Advances in Environmental Health Sciences and Toxicology (AEHST)

A publication of the University of Medical Sciences, Ondo City, Ondo State, Nigeria

URL: https://journals.unimed.edu.ng/index.php/JEMT/index

Vol. 1 No 1, September 2024, Pp. 51 - 61

ANTIOXIDANT AND GLYCEMIC POTENTIALS OF THE FLESH, SEEDS, PEELS AND THE WHOLE FRUIT OF *Picralima nitida*

[*]Gbenga-Fabusiwa Agbaje F.J. [1], Olatunde O. [2], Ololade Z.S. [2], Agbaje D.O. [3], Ojolo G.T. [1]

[1]Department of Food Science, Faculty of Science, University of Medical Sciences
[2]Department of Chemistry, Faculty of Science, University of Medical Sciences
[3]Institute of Health Humanities and Entrepreneurship, University of Medical Sciences

***Corresponding author:**
E-mail: fjgbenga@unimed.edu.ng

Submitted 17 May, 2024
Accepted 11 September, 2024

ABSTRACT

Background: The total number of people living with diabetes is projected to rise to 783 million by 2045. Diabetes resulted in 6.7 million deaths and approximately 966 billion dollars is spent on diabetes per year. Thus, the discovery and application of antidiabetic potential of *Picralima nitida (PN)* (Akuamma) plant as dietary intervention in diabetes management is germane.
Objectives: This study aimed at investigating the antioxidant potentials and glycemic indices of flesh, seed, peel, and whole of *PN* fruit flour.
Methods: The cleansed fruit was peeled, the seed and the flesh were carefully separated, dried, and ground into powder. The aqueous extract of PN flour samples were extracted and used for the determination of polyphenol and other antioxidants parameters. The estimated glycemic index (eGI) was determined by digesting 50 mg of flour in 5 ml stomach solution containing pepsin of the piglets (HCl-KCl buffer pH 1.5). This was then incubated, centrifuged and the absorbance read at 30 minutes interval.
Results: The highest polyphenol was found in the Peel (64.22), total flavonoids in Seed (14.31), scavenging and ferric reducing abilities in Whole (45.11) and (1162.82). The Whole flour had the least value in sugar (0.05), starch (0.091) and eGL (15.84) respectively. The eGI found in all the samples was low (< 60) which may make them good antidiabetic food additives. The Whole and the seed flour samples had good antioxidant potentials with medium eGL.
Conclusion: Thus, utilizing the whole fruit or the seed instead of the flesh or peel could serve as an excellent antidiabetic food supplement.

Keywords: *Picralima nitida;* antidiabetics; estimated glycemic index: food additives

INTRODUCTION

The global prevalence of various metabolic and cardiovascular diseases is still of great interest and concern to food and medical researchers. Diabetes mellitus (DM), commonly referred to as diabetes, is a group of metabolic diseases in which there are high blood sugar levels over a prolonged period, which may lead to serious damage to the heart, blood vessels, eyes, kidneys and blood nerves. The distinctive feature of diabetes is hyperglycemia where the blood sugar level is greater than or equal to 126 mg/dL (7.0mmol/L) while fastening blood sugar ranging from 70 mg/dL – 99 mg/dL (3.9 mmol/L – 5.5 mmol/L (Kupai, Várkonyi, Török, *et al.,* 2022). The total number of people living with diabetes is projected to rise to 643 million by 2030 and 783 million by 2045 IDF (2021). Diabetes led to 6.7 million deaths and a minimum of USD 966 billion dollars is spent on diabetes (9 % of total expenditure on adults). Greater than 1.2 million children and adolescents (0-19 years) are living with type 1-diabetes while twenty-one (21) million women are affected by diabetes during pregnancy (Kupai, Várkonyi, Török, Gáti, *et al*., 2022). To cap it all, 541 million adults are reported to be at high risk of developing type-2 diabetes. Access to affordable treatment such as insulin and affordable functional dietary interventions are very germane to survival and improve the health of people living with diabetes (Kupai, Várkonyi, Török, Gáti, *et al*., 2022;

Edwin, Alexandra, and Gilma,2024). Globally, there is an agreed target to halt the rise in diabetes and obesity by 2025. In view of this, this research work is carried out to determine the antioxidant and glycemic potentials of the flesh, seeds, peels and the whole fruit of *picralima nitida* which could serve as food additives and food beverages needed as dietary intervention in managing diabetes.

Nigeria is one of the sub-Saharan African countries that are currently groaning under a rising prevalence of diabetes mellitus (Uloko *et al*, 2018: Ejiofor *et al*, 2020) A recent meta -analysis reported that approximately 5.8 % (about six million of adult Nigerians are living with diabetes (Uloko *et al*, 2018: Ejiofor *et al*, 2020). This could be attributed to the change in dietary patterns from an African indigenous diet to a western diet, lack of adequate knowledge of functional food needed by an individual based on health status and basic nutrients required in the body, and insufficient physical exercises. The major dietary deficiency linked to diabetes and other cardiovascular diseases is the consumption of meals rich in high carbohydrates, saturated fat that can induce oxidative stress which is the pathophysiological state depicted by a disparity in the number of antioxidants and glycemic responses (Gbenga-Fabusiwa *et al*, 2019).

Picralima nitida belongs to family apocynaceae (common name: Akuamma plant, The Yoruba call it Abere, Igbo: Osi-Igwe, Edo: Osu). The plant is a glabrous tree or shrub about 9-75 feet high with white to yellow flowers in the terminal, mostly densely contracted inflorescences (Osayemwenre, Abiodun, Peter, 2014). The ovary contains about 70-130 ovules. *Picralima nitida*, native to tropical Africa (Benin, Ghana, Ivory Coast, Nigeria, Gabon, Cameroon, Cabinda, Central African Republic, Republic of Congo, Zaire, Uganda. (Harris, 2002; Figueiredo, and Smith, 2008). *Picralima nitida* has many applications in African folk medicine. The seeds have been utilized for antiulcer, antimalarial, antileishmanial, hypoglycemic, larvicidal, antioxidant, analgesic, anti-inflammatory, antimicrobial and cytotoxic treatments (Osayemwenre, Abiodun, Peter, 2014). The fruits are greatly employed for their antipyretic, antimalarial, hypoglycaemic, antipyretic and anti-inflammatory potentials. Previous studies revealed that the leaf has also been gainfully used for its Larvicidal, antimicrobial, hypoglycaemic, and antioxidant properties. The bark, is used traditionally for its antioxidant, larvicidal, antimicrobial, and hypoglycaemic attributes. The bark of the plant has been utilized ethnomedical as a remedy for fever, malaria, hypertension, gastrointestinal disorder, and jaundice to mention but a few (Osayemwenre, Abiodun, Peter 2014). The extracts from different parts of the fruits have been found to depict a wide range of pharmacological activities which lends credence to its ethnomedicinal applications. Indole alkaloids isolated from the seeds of the fruits are compounds with opioid analgesic activity. The seeds are commonly used in West Africa as antipyretic, and aphrodisiac, in treating chest pains, pneumonia, and gastrointestinal disorders (Etukudo, 2003). The seeds are applied externally for the treatment of abscesses. The fruit is applied for the treatment of gastrointestinal disorders and dysmenorrhea. In some parts of West Africa, particularly in Ghana, the fruit shell is filled with palm wine which is taken after it has absorbed bitter parts, useful in treating malaria (Kouitcheu, 2008). A video on the sugar-lowering activity of the *Picralima nitida* fruit went viral recently in Nigeria. In the video, Dr Kennedy Eweka taught and displayed how to prepare the fruit to manage diabetes. He has suffered from the side effects of blood-sugar-lowering medications and someone introduced the fruit to him. He stopped using his medications and stuck to the fruit only. He demonstrated how to cut the fruits into cubes and soak them in a bottle of clean, pure water. Thereafter, two shots of the cover of the bottle would be taken. One of the clients sent the video to the author, who watched and tried to find out about its anti-oxidant potential and glycemic potentials. It is glaring that indigenous people have utilized *Picralima nitida f*ruits in the traditional management of diabetes but there was no data on the glycemic indices of the flesh, seeds, peels, and whole fruits to assess its antidiabetic potential. Thus, people with diabetes can benefit from education about the disease and treatment using *Picralima nitida f*ruits as good functional food additives which may serve as an excellent dietary intervention in regulating blood sugar levels. The question is should we be watching our loved ones dying or better still suffering from this evil surge called diabetes? The answer to this question is NO. This could be achieved by determining the antioxidant and

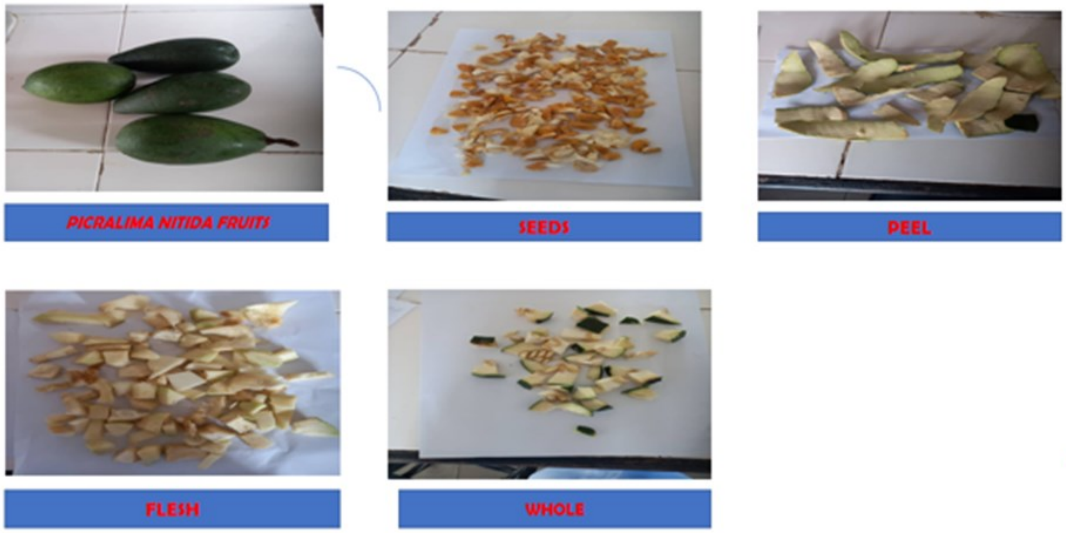

Plate1: Showing the pictures of *picralima nitida* fruits, the seed, peel, flesh and whole samples

glycemic potentials of *picralima nitida* flesh, seed, peels, and whole fruit.

MATERIALS AND METHOD

Materials

The materials used in this study include the flesh, seeds, peels, and the whole fruit of *picralima nitida.* The fruits were procured from a local market in Benin City, Edo State, Nigeria.

Preparation of samples

The valuable unripe fruits were washed under the jet of tap water to remove dust, dirt, sand, and unwanted materials. The cleansed fruit was then peeled with the aid of a cleaned table knife to remove the peel, the seeds, the flesh, and the whole as shown in **Plate 1**. This was then sliced with the aid of a knife and oven-dried at 40 ℃ for a period of five days for each sample. The dried sample was ground to a fine powder of 0.5 mm pore size with the aid of a heavy-duty 750 W solitaire mixer grinder. This was placed in a cleaned dried airtight container and kept in a refrigerator for further analysis.

Preparation of aqueous extract of the *Picralima nitida* samples

The aqueous extract of the Nitida flour was prepared by dissolving 1 g of each of the samples in 100 ml of distilled water for 6 hours at 37ºC. Thereafter, the mixture was filtered and centrifuged at 2000 rpm for 10 min. The supernatant was collected and placed in a 50 ml plastic bottle well covered and stored in a refrigerator for further analysis. This was then used for the determination of total phenol, total flavonoid, ferric reducing power and free radical scavenging ability.

3.5.1 Determination of total phenolic contents of the *Picralima nitida* amples

The total phenolic contents of the extracts of the *picralima nitida* flour samples were determined using Folin–Cioacalteu's reagent (Singleton, Orethofor, & Lamuela-Raventos,1999). Appropriate dilutions of the extracts were oxidized with 2.5 mL of 10% Folin–Cioacalteu's reagent (v/v) and neutralized by 2.0 mL of 7.5% sodium carbonate. The reaction mixture was incubated for 30 minutes at 458ºC and the absorbance was read at 765 nm using the spectrophotometer (JENWAY 6305) Barloworld Scientific Ltd., Dunmow, Essex, The United Kingdom. The total phenol content was subsequently calculated using gallic acid equivalents.

Determination of total flavonoid content of the *Picralima nitida* samples

Total flavonoid content of the *nitida* flour samples extracts was determined spectrophotometrically using the method reported by Meda, Lamien, Romito, Millogo, and Nacoulma (2005). About 0.5 mL of appropriate diluted sample was mixed with 0.5 mL, methanol, 50 mL of 10 % $AlCl_3$, 50 mL of 1 mol/L potassium acetate, and 1.4 mL distilled water. This was allowed to incubate at room temperature

for 30 min. Thereafter, the absorbance of the reaction mixture was subsequently measured at 415 nm. The total flavonoid was calculated using quercetin as standard.

Determination of ferric reducing antioxidant power of the *Picralima nitida* samples

The reducing power of the 80 % extracts was determined according to the method of Yen and Chen (1995). The extract of each of the samples was mixed with an equal volume of 0.2 M phosphate buffer, pH 6.6 and 1 % potassium ferricyanide. The mixture was incubated at 50ºC for 20 min after which an equal volume of 1 % trichloroacetic acid was added to the mixture, which was centrifuged at 3000 rpm for 10 min. The upper layer of the solution was mixed with water and 0.1 % $FeCl_3$ in ratio of 1:1:2 and the absorbance of the upper layer was measured at 700 nm using a spectrophotometer.

Determination of 2,2-diphenyl-1-picrylhydrazyl free radical scavenging ability

DPPH radical scavenging ability of the extracts was determined using a stable 2,2-diphenyl-1-picrylhydrazyl radical (DPPH), a modification of the method reported by Gyamfi, Yonamine, and Aniya (1999). An appropriate solution containing DPPH radical was mixed with the extracts. The mixture was incubated in the dark for 30 min and the absorbance was read at 516 nm using a spectrophotometer (JENWAY 6305). The DPPH free radical scavenging ability was subsequently calculated with respect to the reference which contains all the reagents without the test sample.

Determination of alkaloids of the *Picralima nitida* samples

Five grams (5 g) of the sample was weighed into a 250 mL beaker and 200 mL of 100 % acetic acid in ethanol was added, covered, and allowed to stand for 4 hr. This was filtered and the extract was concentrated in water bath to one-quarter of the original volume. Concentrated ammonium hydroxide was added dropwise to the extract until the precipitation was completed. The whole suspension was allowed to settle and the precipitate was collected and washed with dilute ammonium hydroxide and then filtered. The residue is the alkaloid which was dried and weighed to determine the percentage composition (Harborne, 1993).

Determination of Sugar of the *Picralima nitida* samples

The modified method of Anthony, Dona, Philip & Kuchel (2010) was used. 0.02 g of the sample was weighed into centrifuge tubes and wetted with 1ml of ethanol. 2 ml of distilled water was added, followed by 10 ml of hot ethanol. The mixture was vortexed and centrifuged at 2000 rpm for ten minutes. The supernatant was decanted and made up to 20 ml with distilled water and aliquot of 0.2 ml was taken and 0.5 ml (5 % phenol) was added together with 2.5 ml concentrated H_2SO_4. It was allowed to cool and absorbance was read at 490 nm. The sugar (%) was calculated.

% Sugar =

$$\frac{(Absorbance\ of\ the\ sample - 1\ \Delta \times Df \times V)}{Wt\ of\ the\ Sample \times S \times 1000}$$

Where, Absorbance dilution factor =5, Volume = 20, Slope = 0.01, Intercept = 0.0034.

Determination of starch of the *Picralima nitida* samples

A 7.5 ml per-chloric acid was added to the residue obtained from sugar analysis and allowed to hydrolyze for 1 hour. It was diluted with 25 ml distilled water and filtered through Whatman no 2 filter papers. 0.05 ml of the filtrate was taken, and this was made up of 1 ml of distilled water. The mixture was vortexed and then mixed with 0.5 ml phenol (5 %) and 2.5 ml concentrated H_2SO_4. The mixture was allowed to stand for 10 minutes and incubated for 15 minutes at 28°C. The absorbance was read at 490 nm. The percentage of starch was calculated

% Starch =

$$\frac{(Absorbance\ of\ the\ sample\ - 1 \times Df \times V \times 0.9)}{Weight\ of\ the\ sample \times Slope \times 10000}$$

Where Absorbance dilution factor Df = 20; Volume (V) = 25; Slope (S) = 0.01; Intercept (I) = 0.0034.

Determination of sugar to starch ratio of the *Picralima nitida* samples

The sugar-to-starch ratio was determined by dividing the value obtained from the sugar content by the value obtained from the starch content.

Determination of amylose of the *Picralima nitida* samples

The modified method of Deng *et al.,* (2015) was used. 0.1 g of the sample was mixed with 1.0 ml of 95 % ethanol and 9.2 ml of 1.0 N NaOH was added. The mixture was then heated at 100°C in a water bath for 10 min. After cooling, 0.5 ml of diluted extract was mixed with 0.1 ml of iodine solution (0.2 % I_2 in 2 % KI). The test mixture was made up to 10 ml with distilled water, mixed, and left for 20 min for color development. White wheat bread was used as a reference. Thereafter, the absorbance was read at 620 nm and amylose content was calculated as shown:

$$\% \text{ Amylose} = \frac{Absorbance \times 0.02 \times 2500}{Absorbance\ of\ Standard}$$

Absorbance of Standard = 0.1

Determination of amylopectin content of the *Picralima nitida* samples

Amylopectin was calculated by subtracting the amylose content from 100 % carbohydrate using the formula.

% Amylopectin = 100 % - Amylose (%).

Determination of amylose / amylopectin ratio of the *Picralima nitida* samples

Amylose to amylopectin ratio was evaluated by dividing the amylose content value by amylopectin content value.

Determination of estimated Glycemic Index (eGI) of the *Picralima nitida* samples

The estimated glycemic index (GI) of the samples was determined using a modified method of Goni *et al.* (1997). Fifty milligrams of each of the samples was weighed into a beaker, using JY 20002 electronic balance. Thereafter, a 5 ml stomach solution (containing pepsin of the piglets (HCl - KCl buffer pH 1.5) was added and then incubated in a shaker bath for 60 min at 40 ℃. It was then diluted with phosphate buffer (0.05 M, pH 6.9) then 2.5 ml ∞ - amylase solution from porcine pancreas ((Type VIB, 10 units/mg solid; CAT NO 232-565-6) was added and incubated at 37 °C. 200 µL of the digest were taken into test tube at 30 minutes interval (0, 30, 60, 90, 120, 150, and 180) minutes. The aliquots were boiled for 15 minutes before addition of 500 µL Sodium acetate pH 4.75 followed by 5µL of ∞ - glucosidase from Saccharomyces cerevisiae (Type I, lyophilized powder, 10 units/mg protein; CAT NO: 9001-42-7) and then incubated for 45 minutes at 60 °C. 200 µL DNSA solution was added and incubated for 5 min at 100 °C followed by addition of 2.0ml distilled water and then centrifuged at 3000 rpm for 5 min. The absorbance of the supernatant was read at 540 nm. The sum of area under curve for each sample was divided by the sum of area under curve for standard glucose and multiplied by 100.The value obtained is represented as the hydrolysis index (HI) (Goni *et al*., 1997).

HI = AUC sample / AUC standard * 100

The estimated glycemic index (eGI) was therefore calculated using the equation:

eG.I = 39.71 + (0.549 H.I)

Determination of estimated glycemic load of the *Picralima nitida* samples

Glycemic Load determines a relative indication of how much that serving of food is likely to increase the blood sugar levels (Gianna *et al.,* 2016; Gbenga-Fabusiwa *et al*, 2019). The estimated glycemic load was determined by multiplying the estimated glycemic index with the net carbohydrate divided by 100. Estimated glycemic load (eGL) is calculated as follows:

$$eGL = eGI/100 \times \text{Net carb}$$

Where eGL=estimated glycemic load, eGI=estimated glycemic index and carb = carbohydrate.

Statistical Analysis

The experimental results were expressed as mean ± standard deviation (SD) in triplicates. Data obtained were statistically analyzed using one-way Analysis of Variance (ANOVA), a tool in statistical packages for social sciences (SPSS 24.0). The level of significance was set at $P < 0.05$.

RESULTS AND DISCUSSION

Antioxidant contents of the *Picralima nitida* samples

Antioxidant contents of the *Picralima nitida* flour samples are depicted in **Table 1**. The Frap content ranges from flesh (58.73 ± 7.35) to seed (129.85±28.71) mmolAAE/g. The Frap content of the flour is significantly high. However, highest reducing power almost twice other samples is observed in seed flour sample followed by the whole fruit. Frap is used to measure the total antioxidant capacity of the *Picralima*

nitida samples. The values obtained in our study is higher than the one reported by Rico *et al*., (2023) for pea grain (22.6µmol/g).

Fenton scavenging ability measures the capacity of the flour samples to neutralize or scavenge hydroxyl radicals generated in the Fenton reaction. The Fenton reaction is a chemical reaction that measures the reduction of hydrogen peroxide by a transition metal, such as iron (II) to produce hydroxyl radicals. Hydroxyl radicals are highly reactive and can cause oxidative damage to bimolecules. The result ranges from peel (976.92±00.00 %) to whole (1162.82±72.00 %). This implies that the whole *Picralima nitida* had the highest Fenton scaveging ability and therefore, donates more electrons to reduce the hydroxyl radicals, thereby neutralizing the reactive property followed by the seed flour sample (1021.80±34.00). This may help protect cells and bimolecules from oxidative damage. Fenton scavenging ability of the whole and seed samples in this study are higher than the one reported by Gbenga Fabusiwa *et al.,* (2018) for pigean pea (83.08 ±1.41 %) and that of wheat flour (55.53±1.23 %).

DPPH (2,2-Diphenyl-1-Picrylhydrazyl is a stable free radical that is used to measure the free radical scaveging activity of *Picralima nitida* flour samples. The result reveals that the DPPH ranges from flesh (39.73±1.89 mg/QE/g) to whole (45.11±3.11 mg/QE/g). The whole flour sample has the highest DPPH and thus possesses highest antioxidant capacity to neutralize free radicals, reduce oxidative stress and cell damage. Thus, it contributes to overall health, well-being and helps protect against chronic diseases like cancer and diabetes. The value of DPPH for *Picralima nitida* in this study is higher than the one reported by Ajani *et a*l., (2022) for cassava-wheat compisite flour (1.23±0.06 mg/QE/g).

ABTS (2, 2'-Azino-bis(3-ethylbenzothiazoline -6-sulphonic acid) is used to measure the total antioxidant activities of *Picralima nitida* flour samples. All the samples have high values of ABTS with the highest value (99.30±0.96 TEAC/g) found in seed flour sample followed by the whole fruit flour sample (82.54±0.49 TEAC/g). Thus, the seed and whole fruit samples would help to neutralize free radicals, reduce oxidative stress, cell damage and protect against chronic diseases like diabetes, cancer, heart disease and neurodegenerative disorders. The samples would also inhibit the growth of harmful microorganisms, boost the immune system and prevent illnesses like diabetes. The high content of the whole and seed samples are richer in polyphenols, FRAP, FENTON and flavonoids which may largely contribute to their high ABTS activities. ABTS scavenging ability follows the following pattern: seed > whole> peel > flesh.

Iron chelation is the process of binding iron (II) ion or iron (III) ion to a molecule of *Picralima nitida* flour samples which may help to remove excess iron that might be toxic from the body. Iron Chelation follows the following sequential order: peel > whole > flesh > seed. The peel (53.59±1.49 mg/dL) has the highest iron chelating value followed by the whole flour sample (50.89±1.79 mg/dL). The peel and the whole samples may help minimize iron -catalyzed free radical formation, protecting against cell damage and chronic diseases like diabetes and cancer. In addition to this, they may help reduce inflammation and improve gut health.

Polyhenols are a class of bioactive compounds that are widely distributed in plant-based foods like *picralima nitid*a fruits. Total phenol is the overall amount of polyphenolic compounds present in *Picralima nitida* flour samples. The total phenol ranged from flesh (34.00 ± 1.41 mg GAE /100 g) to peel (64.22 ± 4.03 mg GAE /100 g). The result follows the following sequential order: peel > whole > flesh > seed. The peel and the whole flour samples are very rich in polyphenol. Thus the peel and whole flour may help regulate immune function and prevent infections. They may also, help prevent or slow down the development of diabetes.

Total flavonoid here refers to the overall amount of flavonoid compounds present in the *Picralima nitid*a flour samples. Flavonoids are subclass of polyphenolic compounds that are widely distributed in plant-based foods . The total flavonoid ranges from flesh (8.856 ± 2.01 mg/100 gQE) to seed (14.31 ± 1.96 mg/100 gQE). The result follows this ascending order: Seed > Whole > Peel > Flesh.

The seed has the highest flavonoid content followed by the whole flour. Thus, the seed and the whole flour may serve as good antidiabetic food supplements. The result reveals that the whole flour and the seed flour samples are richer in antioxidant than either the flesh or the peel. This could be the reason why the aqueous extract of the whole sample or the seed is employed traditionally for its antidiabetic potential.

Sugar is a type of carbohydrate that is mostly consumed as a sweetner in foods and beverages. Consumption of excessive amount of sugar has been linked to various health challenges such as obesity, weight gain, diabetes, stroke, heart disease, tooth decay and nutrient imbalance. The American Heart Association recommends that women consume not more than 25 grams (6 teaspoons) of added sugars per day, while men should not take more than 36 grams (9 teaspoons) per day.

Sugar, starch and sugar/starch ratio contents of the samples are as depicted in **Table 2** below. The result revealed that the sugar content ranges from whole (0.05±0.00) to the flesh (0.146±0.01). All the samples have low sugar contents; this could be attributed to the fruit bitter taste, flavonoids and polyphenols present in them. The sugar value obtained in this finding is lower to what was reported for pigeon pea (14.95 ±0.07) Gbenga-Fabusiwa *et al.*, 2021. The lower sugar content of *picralima nitida* may lead to weight management, improved blood sugar control and improve nutrient intake. The observed low sugar content of picralima nitida flour samples could suggest the dietary supplementation of the whole flour and the seed flour of *picralima nitida* samples may help in planning safe, adequate, effective meals for people living with diabetes.

Starch is a complex carbohydrate found in plant-based foods. It is made up of long chains of glucose molecules. It is an impotant source of energy. Starch can add texture and structure to food in baking industries. It can also function as a good thickening agent. It is made up of amylose, a linear, helical starch molecule and amylopectin, a branched, tree-like starch molecule (Gbenga-Fabusiwa *et al.*, 2019). It can be classified as resistant starch, which is resistant to digestion and acts as dietary fiber; slowly digestible starch, which is digested slowly and provides sustained energy; and finally, rapidly digestible starch, which is digested quickly and causes rapid increase in blood sugar (Cornejo-Ramírez, Martínez-Cruz, Del Toro Sánchez, *et al*. 2018). The starch content of the samples followed the same pattern like that of sugar. It ranges from whole (0.091±0.01) to the flesh (0.595±0.01). The whole flour sample has the least starch content followed by the peel and seed flour samples. This implies that the whole, peel, seed and even the flesh flour samples may serve as beneficial food supplements for weight management and improved blood sugar control, thereby reducing the risk of developing insulin resistance and type -2 diabetes. They could also reduce glycemic index. Low-starch foods tend to have a low glycemic index, which means they would not cause a sudden spike in blood sugar levels. They can also increased fiber intake, promote digestive health and lower calorie count. The sugar/ starch ratio were very low in all the samples. The amylose content of the samples follows this trend: Peel > Seed > Flesh > Whole. The Peel (78.00±0.03) has an outstanding amylose content. The Flesh (92.50±2.05) has the highest amylopectin content followed by the whole (82.50±2.07) while the least value is found in the peel (22.00±0.64). The amylose/ amylopectin ratio ranges from the whole (0.188) to the peel (3.540). The amylose/ amylopectin ratio of the whole (0.188) and that of flesh (0.189) are in correlation with the values reported by Gbenga-Fabusiwa *et al*, 2018 for pigeon pea biscuit (0.30).

The glycemic index (GI) is a measure of how quickly the carbohydrates in a particular food raise blood sugar levels after consumption. It is a tool useful in determining how different foods affect blood sugar and insulin responses. Low GI ranges from zero to fifty five (0-55). Foods with a low GI are digested and absorbed slowly, causing a gradual increase in blood sugar levels. Medium GI ranges from fifty six to sixty nine (56-69). Foods with a medium GI are digested and absorbed at a moderate rate, causing a moderate increase in blood sugar levels. High GI ranges from seventy to hundred (70-100). Foods with GI are digested and absorbed quickly, causing a rapid increase in blood sugar levels. Estimated Glycemic Index (eGI) and Estimated Glycemic Load (eGL) of the samples are shown in Table 3.

eGI of the sample ranges from Peel (41.11±2.03) to Flesh (43.21±1.04). All the samples have low eGI below 60. This could be adduced to their low sugar and starch contents. Also, high protein, fibre and ash contents of the samples may contribute greatly to their low eGI. This implies that all the samples especially the peel, the seed and the whole flour samples are low in the estimated glycemic index and thus, could help regulate blood sugar levels, prevent spikes in insulin levels, enhance weight management and lower the risk of heart disease and type-2 diabetes.

Glycemic load (GL) is a measure of how much a plate of food raises blood sugar levels, taking into consideration the specific amount of carbohydrate in the given plate of food. It is a more comprehensive measure than GI, as it considers the serving size and carbohydrate content of the food. Low GL ranges from zero to ten (0-10). Medium GL ranges from eleven to twenty (11-20) while High GL is from 21 and above. The seed (18.87) and peel (18.22) have medium eGL with the least value (15.84) found in the whole sample while the eGL of the peel is high (21.56). The medium estimated glycemic load found in the whole sample could be the reason why the whole of the fruit is being consumed for its antidiabetic potential. Glycemic Load (GL) is a measure of both the quality (the GI value) and quantity (grams per serve) of a carbohydrate in a meal. A glycemic load of less than 20 is normal, while that above 20 is too high (Foster-Powell, Holt, and Brand-Miller, 2002). Edwin, Alexandra, and Gilma (2024) highlighted the important need for intervention methods to improve glycemic control in hospitalized patients with diabetes, which could significantly enhance health outcomes. Therefore, the whole, the seed and the flesh may serve as good functional food supplement in the dietary intervention for people living with diabetes. Clautilde Mofor *et al* (2013) and Ariane Rose *et al* (2020) reported that aqueous extract of the *picralima nitida* seeds significantly lowered and regulated elevated blood glucose levels.

This could be adduced to the low estimated glycemic index and low estimated glycemic load reported in our findings.

CONCLUSION

There is a dire need of information on the antioxidant and antidiabetic potentials of flesh, seeds, peels, and the whole of *Picralima nitida* fruits. Our findings reveal that all the samples had high antioxidant potentials. They all possess low glycemic index with an outstanding result found in the whole flour sample. The whole flour sample has the least glycemic load. This may be the main reason why the WHOLE fruit is being utilized indigenously in the treatment and management of diabetes. This study has generated and provided data on the nutritional and antidiabetic potentials of the flesh, seeds, peels, and the whole of p*icralima nitida* fruits. It is, therefore, recommended that the aqueous extract from the whole fruit and the seeds are the more preferred or better still the whole fruit or the seed flour should be applied as a food additive or supplement in the dietary intervention to exploit its antidiabetic potential. People with normal sugar levels should not consume aqueous extract of the fruit which could lead to hypoglycemic due to its low glycemic load. The food industries and food researchers should pay more attention to how to maximize the medicinal potentials of *picralima nitida* fruits in formulating food additives, fortified food, and food beverages that can serve as dietary interventions to improve the health of people living with diabetes.

Table 1: Antioxidant content of the samples

Samples	Frap (mmolAAE/g)	Fenton (%)	DPPH (mg/QE/g)	ABTS (TEAC/g)	Fe chelation (mg/dL)	Total Polyphenol (mg/g)	Total Flavonoids (mg/g)
Flesh	58.73^{a}±7.35	1002.56^{b}±0.00	39.73^{a}±1.89	21.60^{a}±4.60	49.10^{b}±8.98	34.00^{a}±1.41	8.86^{a}±2.01
Seed	129.85^{c}±28.71	1021.80^{b}±34.00	36.89^{a}±3.01	99.30^{c}±0.96	26.34^{a}±3.59	28.50^{a}±0.71	14.31^{b}±1.96
Peel	60.47^{a}±11.04	976.92^{a}±00.00	35.99^{a}±3.07	24.45^{a}±4.56	53.59^{b}±1.49	64.22^{c}±4.03	9.16^{a}±1.04
Whole	75.69^{b}±0.76	1162.82^{c}±72.00	45.11^{c}±3.11	82.54^{b}±0.49	50.89^{b}±1.79	51.40^{b}±0.06	9.75^{a} ±1.85

Note: Values are Mean plus or minus standard deviation (SD) with different superscript alphabets on the same column which are significantly different ($p < .05$).

Table 2: Sugar, Starch, Amylose, and Amylopectin contents of the samples

Samples (g/100g)	Sugar (g/100g)	Starch (g/100g)	Sugar/ Starch	Amylose (%)	Amylopectin (%)	Amylose/ Amylopectin
Flesh	0.146^{b}±0.01	0.595^{bc}±0.01	0.245	17.50^{a}±0.04	82.50^{c}±2.05	0.212
Seed	0.129^{b}±0.01	0.428^{b}±0.00	0.301	65.50^{b}±3.11	34.50^{b}±0.04	1.899
Peel	0.102^{b}±0.01	0.135^{a}±0.00	0.750	78.00^{c}±0.03	22.00^{a}±0.64	3.540
Whole	0.05^{a}±0.00	0.091^{a}±0.01	0.540	15.50^{a}±1.00	84.50^{c}±2.07	0.183

Values are Mean plus or minus standard deviation (SD) with different superscript alphabets on the same column which are significantly different ($p < .05$).

Table 3: Estimated Glycemic Index (eGI) and Estimated Glycemic Load (eGL) of the samples

Samples	Estimated Glycemic Index (eGI)	Estimated Glycemic Load (eGL)
Flesh	43.21^{a}±1.04	21.56
Seed	41.20^{a}±2.11	18.87
Peel	41.11^{a}±2.03	18.22
Whole	41.40^{a}±1.00	15.84

Values are Mean plus or minus standard deviation (SD) with different superscript alphabets on the same column which are significantly different ($p < .05$).

References

Anthony, C., Philip D., Kuchel, V., (2010). Digestion of starch *in- vivo* kinetic models used to characterize oligosaccharide or glucose release. Carbohydrate Polymers, 80: 599-617.

Ajani, R., Oboh, G., Adefegha, S. A., & Akindahunsi, A. A. (2022). Free Polyphenol Contents, Antioxidant Activity and Inhibition of Enzymes Linked with Type-2 -Diabetes of Bread Produced from Cocoa Powder Flavoured Improved Variety Cassava-Wheat Composite Flours: Tropical Journal of Natural Product Research *(TJNPR)*, *6*(2), 227–235. doi.org/10.26538/tjnpr/v6i2.10.

Ariane, R. N. M., Nyemb N., Tom, E. N., Nguimmo, A. M., Medou, F. M. (2020). Acute and Subacute Effects of Aqueous Extract of *Picralima nitida* Seeds on Dexamethasone Induced Insulin Resistance in Rat. Annals of Biological Sciences, Available online at http://abiosci.com/archive.html 10, 8 (1):10-20

Bachetti G. F. T., Bender C., Oboh G., Zimmermann B. (2016). Polyphenol Content and Glycemic Load of Pasta enriched with Faba Bean Flour. Functional Food in Health and Disease, 6, 291-305.

Clautilde, M. T., Pascaline, C. M., Denis Z., Bruno, T. T. and Fabrice F. B. (2013). Antioxidant and Antidiabetic Profiles of Two African Medicinal Plants: *Picralima nitida* (Apocynaceae) and Sonchus oleraceus (Asteraceae). BMC Complementary and Alternative Medicine, 13 (175): 1-9. http://www.biomedcentral.com/1472-6882/13/175

Cornejo-Ramírez, Y. I., Martínez-Cruz, O., Del Toro, S. C. L., Wong-Corral, F. J., Borboa- Flores, J. and Cinco-Moroyoqui F. J., (2018). The Structural Characteristics of Starches and their Functional Properties. CYTA – Journal of Food, 16 (1): 1003–1017. https://doi.org/10.1080/19476337.2018.1518343.

Daniel, R., Ana. B. C., Sergio, A. A., Gustavo, R. B., and Ana Belen M. D. (2023). Study of the Total Antiixidant Capacity (TAC) in Native Cereal-Pulse Flours and the influence of the Baking

process on TAC using a combined Bayesian and support vectir machine modelling approach. Foods, 12(17) : 3208.

Deng, J., Wu, X., Bin, S., Li, T. J., Huang, R., Liu, Z., Yin, Y. L. (2010). Dietary Amylose and Amylopectin Ratio and Starch Content Affects Plasma Glucose, Lactic Acid; Hormone Levels and Protein Synthesis in Splanchnic Tissues. Journal of Animal Physiology and Animal Nutrition, 94, 220–226.

Edwin Mora Garzón, Alexandra González Montoya, and Gilma Hernández Herrera (2024). Derived Time in Range and Other Metrics of Poor Glycemic Control Associated With Adverse Hospital Outcomes in Patients With Diabetes Mellitus Admitted to Non-ICU Wards at aTertiary-Level Hospital in Colombia: A Cross -Sectional Study. Wiley Journal of Diabetes Research, Article ID 3451158, 10 pages https://doi.org/10.1155/2024/3451158

Etukudo I. (2003). Conventional and Traditional Uses of Plants. Ethnobotany Uyo The Verdict Press; 1: 191.

Ejiofor Ugwu, Ekenechukwu Young, and Marcellinus Nkpozi (2020). Diabetes Care Knowledge and Practice among Primary Care Physicians in South-East Nigeria: a Cross-Sectional Study. BMC Family Practice, 21:128

Foster- Powell, K., Holt, S. H., & Brand – miller, J. C. (2002). International Table of Glycemic Index and Glycemic Load Values. America Journal of Clinical Nutrition, 76: 5-56.

Figueiredo, E. & Smith, G.F. (2008). Plants of Angola. Strelitzia. National Botanical Institute, Pretoria, 22: 1-279

Gbenga-Fabusiwa, F. J., Oladele E. P., Oboh, G., Adefegha, S. A., Oshodi, A. A. (2018). Polyphenol Contents and Antioxidants Activities of Biscuits Produced from Ginger-Enriched Pigeon Pea–Wheat Composite Flour Blends. J Food Biochem; e12526. https://doi.org/10.1111/jfbc.12526

Gbenga-Fabusiwa, F. J., Oladele, E. P., Oboh, G., Adefegha, S. A., Fabusiwa, O. F., Osho, P. O., Enikuomehin, A., & Oshodi, A. A. (2019). Glycemic Response in Diabetic Subjects to Biscuits Produced from Blends of Pigeon Pea and Wheat Flour. Plant Foods for Human Nutrition, 74(4), 553–559. https://doi.org/10.1007/s11130-019-00758-2

Goni, I., Alejandra, G., Fulgenci., S. C. (1997). A Starch Hydrolysis Procedure to Estimate Glycemic Index. Nutrition Research, 17 (3): 427-437.

Gyamfi, M. A., Yonamine, M. and Aniya, Y. (1999). Free-radical Scavenging Action of Medicinal Herbs from Ghana: Thonningia Sanguine on Experimentally-Induced Liver Injuries. Gen. Pharmacol: Vasc. Syst., 32: 661-667.

Harbone, I. B. (1973). Phytochemical methods: A guide to modern techniques of plant analysis. 2nd Edition, Chapman and Hall, New York, 88 -185.

Harris, D.J. (2002). The Vascular Plants of the Dzanga-Sangha Reserve, Central African Republic: National Botanic Garden (Belgium), Meise. 1-274..

IDF (2021). The International Diabetes Federation, Diabetes Atlas. 10th Edition.lp, Seeds and Leaves. Animals, 10 (1714): 1-14.; doi:10.3390/ani10091714.

Kupai, K.; Várkonyi, T.; Török, S.; Gáti, V.; Czimmerer, Z.; Puskás, L.G.; Szebeni, G.J. (2022). Recent Progress in the Diagnosis and Management of Type 2 Diabetes Mellitus in the Era of COVID -19 and Single Cell Multi-Omics Technologies. Life, 12, 1205. https://doi.org/ 10.3390/life12081205.

Meda, A., Lamien, C. E., Romito, M., Millogo, J., and Nacoulma, O. G. (2005): Determination of the Total Phenolic, Flavonoid and Praline Contents in Burkina Faso Honey, as Well as their Radical Scavenging Activity. Food Chemistry, 91, 571– 577.

Osayemwenre, E, Abiodun, F., Peter L. (2014). Medicinal uses, Phytochemistry and Pharmacology Of *Picralima nitid*a (Apocynaceae) in Tropical Diseases: A Review. Asian Pac. J. Trop. Med. 7(1):1 -8 doi: 10.1016/S1995-7645(13)60182-0.

Singleton, V. L., Orthofer, R, and Lamuela-Raventos, R. M. (1999). Analysis of Total Phenols and other Oxidation Substrates and Antioxidants by means of Folin-Ciocalteu Reagent. Methods in Enzymology, 299, 152-178

Shendurse, A. M., Khedkar, C. D., (2016). Glucose: Properties and Analysis. The Encyclopedia of Food and Health, 3: 239-247

Uloko, A. E, Musa, B. M, Ramalam, M. A., Gezawa, I. D., Puepet, F. H, Uloko AzT *et al.,* (2018). Prevalence and risk factors for diabetes mellitus in Nigeria: a systematic review and meta-analysis. Diabetes Ther.: 9 (3):1307-1316.

Yen, G. C. and Chen, H. Y. (1995). Antioxidant Activity of various Tea Extracts in Relation to their Antimutagenicity. Journal of Agricultural and Food Chemistry, 43, 27-32.