a part of energy required per day when consumed.

Mineral composition of jam developed from velvet tamarind (*D. guineense*) jam

The results of mineral profile of velvet tamarind jam are presented in Table 2. The most concentrated mineral was potassium followed by magnesium while calcium took the third position. Both calcium and magnesium are mostly found in the skeleton. In addition to its structural role, magnesium is an activator of various enzymes. The calcium is an essential component in bone formation. The value of calcium was greater than those values reported for velvet tamarind pulp (44.1 mg/g) (Niyi, 2015). This suggests that the amount of calcium present in the sample would be adequate for infant development of bones and teeth. Sodium and potassium control water equilibrium level in the body tissue and are also important in the transportation of some non-electrolyte. The Na/K ratio was 0.15. The ratio of 0.60 is recommended for intake (Niemann et al., 1992). The value reported for the sample was lower than the recommended value. This indicates that velvet tamarind would not support hypertension. Phosphorus is required for most chemical reactions in the body especially in the teeth. The Ca/P ratio of >0.5 is required for favourable calcium absorption in the intestine for bone formation (Niemann et al., 1992).

Table 2. Mineral composition (mg/100 g) of velvet tamarind (*D. guineense)* jam (dry basis).

Nutrient	Velvet jam
Calcium (Ca)	0.97±0.03
Magnesium (Mg)	1.0±0.08
Phosphorus (P)	0.35±0.01
Potassium (K)	1.44±0.02
Sodium (Na)	0.21±0.42
Iron (Fe)	0.25±0.02
Na/K	0.15
Ca/P	2.77

Values of means ± standard deviation of duplicate determinations.

Table 3. Vitamin composition (mg/100 g) of velvet tamarind (*D. guineense)* jam (dry basis).

Nutrient	Velvet jam
Vitamin C	27.7±0.13
Thiamin	0.10±0.01
Riboflavin	2.0±0.01
Niacin	1.4±0.02

Values of means ± standard deviation of duplicate determinations.

The Ca/P that was greater than 0.5 obtained for the sample would enhance high absorption of calcium in the digestive system, when consumed. The imbalance of calcium and phosphorus may also lead to adult rickets called osteomalacia and deficiency of calcium may equally result to bone thinning called osteoporosis, which is common among older people (Moldawer et al., 1965). This indicates that when the daily consumption of calcium is insufficient, the body utilizes the available calcium in the blood serum and bones to maintain constant body activities. Therefore, consumption of calcium should be maintained at optimal level over human life span. The value of iron was higher than those of velvet tamarind pulp (19.1 mg/g) (Niyi, 2015). Iron is essential for the formation of blood. Iron deficiency anaemia (IDA) is a major cause of low birth weight and maternal mortality and has been identified as an important cause of cognitive deficit in infants and young children (Nnorom et al., 2007). Bassa et al. (2003) reported that IDA is one of the major public health diseases in the world at large, most especially in Asia, sub-Saharan African countries; Nigeria inclusive. The iron level in velvet tamarind will therefore, alleviating IDA when fortified with other human foods of low iron value. Iron element is essential for blood cell particularly hemoglobin.

Vitamin composition of velvet tamarind jam (*D. guineense)*

The vitamin composition of the jam developed from velvet tamarind is presented in Table 3. The vitamin C level of velvet tamarind jam was 27.7 mg/100 g. The high vitamin C value obtained from velvet tamarind makes it an important product to be incorporated in diet plan in the developing countries where most people depend on plant for their iron source. Okegbile et al. (1991) found high content of vitamin C and other micronutrients in wild fruits when compared with nutrition supplied by other fruits such as oranges, Avogadro pear, pineapple, pawpaw and commercially produced fruits. Other vitamins obtained in velvet tamarind jam were thiamin (0.10 mg/100 g), riboflavin (2.01 mg/100 g) and niacin (1.5 mg/100 g). The B-vitamins are known for their roles in energy metabolism *in vivo* (Wardlaw and Hampl, 2007). The value of vitamin C in velvet tamarind jam was fairly high. The deficiency in man may cause scurvy. The value currently reported for the sample was in close agreement with those values reported for velvet tamarind pulp (33.3 mg/100 g) (Niyi, 2015) but higher than that of beach pea (1.60 mg/100 g) and green pea (6.50 mg/100 g) (Chavan et al., 1999). The vitamin C value for velvet tamarind jam was also lower than that of cashew apple (203.5 mg/100 g) (Akinwale, 2000). The high value of ascorbic acid in velvet tamarind pulp makes it useful in the prevention of scurvy, bleeding gums, limbs pain and blindness. The daily dietary allowance for vitamin C is 45 mg/day as reported by NAS (1974).The vitamin C content in velvet tamarind will meet the recommended daily requirements (NAS, 1974) when consumed.

Phytochemical composition of velvet tamarind (*D. guineense*) jam

The results of the phytochemical composition of the product are shown in Table 4. Tannin was the highest phytochemical obtained in the product (0.55 mg/100 g). When compared with other study, the value of tannin (0.55 mg/100 g) in this study was higher than the tannin value (0.19 mg/100 g) reported for pineapple jam (Aina et al., 2015). Phytic acid (0.06 mg/100 g), HCN (0.07 mg/100 g), saponin (0.4 mg/100 g), alkaloid (0.3 mg/100 g) and flavonoid (0.1 mg/100 g). Flavonoids are a class of secondary plant metabolites that exert beneficial health effects through their antioxidant activity (Heim et al., 2002). Though phytochemicals such as phytic acid, saponin, alkaloid and hydrogen cyanide were found in the product, it is important to note that their values were enhance the formation of red blood cells in the body and

Table 4. Phytochemical composition (mg) of velvet tamarind (*D. guineense*) jam (dry basis).

Phytochemical	Velvet jam
Tannin	0.55±0.01
Phytic acid	0.06±0.00
HCN	0.07±0.00
Saponin	0.04±0.00
Alkaloid	0.3±0.02
Flavonoid	0.1±0.00

Values of means ± standard deviation of duplicate determinations.

Table 5. Sensory attributes of velvet tamarind and pawpaw jam.

Sample	Colour	Flavor	Taste	Texture	Overall acceptability
Velvet tamarind jam	6.5±1.3^{b}	7.1±1.5^{a}	7.1±1.4^{a}	6.1±1.9^{b}	7.2±1.2^{b}
Pawpaw jam	7.7±1.6^{a}	6.4±2.1^{b}	6.9±1.7^{b}	6.9±1.6^{a}	7.3±1.3^{a}

Means with different superscripts along the same row are statistically different from each other (P<0.05).

within the permissible level (<1%). This implies that the jam developed from velvet tamarind is safe for human consumption.

Sensory attributes of velvet tamarind jam

The organoleptic evaluation remains the final judge of food quality. The results of sensory evaluation of velvet tamarind jam are presented in Table 5. The scores for colour (7.7) and texture (6.9) obtained for pawpaw jam were significantly higher than scores obtained for velvet tamarind jam (6.5 and 6.1, respectively). The preference of the colour of pawpaw jam to that of velvet tamarind jam may be due to its high carotenoids content which give attractive red or yellow colour and also contribute to food quality (Sharma et al., 2011). The smooth nature of pawpaw jam must have contributed to it been preferred to velvet tamarind jam in terms of texture. The taste and flavor of velvet tamarind jam were preferred to those of pawpaw jam, but the generally acceptability of velvet tamarind jam was comparable to that of pawpaw jam. The taste and flavor of velvet tamarind jam may be due to a combination of high contents of tartaric acid and reducing sugars found in velvet tamarind (Minh, 2015).

Conclusion

The study showed that velvet tamarind jam contained substantial amount of protein, potassium, magnesium, vitamin C and riboflavin. The taste and flavor of velvet jam were preferred to those of pawpaw jam, but the generally acceptability of velvet tamarind jam was comparable to that of pawpaw jam. There are appreciable levels of vitamin C in velvet tamarind jam which in the nutrition of humans could prevent the manifestation of diseases. Food industries may therefore consider the adoption of these indigenous fruit tree for jam production. The data suggest that the jam is nutritionally good for children, adult and also may supply some nutrition deficiencies.

Conflict of interest

The authors have not declared any conflict of interest

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