IPS Journal of Nutrition and Food Science
IPS J Nutr Food Sci, 2(1): 1-4 (2023)
DOI: https://doi.org/10.54117/ijnfs.v2i1.17

Carbohydrate content and Glycaemic indices of *Pentaclethra macrophylla*, *Telfairia occidentalis* and *Treculia africanum*

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Abstract

The *Glycaemic Index* (GI) is a numerical system of measuring how fast a carbohydrate triggers a rise in circulating blood sugar – the higher the number, the higher the blood sugar response. The objectives of this study were to evaluate the carbohydrate content and glycaemic index of some vegetables and seeds. The phenol- sulphuric acid method for the estimation of carbohydrate quantitatively was used. Sucrose was used as standard carbohydrate to prepare a calibration curve. Albino rats were used for the determination of blood glucose. In estimating the rate of blood glucose after feeding with samples, three (3) animals were used for each sample. Each blood sample was placed on a test strip which was inserted into a calibrated glucometer (prestige) which gave direct readings after 45 seconds based on glucose oxidase assay method. *Pentacletra macrophylla*, *Treculia africanum* and *Telfaria occidentalis. Pentacletra macrophyylla* has a glycaemic of 61.3% ± 9.30, *Telfaria occidentalis* has a glycaemic index of 86.5% ± 0.70 while *Treculia africanum* has glycaemic index of 49.1% ± 4.42. The present study shows that *Pentacletra macrophylla* is a natural snack that can be eaten by athletes to maintain stamina and provide energy for a longer time.

Keywords: *Pentacletra macrophylla, Treculia africanum , Telfaria occidentalis, carbohydrate content, glycaemic index , glucometer*

Article History
Received: 17 Dec 2022
Accepted: 24 Dec 2022
Published: 03 Jan 2023

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How to cite this paper: Mere, C.A. (2022). Carbohydrate content and Glycaemic indices of *Pentaclethra macrophylla*, *Telfairia occidentalis* and *Treculia africanum*. *IPS Journal of Nutrition and Food Science*, 2(1), 1–4. https://doi.org/10.54117/ijnfs.v2i1.17.

Introduction

The African oil bean seed, also known by its scientific name, *Pentacletra macrophylla*, (*ugba or ukpaka*, Igbo name) is native to tropical regions of Africa and has been cultivated since 1937. The glossy, brown seeds average eight in number and are contained in a flattened pod that opens up when ripe, dispersing the seeds. The seeds then require processing and fermentation before they can be eaten, although other parts of the plant are used in folk medicine and in wooden products and crafts.

African oil bean seeds contain up to 44 percent protein, with all twenty essential amino acids (Runsewe-Abiodun *et al*., 2018). The seeds also contain essential fatty acids within the seed oil, as well as many minerals, particularly magnesium, iron, manganese, copper, phosphorus and calcium, and trace amounts of vitamins (Kayode *et al*., 2009).

Telfairia is classified in the tribe *Joliffieae* of the subfamily *Cucurbitaceae*. *T. occidentalis* (Hook) often called fluted pumpkin is found in the forest zone of West and Central Africa, most commonly in Benin, Nigeria and Cameroon. It is a prevalent vegetable in Nigeria. *T. occidentalis* is an important staple vegetable grown in Nigeria. The plant produces luxuriant edible green leaves, which are rich in iron and vitamins. Recent studies have shown that *T. occidentalis* leaf is rich in minerals (such as iron, potassium, sodium, phosphorus, calcium and magnesium), antioxidants, vitamins (such as thiamine, riboflavin, nicotinamide and ascorbic acid, phytochemicals such as phenols. The harvesting of *T. occidentalis* occurs after 120-150 days of sowing (Akoroda *et al*., 1990; Oboh, 2005; Oboh *et al*., 2006; Ajibade *et al*., 2006; Kayode *et al*., 2009). The leaves contain vitamins and essential oils. The root contains lactones, cucubitacine and sesquiterpene, (Iwu, 1983). The leaf extract can be used in the management of hepatic problems, cholesterolemia, and defective defense immune systems (Eseyin *et al*., 2005a, b). The roots are useful as for the control of rodents and an ordeal poison (Gill, 1992).

Treculia africanum locally called *Ukwa* in Igbo vernacular is one of the most cherished economic plants, and is also a highly valued medicinal plant widely utilized in most preparations in the traditional herbal medicine. African breadfruit (*T. africanum*) is one of naturally nutritive species. The African breadfruit (*Treculia africana* Decne) is large evergreen tree found in tropical and sub-tropical humid forests. It is widely distributed in West and Central Africa (Ojimelukwe and Ugwuona, 2021). It belongs to the mulberry family moraceae (Fosberg, 1978; Morton, 1946). Crude extracts from diferent parts of the plant are used either singly or in combination with other herbs to treat various diseases (Ojimelukwe and Ugwuona, 2021). African breadfruit seeds are highly nutritious and constitute a relatively cheap source of vitamins, minerals, proteins, carbohydrates and fats. The nutrient composition of African bread fruit is 14.23% protein; 0.22% ash; 91.25% moisture. 12.5% crude protein; 4.2% fat; 2.3% ash; 1.6% fbre; 73.0% carbohydrates (Akubor *et al*., 2000) The protein content, especially, is high and conforms to a composite analysis of the breadfruit done in some part of Central America, Mexico, Africa and India. So, it can be said that *Ukwa* is a protein rich food under the different conditions (Ezigbo *et al*., 2010).

Food samples contain carbohydrates at varying concentrations. Some food samples are carbohydrate rich foods; some are rich in other nutrients.

Carbohydrate in foods is the main source of dietary glucose. During digestion in mammals, carbohydrates undergo enzymatic hydrolysis into its monomeric subunits (glucose). This breakdown is necessary because the epithelial cells lining the intestinal lumen absorb only relatively small molecules. After being absorbed, most of the sugars pass through the blood to hepatocytes. Hepatocytes transform dietary nutrients into fuels and precursors required by other tissues, and export them through the blood. The amounts and kinds of sugar supplied to the liver vary with the carbohydrate content of the food and the rate at which the food product break down to sugar in the blood system (Nelson and Cox, 2000).

The most common process for evaluating the energy content of foods is the factorial approach (Youdim, 2021) where the amount of energy contained in each of the different components of the food (ie. fat, protein, carbohydrate, alcohol) is calculated, and the total of the resultant data is used as the amount of energy in the food. Quantifying the energy value of carbohydrate presents a theoretical challenge since carbohydrates vary in their gross energy content per gram, the degree at which they are digested and absorbed, and the fact that the undigestible carbohydrates offer a quantity of energy which is dependent on the rate at which they are fermented in the colon. This may be in the range of 0 to 100%. Alternative empirical models have been suggested on the basis of regression equations established from experiments in which gross energy intake plus energy excretion in urine and stool were measured on a variation of diets. Here, energy that can be metabolized in the food is equivalent to gross energy intake minus energy losses, the energy losses being estimated from nitrogen and unavailable carbohydrate intakes. There has been debate that empirical models for assessing the energy content of the food are more accurate than the factorial approach because they have rarer and reduced bases of error (Youdim, 2021).

The glycaemic Index (GI) is a measure of the effect that a carbohydrate containing food has on blood glucose levels compared to the effect of the same amount of pure glucose, on blood glucose levels. The blood glucose responses of carbohydrate foods can be categorised by the GI. The GI is a mathematical system of evaluating how fast carbohydrate elicits an increase in circulating blood sugar – the higher the number, the higher the blood sugar response (Barke, 2004). The GI gives us a ranking of foods containing carbohydrate on the basis of the effect the food will have on blood glucose level of a person. There is decent evidence showing that reducing diet GI increases general blood glucose control in subjects having diabetes (Wolever *et al*., 1991) and moderates serum triglycerides for subjects with hypertriglyceridaemia (Wolever *et al*., 1991).

Materials and Methods

Materials and Sample Collection

Metler toledo electronic weighing balance, visible spectrophotometer *shanghai* precision scientific instrument. Model 722N, Centrifuge, 8 buckets. Model 0412-1

Electric blender, Test tubes, Mortar and pestle, PRESTIGE Glucometer and its strips**,** Sucrose as standard carbohydrate (10mg/100ml of distilled water), distilled water, testtubes, 5% Phenol, Concentrated sulphuric acid, pipettes, T. *occidentalis*, *G. latifolium*, *G. africanum*, *T. africanum* and *P. macrophylla*. All chemicals used were in analytical grade and were either Sigma-Aldrich GmbH, Sterhnheim, Germany or Merck. Fresh vegetables and dehulled *T. africanum* and *P. macrophylla* were purchased from *Afo Egbu* market in *Egbuoma*, *Oru* East, Imo state, Nigeria.

Albino rats. The experimental animals were obtained from the animal unit of the Department of Zoology and Environmental Biology, University of Nigeria, Nsukka, Nigeria.

Estimation of carbohydrate content of samples

The phenol- sulphuric acid method for the estimation of carbohydrate quantitatively was used. Sucrose was used as standard carbohydrate to prepare a calibration curve. 10 mg of sucrose was weighed and dissolved with 100 ml of distilled water. Six test tubes were labeled one to six and carbohydrate standard (10 mg/100 ml sucrose) was dispensed in increasing order of 0.1 ml. Distilled water was added to make it up to 0.5 ml. 0.5 ml of 5% phenol solution was then added with thorough mixing. 2.5 ml of concentrated sulphuric acid was added to the mixture and the test tube was shaked thoroughly. It was allowed to stand for 20 minutes and read in a spectrophotometer at 420 nm.
T. occidentalis leaves, *T. africanum* and *P. macrophylla* seeds were used as samples. The samples were ground differently to fine suspension using mortar and pestle. 10 mg of each ground sample was weighed and dissolved in 100ml of distilled water.

The estimated carbohydrate concentration of each sample was used to determine the serving size of the test foods that is the quantity of test foods that contain 1-gram carbohydrate.

Experimental design

A total of twelve (12) male albino rats weighing 139 – 180 g were used for blood glucose response study. They were acclimatized for one week and randomly distributed in groups.
Three (3) animals were used for each of the food samples. Oral glucose was used as control.

Determination of blood glucose

The experimental animals were fasted overnight. Their fasting Blood sugar was taken at 0 hour. Then they were fed with calculated quantity of sample that contains 1g carbohydrate. Animals that finished eating the sample between 5 to 10 minutes were used for the experiment. Their blood was taken and checked for glucose level after 30 minutes of feeding and consequently for 3 hours. Blood was taken from the tail of the animals.

Blood Glucose Response Estimation

In estimating the rate of blood glucose response after feeding with samples, three (3) animals were used for each sample. Each blood sample was placed on a test strip which was inserted into a calibrated glucometer (prestige) which gave direct readings after 45 seconds based on glucose oxidase assay method. The determination of blood glucose level was done in 30 minutes intervals for 3 hours.

Glycaemic index calculation and statistics

Changes in blood glucose concentration were calculated separately for each post meal period by using the blood concentration before meal (time 0) as a baseline. Postprandial responses were compared for maximum increase and incremental area under the glucose curves for each food. The integrated area under the postprandial glucose curve was calculated by the trapezoidal method (Wolever *et al*., 1991). Area increments under the curves for a given food were determined for the 3-hour period after the meal.

Statistical Analysis

The relative glycaemic index of each food was calculated as a percent of the mean of individual areas under the glucose response area ± SEM.

Results

Carbohydrate content

The results of carbohydrate content of the test foods using phenol-sulphuric method were shown in table 1. This shows the carbohydrate content of the test foods per 100 g of test food samples.

The serving size i.e. the quantity of test foods that contain 1g of carbohydrate was determined from the carbohydrate content (Table 2). The glucose concentration attained after consumption of the test foods and white bread (reference food) is graphically displayed in figures 1- 3. The glycaemic index of the test foods were calculated (Table 3). *T. occidentalis* has a high glycaemic index; *P. macrophylla* has a medium glycaemic index while *T. africanum* has a low glycaemic index.

Table 1: Carbohydrate content in food samples (carbohydrate content/ 100 grams)

Food samples	Carbohydrate content (per 100 g)
T. occidentalis	12.7 ± 6.18
P. macrophylla	20.6 ±14.82
T. africanum	48 ±13.66

Values are mean ± SEM (n = 3 determinations)

Table 2: Serving Size of test food samples

Food samples	Serving Size (quantity/ 1 g of carbohydrate)
P. macrophylla	4.85
T. occidentalis	7.87
T. africanum	2.08

Table 3: **Glycaemic index of the test food samples**

Food samples	Glycaemic index (%)
T. occidentalis	86.5 ± 0.70
P. macrophylla	61.3 ± 9.30
T. africanum	49.1 ± 4.42

Values are mean ± SEM (n = 3 determinations)

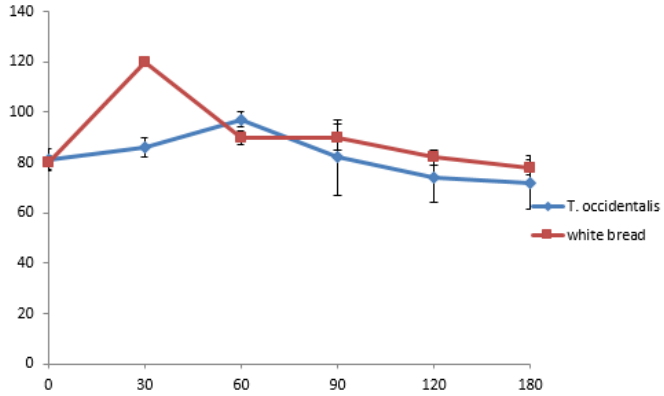

Figure 1: Graphical representation showing glucose response area of test food *T. occidentalis* and reference food (white bread).

Figures 2 and 3 show the glucose response area of albino rats after being fed with test foods *P. macropylla* and *T. africanum* respectively and that of reference foods. They show that white bread has more effect on blood glucose concentration than the test foods.

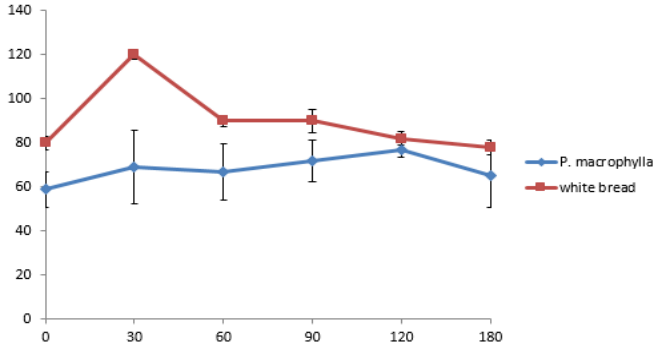

Figure 2: Graphical representation showing Incremental glucose response area of test food *P. macrophylla* and reference food white bread.

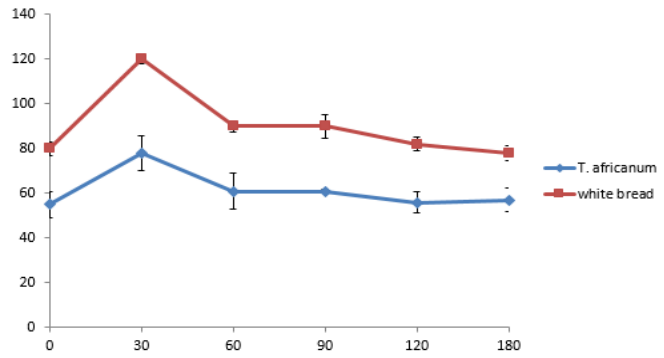

Figure 3: Graphical representation showing glucose response area of test food *T. africanum* and reference food (white bread).

Incremental Glucose Response Area Curves

Figures 4 through 6 show the rate at which blood glucose concentration of albino rats increase after being fed with test foods over a 3-hour period. The blood glucose concentration level at different intervals were subtracted from the initial blood glucose concentration i.e. blood glucose concentration before feeding.

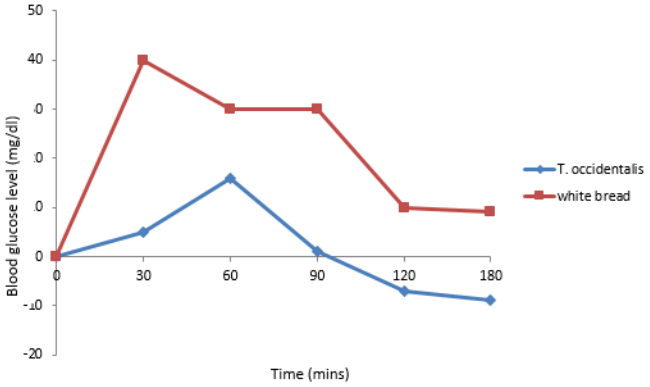

Figure 4: Graphical representation showing Incremental glucose response area of test food *T. occidentalis* and reference food (white bread).

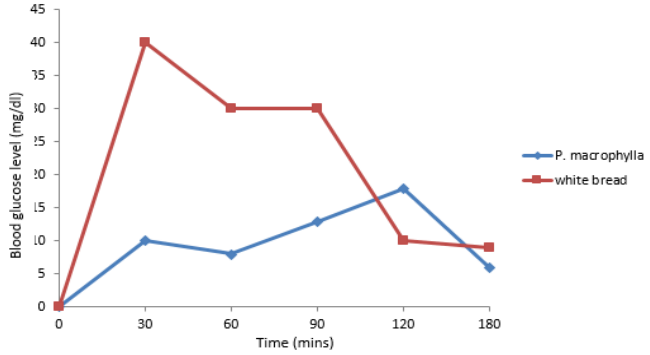

Figure 5: Graphical representation showing Incremental glucose response area of test food *P. macrophylla* and reference food white bread.

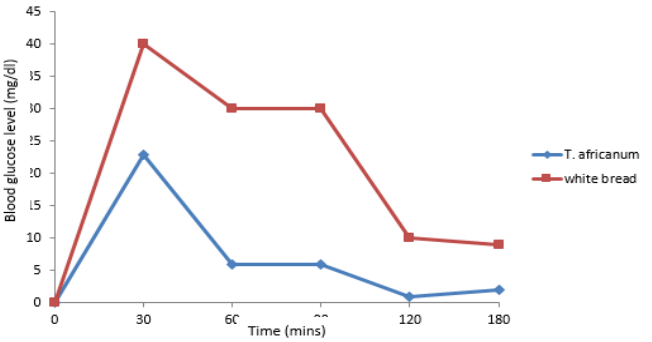

Figure 6: Graphical representation showing Incremental glucose response area of test food T. africanum and reference food white bread.

The incremental mean glucose response area of the test foods, *T. africanum*, *T. occidentalis* and *P. macrophylla* and of the reference food, white bread (Figure 7) demonstrates how the blood glucose concentration of albino rats rises fast and falls within a short time interval after being fed with *T. occidentalis*. Blood glucose concentration for *P. macrophylla* and *T. africanum* rises but do not fall as fast as that of *T. occidentalis*.

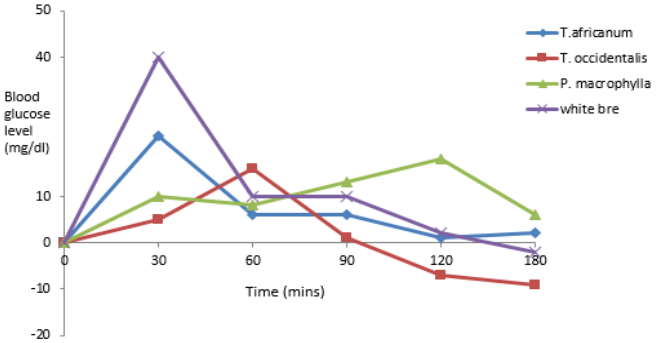

Figure 7: Incremental blood glucose area curve for the various test foods and reference food.

Discussion

Carbohydrate content and serving size

The test foods under reference contain as follows the quantities of carbohydrate in every 100 g of test samples: *T. occidentalis*---12.7 ± 6.18g, *P. macrophylla*—20.6 ±14.82g and *T. africanum*— 48 ±13.66g. This shows that *T. africanum* contains higher quantity of carbohydrate when compared to *P. macrophylla* and *T. occidentalis.* Longe *et al*. (1983) reported that fluted plumpkin seeds had 15% carbohydrates while this study shows the leaves have 12.7% carbohydrate. The serving sizes for the samples which are the quantity of sample that contain 1 g of carbohydrate were calculated from the carbohydrate content.

Glucose response curves

Consumption of the test foods resulted in lower levels of blood glucose than the reference sample within two hours. The samples *P. macrophylla* and *T. occidentalis* resulted in the same level of within two hours while *T. africanum* has a lower level at the same time.

Glycaemic index

This study shows the glycaemic indexes of *T. occidentalis*, *P. macrophylla* and *T. africanum*. *T. occidentalis* has a glycaemic index of 86.5% ± 0.70, *P. macrophylla*, glycaemic index of 61.3 ± 9.30% while *T. africanum* has GI of 49.1 ± 4.42%. This shows that *T. occidentalis* has a high GI while *T. africanum* has a low GI.

The consumption of the foods under reference might not have severe health implications in ailments such as the heart diseases via insulin resistant syndrome called metabolic syndrome X (Ludwig, 2003). *T. occidentalis* has a high GI but it is a vegetable and is not usually consumed in large quantity or often. *P. macrophylla* has a medium GI such that care has to be taken in using it together with high GI foods or using much oil with it especially in the preparation of *ugba* delicacy. *T. africanum* has a low GI and thus is a good diet for diabetics. It is important to note that moderation is necessary in all things.

In recent years, the GI has been transformed by its popularizers from a potentially useful tool in planning diets for diabetic patients to a key player for the prevention of diabetes, cardiovascular disease, dyslipidaemia and some cancers in the overall population. It has not been decided whether it is reasonable and wise to set as a public health policy for the entire population abstinence from certain foods as a result of their GI. To explore this question, there is need to examine the supporting data, their quantity and quality.

There are 2 theories about how GI foods increase food intake. The first is that it is due to elevation in blood glucose and more commonly expressed recently, is that it is as a result of high insulin response. The high insulin response has been associated to several phenomenon including increased food intake leading to obesity, hyperinsulinaemia leading to insulin resistance (Frost *et al.*, 1999), cell exhaustion leading to type II diabetes (Salmeron *et al.*, 1997), dyslipidaemia leading to coronary heart disease (CHD) (Liu *et al*., 2001) and unidentified factors leading to certain categories of cancers.

Conclusion

According to the data obtained, *P. macrophylla* has an intermediate glycaemic index. *T. africanum* has a low glycaemic index. *T. occidentalis* has a high glycaemic index. In which case an athlete may be advised to take *abacha* garnished with a large quantity of *P. macrophylla*. Fluted pumpkin is a good vegetable for use with proteinous foods.

Acknowledgements

I wish to thank my husband for his support in my growth. To my kids and mum, God bless you all.

References

Ajibade, S.R., Balogun, M.O. Afolabi O.O. and Kupolati, M.D. (2006). Sex differences in biochemical contents of *Telfairia occidentalis* Hook F. *Journal of Food Agriculture and Environment*. **4**: 155-156.

Akubor, P.I., Isolukwu, P.C., Ugbabe, O. and Onimawo, I.A. (2000). Proximate composition and functional properties of African breadfruit kernel and wheat four blends. *Food Research International Journal*. **33**:707–712.

Akoroda, M.O., Ogbechie-Odiaka, N.I., Adebayo, M.L. Ugwo, O.E. and Fuwa, B. (1990). Flowering, pollination and fruiting in fluted pumpkin (*Telfairia occidentalis*). *Science and Horticulture*. **43**: 197-206.

Barke, S., (2004) Glycemic Index. http://www.mendosa.com/gilists.htm

Eseyin, A.O., Igboasoiyi, C.A., Mbagwu, H., Umoh, E. and Ekpe, F.J. (2005). Studies on the effects of an alcohol extract of the leaves of *Telfairia occidentialis* on alloxan induced diabetic rats. *Global Journal of Pure Applied Science*. **11**: 77-79.

Ezigbo, V.O., Aboh, A. and Udogu, M.E. (2010). The effect of different drying conditions on the nutritive value of *Treculia Africana*. *Oasis Journal*: 1(1)

Fosberg, F.R (1978). Breadfruit as a tropical Fruits. 5th ed. 1-4

Frost, G., Leeds, A.A., Dore, C.J., Madeiros, S., Brading, S. and Dornhorst A. (1999). Glycaemic index as a determinant of serum HDL-cholesterol concentration. *Lancet*; **353**:1045–1048.

Gbile, Z.O. (1986). Ethnobotany, Taxonomy and Conservation of Medicinal Plants. In: The State of Medicinal Plants Research in Nigeria, Sofowora, A. (Ed.). University of Ibadan Press, Ibadan, Nigeria

Gill, L.S. (1992). Ethnomedical Uses of Plants in Nigeria. Uniben Press, University of Benin, Benin City, Edo State, Nigeria, pp: 228-229

Iwu, M.W. (1983). Traditional Igbo Medicine. Institute of African Studies University of Nigeria, Nsukka

Kayode, O.T., Kayode, A.A and Odetola, A.A. (2009). Therapeutic effect of telfairia occidentalis on protein energy malnutrition-induced liver damage. *Research Journal of Medicinal Plants*. **3**: 80-92.

Liu, S., Willett, W. and Stampfer, M.J. (2001). A prospective study of dietary glycemic index load, carbohydrate intake, and risk of coronary heart in US women. *American Journal of Clinical Nutrition*: **71**: 1455– 1461.

Longe, O.G., Rarinu, G.O. and Fetnoa, B.L. (1983). Nutritious value of fluted pumpkin (*Telfairia occidentalis*). *Journal of Agriculture, Food and Chemistry*, **31**: 982-992

Nelson, M.M. and Cox, D.C. (2000). Carbohydrates and glycobiology. *Lehninger principles of Biochemistry*. Worth publishers. Third edition. Pp 298

Oboh, G., 2005. Hepatoprotective property of ethanolic and aqueous extracts of fluted pumpkin (*Telfairia occidentalis*) leaves against garlic-induced oxidative stress. *J. Med. Food*, **8**: 560-563.

Oboh, G., Nwanna, E.E. and Elusiyan, C.A. (2006). Antioxidant and antimicrobial properties of *Telfairia occidentalis* (Fluted pumpkin) leaf extracts. *Journal of Pharmacology and Toxicology*, **1**: 167-175.

Ojimelukwe P. C. and Ugwuona, F.A. (2021) The traditional and medicinal use of African breadfruit (Treculia africana Decne): an underutilized ethnic food of the Ibo tribe of South East, Nigeria. Journal for *Ethnomedicinal Food*. **8**:21

Runsewe-Abiodun, T.I., Aliyu, A.O. and Oritogun, K.S. (2018). Evaluation of nutrients and anti-nutrient properties of traditionally prepared Treculia africana Decne (bread fruit diet and toasted seeds). *African Journal for Food Agricultural Nutrients and Development*; **18**(2):13272–13286.

Salmeron, J., Ascerio, A. and Rimm, E. (1997) Dietary fiber, glycemic load and rise of NIDDM in men. *Diabetes care*; **47**: 1244-1251

Wolever, T.M.S., Jenkins, D.J.A., Jenkins, A.L.and Josse, R.G. (1991) The glycemic index: methodology and clinical implications. *American Journal of Clinical Nutrition*; **54**: 846- 854.

Youdim, A. (2021). Calories. *Merck Manual Home Edition online*. **3**:15

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