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Evaluation of Proximate, Mineral, Anti-Nutrients and Phytochemical Constituents of Indigenous Beans (*Cajanus cajan, Sphenostylis stenocarpa* and *Phaseolus lunatus*)

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ABSTRACT

The rate of neglect of local beans due to lack of relevant information about their nutritional and medicinal values cannot be over-emphasized. This study aimed to determine the nutritional, phytochemical and anti-nutrient contents of three indigenous beans (*Cajanus cajan, Sphenostylis stenocarpa*, and *Phaseolus lunatus*). Nutritional, phytochemical and anti-nutrient contents of the beans were determined. Data were analysed using statistical analysis system. Results showed that fat (1.46±0.01 mg/100g), moisture (12.71±0.02 mg/100g) and carbohydrate (58.04±0.37 mg/100g) were significantly ($p < 0.05$) higher in *C. cajan* seeds. Crude fibre (16.91±0.05 mg/100g) and ash (6.41±0.01 mg/100g) were significantly higher in *S. stenocarpa* as well as crude protein (26.93±0.04 mg/100g) in *P. lunatus* seeds. Also, potassium (1393.07±1.53 mg/100g), phosphorus (396.71±0.49 mg/100g) and zinc (2.77±0.01 mg/100g) were significantly higher in *C. cajan* seeds while iron (6.44±0.02 mg/100g), magnesium (189.77±0.06 mg/100g) and copper (2.33±0.01 mg/100g) were significantly higher ($p < 0.05$) in *S. stenocarpa* seeds. Vitamin A (0.11±0.00 mg/100g) was significantly higher in *S. stenocarpa* seeds, Vitamin B (0.65±0.00 mg/100g) in *C. cajan* while higher quantity of Vitamin C (23.73±0.02 mg/100g) was recorded in *P. lunatus* seeds. Also, tannin (2.72±0.02 mg/100g) and oxalate (0.89±0.00 mg/100g) were significantly ($p<0.05$) higher in *P. lunatus* seeds. In addition, alkaloids (14.04±0.01 mg/100g), flavonoids (1.59 ± 0.00 mg/100), steroids (0.42±0.00 mg/100g) and phenol (2.44±0.00 mg/100g) were significantly higher in *P. lunatus* seeds. In conclusion, *C. cajan*, *S. stenocarpa*, and *P. lunatus* are rich in nutritional and phytochemical contents therefore, consumption of the beans is encouraged.

Keywords: Nutritional contents, Phytochemical, *Cajanus cajan*, *Sphenostylisstenocarpa*, *Phaseolus lunatus*.

Introduction

The rate at which local agricultural produce including legumes go on extinction is quite alarming. The few ones available are highly neglected due to inadequate information about their food and therapeutic values.[1] However, leguminous seeds, including pigeon pea (*Cajanus cajan*), lima bean (*Phaseolus lunatus*), and African yam bean (*Sphenostylis stenocarpa*) seeds among others are commonly cultivated in Nigeria to meet the food requirements of the populace. Nowadays farmers no longer cultivate local beans in large quantities due to the low demand for the produce, therefore, the few local beans available can no longer meet the food demand of fast growing population of countries such as Nigeria. Based on this, most local beans have been substituted with genetically modified products with or without putting into consideration the health risk of the modified agricultural produce.[1] Studies have shown that local farm produce such as *C. cajan*, *S. stenocarpa* and *P. lunatus* among others are essential sources of dietary components such as proteins, fibre, carbohydrates, vitamins and minerals needed in human diets.

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Many households in developing countries such as Nigeria can afford the beans compared with other expensive nutritional sources making the beans staple food for the populace consumption.[1-3]
Although several studies have reported the cultivation of many of these beans in Nigeria[1,4] yet, they are currently under-exploited despite their rich nutritional relevance.[5] According to Adewale and Odoh; Baiyeri [6--7] poor utilization of local beans and other legumes can be attributed to lack of adequate characterization and documentation of nutritional and medicinal profile of the beans. This challenge has consequentially resulted in low demand and cultivation of the products for human consumption, hence low quantities of them are being offered for sale in the markets compared to other legumes.
However, adequate information on the nutritional and therapeutic relevance of these indigenous beans is required to increase their low adoption rate in Nigerian diets. Based on these challenges, the present study was carried out to evaluate the nutritional, anti-nutrients, and phytochemical contents of three under-utilized beans.

Materials and Methods

Sample collection
Two hundred grams (200 g) of *C. cajan*, (FHI-1129399) *S. stenocarpa* (FHI-51382) and *P. lunatus* (FHI-37193) seeds were purchased from various markets in Ibadan and identified at Forestry Research Institute of Nigeria (FRIN), Ibadan, Nigeria. The beans were air-dried, ground into powder and used for analysis.

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Proximate analysis of C. cajan, S. stenocarpa, and P. lunatus
Crude fibre
One gram each of defatted samples of the powder of the three beans was boiled in 20 mL of 1.25% H_2SO_4 for 30 min. After this, the content was filtered, washed with hot distilled water and boiled in 200 mL of 1.25% sodium hydroxide for about 30 min. Spotless beaker was dried at 100 ± 5^oC overnight, cooled in desiccators and weighed to a constant weight. The spotless beakers with its content was put in a muffle furnace at 932^{0}F-1112^{0}F for 2-3 h cooled in a desiccator and weighed. Crude fibres were determined using the formula.[8]

$$\%\ \text{Crude Fibre in Ground Sample} = \frac{\text{Loss in Weight on Ignition}}{\text{Weight of Ground Sample}}\ x100$$

Crude protein
Total nitrogen (N) was determined using Micro-Kjeldahl method (2009). One hundred milligrams (100-mg) sample of each plants was placed in a clean, dry Folin-Wu digestion tube and 2 g of salt-catalyst mixture (100 g K_2SO_4:10 g $CuS0_4{\cdot}5H_20$:1 g Se) and 4 mL of concentrated H_2SO_4 were added. The tube was swirled to mix the sample and digestion reagents and the mixture was placed in the aluminum heating block preheated to 300^oC. A small glass funnel (25 mm diameter) was placed in the mouth of the tubes to ensure efficient refluxing of the digestion mixture and prevent loss of H_2SO_4. The samples were digested at the boiling point of the mixture for 60 min past the time of clearing, removed from the heating block and allowed to cool to room temperature. The digest was diluted with distilled water to 50 mL mark inscribed on the digestion tube, stoppered and mixed by inverting several times. Ammonium in the digest was then determined by making an aliquot (10 mL) alkaline with 10 N NaOH and steam distillation analysis performed
Protein (%) was determined using the mathematical relationship below.

$$\text{Protein (\%)} = \frac{\text{V} \times 1.4 \text{ x } 6.25 \text{ x } 0.1\text{N Hcl x Vol (used)}}{\text{W} \times \text{A} \times 1000} \text{X100}$$

Where;
V = Titter value. 1.4 -Weight of nitrogen expressed in gram in the formula.
6.25 = Protein factor.
W = Weight of sample.
A = Aliquot digested sample used for distillation

Crude fat
One gram of crushed dried sample was taken in a paper thimble kept in a pre-weighed flask of the fat extractor. Eighty (80 mL) of petroleum ether was added and refluxed for 8 h. The flask was cooled and weighed and crude fat was determined using the formula.

$$\text{Crude fat (\%)} = \frac{\text{Weight of flask with fat} - \text{weight of empty flask})}{\text{Weight of original sample}} \text{X100}$$

Moisture content
This was determined using the gravimetric method. Two grams (2.0 g) of the samples were weighed into a weighed moisture can. The sample in the can was dried in the oven at 105^oC for 3 h, cooled in a desiccator and weighed. It was then returned to the oven for further drying. Drying, cooling and weighing were done repeatedly at hourly interval until there were no further diminutions in the weight. The weight of moisture lost was calculated and expressed as weight of the samples analysed using the formula.

$$\text{Moisture content} = \frac{\text{Wt of empty moisture can – wt of can+Sample before dring}}{\text{Wt of empty can+Sample before drying–Wt of can+Sample dried to constant wt}} \text{X100}$$

Ash content
Ten grams (10 g) of the each sample were added to a reweighed crucible, weighed, placed in a muffle furnace at 932^{0}F for 4 h, cooled in a desiccator and reweighed. Ash content was determined using mathematical relationship;

$$\text{Ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} X100$$

Carbohydrate
Available carbohydrate was determined using difference method. The sum of the percentages of crude fibre, crude fat , ash and crude protein was determined and subtracted from 100% using the formula below;

Carbohydrate (%) = 100 - (crude fibre + crude fat + ash + crude protein) % .[8]
Mineral analysis of C. cajan, S. stenocarpa, and P. lunatus
Three gram (3.0 g) of the powder form of each bean was digested using $HNO_3/HCl_4O/H_2SO_4$ in the ratio 9:2:1 v/v, respectively. Mineral such as magnesium, Calcium, Phosphorus, Iron, Copper and Zinc were determined using an atomic absorption spectrophotometer. The potassium and sodium of the sample were determined using an atomic emission spectrometer and phosphorus by the colorimetric method of AOAC 1990 described in Okey *et al*.[9]

Determination of Vitamins in C. cajan, S. stenocarpa, and P. lunatus
Vitamin A**:** Vitamins A was determined according to the method of AOAC.[8] Two gram (2 g) of the sample of each plant was weighed into a flat bottom reflux flask, 10 mL of distilled water was added and shaken to form a paste after which 25 mL of alcoholic KOH solution was added and a reflux condenser attached. The mixture was heated using a boiling water bath for one hour, shaken, cooled rapidly and about 30 mL of water was added after which hydrolysate obtained was transferred into a separatory funnel. The solution was extracted thrice with 250 mL quantities of chloroform. Besides, 2 g anhydrous sodium sulphate was added to the extract to remove traces of water. The mixture was then filtered into l00 mL volumetric flask and made up to the mark with chloroform. Standard solution of Beta-carotene ranged from 0-50 µg/mL in chloroform, and was obtained by dissolving 0.003 g of standard alpha-carotene in l00 mL of chloroform. The above gradients of different standard solutions prepared were determined with reference to their absorbance from which average gradient was taken to calculate Vitamin A using a spectrophotometer (Metrohm Spectronic 21D Model) at a wavelength of 328 nm.
Vitamin B (Niacin)**:** Five gram (5.0 g) of the sample was treated with 50 mL of 1 N H_2SO_4 and shaken for 30 min. Thereafter, 3 drops of ammonia solution were added to the sample and filtered. Afterward, 10 mL of the filtrate was added into a 50 mL volumetric flask and 5 mL of 0.02 N H_2SO_4 was added. Absorbance was measured in the spectrophotometer at 470 nm.[8,10,11]
Vitamin C**:** One gram of each sample was weighed into a 25 mL conical flask. Then, 10 mL of oxalic acid (0.05 M)-EDTA (0.02 M) solution was added to provide the required reaction time. After 24 hours, the samples were filtered using a 0.45 µm filter paper. Then 2.5 mL of each sample was transferred to a separate 25 mL volumetric brown flask, after which 2.5 mL of the oxalic acid (0.05 M)-EDTA (0.02 M) solution was added.
Subsequently, metal phosphoric acid was added separately with acetic acid (0.5 mL), H_2SO_4 (5% v/v) solution (1 mL) and ammonium molybdate solution (2 mL) each volumetric brown flask and the volume made up to 25 mL with distilled water. The absorbance was read at 760 nm in a UV/VIS spectrophotometer.

Determination of anti-nutrients in C. cajan, S. stenocarpa, and P. lunatus
Phytic acid: Phytic acid was determined according to the method Sofowora. [12] Two (2 g) of each sample was weighed into 250 mL conical flask. 100 mL of 2% hydrochloric acid was added to soak each sample in the conical flask for 3 h and filtered through a double layer of hardened filter paper. Then, 50 mL of each filtrate was placed in a 500 mL conical flask and 107 mL distilled water was added in each case to give proper acidity. Thereafter, 10 mL of 0.3% Ammonium

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Thiocyanate (NH_4SCN) solution was added into each solution as indicated. This was titrated with standard iron (Ill) chloride solution which contained 0.00195 g Iron per mL. The end point was slightly brownish-yellow which persisted for 5 min. The percentage phytic acid was calculated using the formula:

$$\% \text{ Phytic Acid} = \frac{\text{Titre value x } 0.00195 \text{ x } 1.19 \text{ x } 100 \text{ x } 3.55}{\text{Wt. of sample}}$$

Tannin: Half gram (0. 5 g) of the sample was measured into a 50 mL beaker and 20 mL of 50% methanol was added, covered with paraffin and placed in a water bath at 77-80ºC for 1 h and shaken to ensure a uniform mixing. The extract was quantitatively filtered using a double layered Whatman No. 41 filter paper into a 100 mL volumetric flask, 20 mL water was added, 2.5 mL folin-Denis reagent and 10 mL of 1% sodium carbonate were added and mixed properly. The mixture was made up to mark with water, mixed well and allowed to stand for 20 min. The bluish-green colour was developed and treated similarly as the 1 mL sample above. The absorbance of the tannic acid standard solutions as well as samples was read after colour development on a spectronic 21D spectrophotometer at a wavelength of 760 nm. Percentage Tannin was calculated using the formula.

$$\% \text{ Tannin} = \frac{\text{Absorbance of sample X average gradient factor X dilution factor}}{\text{Wt. of sample X } 10{,}000}$$

Trypsin inhibitor: Using the method of Sofowora [12] 1 g of each sample was dispersed in 50 mL of 0.5 M sodium chloride solution. The mixture was stirred for 30 min at 25°C and centrifuged at 1500 rpm for 5 min. The supernatant was filtered and the filtrate was used for the assay. Two milliliters of the standard trypsin solution was added to 10 mL of the substrate of each sample. The absorbance of the mixture was taken at 410 nm using 10 mL of the same substrate as blank.

Oxalate: Two gram powder sample of each bean was boiled in 40 mL of water for 30 min in a reflux condenser and 10 mL of 20% sodium carbonate was added and boiled for another 30 min. The mixture was filtered and the liquid extract washed with hot water until the wash water does not show any alkaline reaction. The combined wash water was filtered to a small volume and cooled. With constant stirring, hydrochloric acid (HCL) (1:1) (in drop wise) was added until the final acid concentration of neutralization was about 4% and the extract was filtered into a 250 mL flask to make up to mark and kept overnight. An aliquot of this filtrate was taken in a 400 mL beaker, diluted with water to 200 mL and made just ammoniacal, and reacidified with Lacotic Acid. In the cold medium, 10 mL of a 10% calcium chloride solution was added and stirred well to include calcium oxalate precipitate to appear and allowed to settle overnight. The clean supernatant liquid was decanted off through Whatman No. 42 filter paper, without disturbing the precipitate. Then, the precipitate was dissolved in HCL (1:1). Oxalic acid was reprecipitated by adjusting pH with ammonium hydroxide solution. The contents were boiled, allowed to settle overnight and oxalic acid was determined by titrating against 0.05 N potassium permanganate solution.[12]

Calculation

$$1\text{mL of } 0.05\text{N } KMNO_4 = 0.00225 \text{ anhydrous Oxalic Acid}$$

$$= \% \text{ Oxalic Acid} = \frac{\text{Titre value x } 0.00225}{2} \text{ x} \frac{100}{1}$$

$$= \text{T.V x } 0.1125$$

Determination of phytochemicals in C. cajan, S. stenocarpa, and P. lunatus

Phytochemical contents of the samples were determined according to the methods of Sofowora and Harborne[13-14]

Alkaloids: Using distillation and titrimetric method described by Harborne. [13] 2 g of finely grounded sample was weighed into a 100 mL beaker and 20 mL of 80% absolute alcohol added to give a smooth paste. The mixture was transferred to a 250 mL flask and more alcohol was added to make up to 100 mL after which 1 g magnesium oxide was added. The mixture was digested in a boiling water bath for 1.5 h under a reflux air condenser with occasional shaking. The mixture was filtered while hot through a small buchner funnel. The residue was returned to the flask, re-digested for 30 min and evaporated with 50 mL alcohol after which, 3 drops of 10% HCl was added. The whole solution was later transferred into a 250 mL volumetric flask. 5 mL of zinc acetate solution and 5 mL of potassium ferrocyanide solution were added and mixed thoroughly to give a homogenous solution. The flask was allowed to stand for 30 min after which 10 mL of the filtrate was transferred into a separatory funnel. The alkaloids present were extracted by shaking the filtrate vigorously with five successive portions of chloroform. The residue obtained was dissolved in 10 mL hot distilled water and transferred into a kjeldahl tube with the addition of 0.20 g sucrose and 10 mL Conc. H_2SO_4 and 0.02 g selenium for digestion to be a colourless solution after which % N was determined using Kjeldahl distillation method. % Nitrogen got was converted to % total alkaloid by multiplying it with a factor of 3.26 i.e

$$\% \text{ Total alkaloid} = \%N \text{ X } 3.26$$

Flavonoids: Flavonoids were determined according to Harborne [13] Half gram (0.5 g) of finely ground sample was weighed into a 100 mL beaker and 80 mL of 95% ethanol was added, stirred with a glass rod to prevent lumping, filtered into a 100 mL volumetric flask and made up to the mark with ethanol. Also, 1 mL of the extract was pipetted into a 50 mL volumetric flask and four drops of concentrated hydrochloric acid was added via a dropping pipette after which 0.5 g of magnesium turnings was added to develop a magenta red colouration. Standard flavonoid solution which ranged from 0 to 5 ppm were prepared from 100 ppm stock solution and treated similarly with HCl and magnesium turnings like the sample. The absorbance of magenta red coloration of sample and standard solutions were read on a digital Jenway V6300 Spectrophotometer at a wavelength of 520 nm. The percentage flavonoid was calculated using the formula;

$$\text{Flavonoids} = \frac{\text{Absorbance of sample X average gradient factor X dilution factor}}{\text{Wt. of sample X } 10000}$$

Saponins: One gram (1 g) of finely ground sample was weighed into a 250 mL beaker and 100 mL of isobutyl alcohol was added. The mixture was shaken on a UDY shaker for 5 h to ensure uniform mixing. Thereafter, the mixture was filtered through a Whatman No.1 filter paper into a 100 mL beaker and 20 mL of 40% saturated solution of magnesium carbonate was added. The mixture obtained with saturated Magnesium carbonate was again filtered to obtain a clear colourless solution. One (1 mL) of the colourless solution was pipetted into 50 mL volumetric flask and 2 mL of 5% Iron (III) chloride solution was added and made up to the mark with distilled water. The mixture was allowed to stand for 30 min for blood red colour to develop. 0-10 ppm standard Saponin solutions were prepared from the saponin stock solution. The standard solutions were treated similarly with 2 mL of 5% Iron (III) chloride solution as done for 1 mL sample above after which absorbance of the sample and standard saponin solutions were read after colour development in a Jenway V6300 Spectrophotometer at 380 nm.

$$\% \text{ Saponin} = \frac{\text{Absorbance of sample X gradient factor X dilution factor}}{\text{Wt. of sample X } 10000}$$

Steroids: One gram (1 g) of the sample was weighed into a 100 mL beaker and 20 mL of chloroform-methanol (2:1) mixture was added to dissolve the extract after which the mixture was filtered into another 100 mL conical flask. The resultant residue was repeatedly treated with chloroform-methanol mixture until free of steroids. One (1 mL) of the filtrate was pipetted into a 30 mL test tube and 5 mL of alcoholic potassium hydroxide was added and shaken thoroughly to

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obtain a homogenous mixture. The mixture was later placed in a water bath set at 37°C-40°C for 90 min, cooled to room temperature and 10 mL of petroleum ether was added followed by the addition of 5 mL distilled water and later evaporated to dryness on the water bath. Six millilitres (6 mL) of Liebermann Burchard reagent was added to the residue in a dry bottle and absorbance was measured at a wavelength of 620 nm on a Spectronic 21D digital Spectrophotometer. Standard Steroids of concentration of 0-4 mg/mL were prepared from 100 mg/mL stock steroid solution and treated similarly like the sample above.

$$\text{Steroids} = \frac{\text{Absorbance of Sample X Gradient X Dilufion Factor}}{\text{Wt of sample x10000}}$$

Anthocyanins: One gram (1 g) of the sample was blended in a blender with 75 mL (methanol: water: acetic acid) (25:24:1) mixture to extract anthocyanin. The extract was then centrifuged at 12,000 rpm for 20 min at 15°C. The residue remaining was mixed thoroughly with the 75 mL of rnethanol/water/acetic acid mixture. The extraction was repeated thrice. The three extracts were pulled together into a 250 mL beaker to evaporate to dryness in a rotary evaporator. The residue obtained was re-dissolved in 10 mL 15% methanol and 85% of 5% (w/v) formic acid solution. This extract was diluted to 250 mL with 135 mL of a mixture of methanol/0.1 M HC1 at ratio of 85:15. Working standard solutions of anthocyanin of range 0-10 mg/mL were prepared from stock 50 mg/mL anthocyanin solution and treated like sample above. Absorbances of sample extracts as well as anthocyanin working standard solutions were read at a wavelength of 535 nm on a UV Spectronic 21D Spectrophotometer.

$$\%\ \text{Total Anthocyanin} = \frac{\text{Absorbance of sample X gradient X Dilution Factor}}{10{,}000}$$

Phenols: 0.20 g of the sample was weighed into a 50 mL beaker, 20 mL of acetone was added and homogenized properly for 1 h to prevent lumping. The mixture was filtered into a 100 mL volumetric flask using acetone to rinse and made up to mark with distilled water. One (1 mL) of sample extract was pipetted into a 50 mL volumetric flask, 20 mL water added, 3 mL of phosphomolybdic acid added followed by the addition of 5 mL of 23% sodium carbonate and mixed thoroughly, made up to the mark with distilled water and allowed to stand for 10 min to develop bluish-green colour. Standard Phenol of concentration range 0-10 mg/mL was prepared from 100 mg/L stock phenol solution from Sigma-Aldrich chemicals, U.S.A. The absorbance of the sample and standard concentrations of phenol was read on a Digital Spectrophotometer at a wavelength of 510 nm. The percentage phenol was calculated using the formula;

$$\%\ \text{Phenol} = \frac{\text{Absorbance of sample X gradient factor X dilution factor}}{\text{Weight of the of sample X 10,000}}$$

Statistical analysis

Data obtained were analysed using the statistical analysis system. One way analysis of variance (ANOVA) was conducted to determine the significant difference between parameters. Means were separated using Duncan's Multiple Range Test at $p < 0.05$.

Results and Discussion

Results revealed that crude fibre (16.91 ± 0.05 mg/100 g) and ash (6.41 ± 0.01 mg/100 g) were significantly ($p < 0.05$) higher in *S. stenocarpa* seeds than *C. cajan*, and *P. lunatus* seeds. Similar observations were noticed in the values of fats (1.46 ± 0.01 mg/100 g) and moisture (12.71 ± 0.02 mg/100 g) recorded in *C. cajan* seeds. In the same vein, crude protein (26.93 ± 0.04 mg/100 g) and total nitrogen (4.31 ± 0.01 mg/100 g) were also significantly higher ($P < 0.05$) in *P. lunatus* seeds (Table 1).

A significant difference ($p < 0.05$) was also observed in the number of minerals determined in the seeds of the three plants. Potassium (1393.07 ± 1.53 mg/100 g), phosphorus (396.71 ± 0.49 mg/100 g), and zinc (2.77 ± 0.01 mg/100 g) were significantly higher ($P < 0.05$) in *C. cajan* seeds than values of such minerals determined in the seeds of the other two beans studied. Also, iron (6.44 ± 0.02 mg/100 g), magnesium (189.77 ± 0.06 mg/100 g) and copper (2.33 ± 0.01 mg/100 g) were significantly ($p < 0.05$) higher in *S. stenocarpa* seeds than *C. cajan*, and *P. lunatus* seeds (Table 2).

A high amount of proximate contents recorded in *S. stenocarpa* and mineral content in *C. cajan* indicate that beans of the two plants are potential sources of nutrients despite the neglect or under-utilization of the beans. Also, the appreciable amount of nutritional index recorded could be the basis of consuming the beans. [15-16] Studies of Baiyeri *et al.*, [4]revealed that legumes such as African yam bean are potential sources of protein and carbohydrate required for the enhancement of the body physiological process and serve as the cheap nutritional alternative for many nutritional deficient individuals. Furthermore, utilization of these legumes by the humans may help to achieve the targeted daily dietary protein intake recommended by the World Health Organization especially in developing nations such as Nigeria. A high quantity of nutritional contents recorded in this study may be contributions of the beans towards the attainment of sustainable food security in terms of nutritional quality being clamored by the poor.

Results also revealed that vitamin A (0.11 ± 0.00 mg/100 g), Vitamin B (0.65 ± 0.00 mg/100 g) and vitamin C (23.73 ± 0.02 mg/100 g) were significantly ($p < 0.05$) higher in *S. stenocarpa*, *C. cajan* and *P. lunatus* seeds. The appreciable amount of vitamins recorded in these beans may be responsible for the acclaimed roles of the beans such as the provision of normal vision, cell development, gene expression, growth and maintenance of epithelial cell .[16a,17,18] Also, this result is in agreement with findings of Oladejo [19] cited in [20b-21] who reported a high concentration of vitamins and mineral elements in five lima accessions.

The level of anti-nutrients observed in the seeds of the beans investigated revealed that *P. lunatus* seeds contained higher proportion of tannins (2.72 ± 0.02 mg/100 g), oxalate (0.89 ± 0.00 mg/100 g) and phytate (0.93 ± 0.00 mg/100 g) compared with *S. stenocarpa* and *C. cajan* seeds while higher trypsin inhibitors (3.47 ± 0.00 mg/100 g) was recorded in *S. stenocarpa* seeds (Table 4). The anti-nutrients recorded in this study are below that reported by Taofeek *et al.*,.[22] This observation may indicate that the beans are nutritionally safe for consumption. Also, Taofeek *et al.*,[22] opined that anti-nutrients such as tannins, oxalate and trypsin inhibitor are nutritionally disadvantageous when consumed in excess as they form strong insoluble complexes with proteins and divalent metals which result in poor digestion and palatability in humans and animal.[24-26] Studies had revealed that excessive consumption of anti-nutrients had an adverse effect on the health status of humans and as well as useful defensive mechanism for plants against herbivours.[23]

Also, results revealed that *P. lunatus* contained a significant amount of most phytochemicals than *S. stenocarpa* and *C. cajan* seeds (Table 5). Results of this investigation based on the number of phytochemical contents recorded in the beans inform that the beans could be used not only as food but as the basis of the discovery of drugs.[27-30]

Table 1: Proximate composition of *Cajanus cajan*, *Sphenostylisstenocarpa*, and *Phaseolus lunatus* seeds

Beans names	Proximate composition (mg/100 g)						
	Crude fibre	Crude protein	Fat	Ash	Moisture	Carbohydrate	Total nitrogen
Cajanus cajan	14.86±0.01^{b}	22.42 ± 0.34^{c}	1.46 ± 0.01^{a}	5.37 ± 0.01^{c}	12.71 ± 0.02^{a}	57.27 ± 0.19^{a}	3.62 ± 0.00^{c}
Sphenostylis stenocarpa	16.91 ± 0.05^{a}	23.67 ± 0.17^{b}	1.18 ± 0.01^{b}	6.41 ± 0.01^{a}	11.47 ± 0.01^{b}	58.04 ± 0.37^{a}	3.75 ± 0.00^{b}
Phaseolus lunatus	14.96 ± 0.01^{b}	26.93 ± 0.04^{a}	0.89 ± 0.01^{c}	5.91 ± 0.01^{b}	10.89 ±0.02^{c}	55.38 ± 0.07^{b}	4.31 ± 0.01^{a}

Values are Means ± standard error of mean with different superscripts in columns are significantly different using Duncan Multiple Range Test at $P < 0.05$.

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Table 2: Mineral composition of *Cajanus cajan, Sphenostylisstenocarpa,* and *Phaseolus lunatus* seeds

Beans names	Mineral composition (mg/100g)							
	Sodium	Potassium	Calcium	Phosphorus	Iron	Magnesium	Zinc	Copper
Cajanus cajan	14.47 ± 0.05^{b}	1393.07 ± 1.53^{a}	131.88 ± 0.75^{a}	396.71 ± 0.49^{a}	5.27±0.01^{b}	184.6 ± 0.81^{b}	2.77 ± 0.01^{a}	2.14 ± 0.01^{c}
Sphenostylis stenocarpa	15.82 ± 0.01^{a}	1243 ± 1.7^{b}	133.34 ± 0.37^{a}	3 65.76 ± 0.82^{b}	6.44 ± 0.02^{a}	189.77 ± 0.06^{a}	2.71 ± 0.01^{b}	2.33 ± 0.01^{a}
Phaseolus lunatus	8.45 ± 0.03^{c}	468.92 ± 0.01^{c}	34.66 ± 0.08^{b}	136.20 ± 0.12^{c}	3.18 ±4 0.01^{c}	59.36 ± 0.39^{c}	0.83 ± 0.03^{c}	2.21 ± 0.01^{b}

Values are Means ± standard error of mean with different superscripts in columns are significantly different using Duncan Multiple Range Test at $P < 0.05$.

Table 3: Vitamin composition of *Cajanus cajan, Sphenostylis stenocarpa,* and *Phaseolus lunatus* seeds

Plants	Vitamin composition (mg/100 g)		
	Vitamin A	Vitamin B (Niacin)	Vitamin C
Cajanus cajan,	0.02 ± 0.01^{b}	0.65 ± 0.00^{a}	2.13 ± 0.00^{c}
Sphenostylisstenocarpa	0.11 ± 0.00^{a}	0.62 ± 0.00^{b}	4.84 ± 0.01^{b}
Phaseolus lunatus	0.03 ± 0.00^{b}	0.22 ± 0.00^{c}	23.73 ± 0.02^{a}

Values are Means ± standard error of mean with different superscripts in columns are significantly different using Duncan Multiple Range Test at $P < 0.05$.

Table 4: Anti nutrient composition ofCajanus cajan, Sphenostylisstenocarpa, and Phaseolus lunatus seeds

Legume	Anti-nutrient composition (mg/100g)			
	Tannin	Oxalate	Phytate	Trypsin inhibitor
Cajanus cajan	1.43 ± 0.00^{c}	0.68 ± 0.00^{c}	0.78 ± 0.00^{b}	2.64 ± 0.00^{c}
Sphenostylisstenocarpa	2.64 ± 0.00^{b}	0.79 ± 0.00^{b}	0.90 ± 0.00^{a}	3.47 ± 0.00^{a}
Phaseolus lunatus	2.72 ± 0.02^{a}	0.89 ± 0.00^{a}	0.93 ± 0.00^{a}	3.37 ± 0.00^{b}

Means ± standard error of means with different superscripts in columns are significantly different using Duncan Multiple Range Test at $P < 0.05$

Table 5: Phytochemical contents of *Cajanus cajan, Sphenosty lisstenocarpa,* and *Phaseolus lunatus* seeds

Legumes	Phytochemical composition (mg/100g)					
	Alkaloids	Anthocyanins	Flavonoids	Phenols	Saponins	Steroids
Cajanus cajan	11.79 ± 0.00^{c}	0.14 ± 0.00a	1.24 ± 0.00^{c}	1.24 ± 0.00^{c}	2.33 ± 0.01^{a}	0.13 ± 0.00^{c}
Sphenostylis stenocarpa	12.24 ± 0.00^{b}	0.16 ± 0.00^{a}	1.47 ± 0.00^{b}	2.40 ± 0.00^{b}	2.22 ± 0.00^{b}	0.24 ± 0.00^{b}
Phaseolus lunatus	14.04 ± 0.01^{a}	0.15 ± 0.00a	1.59 ± 0.00^{a}	2.44 ± 0.00^{a}	2.32 ± 0.00^{a}	0.42 ± 0.00^{a}

Values are Means ± standard error of means with different superscripts in columns are significantly different using Duncan Multiple Range Test at $P < 0.05$.

Conclusion

The study revealed that *C. cajan, S. stenocarpa, P. lunatus* beans contained appreciable amount of nutritional and phytochemical contents despite the underutilization of the beans. Also, the beans are potential sources of nutritional and phytochemical contents; therefore, people are encouraged to incorporate the beans into their diets.

Conflict of interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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