

Full Length Research Paper

Proximate composition and micronutrient potentials of three locally available wild fruits in Nigeria

Oladejo Thomas Adepoju

Department Of Human Nutrition, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Oyo State, Nigeria. E-mail: tholadejo@yahoo.com. Tel: (+234) 8033257333.

Accepted 3 August, 2009

***Spondias mombin*, *Dialium guineense* and *Mordii whytii* which grow wild and are consumed raw in the South-west and Middle belt of Nigeria were analysed for their nutrition potential in meeting some or all of micronutrients needs of consumers. Nutrient composition and antinutritional factors of the fresh fruit pulps were determined using standard methods of AOAC. Results of proximate analyses showed their moisture content to be 82.3, 71.5 and 4.0 g /100 g for *S. mombin*, *M. whytii* and *D. guineense*, respectively. Their crude protein ranged between 2.6 and 8.3 g, crude lipid 1.6 to 2.0 g, crude fibre 0.6 to 11.8 g, ash 1.0 to 6.8 g /100 g; and total carbohydrate was 7.9, 8.9 and 84.0 g /100 g sample for *S. mombin*, *M. whytii* and *D. guineense*, respectively. The fruit pulps were rich in sodium (360.0 – 400.0 mg), magnesium (300.0 – 465.0 mg) and potassium (260.0 - 410.0 mg) /100 g. *M. whytii* was rich in calcium (300 mg) and phosphorus (170 mg). Their iron and zinc content ranged between 2.0 and 4.1 mg and 0.2 – 2.2 mg, respectively; while retinol equivalents ranged between 84.9 and 361.5 µg /100 g fresh sample. The fruit pulps were low in all antinutritional factors studied and can serve as good sources of micronutrients.**

Key words: *Spondias mombin*, *Mordii whytii*, *Dialium guineense*, proximate composition, micronutrient potentials.

INTRODUCTION

Fruits are generally acceptable as good source of nutrients and supplement for food in a world faced with problem of food scarcity. They are known to be excellent source of nutrients such as minerals and vitamins; and also contain carbohydrates in form of soluble sugars, cellulose and starch (Nahar et al., 1990). Fruits are very vital portion of an adequate diet and they serve as food supplement, and an appetizer. The fruits, seeds and leaves of many wild plants already form common ingredients in a variety of traditional native dishes for the rural populace in developing countries (Humphrey et al., 1993).

Wild fruits are important source of vitamins and minerals. However, as a result of the changes sweeping through African societies, wild plants are in danger of disappearing and this may have harmful consequences on the nutritional status of the rural populace (Herzog et al., 1994). Wild fruits constitute source of nutrients to the rural populace (Kuhnlein, 1989), and can be a source of micronutrients; hence knowledge about their composition

and nutrient potentials is imperative.

Spondias mombin tree is native and common in most lowland forests, and indigenous to tropical Africa. The true yellow mombin, *S. mombin* L. (*Syn. S. lutea* L.) is most often called hog plum in the Caribbean Islands. In Jamaica, it is also known as Spanish plum, or gully plum. The yellow mombin is (Figure 1) appreciated mostly by children and passers-by as means of alleviating thirst. The purple mombin (*Spondias purpurea* L.) is stewed whole, with sugar, and consumed as dessert (Morton, 1987), and can be preserved for future use merely by boiling and drying, which keeps the fruit in good condition for several months. In Florida, yellow mombin is sold in local markets and consumed fresh; and it makes a significant contribution to the diet of people in local areas of the tropics when in season (<http://edsifas.ufl.edu/pdf/edsifas/MG/MG05900.pdf>).

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



Figure 1. *Spondias mombin* fruit.



Figure 2. *Mordii whytii* fruit.

red, with a sweet-sour, astringent flavour similar to baobab, but sweeter is eaten raw when dry by man and animal (Matsuda, 2006).

Mordii whytii is a wild green leafy shrub producing yellowish-green fruit (Figure 2) with white milky latex and tiny seeds when matured. The milky latex is tasteless and the pulp is eaten raw by the Mid-Westerners of Nigeria. It is less known with little or no literature information on its nutrient composition.

Achoba et al. (1992) analysed fruits of *D. guineense* Wild for proximate composition, selected inorganic ions and vitamin C. Arogba et al. (1994) reported that the edible part (pulp) of ripe *D. guineense* fruit is sweet but acidic (pH 3.3), relatively poor in protein and oil, and fairly low levels of ascorbic acid. Ubbaonu et al. (2005) investigated the pod weight, pod diameter, percent fruit portions, sugar and acid composition of the velvet tamarind pulp. Adepoju and Onasanya (2008) reported the nutrient composition and antinutritional factors of *D. guineense* Wild fruit pulp; while some works have been reported on the suitability of *S. mombin* pulp extract in jams, juice and ice cream production (Adepoju and Karim, 2004; Oyewole and Adepoju, 2005; Adepoju et al., 2006; Akubor and Egbekun, 2007; Adepoju and Oyewole, 2008) but there is dearth of information on the micro-

nutrient potentials of these fruit pulps.

There is global search for means of combating micronutrient deficiencies especially in developing countries of the world, and wildy grown fruits can be good source of these micronutrients. It is therefore the aim of this study to determine the proximate composition, micronutrient potentials and antinutritional factors of *S. mombin*, *D. guineense* and *M. whytii* fruits as means of combating some micronutrient deficiencies in Nigeria.

MATERIALS AND METHODS

Sample collection

S. mombin and *D. guineense* fruits were obtained and identified from the University of Ibadan campus, Nigeria, while *M. whytii* fruit was obtained from Forestry Research Institute of Nigeria (FRIN). *S. mombin* fruits were selected and washed to remove all debris and sand. All fruits were ripe and blemish-free. Composite sample of the three fruits were made. The pulps of the fruits were scraped for analysis.

Chemical analyses

Each sample comprising of forty randomly selected fruits of *S. mombin* and *D. guineense*, and ten *M. whytii* fruit from the three composites, was analysed in triplicate for moisture, crude protein, crude lipid, crude fibre and ash using standard methods of AOAC (1995). The carbohydrate content was obtained by difference. Potassium and sodium were determined using modified method of Bonire et al. (1990) by digesting the ash of the pulp with perchloric acid and nitric acid and readings taken on Jenway digital flame photometer/ spectronic20. Phosphorus was determined by vanadomolybdate colorimetric method. Calcium, magnesium, iron, zinc, copper and manganese were determined spectrophotometrically using Buck 200 atomic absorption spectrometer (Buck scientific, Norwalk) (Essien et al., 1992); and compared with absorption of standards of these minerals.

Ascorbic acid in the pulps was determined by titration with 2, 6-dichlorophenol-indophenol solution, while riboflavin was extracted using 5 ml of 5 M HCl and 5ml of dichloroethene and measurement made with fluorometer. Standard solutions of riboflavin were prepared and readings taken, and the pulp riboflavin obtained through calculation. β -carotene was determined through ultraviolet absorption measurement at 328 nm after extraction with chloroform. Calibration curve of β -carotene was made and the pulp β -carotene concentration estimated as microgram (μ g) of β -carotene.

Oxalate was determined by extraction with water for about three hours and standard solutions of oxalic acid prepared and read on spectrophotometer (Spectronic20) at 420 nm. The absorbance of the fruit pulp extracts were also read and amount of oxalate estimated. Phytate was determined by titration with ferric chloride solution (Sudarmadji and Markakis, 1977); while trypsin inhibitory activity was determined on casein and comparing the absorbance with that of trypsin standard solutions read at 280 nm (Makkar and Becker, 1996). The tannin content was determined by extracting the fruit pulps with a mixture of acetone and acetic acid for five hours, measured their absorbance and compared the absorbance of the extracts with the absorbance of standard solutions of tannic acid at 500 nm on spectronic20 (Griffiths and Jones, 1977). Saponin was also determined by comparing the absorbance of the fruit extracts with the standard at 380 nm (Makkar and Becker, 1996).

Table 1. Proximate composition of *S. mombin*, *D. guineense* and *M. whytii* (g /100g edible portion of fruit pulp)*.

	<i>S. mombin</i>	<i>D. guineense</i>	<i>M. whytii</i>
Moisture	82.3 ± 3.57	4.0 ± 0.10	71.5 ± 2.10
Crude Protein	2.6 ± 0.04	8.3 ± 0.10	6.2 ± 0.05
Crude Lipid	2.0 ± 0.05	4.9 ± 0.03	1.6 ± 0.01
Crude Fibre	4.2 ± 0.04	0.6 ± 0.01	11.8 ± 0.25
Ash	1.0 ± 0.02	3.2 ± 0.01	6.8 ± 0.17
Total Carbohydrates	7.9 ± 0.05	79.0 ± 0.01	2.1 ± 0.02
Total Soluble Sugars	4.7 ± 0.02	-	-

*n = average of three independent samples, analysed in triplicate.

** No titratable acidity on the table..

RESULTS

S. mombin and *M. whytii* pulps had high moisture content while *D. guineense* had low moisture because it was harvested dry. *D. guineense* and *M. whytii* pulps were very firm, hence their total soluble sugar, pH and total titratable acidity could not be determined.

The three fruit pulps were high in magnesium, sodium, potassium and β -carotene. *S. mombin* and *D. guineense* were low in calcium, phosphorus, zinc, manganese, and copper, while *S. mombin* and *M. whytii* were high in ascorbic acid.

S. mombin fruit pulp had low level of antinutrients *D. guineense* and *M. whytii* had high level of trypsin inhibitors.

DISCUSSION

The moisture, ash and carbohydrate values obtained for *S. mombin* fruit pulp (Table 1) were within the range stated in the literature, while the values obtained for crude protein, lipid, and fibre were higher than those reported in literature (Altschul, 1983, Morton, 1987; Adepoju et al., 2006). This observed variation might have resulted from geographic, climatic and seasonal variations.

The pulp was very high in moisture content and this may underscore its high perishability and susceptibility to microbial infections; and this is indicative of low solid matter in the pulp. High moisture content characterizes the freshness of a fruit since fruits kept for some time tend to lose moisture (Tressler et al., 1980).

The moisture content of *M. whytii* fruit pulp was also high and within the range of moisture content for fruits and vegetables (60 - 83 g/100 g, (FAO, 1968)). However, the moisture content of *D. guineense* Wild pulp was very low because it is normally harvested and consumed in the dry form. This value was closely related to the value reported by Achoba et al. (1992). The low moisture content was indicative of its high dry matter content and

possible long shelf-life.

The values obtained for crude protein, lipids and ash were higher than those reported by Achoba et al. (1992) while lower values were obtained for crude fibre and carbohydrate in this study. These observed differences might have resulted from geographic and climatic variation in the areas of study.

The three pulps studied were low in protein content, and their values differ significantly ($p < 0.05$), with *S. mombin* having the lowest and *D. guineense* having the highest value. Fruits in general are usually not considered as excellent sources of proteins (Edem et al., 1984; Kuhnlein, 1989; Ishola et al., 1990). However these values are higher than those reported for wild berries from Bella Coola in British Columbia (Kuhnlein, 1989); and for orange, apple, strawberries and melon (Anon, 1960).

The lipid content of the three pulps was very low; hence the pulps may not be possible source of oil-soluble vitamins. The values were however higher than the ones recorded for fluted pumpkin pod and pulp which were 0.50 and 0.30 g /100 g, respectively (Essien et al., 1992), and for banana, orange, apple, strawberries and melon (Anon, 1960).

The crude fibre value for *D. guineense* was very low, moderately high for *S. mombin* and high for *M. whytii*. Holloway, (1983) revealed that the composition of fruits and vegetable dietary fibre were predominantly arabinose, galactose and uronic acid, which are water soluble. The high fibre content of *M. whytii* may be an advantage for the fruit pulp to be a good source of dietary fibre. The moderately high crude fibre content of *S. mombin* fruit pulp was indicative of its high soluble fibre (pectin) content since the shaft had been removed through sieving. Soluble dietary fibres have health-promoting properties as they have been implicated in lowering plasma and liver cholesterol concentration (Behall and Resier, 1986), diarrhoea treatment and detoxification of poisonous metals (Cohn and Cohn 1996).

S. mombin was low in ash content, and this was indicative of low mineral value, especially the macro-

Table 2. Minerals and some selected vitamin composition of *S. mombin*, *D. guineense* and *M. whytii* fruit pulp (mg/100g edible portion)*.

	<i>S. mombin</i>	<i>D. guineense</i>	<i>M. whytii</i>
Potassium	270.0 ± 14.14	260.0 ± 14.14	410.0 ± 12.20
Sodium	400.0 ± 12.43	390.0 ± 15.42	360.0 ± 14.30
Calcium	31.8 ± 0.42	47.0 ± 0.40	300.0 ± 12.20
Magnesium	465.0 ± 21.21	300.0 ± 14.14	300.0 ± 11.4
Phosphorus	37.1 ± 0.21	42.9 ± 0.40	170.0 ± 7.50
Iron	3.2 ± 0.14	4.1 ± 0.14	2.0 ± 0.08
Zinc	0.2 ± 0.01	0.7 ± 0.14	2.2 ± 0.12
Manganese	0.2 ± 0.01	2.5 ± 0.14	6.2 ± 0.15
Copper	1.0 ± 0.14	1.0 ± 0.04	0.3 ± 0.02
Ascorbic acid	34.0 ± 0.28	6.2 ± 0.75	35.8 ± 0.32
β-carotene (µg/100 g)	85.0 ± 0.03	362.0 ± 0.04	105.0 ± 0.05
Niacin	0.5 ± 0.01	0.52 ± 0.00	0.52 ± 0.02
Riboflavin	0.07 ± 0.01	0.06 ± 0.00	0.08 ± 0.02

*n = average of three independent samples, analysed in triplicate.

minerals. *D. guineense* had moderately high value of ash while *M. whytii* had the highest value.

The carbohydrate content of *S. mombin* was slightly lower than the range (8.70 - 10.0 g /100 g) stated in the literature (Altschul, 1983). This variation in value may be due to climatic and geographic difference in the samples used. The pulp was also low in gross energy, which was believed to be a direct result of its low carbohydrate, lipid and protein content. *D. guineense* was very high in carbohydrate content, and this may possibly explain its sweet taste. *M. whytii* was very low in carbohydrate, and this may be responsible for insipid taste as well as low gross energy value. The low carbohydrate and gross energy values may qualify *M. whytii* as a good fruit snack for the obese and diabetics.

S. mombin fruit pulp extract was highly acidic. The high acidity explains the use of the pulp extract as basal material for jam preparation (Adepoju and Karim, 2004; Oyewole and Adepoju, 2005; Adepoju and Oyewole, 2008), since substances with high pectin value are always associated with high acidity (Schneeman, 1990). The results of selected mineral and vitamin composition of *S. mombin*, *D. guineense* and *M. whytii* are as shown in Table 2. The three fruit pulps were high in magnesium, sodium and potassium; and can be good sources of these minerals. *S. mombin* and *D. guineense* were low in calcium, phosphorus, zinc, manganese, and copper. The observed low values of minerals in the pulps were in line with the low ash values of these fruits. However, the calcium, phosphorus, zinc and manganese values of *M. whytii* were significantly higher ($p < 0.05$) than the corresponding values of other two fruits, and can be good source of these minerals. There was significant difference ($p < 0.05$) in levels of iron content of the three pulps. *M.*

whytii pulp was comparably lower in iron content compared with other two pulps, while *D. guineense* had the highest value, and can be a good source of the mineral.

Ascorbic acid content of *S. mombin* obtained here was slightly lower than that reported by Altschul, (1983) but comparable to that of Adepoju et al., (2006). The similarity in ascorbic acid content in this study and that of Adepoju et al., (2006) might have to do with climatic similarities of the sample areas. Its β-carotene value was similar to that reported by Morton, 1987 but higher than that of Adepoju et al., 2006. The variation in value may be a direct consequence of seasonal variation in nutrient content of the samples. *S. mombin* and *M. whytii* fruits can serve as good sources of ascorbic acid while the three fruits can serve as good sources of β-carotene, vitamin A precursor.

Antioxidants such as ascorbic acid and carotenoids coupled with dietary fibre have been associated with prevention of nutritionally related diseases such as cancers, diabetes mellitus, coronary heart disease and obesity (Mc Dougall et al., 1996; Larrauri et al., 1996); and the three fruits contain these antioxidants in appreciable amount. Evidence of vitamin C playing a key role in decreasing the incidence of degenerative diseases is considered to be strong (Haliwell, 1996). Low ascorbic acid levels have been associated with fatigue and increased severity of respiratory tract infections (Johnston et al., 1998), while high intake of vitamin C from food had been shown to raise serum HDL-cholesterol and lowers serum triglyceride concentration (Ness et al., 1996); hence, the three fruits have health-promoting potentials. The fruits can be good sources of niacin but they were low in riboflavin content.

Table 3 shows the result of anti-nutritional factors pre-

Table 3. Anti-nutritional factors / toxicants in *S. Mombin* fruit pulp, *D. guineense* and *M. whytii* (mg/100 g sample).

	<i>S. mombin</i>	<i>D. guineense</i>	<i>M. whytii</i>
Phytate	0.21 ± 0.03	1.30 ± 0.03	1.64 ± 0.04
Oxalate	1.88 ± 0.06	0.90 ± 0.04	1.44 ± 0.05
Tannin	2.41 ± 0.02	0.60 ± 0.04	1.55 ± 0.02
Saponins	1.06 ± 0.01	0.20 ± 0.02	1.82 ± 0.08
Trypsin Inhibitors	0.00 ± 0.00	16.40 ± 0.04	16.70 ± 0.25

sent in the three fruits studied. *S. mombin* fruit pulp was very low in anti-nutritional factors. This might be due to the sieving of the shaft of the pulp. *D. guineense* and *M. whytii* were slightly high in trypsin inhibitors value. Plant products generally contain higher level of antinutritional factors than animal products. The slightly high values of the antinutritional factors might be due to non-processing of their pulps.

The levels of all the antinutritional factors in the three fruits were lower than what can constitute any health hazard or mal-absorption of other nutrients when taken in large quantity.

Conclusion and Recommendation

The three wildy grown fruits studied were promising sources of essential micronutrients such as calcium, phosphorus, iron, ascorbic acid as well as β -carotene. Since the level of their antinutritional factors is lower than what can cause mal-absorption of other nutrients, their consumption should be encouraged when available. *Spondias mombin* and *Mordii whytii* pulps are recommended as fruit snacks for the obese and diabetics.

REFERENCES

- Achoba II, Choba JA, Lori JA, Elegbede JA, Kagbu JA (1992). Nutrient composition of black (African) velvet tamarind (*Dialium guineense* wild) seed and pulp from Nigeria. *J. Food Biochem.* 16(4): 229-233.
- Adepoju OT, Karim SA (2004). Nutrient composition, anti-nutritional factors and jam preparation from *Spondias mombin*_(hog plum (Iyeye)) fruit pulp. *Niger. J. Nutr. Sci.* 25(1), 20 – 25.
- Adepoju OT, Oyewole EO (2008). Nutrient composition and acceptability of fortified jam from *Spondias mombin* (Hog plum, (Iyeye)) fruit pulp. *Niger. J Nutr Sci* 29(2): 180-189.
- Akubor PI, Egbekun MK (2007). Adepoju OT, Onasanya LO, Ogunfuwa AO, Ayoade SO (2006). Nutrient composition and acceptability test of juice and ice cream from *spondias mombin* (Hog plum) fruit pulp extract. *J. Trop. For. Res.* 22: 25–32.
- Altschul EL (1983). Edible fruit in the tropical Africa. P 35 AVL Publishing Co. West port Connecticut, USA.
- Anon (1960). Food and Agricultural Organisation, United Nations. Food Composition Tables. Vol. 1: 16 pp.
- AOAC (1995). Official methods of analysis (16thedn) Association of Official Analytical Chemists. Virginia, USA.
- Arogba SS, Adejoke AA, Ifeanyi JO (1994). A physico-chemical study of Nigerian velvet tamarind (*Dialium guineense* L) fruit. *Journal Food*

- Biochemistry.
- Behall K, Resier (1986). Chemisry and function of pectin. In: ACS System symposium series 310, ed FishmanM L, Jen J.J. Am. Chemical Society, Washington, D C USA, 248-250.
- Bonire JJ, Jalil NSN, Lori JA (1990). Sodium and potassium content of two cultivars of white yam (*Dioscorea rotundata*) and their source soils. *J. Sci. Food Agric* 53: 271-274.
- Cohn R, Cohn AL (1996). The by- products of fruit processing in: Fruit processing, ed Arthey D, Ashurst PR, Chapman & Hall, London, U.K. pp. 196-220.
- Edem DO, Eka OU, Ifon, ET (1984). Chemical Evaluation of the Value of the Fruit of African Star apple (*chrysophyllum albidum*). *Food Chem.* 14: 303-311.
- Essien AI, Ebana RUB, Udo HB (1992). Chemical evaluation of pod and pulp of the fluted pumpkin (*Telfairia occidentalis*) fruit. *Food Chem* 45: 175-178.
- FAO (Food and Agricultural Organisation) (1968). Food composition table for use in Africa Food and Agric. Organisation of the United Nations, Rome, Italy.
- Griffiths DW, Jones DIH (1977). Cellulase inhibition by tannins in the testa of field beans (*Vicia faba*). *J. Sci. Food Agric.* 28(911): 938-989.
- Halliwell B (1996). Antioxidants and human disease: a general introduction. *Nutr. Rev.* 55: 44-52.
- Herzog F, Farah Z, Amado R (1994). Composition and consumption of gathered fruits in the V-Babule, Cote D'Ivoire. *Ecol. Food Nutr.* 32: 181-196.
- Holloway DW (1983). Composition of fruit, vegetable and cereal dietary fibre. *J Sci. Food Agric* 34, 1236-1240.
<http://edsifas.ufl.edu/pdffiles/MG/MG05900.pdf>
- Humphrey CM, Clegg MS, Keen CL, Grivetti LE (1993). Food diversity and Drought survival: The Housa example. *Int. J.Food Sci. Nutr.* 44: 1-16.
- Ishola MM, Agbaji EB, Agbaji AS (1990). A chemical study of *Tamarandus indica* (Tsamiya) fruits grown in Nigeria. *J. Sci. Food Agric.* 51(1): 141-143.
- Johnston CS, Solomon RE, Corte C (1998). Vitamin C status of a campus population: College students get a C minus. *J. Am. Coll. Health* 46: 209-213.
- Kuhnlein HV (1989). Nutrient values in indigenous wild berries used by the Nuxalk people of Bella Coola, British Columbia. *J. Food Comp. Anal.* 2: 28-36.
- Larrauri JA, Gõni I, Martín-Carrón N, Rupérez P, Saura-Calixto (1996). Measurement of health-promoting properties in fruit dietary fibres, Antioxidant capacity, Fermentability and Glucose retardation index. *J. Sci. Food Agric.* 71: 515-519.
- Makkar HPS, Becker K (1996). Nutritional value and antinutritional components of Whole and ethanol extracted *Moringa oleifera* leaves. *Anim. Feed Sci. Technol.* 63: 211-238.
- Matsuda R (2006). Feeding ecology of the Mona monkey (*Cercopithecus mona*) in a seasonally dry flooded forest in the Dahomey gap. Dept. of Anthropology, Graduate Center, City University of New York, New York, NY, 10016, (USA IPS Conference 2006 (Abstracts)).
- McDougall GJ, Morrison I A, Stewart D, Hillman JR (1996). Plant cell walls as dietary fibre: Range, Structure, Processing and Function. *J. Sci. Food Agric.* 70: 133-150.

- Morton J (1987). Purple Mombin. In: Fruits of warm climates. Miami FL. pp. 242 - 245.
- Nahar N, Rahman S, Mosihuzzaman M (1990). Analysis of carbohydrates in seven edible fruits of Bangladesh. *J. Sci. Food Agric.* 51: 185-192.
- Ness AR, Khaw KT, Bingham S, Day NE (1996). Vitamin C status and serum lipids. *Eur. J. Clin. Nutr.* 50: 724-729.
- Oyewole EO, Adepoju OT (2005). Nutrient composition and acceptability of honey-substituted jam from spondias mombin (Hog plum) fruit pulp. *Niger. J. Nutr. Sci.* 26 (2); 38-44.
- Schneeman BO (1990). Gastrointestinal responses to dietary fibre. In: *New Dev. in dietary fibre* Eds. Furda I, Brine CJ. Plenum Press New York, USA pp. 37-42.
- Sudarmadji S, Markakis P (1977). The phytate and phytase of soybean Tempeh. *J. Sci. Food Agric.* 28(4): 381-383.
- Tressler DK, Van Arsdell WB, Copley MJ (1980). *The freezing preservation of foods.* 4th Edn. Vol. 23. AVI Publishing Co. Westport, Conn.
- Ubbaonu CN, Onuegbu NC, Banigo EOI, Uzoma A (2005). Physico-chemical changes in velvet tamarind (*Dialium guineense* Wild) during fruit development and ripening. *Niger. Food J.* 23: 133-138.