

Evaluation of Some Vitamins and Minerals in Palmyra Fruit (*Borassus Aethopium*)

¹Danbature Wilson Lamayi, ²Fai Frederick Yirankinyuki, ³Abdullateef Olalekan Abdullahi & ⁴Goji Mbursa

^{1,2,3,4} Department of Chemistry,
Gombe State University Gombe, Nigeria

Abstract

Palmyra (*Borassus spp*) is a genus of six species of fan-palm fruits native to tropical region of Africa and Asia. Palmyra fruit is eaten and the water extract of the fruit is taken as juice and used in making pap. Samples of the fruits were collected randomly from the Palmyra tree in Kaltungo L.G.A of Gombe State. UV-Spectrophotometer was used to quantify vitamins A, B₁, B₂, B₄ and B₆, while Atomic Absorption Spectrophotometer (210VGP) was used to determine the concentrations of Na, K, Ca, Mg, Zn, Fe, Cu and Cd. The results revealed that Palmyra fruits contains 0.00mg/l of vitamin B₂, and is richer in vitamin B₆ (1.2 ± 0.003 mg/l). The mineral composition showed that the fruit contains a high concentration of Na (480 ± 0.002 mg/kg) and K (340 ± 0.002 mg/kg) and a low composition of Ca and Zn (28 ± 0.002 and 25.8 ± 0.003 mg/kg respectively). There was no Cd present in the fruit. Of the heavy metals, Fe has the highest concentration of 8.571 ± 0.250 mg/100g). From the results obtained, it could be concluded that the consumption of Palmyra fruit should be encouraged since it contains vitamins and minerals required for proper functioning of the body.

Keywords: AAS, Minerals, Palmyra, UV - Visible Spectrophotometer, Vitamins

Corresponding Author: Danbature Wilson Lamayi

Background to the Study

Fruits are vital components of food. They are a good source of vitamins and minerals that can help keep the body healthy. Because of this, the consumption of fruits can help protect and reduce the risk of some diseases. Palmyra (*Borassus spp*) is a genus of six species of fan-palm fruits native to tropical region of Africa and Asia (Wikipedia, 2016). The Palmyra plant (*Borassus aethiopum*) has been described as a palm tree with huge fan shaped leaves (Ahmed *et al.*, 2010). The plant is dioecious and can reach up to 20 m high on average and 1 m in diameter (Muller, 1988). The fruits have a large fibrous pulp that smells strongly of turpentine. The fruits are consumed raw or cooked. The water extract of the fruit is taken as juice and some use in making pap. The kernels contain albumen, which before ripening is sweet and refreshing. Fresh sap is used as yeast or made into vinegar (Ozgur and Koyunco, 2000).

The term vitamin was derived from "vitamines" a compound word coined in 1912 by a Polish Biochemist Kazimierz Fonk (Maciej, 1981). The name is from "vital" and "amine" meaning amine of life. Thirteen vitamins are universally recognized at present and classified according to their biological and chemical activities (Wikipedia, 2016). Vitamins are classified as either water soluble or fat soluble. In humans the water soluble vitamins are readily excreted to the extent that urinary output is a strong indication of vitamin consumption (Fukuwatiri and Shibita, 2008) while fat soluble proteins are absorbed through the intestinal track with the help of lipids (Maqbool and Stallings, 2008).

Minerals are elements (inorganic) or metals constituting only a small proportion of the body weight. These minerals perform vital functions which are absolutely essential for the very existence of an organism. These include calcification of bone, blood coagulation, neuromuscular irritability, acid-base equilibrium, fluid balance and osmotic regulation.

Certain minerals are integral component of biologically important compounds such as hemoglobin (Fe), thyroxin (I), insulin (Zn) and vitamin B₁₂ (Co). Sulfur is present in thiamine, biotin, lipid acid and coenzyme. Several minerals participate as cofactor for enzymes in metabolism (e.g. Mg, Cu, Zn, K etc.). Some elements are essential constituents of certain enzymes (e.g. Co, Mo, Se etc.) (Satyanarayana *et al.*, 2006).

There are two categories of mineral essential to the body, macro-minerals and micro-minerals. There should be no mineral deficiency; they all must be maintained in balance with the body. Macro or principal elements are calcium, magnesium, phosphorus, Sodium, potassium, and sulfur whereas micro or trace elements (heavy metals) are iron, silicon, cobalt, copper, manganese, zinc, and cadmium. Most of the required essential minerals are widely distributed in our food and most people eating a mixed diet are likely to receive adequate intakes as the amount required do vary from grams per day (e.g. sodium, calcium, potassium), through milligrams per day (e.g. iron, zinc), to micrograms per day for the trace element

The aim and objective of this work is to determine some of the vitamins and minerals found in Palmyra (*Borassus aethiopum*) fruit.

Materials and Method

Reagents/ Equipments

All the reagents were of analytical grades and purchased from Sigma Aldrich. The major Equipments used were UV - Visible Spectrophotometer, Atomic Absorption Spectrophotometer, Centrifuge, pH meter, sieve, pestle, mortar, water bath and oven.

Sample Collection/Preparation

The sample was randomly collected from Kalorgu in Kaltungo L.G.A of Gombe State, Nigeria. The obtained fruit samples were allowed to ripen and pounded gently so that it softens for easy removal of the fibrous cover and access to the fruit pulp.

Preparation of sample for vitamin analysis

A 0.01 g/ml of the fruit extract was prepared by dissolving 1.0 g of the fruit pulp in 100 ml of deionized water and kept vitamins for analysis

Preparation of Sample for Elemental Analysis

The fresh pulp was obtained and then dried. The dried pulp was ground into fine particles and sieved. The sieved sample was kept for digestion.

Determination of Vitamin A

The method described by Maciej *et al.* (2007) was used and adopted where 1 ml of the fruit extract was measured into a centrifuge tube and 1 ml of KOH in 90% alcohol was added. The tube was stoppered and shaken vigorously for 1 minute. It was then heated on a water bath at 60 °C for 20 minutes, cooled in cold water and then 1 ml of xylene was added. The mixture was shaken vigorously for 1 minute and then centrifuged at 15000 revolution for ten minutes. The upper layer was transferred to a borosilicate glass and the absorbance A_1 read at 335 nm against xylene with a UV - Visible Spectrophotometer. The extract was exposed to sunlight for 45 minutes and the absorbance A_2 was read again at 335 nm. The concentration of Vitamin A C_x was calculated using the formula

$$C_x = (A_1 - A_2) \times 22.23 \dots\dots\dots 1$$

Where; C_x is the concentration of vitamin A in the analyzed liquid

A_1 is the absorbance of the obtained extract after centrifugation

A_2 is the absorbance of the obtained extract after exposure to light

22.23 is the multiplier received on the basis of the absorption coefficient of 1 % solution of vitamin A

Determination of Vitamin B₁ (Thiamine)

A modified method of Nethaji *et al.* (2010) was adopted. Fifty milligram's of thiamine hydrochloride was accurately weighed and transferred to a 100 ml volumetric flask. It was dissolved with distilled water and made up to the mark to give a stock solution of 100 μgml^{-1} . Different aliquots of the stock solution were taken in seven different test tubes and serially diluted to cover a concentration range of 0.2 - 14 μgml^{-1} . An accurately measured amount (0.19 ml) of 0.1 M ferric sulphate solution was added and thoroughly shaken and 0.6 ml of 0.1 M

potassium hexacyanoferrate (III) solution was then added followed by the addition of deionized water to make it 25 ml. The mixture was allowed to stand for 20 minutes in a water bath at 40 °C. The absorbance of the resulting mixture was measured at a λ_{\max} of 747 nm with a UV - Visible Spectrophotometer. The test sample was prepared in the same manner with the test sample replacing the thiamine hydrochloride.

Determination of Vitamin B₂ (riboflavin)

A standard solution of 50 µg/ml of riboflavin in 10% methanol solution was prepared by dissolving 0.0133g of riboflavin in 100 ml of 10% methanol solution. Five different solutions of riboflavin were made from the standard solution in a 50 ml volumetric flask. The test sample solution was also prepared in the same manner but containing no riboflavin. The absorbances of the solutions were read at λ_{\max} 445 nm with a UV - Visible Spectrophotometer with deionized water as blank.

Determination of Vitamin B₆ (pyridoxine)

An accurately weighed 50 mg of pyridoxine hydrochloride was transferred to a 100 ml volumetric flask, distilled water was added and made to the mark. Different aliquots of the standard pyridoxine hydrochloride solution equivalent to concentrations of 50 - 700 µg (i.e 0.5 - 7 ml) were transferred into series of 50 ml volumetric flasks. A 0.5 ml buffer solution (pH = 3) and 7 ml of ferric ammonium sulphate solutions were added. The contents were thoroughly mixed and allowed to stand for 5 minutes with occasional shaking. Approximately 10 ml of distilled water was added to make it up to 25 ml and the solutions were mixed well. The test solution was also prepared in the same way but containing no pyridoxine hydrochloride. The absorbances of the solutions were determine using UV - Visible Spectrophotometer at λ_{\max} 465nm with distilled water as blank (Ahmed, 2012).

Digestion of Sample

Two grammes of the sample was weighed and placed into a 100ml conical flask containing 30 ml of concentrated hydrochloric acid (HCl) and heated at 90°C until a clear solution was obtained. The solution was then filtered into a 50ml volumetric flask and deionized water was added to mark. This was labeled A₁. A volumetric flask containing only 30ml. of concentrated Hydrochloric acid (HCl) without the sample was used as blank and labeled A₂. This was used for the analysis of calcium, magnesium, potassium and sodium.

Another 2g of the sample was added into a conical flask containing concentrated Hydrochloric acid (HCl) and concentrated Nitric acid (HNO₃) in the ratio of 3:1 (30ml of HCl and 10ml of HNO₃). It was heated at 90°C till a clear solution was obtained. A 20ml of the mixture (30ml of HCl and 10ml of HNO₃) was added to the solution and filtered into a 50ml volumetric flask and deionized water was used to fill it to mark and was labeled as B₁. Another conical flask containing the reagent (30ml of HCl and 10ml of HNO₃) was used as the blank. This was used for the analysis of copper, iron, manganese and zinc. These samples were analyzed using 210 VGP (AAS) Atomic Absorption Spectrophotometer.

Results and Discussions

The results for the determinations of vitamins are as shown in Table 1. From the table it could be seen that the Recommended Daily Allowance (RDA) for vitamin A in adults is 700 μg per day (Food and Nutrition Board, 2015). The vitamin A content of Palmyra fruit obtained in this research is 8.89 $\mu\text{g}/100\text{g}$ which is close to the value (9.80 $\mu\text{g}/100\text{g}$) as reported by Pemberton (2005). This indicates that more of the Palmyra fruit would have to be consumed alongside other sources in order to meet up with the RDA.

The RDA for vitamin B₁ in adults is 1.1mg/100g (Food and Nutritional Board, 2015). In this research, it was found that there is no vitamin B₁ present in Palmyra fruit. This result is in agreement to the finding of Davis and Johnson (1987) who reported that Palmyra jaggery contains no thiamine. It implies that Palmyra fruit is not a source of vitamin B₁. However, according to Mission and Clean (2015), the fruit contains about 0.04 mg/100g of vitamin B₁. The variation in the two results could be due to differences in geographic locations, climatic factors, effect of temperature and time (Danbature *et al.*, 2014).

The RDA for vitamin B₂ (Riboflavin) in adult is 1.2 mg (Food and Nutrition Board, 2015). The vitamin B₂ of Palmyra fruit obtained in this research is 0.03 mg/100g which is higher than that obtained by Mission and Clean (2015) which is 0.02 mg/100g of palm sugar. This shows that Palmyra fruit alone is not a good source of vitamin B₂ but if consumed with other sources vitamin B₂ could be a good supplement. The consumption of 1 kg of the fruit could supply the 25 % of the needed RDA.

The RDA for vitamin B₆ (pyridoxine) in adults is 1.3 mg/100g (Food and Nutrition Board, 2015). The vitamin B₆ content of Palmyra fruit obtained in this research is 3.5 mg/100g. This implies that 100 g of the fruit only if consumed is capable of supplying the body with about three times the RDA requirement. Mission and Clean (2015) reported that a table spoon of Palmyra jaggery contains 222% of the adult's RDA for vitamin B₆ which is 2.886mg/100g. Bailey (2015) also reported that the jaggery contains a wealth of vitamins and minerals including iron, vitamin B₆, calcium, potassium and vitamin B₁₂.

Table 1: Results for Vitamin A (Retinol), Vitamin B₁ (Thiamine), Vitamin B₂ (Riboflavin) and Vitamin B₆ (pyridoxine) With RDA and results from Literature.

Type of Vitamin	Wavelength λ_{max} nm	RDA mg/100g	Results obtained per 100 g	Results obtained from literature
A (Retinol)	335	700	8.89 \pm 0.03	9.89 $\mu\text{g}/100\text{g}$ (Pemberton, 2005)
B ₁ (Thiamine)	747	1.1	0.00	0.00 (David and Johnson, 1987)
B ₂ (Riboflavin)	445	1.2	0.03 \pm 0.006	0.02 (Mission and Clean, 2015)
B ₆ (pyridoxine)	465	1.3	3.5 \pm 0.2	2.89 (Mission and Clean, 2015)

The results for the elemental determination of the minerals and some heavy metals as shown in Table 2,

Table 2: Result for elemental analysis of the minerals and some heavy metals.

Elements	RDA mg/kg (for adult) (Food and Nutrition Board, 2015)	Concentration mg/kg
Na	2300	12000 ±0
K	4700	8500 ±0
Ca	100	74.2 ±13.8
Mg	400	850.2 ± 42.8
Mn	448.5	262.4 ± 18.8
Fe	11	18.53 ±25
Zn	40	25.8 ±0.14
Cu	0.9	2.46 ±2.8
Cd	0.04	0.00 ± 0.00

Sodium in the fruit has the highest concentration 12000 mg/kg which is very high compared to the RDA of sodium 2300 mg per day and good for our body system.

The RDA for sodium is the intake level of what you should be getting from your daily diet. In small amounts, sodium is essential for normal nerve and muscle functioning. It is also required for the proper balance of fluids in your body. Too much sodium in diet can result in a sodium build up in the blood stream. If left untreated, high levels of sodium can lead to many diseases such as high blood pressure, heart disease, stroke and kidney disease. The high level of sodium in the fruit indicates that people suffering from high blood pressure is at risk if they consume the juice.

The concentration of potassium in the fruit is 8500 mg per kg which is almost twice that of RDA of potassium 4700 mg per day in adult and 5100 mg in pregnant and lactating mothers. Potassium is the most abundant intracellular cation and an essential nutrient that is present naturally in food and available as a dietary supplement. It is also present in all body tissues and is required for normal cell function because of its role in maintaining intracellular volume and transmembrane electrochemical gradient (Stone *et al.*, 2016). Insufficient potassium intake can increase blood pressure, kidney stone risk, bone turnover etc. and severe potassium deficiency can cause hypokalemia (Preuss *et al.*, 2012 and Viera *et al.*, 2015).

The RDA for calcium is 100 mg per day in both male and female while the concentration in Palmyra fruit is 74.2 mg/kg. This result is slightly lower than the recommended intake in adult and there is need for food richer in calcium (milk) to be taking alone with the fruit. Calcium ion place a vital role in many, if not most metabolic process, neuromuscular function, enzymes mediated process and blood clotting as well as providing rigidity to the skeleton (Forbes, 1987). In adults the rate of calcium absorption from the gastrointestinal tract need to match the rate of its losses from the body if the skeleton is to be preserved, in children and adolescent an extra input is needed to cover the requirement of the skeletal growth.

The adult RDA for magnesium in male is 400 mg per day, in female 320 mg per day and 350 mg per day in pregnant women. The concentration of magnesium in the fruit is 850.2 mg which is higher than that of RDA therefore, the consumption of 1 kg of the fruit can give the require dosage of magnesium in a day. The human body contains about 760 mg of magnesium at birth approximately 5 g at age 4-5 month and 25 g when adolescent (Widdowson *et al.*, 1951). Magnesium is a mineral that is crucial to the body's function. Magnesium helps keep blood pressure normal, bones strong and the heart rhythm steady. Magnesium supplement often causes softening of stool.

The concentration of manganese is 262.4 mg/kg of the fruit sample while the RDA of the trace mineral is about 448.5 mg. Manganese is necessary for healthy bone structure, it is a component of several enzyme systems, including manganese specific glycosyltransferases and phosphoenolpyruvate carboxykinase. Manganese deficiency has not been conclusively documented, although one experimental case in a volunteer resulted in transient dermatitis, hypocholesterolemia, and increased alkaline phosphatase levels. Manganese toxicity is usually limited to people who mine and refine ores, prolonged exposure causes neurologic symptoms resembling those of Parkinson or Wilson disease (Larry, 2017).

The concentration of iron in the fruit sample is 18.53 mg/kg of the fruit. This shows that the fruit has a high iron content. The RDA of Iron in adult male (14-18 years) is 11 mg, 19-50 years is 8 mg and in female (14-18 years) is 15 mg, 19-50 years is 18 mg. This shows that consuming 1kg of the fruit alone can supply what an adult needs per day. The RDA for iron while in pregnancy and lactating mothers is 27 mg and 10 mg respectively, this means that the consumption of the juice alone could meet the need of both pregnant and lactating mothers.

The concentration of zinc in the fruit is 25.8mg/kg which is low compared to the RDA of 40mg/day at the recommended upper limit in adults. Zinc deficiency in children causes impaired growth, impaired taste (hypogeusia), delayed sexual maturation and hypogonadism in both children and adult. Manifestation also include alopecia, impaired immunity, anorexia, dermatitis, night blindness, anemia, and impaired wound healing. The treatment of zinc deficiency consists of elemental zinc 15 to 120mg ones a day until symptoms and signs resolve. The zinc content of the fruit is very low, the fruit would have to be fortified before it could meet the RDA

The concentration of copper in the fruit 2.46mg/kg and the RDA of copper 0.9mg and an upper limit of 10mg per day. Copper functions as a component of enzymes in iron metabolism. Metabolism of copper in humans relies on the intestine for control of homeostasis as the capacity for renal copper excretion is limited. Nearly two thirds of the body copper content is located in skeleton and muscles, but studies with stable isotopes have shown that the liver is a key site in maintaining plasma copper concentration (Olivares and Uavy, 1996; Turnland *et al.*, 1999). The biochemical role for copper is primarily catalytic, with many copper metal enzymes acting as oxidases to achieve the reduction of molecular oxygen. Many copper metal enzymes have been identified in humans (Harris, 1997). Copper absorption occurs primarily in the small intestine. Some absorption may occur in the stomach where the acidic environment promotes

copper solubility by dissociation from copper containing macromolecules derived from dietary sources (Turnland, 1999). Copper deficiency in humans is rare but has been found in a number of special conditions. It has been observed in premature infants fed milk formulas, in infants recovering from malnutrition associated with chronic diarrhea and fed cow's milk (Shaw, 1992). Dangers exceeding the upper limit are gastrointestinal distress and cure damage.

Conclusion

The study revealed that Palmyra fruit contains Vitamin A, B₂ and B₆ with the following quantities $8.89 \pm 0.03 \mu\text{g}/100\text{g}$, $0.03 \text{ mg}/100$ and $3.50 \text{ mg}/100\text{g}$ respectively while it contains no vitamin B₁. The fruit is very rich in vitamin B₆, consumption of 100 g alone can supply the body with about three times the RDA.

The result obtained from the elemental analysis using AAS shows that the fruit contains a good appreciable amount of macro and micro elements. Among the macro elements, sodium has the highest concentration followed by potassium, magnesium and calcium, recorded as 12000 mg, 8500 mg, 850.2 mg and 74 mg/kg dry weight respectively of the fruit. Similarly the micro elements manganese, iron, copper and zinc were recorded as 262.4 mg, 185.3 mg, 24.6 mg and 2.58 mg/kg of the dry weight of the fruit. Cadmium although very poisonous was found to be absent in the fruit. It could be concluded that the consumption of this fruit should be encouraged considering the rich macro and micro element present.

Recommendation

It is recommended that some of the vitamins not determined in this research together with the anti nutritional test be conducted for a positive decision on the consumption of the fruit.

References

- Ahmed, A., Djibrilla A., Clerge, T & Clement, S. (2010). Physicochemical properties of palmyra palm (*Borassus aethiopum*) fruits in Northern Cameroun. *African Journal of Food Science*, 4(3) 115-119.
- Akinniyi J. A. & Waziri M. (2011). Proximate value and mineral content of the shoots of *Borassus aethiopum* Mart (Giginya). *Journal of Chemical Society of Nigeria*, 36 (1) 100 – 103.
- Bailey, S.W. & Ayling, J. A (2009). The extreme slow and variable activity of dihydrofolatereductase in human liver and its imolication for High Folic Acid Intake. *Proceeding of the National Academy of Sciences of the United States of America*, 106 (36) 15424-15429.
- Danbature, W. L., Fai, F. Y., Usman, A.A. & Patrick, A. (2014). Nutritional evaluation of baobab seed. *International Journal of Research in Agriculture and Food*, 2 (2) 44-48.
- Food and Nutritional Board of Medicine (2016). *Dietary reference In takes: Vitamins*. Washinton D.C., National Academy Press, pp 230-241.

- Forbes G.B. (1987). *Human body composition growth, aging, nutrition and activity*. New York, NY, Springer-Verlag. pp 241- 253.
- Fukuwatiri, T. & Shibita, K. (2008). Urinary water soluble vitamins and their metabolite contents as nutritional makers for evaluating vitamin intake in young Japanese Women. *Journal of Nutritional Science and Vitamins*, 54 (3):223-229.
- Larry, E. J. (2017). *Family and preventive medicine university of Arkansas for medical science*. Central Arkansas Veterans Health care system.
- Maqbool, A. & Stallings, V. A. (2008). Update on fat soluble vitamins in cystic fibrosis. *Curriculum of Pulmonary Medicine*, 14(6):574-581.
- Mission and Clean (2015). Available at <http://missioncleanlean.com/blog/2015/6/15/supersimple-2-ingredients-pancakes>.
- Muller, H.G. (1988). *An introduction to tropical food science*, Cambridge University Press, pp 59-118.
- Nethaji, S., Sivasamy, A., Thennarasu, G & Saravana, S. (2010). Adsorption of malachite green Dye onto Activated Carbon Derived from *Borassus aethopum* Flower Biomass. *Journal of Hazardous Materials*, 181:271-280
- Pemberton, J. (2006). Medical experiments carried out in sheffield on conscientious objectors to military service during the 1939-45 War. *International Journal of Epidemiology*, 35 (3): 556-558.
- Preus, H.G., Clouatre, D.L., Erdman, J.W., Macdonald, I.A. & Zeisel, S. H.(2012). Present knowledge in nutrition. 10th ed. Washington DC: Wiley Blackwell, pp 1021 -1029.
- Said, H.M. & Mohammed, Z. M. (2006). Intestinal absorption of water soluble Vitamins: An update. *Curr. Opin. Gastroentero*, 22 (2):140-146.
- Sathawara N. G., Parikh D. J. & Agarwal Y. K. (2004). Essential heavy metals in environmental samples from Western India. *Bulletin of Environmental Contamination and Toxicology*, 73(4),756–761.
- Satyanarayana U. & Chakrapani U. (2006). *Biochemistry 3rd ed. Arunah and Son, Books and applied (p) Ltd.* Chintomoni Das lane Kolkata, India, pp 173 -205
- Stone M.S., Martyn L. & Weaver C.M. (2016). Potassium Intake Bioavailability, Hypertension and Glucose Control. *Nutrient*, 5: 106 - 201.
- Tewari, G. & Juneja, V. K. (2007). *Advances in thermal and non-thermal food preservation*, Blackwell Publishing pp. 96-116.

Viera, A. J. & Wouk, N. (2015). Potassium disorders: Hypokalemia and hyperkalemia. *Am Fam Physician*, 92:487-495.

Widdowson, E.M., McCance R.A. & Spray C.M. (1951). The chemical composition of human body, *Clinical Science*, 10:13-125.

Wikipedia (2016). <http://en.m.wikipedia.org/wiki/Vitamins>.