Phytochemicals, Antioxidants and Glycemic Index Assessmentof *Lablab purpureus*(Lablab Bean) and *Phaseolus lunatus*(Lima Bean) Seeds

Abstract

Some legumes are commonly used as commercial food crops in West Africa while others are lesser known, neglected or underutilized. This research work is aimed at the evaluation of the chemical compositions and possible utilization of the legume Lablab purpureus and Phaseolus lunatus samples to solve metabolic diseases. The evaluation of the chemical compositions and glycemic index (GI) of both seeds were carried out using standard methods. Phytochemical screening conducted on the seeds showed the presence of tannin, saponin, alkaloid and flavonoids in both samples. The results of antioxidant properties of the seeds showed that *Phaseolu slunatus* and *Lablab purpureus*have Vitamin C (35.01 ± 0.02 and8.75± 0.03)mg/g, ferric reducing property (20.54 ± 0.02and 12.75 ± 0.03)mg/g, phenol (2.02 ± 0.02 and 2.05 ± 0.02)mg/g, flavonoids (3.47 ± 0.11 and3.22 ± 0.02) % andfree radical scavenging property (46.52 ±0.05 and 60.16 ±0.32)% respectively.The anti-nutrient results showed tannin (1.07 ± 0.01 and 1.22 ± 0.02)%, saponin (4.66 ± 0.05 and 5.15 5.15 ± 0.05)%, oxalate (3.20 ± 0.19 and 5.19 ± 0.19)mg/g, phytate(6.51 ± 0.01 and 2.64 ± 0.01) % for *Lablab purpureus* and *Phaseoluslunatus*seeds are respectively.The glycemic indices observed are (50.86 and 58.21)% for*Lablab purpureus* and *Phaseoluslunatus*seeds respectively. The findings revealed that both seeds possessed good nutritional quality required in human diet together with adequate antioxidant properties plus low and medium glycemic indices that could help in fighting various cardiovascular diseases and prove them to be good sources of neutraceuticals required for a healthy living especially in diabetic patients.

Key words: *Lablab purpureus, Phaseoluslunatus*, Phytochemical, Glycemic index, Antioxidants

1.0 Introduction

"Legumes are the third largest family of angiosperms belong to Fabaceae/Leguminosae" (Ayodele et al. 2014). Thousands of promising species of legumes await research, yes there is over dependence on just a few species because twenty out of these thousands are used extensively (Amoo and Agunbiade, 2009). "Pulses are the important components of a healthy diet and take an important place in the traditional diets throughout the World. They are sources of low-cost dietary vegetable proteins and minerals which compare favourably with animal products such as meat, fish and egg" (Apata and Ologhobo 1997). "They provide a range of essential nutrients including protein, low glycemic index carbohydrates, dietary fibre, minerals and vitamins. Legumes are uniquely rich in both protein and dietary fibre as well as one of the best sources of resistant starch. Raw, dried legumes contain about 20-30% resistant starch by weight (Bednar et al. 2001)that means, almost half of the starch in raw legumes is resistant to digestion. Since resistant starch is not metabolized in the small intestine, it reduces the amount of glucose released into the blood, thus lowering the demand for insulin while also reducing the caloric density of food" (Behall and Howe 1995).

"Currently, there is an uptick in adoption of plant-based diets, as correlated by the rising trends of vegetarianism, veganism and flexitarianism. A variety of reasons – cost, health, environmental concerns, animal welfare issues, religious beliefs are mentioned in connection with the adoption and practice of plant-based diet" (Cramer et al. 2017, Sabaté and Soret 2014 and Willet et al 2019).

A plant-based diet, generally, focuses on the primary consumption of foods derived from plants (fruits, vegetables, nuts, seeds, legumes and whole grains). But it can also include small amounts of foods of animal origin – dairy, eggs, meat and fish. Therefore, the term "plant-based diet" is

quite broad in its connotation. Over dependence of the world's population on these animal protein sources which are often not affordable (to a high percentage of the populace), and have high cholesterol content has consequently resulted in increased prevalence of non-communicable diseases such as obesity, diabetes, heart diseases and certain types of cancer. "Foods that contain significant levels of resistant starch increase satiety and have a lower glycemic index, producing a smaller rise in blood glucose than high starch foods that contain very little resistant starch, such as baked potatoes, rice, and white bread. Fortunately, legumes are among foods that are low glycemic champions. Glycemic index (AOAC 2005)is the increment area under blood glucose response curve of 50g carbohydrate, portion of a test food expressed as a percent of the response of the same amount of carbohydrate from a standard food taken by the same subjects"(FAO 2022).

"Glycemic Index (GI) of food has been classified as low (0-50%), medium (56 – 59%) and high (>70%)"(Foster-Powell et al. 2000). "Foods that raise blood sugar slowly and steadily give continuous energy are low glycemic index food while high glycemic index foods have a characteristic sharp rise in blood glucose, which declines within a short time" (Ludwig 2002). The higher the rise in glucose in the blood stream, the more insulin is produced to store it. Over time this can lead to higher insulin levels that can result in inflammation, weight gain and resistance to insulin's ability to store sugar. The end result can be the progression to type II diabetes.

"Low GI foods are absorbed slowly and have a moderate effect on postprandial rise of blood sugar levels. Minimally processed, high fiber and complex carbohydrates foods, with a less fat as well as phytochemicals tends to have lower glycemic index. Eating foods with a low glycemic

index may help to control blood glucose level, cholesterol level, appetite, lower risk of developing heart disease, and type 2 diabetes.It is documented that there are thousands of underutilized crops which have desirable nutritional profiles compared to major crops and have the potential to alleviate the 'hidden hunger' of the poor communities. In this regard, legumes have been highlighted as cost effective substitute to animal protein. They contain a range of nutrients and bioactive components that may best explain their protective effects"(Schröder 2007 and Sievenpiper et al. 2009).

Lima bean (*Phaseoluslunatus*) belongs to the family Fabacea (Leguminosae) and genus of Phaseolus. The seeds are called "kapala" (among the Yorubas), "ukpa" (among the Igbos) South-western and South-eastern Nigeria respectively; where the seeds are commonly consumed among the rural dwellers. "*Lablab purpureus*seed is a species of bean in the family Fabaceae. It is native to Africa and it is cultivated throughout the tropics for food. Common names include hyacinth bean, bonavist bean/pea, dolichos bean, seim bean, lablab bean, Egyptian kidney bean, Indian bean, bataw and Australian pea. It is the only species in the monotypic genus *Lablab"*(Smart 1985). However, the consumption of some underutilized legume seeds such as *Lablab purpureus* and *Phaseoluslunatus*seeds is not common. It is therefore necessary to quantitatively evaluate the phytochemical compositions, antioxidant properties, total carbohydrate, amylose and amylopectin as well as the glycemic indices of *Lablab purpureus*and *Phaseoluslunatus* seeds for application in the management of diabetic mellitus.

2.0 Materials and Methods

2.1 Materials

Samples Collection and Preparation

The samples, *Lablab purpureus* and *Phaseoluslunatus*seeds were obtained from the International Institute of Tropical Agriculture (IITA), Ibadan. The samples were screened by hand picking to remove the bad ones, sun dried and ground with electrical blender to obtain homogenous fine powder. The powdered samples were packed in screwed-capped air tight polyethylene container and kept in a refrigerator at 4^0C prior to analysis.

2.2 Chemicals and equipment used

The chemicals used were of analytical grade, reagents were standardized (where necessary) and the equipment were calibrated. The values reported are results of triplicate determinations which were pooled and expressed as mean.

2.3 Methods

2.3.1 Phytochemical screening tests of the samples for tannins,and terpenoids were carried out by the methods of Sofowora(1993) while those of saponins, flavonoids and alkaloids were done by the methods described by Oseni et.al (2011). The method of Singleton et.al (1999) was used to determine cardiac glycosides

2.3.2 Quantitative Determination of Anti–Nutrients.

2.3.2.1 Determination of Oxalate.

Total oxalates were determined according to the procedure of(Benderitter 1998). 1.0g of the sample was weighed and 75ml of 0.75 M H_2SO_4 solution was added. The mixture was carefully stirred intermediately with magnetic stirrer for one hour and then filtered using whatman No1 filter paper. About 25 ml of the filtrate was collected and then titrated hot (80-90^{o}C) against 0.05M $KMNO_4$ solution till the end point of a faint pink colour appeared that persisted for at least 30 minutes. Then the amount of oxalate in each sample was then calculated by:

$$\text{Oxalate (mg/g)} = \frac{V_t \times 0.9004}{W} \quad \text{……………………………………………} \quad (3.6)$$

Where:

V_t = volume of 0.05M $KMnO_4$ used for titration;

W = weight of sample.

2.3.2.2 Determination of Phytate

"Exactly 4.0 g of sample was soaked in 100ml of 2% HCl solution for three hours and filtered through Whatman No 2 filter paper. About 25 ml of the filtrates was placed in a conical flask and 5ml of 0.3% ammonium thiocyanate (NH_4SCN) solution was added, after which 53.5 ml of distilled water was added. The solution was titrated against a standard iron (III) chloride solution containing 0.00195 g/ml until brownish yellow colour persisted for five minutes. The phytate content was expressed as percentage phytate in the sample"(Pulido et al. 2000).

$$\text{Phytate (\%)} = \frac{T \times 0.00195 \times 1.19}{2} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3.7)}$$

Where:T- Volume of standard iron (iii) chloride solution used for titration.

2.3.2.3 Determination of Saponin

"The spectrophotometric method(Gyamfi et al. 1999)was used for Saponin determination. Two grams (2 g) of the finely ground sample was weighed into a 250 ml beaker and 100 ml of Isobutyl alcohol was added. Shaker was used to shake the mixture for 5 h to ensure uniform mixing. The mixture was filtered using No 1 Whatman filter paper into 100 ml beaker containing 20 ml of 40 % saturated solution of magnesium carbonate ($MgCO_3$)". The mixture obtained again was filtered through No 1 Whatman filter paper to obtain a clean colourless solution. 1 ml of the colourless solution was taken into 50 ml volumetric flask using pipette, 2 ml of 5 % iron (iii) chloride ($FeCl_3$) solution was added and made up to the mark with distilled water. This was allowed to stand for 30 min for the colour to develop. The absorbance was read against the blank at 380 mm.

3 Determination of Alkaloid

Fifty (50 g) of powdered wonderful kola seed were extracted with litre of methanol: (1:1v/v) mixture and solvent evaporated. "The resultant residue was mixed with 200 ml of Tetraoxosulphate (vi) acid and partitioned with ether to remove unwanted materials. The aqueous then extracted with excess chloroform to obtain the alkaloid fraction. The chloroform extraction was repeated several times and the bulk of extract was concentrated to dryness. The alkaloid was weighed and the percentage was calculated with reference to the initial weight of the sample"(Trease and Evans 1989).

$$\%\, Alkaloid = \frac{Weight\ of\ Alkaloid\ residue \times 100}{Volume\ taken}$$

2.3.3 Evaluation of Antioxidant Activity.

2.3.3.1 Preparation of the Extract.

The sample was homogenized using blender and the homogenate was then stored at 4^{o} C in a refrigerator. Distilled water was used for extraction of phytonutrients using soxhlet extraction method. The extraction was carried out for 6h. The extracts were concentrated at 55^{o}C using rotary evaporator and resultant residues were then made-up to 50ml and stored under refrigerated at 4^{o} C prior to analysis.

2.3.3.2 Determination of Total Phenol Content.

"The phenolic contents were determined using Follin-Ciocalteu reagent and expressed as Gallic Acid Equivalents (GAE)"(Singleton et al. 1999). The extracts were diluted with methanol by taking 3ml of methanol and 1ml of crude extract solution. To this sample solution, 1ml of 5-fold diluted FolinCiocalteu's reagent was added. The contents were mixed well, kept for 5 minutes at

room temperature followed by the addition of 1ml of 10 % aqueous sodium carbonate. After incubation at room temperature for one and half hour, the absorbance of the developed blue colour was read at 760nm (Shimadzu UV-1650 PC Shimadzu Corporation, Kyoto, Japan) against blank. Gallic acid (100-1000 mg/ml) was used to construct the calibration curve. Results were calculated as garlic acid equivalent (mg/g) of samples. The determination was done in triplicates and concentrations of phenolic compounds were calculated from obtained standard garllic acid graph.

2.3.3.3 DPPH Radical Scavenging Activity.

"Free radical scavenging activities of the extracts were determined using a stable 2, 2-diphenyl-1-picrylhydrazyl radical (DPPH)"(Brand et al. 1995). DPPH is a free radical of violent colour. The antioxidants in the sample scavenge the free radicals and turn it into yellow colour from violet which was proportional to the radical scavenging activity. The assay contained 1ml of 0.1mM DPPH in methanol and varying concentrations of extracts (50-1000 ug/ml) methanol and standards in the same solvent and made up to 3.5ml with methanol. The contents were mixed immediately and then incubated for 30min at 30^{o}C in water bath. The degree of reduction of absorbance was recorded in UV-Vis spectrophotometer at 517nm. The percentage of scavenging activity was calculated as:

A% = (Ac – As)/Ac x 100 ……(3.10)

Where:

Ac = Absorbance of control (without sample);

As = Absorbance of sample.

2.3.3.4 Iron Reducing Power Assay.

The reducing power of the sample was determined according to the method(Oyaizu et al. 1986).About 1ml of the sample extracts were mixed with 2.5ml of phosphate buffer (0.2 M, pH 6.6) and 2.5ml of 1% potassium ferricyanide. The reaction mixture was incubated at 50°C for 20minutes. After incubation period, 2.5ml of 10% trichloroacetic acid (TCA) was added and the reaction mixture was centrifuged at 1000rpm for 10min. The upper 2.5ml layer was mixed with 2.5ml of deionized water and 0.5ml of ferric chloride and then thoroughly mixed. The absorbance was measured spectrophotometrically at 700nm. A higher absorbance indicates a higher reducing power.

2.4.0 Determination of carbohydrates

2.4.1 Determination of soluble sugars and starch

About100 mg of each of the samples was weighed into a 50 ml centrifuge tube and 1.0 ml of 80% ethanol was added. A 2 ml distilled water was added and mixed thoroughly. Then, 10 ml of hot 80% ethanol was added and mixed thoroughly. The samples were centrifuged at 1400 rpm for 5 min. Then, the supernatant was carefully decanted into 100 ml volumetric flask, followed by addition of 10 ml of hot 80% ethanol to the residue. The mixture was shaken thoroughly and centrifuged at 1400 rpm for 5 min, and the supernatant decanted into the same flask. The extraction with hot ethanol was repeated and the flask was made up to volume with distilled water while the residue was kept for starch determination.

An aliquot of 1.0 ml of the supernatant was pipetted into a test tube and diluted to 2.0 ml with distilled water. Thereafter xml of 5% phenol was added and mixed thoroughly. Then, 5.0 ml concentrated sulphuric acid was directly added to the liquid surface and not to the sides of the tube in order to obtain good mixing. The tubes were allowed to stand for 10 min and shaken thoroughly for proper mixing. The test tube was placed in a water bath for 20 min at 30^{o}C and

the absorbance was measured thereafter at 490 nm. The blank was prepared by substituting distilled water for the sugar extract solution while standard glucose curve was prepared from a 100 mg/ml glucose solution (DuBois 1956)

2.4.2 Determination of total starch

"Concentrated perchloric acid (7.5 ml) was added to the residue from 2.4.1 and allowed to hydrolyze for 1 hour. It was then diluted to 25 ml with distilled water and filtered through a glass wool. A 0.2 ml aliquot was taken from the filtrate and made up to 2.0 ml with distilled water, vortexed and allowed for colour development as was described for standard glucose curve preparation using 3, 5- dinitrosalicylic acid"(DuBois et al. 1956).

2.4.3 Determination of amylose content

A 100 mg of each sample was weighed into a 100 ml volumetric flask. Then 1 ml of 95% (v/v) ethanol and 9 ml of 1 M NaOH were carefully added and heated for 10 min in a boiling water bath to gelatinize the starch; the mixture was cooled and made up to volume with distilled water. A 5 ml portion of the starch solution was pipetted into a 100 ml volumetric flask, 1 ml of 1 M ethanoic acid (to acidify the solution) and 2 ml of iodine solution (0.20%) were added. This was then made up to volume with distilled water. Thereafter, the mixture was shaken and absorbance was determined at 620 nm using spectrophotometer after 20 min. A calibration curve was prepared from a standard amylose solution containing 100 mg/ml. Amylose content of the sample was read from the standard curve and expressed on percentage basis (DuBois et al. 1956)

2.4.4 Amylopectin Determination

Amylopectin in tested food was calculated bydifference using followingformula:

Amylopectin (%) = % Total starch – Amylose (%)(DuBois et al. 1956).

2.5.0 *In - vitro* starch hydrolysis and estimation of glycemic index

The*in-vitro* method of (Goni et al. 1997)as modified by(Oboh et al. 2015) was used.The aim of the *in vitro* starch hydrolysis was tosimulate the gastrointestinal tract (GIT) starch digestion. Theoral phase was simulated by means ofmechanical disaggregation of 50 mg of foodportions. The gastric phase was developed for 1h at 37 ^{o}C with 10 ml of HCl - KCl buffer (pH =l.5) and pepsin. The intestinalphase was carried out in sodium potassiumphosphate buffer 0.05M pH 6.9 containingcrudepancreatic amylase extracted from swine gut. About50mg of each sample was incubated with 1 mg of pepsin in 10 mlHCl-KCl buffer (pH 1.5) at 40^{o}C for 60 min in a shaking water bath. The digest was diluted with 7.5ml of phosphate buffer (0.05M, pH 6.9) and then, 2.5ml of alpha amylase solution containing 0.005g/10 ml was added. Sampleswere then incubated at 37^{o}C in a shaking waterbath for 60 minutes. On expiration of the time, 0.2 ml aliquot was taken from each tube at 0, 30, 60, 90, 120, 150 and 180 min intervals and boil in a water bath at 100^{o}C for 5 min to inactivate the enzyme. Then 0.5ml sodium acetate buffer (0.4M, pH 4.7) was added and the residual starchdigested to glucose by adding 7 ml of alpha-glucosidase solution extracted from swine gut in phosphate buffer (1:4). The mixture was incubated for 45 min at 60^{o}C after which 0.2ml of 3, 5- dinitrosalicylic acid (DNSA) was added. The enzyme reaction was terminated by boiling the mixture at 100^{o}C in a water bath for 5 min. About 2ml of distilled water was added and the mixture was centrifuged at 2000 rpm for 10min. Then, the absorbance of the supernatant was read at 450nm using a spectrophotometer.Standard white bread was also analyzed as reference product. The rate of starch digestion was expressed as the percentage of starch hydrolyzed per time using glucose standard curve. A nonlinear model established by (Goni et al. 1997)was applied to describe the kinetics of starch hydrolysis. Values

for the area under the curve (AUC) were obtained for each of the starch hydrolysis curves and standard from which the glycemic index (GI) was calculated using the equation (Goni et al. 1997 and Oboh et al. 2015)

$$GI\ (\%) = \frac{AUC\ of\ sample}{Average\ AUC\ of\ std} \times 100 \qquad \text{……..(16)}$$

3.0 Results and Discussion

Phytochemical Screening

The phytochemical screening conducted on the seeds of *Lablab purpureus* and *Phaseoluslunatus* revealed the presence of tannin, saponin, alkaloid and flavonoids in both samples (Table 1).

Table 1: Phytochemical screening of *Lablab purpureus* and *Phaseoluslunatus* seeds

Phytochemicals	***Lablab purpureus***	***Phaseoluslunatus***
Saponin	+	+
Flavonoids	+	+
Terpenoids	-	-
Alkaloids	+	+
Tannins	+	+
Glycosides	-	-

KEY: + means present
- means absent

From the phytochemical screening, the presence of phytochemicals in *Lablab purpureus*and *Phaseoluslunatus* seeds is biologically important e.g. saponins and flavonoids contribute to its medicinal value thus they can be potential sources of nutraceticals. It is known that the darker the colour of a seed the higher the tannin levels (Silano et al. 1982).

The results of antioxidant properties of the seeds are presented in Table 2. *Phaseoluslunatus* has higher concentrations of Vitamin C (35.01 ± 0.02 mg/g) and ferric reducing property (20.54 ± 0.02 mg/g) than *Lablab purpureus* with Vitamin C (8.75 ± 0.30 mg/g) and Ferric reducing property of (12.75 ± 0.03 mg/g). These values are higher than the values 3.04±0.06 mg/g and 7.64±2.33mg/g respectively reported for Canavaliaensiformis(Amoo et al. 2019).

Table 2: Antioxidant properties of *Lablab purpureus* and *Phaseoluslunatus* seeds

Antioxidants	***Lablab purpureus***	***Phaseoluslunatus***
Ferric Reducing Property (mg/g)	12.75 ± 0.03	20.54 ± 0.02
Vit. C (mg/g)	8.75 ± 0.30	35.01 ± 0.02
Phenol (mg/g)	2.05 ± 0.02	2.02 ± 0.02
Free Radical Scavenging Property (%)	60.16 ± 0.32	46.52 ± 0.05
Flavonoids (%)	3.22 ± 0.02	3.47 ± 0.11

The values of free radical scavenger properties(60.16 ±0.32 and 46.52 ±0.05)% and flavonoid (3.22±0.02 and 3.47±0.11)% were obtained in this study for Lablab purpureus and Phaseoluslunatus respectively. These values are lower than 66.31±0.71% and 9.33±0.28% reported for Canavalia gladiate (Amoo et al. 2019). The total phenol(mg/g) in both Lablab purpureus and phaseoluslunatus respectively are 2.05±0.02 and 2.02±0.02. These values are lower than 4.63±0.3 reported for Canavalia gladiate (Amoo et al. 2019).

From Table 3, the tannin contentsof 1.07± 0.01 % and1.22± 0.02 % for *Lablab purpureus* and *Phaseoluslunatus*seeds respectively were observed in this study.The tannin content 1.07 ± 0.01 mg/gin *Lablab purpureus*seeds is higher than 0.42 % tannin content reported for *Lablab purpureus*seeds(Osman 2007).

Table 3: Antinutritional compositions of *Lablab purpureus* and *Phaseoluslunatus*seeds

Samples	Phytate (%)	Saponin (%)	Oxalate(mg/g)	Tannin (mg/g)	Alkaloid (%)
Lablab Purpureus	6.51 ± 0.01	4.66 ± 0.05	3.20 ± 0.17	1.07 ± 0.01	1.40±0.02
Phaseoluslunatus	2.64 ± 0.01	5.15 ± 0.05	5.19 ± 0.15	1.22 ± 0.02	1.29±0.02

"0.02% in *Phaseoluslunatus*seeds is lower than the 1.41% found in mucuna(Tuleun and Patrick 2007) and higher than 0.34% in African oil bean seed" (Enujiugha and Agbede 2000). "The poor palatability associated with high tannin diets can be ascribed to its astringent property which is a consequence of its ability to bind with protein of saliva and the mucosal membrane of the mouth during the mastication of food" (Arora 1991). "The values of 1.40 ± 0.02 % and 1.291.29 ± 0.02% are obtained for alkaloids in *Lablab purpureus*and *Phaseoluslunatus*seeds respectively. A 20 mg/100g amount of alkaloid is considered to be toxic (Aletor 1999). The values of saponin in *Lablab purpureus*and *Phaseoluslunatus* were4.66 ± 0.05 % and 5.155.15 ± 0.05 % respectively, which are higher than 1.1% found in mucuna seed" (Tuleun and Patrick 2007). "Saponin in seeds imposes an astringent taste that affects palatability, reduces feed intake, affects the utilization of protein (Sathe and Salunkhe 1984), and consequently body growth. The oxalate valuesof 3.20 ± 0.19 mg/g and 5.19 ± 0.19 mg/g wereobtained for *Lablab purpureus* and *Phaseoluslunatus*respectively". "Oxalates can bind to calcium present in food thereby rendering calcium unavailable for normal physiological and biochemical role such as the maintenance of strong bone, teeth, co-factor in enzymatic reactions, nervous impulses transmission and as clotting factor in the blood" (Ladeji et al. 2004). Phytate level in *Lablab purpureus* and *Phaseoluslunatus* are 6.51 ± 0.01 % and 2.64±0.01 % respectively.

Table 4: Glycemic Indices (%) of *Lablab purpureus* and *Phaseoluslunatus* seeds

	Total Sugar	Amylose	Amylopectin	Glycemic Index

Lablab purpureus	8.26 ± 0.02	50.42 ± 0.02	41.32 ± 0.01	50.86 ± 0.02
Phaseolus lunatus	6.93 ± 0.02	69.58 ± 0.25	23.49 ± 0.02	58.54 ± 0.59

NOTE:
Low Glycemic Index: 0 – 54; Middle Glycemic Index: 55- 69; High glycemic Index: 70 and above (Foster-Powell *et al*., 2002)

Legumes produce relatively low glycemic responses in both healthy individuals and in diabetics (Jenkins et al. 1998 and Viswanathan et al. 1989)The components present in legumes, particularly the soluble dietary fibre(Wolever and Jenkins 1986), and the nature of the starch (Gallant et al. 1992) can influence the rate by which glucose is released from starch and consequently absorbed from the small intestine. This makes it suitable for use in controlling postprandial rise of blood glucose levels. From Table 4, the free sugar contents of *Lablab purpureus* and *Phaseoluslunatus* are8.26 ± 0.02 % and 6.93 ± 0.02% respectively. These values are higher when compared with 1.148 ± 0.00 % and 1.061 ± 0.00 % obtained for whole seed flour of *Canavaliaensiformis*and *Canavaliagladiata*by Amoo et al. (2019) and 2.4 ± 0.1% reported by (Viswanathan et al. 1989) for Bambara ground nut. Percentage concentrations of amylose and amylopectin were *Lablab purpureus* (50.42 ± 0.02 and 41.32 ± 0.01) while *Phaseoluslunatus*(69.58 ± 0.25 and 23.49 ± 0.02) respectively. The values for amylose are higher when compared with 42.36 ±0.42% and 45.28 ± 1.11% obtained for for whole seed flour of *Canavaliaensiformis*and *Canavaliagladiata*by Amoo et al. (amoo2019). The results show that *Lablab purpureus*has low glycemic index (GI) of 50.86% while*Phaseoluslunatus* has a medium glycemic index of 58.54%. The low GI of *Lablab purpureus*could be attributed to the low amylose since research has revealed that there is reciprocal relationship between GI and amylose. More so, the presence of phytochemicals has been confirmed to lower blood glucose as reported

by(Denis et al. 2015). “Research has also suggested that low glycemic index diets improve glycemic control in individuals with impaired glucose tolerance and type-2 diabetes by lowering blood glucose and improving insulin sensitivity” (Denis et al. 2015). This could mean that *Lablab Purpureus* and *Phaseoluslunatus* seeds can be incorporated into the diet meant for the control of diabetes mellitus such as incorporation of whole seed flour in bread making, snacks, beans cake among others. Low glycemic index diets are important in the management of hyperglycemia and hyperinsulinemia because they have a high satiety effect and therefore can reduce excessive consumption of calories (Simpson et al. 1981) with a corresponding decreasein chances of obesity and type 2 diabetic (Anderson et al. 1991). This study shows that *Lablab Purpureus* and *Phaseoluslunatus* have low GI and medium GI respectively.

4.0 Conclusion

The result of the Glycemic Indices (GI) of *Lablab purpureus*and *Phaseoluslunatus*seeds showed that *Lablab purpureus*has a low GI compared to that of *Phaseoluslunatus*which has a medium GI. Thus, both seeds can be mixed with wheat flour to produce bread,and biscuit as an effective , cheap and natural means for managing and preventing type II diabetes and its associated cardiovascular diseases. They can also be in preparing African dishes such as legume soup (gbegiri) and legume porridge . They can also serve as a better source of nutraceuticals in the management of diabetes and its associated complications

References

Anderson, J. W., Zeigler, J. A., Deakins, D. A., Floore, T. L., Dillon, D. W., Wood, C. L. and Oeltgen, P. R. 1991. Metabolic Effects of High-Carbohydrate, High-Fiber Diets for Insulin-Dependent Diabetic Individuals. *The American Journal of Clinical Nutrition,* 54(5):936-943. https://doi.org/10.1093/ajcn/54.5.936

Amoo Isiaka Adekunle, Ibeto Augustina Ukamaka and JogbodoTolulope: Chemical Composition and Glycemic Indexes of Jack Bean (Canavaliaensiformis) and Sword Bean (Canavalia gladiate) Seeds; International Journal of Social Science and Technology, Vol. 5, No 4, 65-76

Amoo I. A and Agunbiade F. O (2009): "Some Nutrient and Anti-Nutrient Components of pterygota macrocarpa Seed Fluor". Pacific Journal of Science and Technology, 10(2), 949-955. USA.

AOAC. 2005. Official Method of Analysis (18th Ed.). Association of Official Analytical Chemists Washington D.C. p. 106. https://www.researchgate.net/publication/292783651_AOAC_2005

Apata, D. F. and Ologhobo, A. D., 1997. Trypsin Inhibitor and the Other Anti-nutritional Factors in Tropical Legume Seeds. *Tropical Science*, 37:52-59. https://doi.org/10.12691/ajfst-5-4-6

Ayodele O.M., Ade-Omowaye B.I., Ngoddy P.O, 2014. Comparative study of phytochemical profiles and *In Vitro* multienzymes protein digestibility of two species of *Mallotussubulatus*--- A tropical underutilized hard-to-cook legume. Afr. J. Food Sci. Technol. 5(8):174-179. http://dx.doi.org/10.14303/ajfst.2014.100

Bednar G.E., Patil A.R., Murray S.M., Grieshop C.M., Merchen N.R., Fahey G.C. Jr., 2001. Starch and fiber fractions in selected food and feed ingredients affect their small intestinal digestibility and fermentability and their large bowel fermentability in vitro in a canine model. *J Nutr.*;131(2):276-86. https://doi.org/10.1093/jn/131.2.276

Behall, K. M., and Howe, J. C., 1995. *Contribution of Fiber and Resistant Starch to Metabolizable Energy. Am. J. Clin. Nutr. 62: 1158S-1160S.* https://doi.org/10.1093/ajcn/62.5.1158s

Benderitter, M., Maupoil, V., Vergely, C., Dalloz, F., Briot, F. and Rochette, L., 1998. Studies by Electron Paramagnetic Resonance of The Importance of Iron in The Hydroxyl Scavenging Properties of Ascorbic Acid in Plasma: Effects of Iron Chelators. *Fundamental and Clinical Pharmacology*, 12(5):510 -516. https://doi.org/10.1111/j.1472-8206.1998.tb00979.x

Brand W., W., Curvelier, M.E., and Berset C., 1995. Use of a free radical method to evaluate antioxidant activity, Lebensm. *Journal of Wiss Technology*, 28(1): 25 47https://doi.org/10.1016/S0023-6438%2895%2980008-5

Cramer, H., Kessler, C.S., Sundberg, T., Leach, M.J., Schumann, D., Adams, J. &Lauche, R., 2017. Characteristics of Americans Choosing Vegetarian and Vegan Diets for Health Reasons. Journal of Nutrition Education and Behavior,49(7):561-567.e1. https://doi.org/10.1016/j.jneb.2017.04.011

Denis N. Y., Kouakou N. K., Daniela E., Francesca S., Nicoletta P., Casiraghi, M. C 2015: Nutritive Evaluation of the Bambara Groundnut Ci12 Landrace [*Vignasubterranea*(L.) Verdc. (*Fabaceae*)] Produced in Côte d'Ivoire. *InternationalJournal of Moecular Science, 16*: 21428-21441.http://dx.doi.org/10.3390/ijms160921428

DuBois, M., Gilles, K. A., Hamilton, J. K., Rebers, P. A. T., & Smith, F., 1956. Colorimetric Method for Determination of Sugars and Related Substances. *Analytical chemistry*, 28: 350-356. https://doi.org/10.1038/168167a0

Enujiugha, V.N. and Agbede, J.O., 2000. Nutritional and Anti-Nutritional Characteristics of African Oil Bean (PentaclethraMacrophyllaBenth) Seeds. *Appied Tropical Agriculture*, 5(1):11-14. http://dx.doi.org/10.3923/pjn.2003.320.323

Food And Agriculture of United Nations, 2022: Thinking about the future of food Security- A foresight report, Rome. https://doi.org/10.4060/cb8667en

Foster-Powell, K., Holt, S. H. and Brand-Miller, J. C., 2000. International table of Glycemicindex and Glycemic load values. *American Journal of Clinical Nutrition*, 76:5-56. https://doi.org/10.1093/ajcn/76.1.5

Gallant, D. G., Bouchet, B., Bulion, A. and Perez, S., 1992. Physical Characteristics of Starch Granules and Susceptibility to Enzyme Degradation.*European Journal of Clinical Nutrition*, 46(2):S3-

S16.https://www.researchgate.net/publication/216091041_Physical_Characteristics_of_Starch_Granules_and_Susceptibility_to_Enzymatic_Degradation

Goni, L., Garcia-Alonso, A. and Saura-Calixto, F. A., 1997. Starch Hydrolysis Procedure to Estimate Glycemic Index. *Nutrition Research*, 17:427-43. https://doi.org/10.4236/gsc.2014.41005

Gyamfi, M. A., Yonamine, M. and Aaniya, Y., 1999. Free Radical Scavenging Action of Medicinal Herbs from Ghana: Thonningia Sanguine on Experimentally Induced Liver Injuries. *General Pharmacology*, 32:661-667. https://doi.org/10.1016/s0306-3623(98)00238-9

Jenkins, D. J. A., Wolever, T. M. S., Buckley, G., Lam, K. Y., Giuda, S. and Kamulsky, J. (1988). Low glycemic index starchy foods in the diabetic diet. *American Journal of Clinical Nutrition*, 48:248-254. https://doi.org/10.1093/ajcn/48.2.248

Ladeji, O., Akin, C. U., Umaru, H. A., 2004. Level of Antinutritional Factors in Vegetables Commonly Eaten in Nigeria. *African Journal of Natural Science*, 7:71-73.https://www.researchgate.net/publication/286274863_Level_of_antinutritional_factors_in_vegetables_commonly_eaten_in_Nigeria

Ludwig, D. S., 2002. The Glycemic Index. Physiological Mechanisms Relating to Obesity, Diabetes and Cardiovascular Disease. *Journal of American Medical Association*, 287:2421-2423. https://doi.org/10.1001/jama.287.18.2414

Oboh, G., Agunloye,O. M., Adefegha, S. A., Akinyemi,A. J. and Ademiluyi, A. O., 2015. Caffeic and Chlorogenic Acids Inhibit Key Enzymes Linked to Type-2 diabetes (In vitro): A Comparative Study. *Journal of Basic and Clinical Physiological Pharmacology*, 26:165–170. https://doi.org/10.1515/jbcpp-2013-0141

Osman, M.A., 2007. Effect of Different Processing Methods, on Nutrient Composition, Antinutrional factors, and in vitro Protein Digestibility of Dolichos Lablab Bean [Lablab purpuresus (L) Sweet].*Pakistan Journal of Nutrition*, 6(4): 299-303.http://dx.doi.org/10.3923/pjn.2007.299.303

Oyaizu, H., Debrunner-Vossbrinck, L., Mandelco, J. A., Wosese. C., 1986. A green non – sulfur bacteria: A deep branching in the eubacterial line of descent. *Journal of systematic and applied microbiology*.9 (2) 47-53. https://doi.org/10.1016/s0723-2020(87)80055-3

Pulido, R., Bravo, L. and Saura-Calixto, F., 2000. Antioxidant Activity of Dietary Polyphenols Reducing/ Antioxidant Power Assay. *Journal of Agriciculture and Food Chemistry*, 48:3396-3402.https://doi.org/10.1021/jf9913458

Sabaté, J. &Soret, S., 2014. Sustainability of plant-based diets: back to the future. The American Journal of Clinical Nutrition, 100(suppl.1): 476S–482S. https://doi.org/10.3945/ajcn.113.071522

Silano, V., Bansul, H.C. and Bozzini, A., 1982. Improvement of Nutritional Quality of Food Crops. FAO Plant Production and Protection Paper 34, F AO Press, Rome, Italy.https://www.worldcat.org/title/improvement-of-nutritional-quality-of-food-crops/oclc/888800976?referer=di&ht=edition

Simpson, H. C. R, Lousley, S., Geekie, M., Simpson, R. W., Carter, R. D., Hockaday, T. D. R. and Mann, J. I., 1981. A highcarbohydrate leguminous fiber diet improves all aspects of diabetic control. *Lancet*, 1(8210):1-4.http://dx.doi.org/10.1016/S0140-6736(81)90112-4

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-Cioalteau Reagents. *Methods in Enzymol*. 299: 152-178. https://doi.org/10.1016/S0076-6879(99)99017-1

Smartt J., 1985. Evolution of grain legumes. II. Old and New World Pulses of Lesser Economic Importance. *Experimental Agriculture*,21 (3):1–18.https://doi.org/10.1017/S0014479700012205

Sofowora, E. A., 1993. Medicinal Plants and Transitional Medicine in Africa, third ed. John Wiley and Sons Limited, New York, : 191-234.

Trease, G. E. and Evans, N. C., 1989. Pharmacognosy. (2nd. Edn). Braille Tiridel and Macmillan Publishers. Washington D. C.: 774-784.

Tuleun, C.D. and Patrick, J.P., 2007. Effect of Duration of Cooking Mucunautilis Seed on Proximate Analysis, Levels of Anti-nutritional Factors and Performance of Broiler Chickens. *Nigerian Journal of Animal Production.* 34(1):45-53. https://doi.org/10.51791/njap.v34i1.2418

Viswanathan, M., Ramachandran, A., Indira, P., John, S., Snehalatha, C. and Mohan, V., 1989. Responses to Legumes in NIDDM subjects – Lower Plasma Glucose and Higher Insulin Levels.

Nutrition Reports International, 1989:40(4):803-812.http://www.speciation.net/Appl/Literature/Source/sources.html?id=602

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T. et al., 2019. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. The Lancet, 393(10170): 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4

Wolever, T. M. S., Jenkins, D. J. A., 1986. Effect of Fiber and Foods on Carbohydrate Metabolism. In: Spiller G, Ed. Handbook of Dietary Fiber In Human Nutrition. Boca Raton: CRC Press Inc.: 87-119.