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BioFunctional Properties and Nutrient Components of Common Nigerian Cowpea Accessions

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ABSTRACT

Various cowpea varieties are grown in Nigeria, each possessing distinct characteristics and potential nutritional properties. Four most consumed cowpea varieties in Nigeria namely Drum (big and small), Oloyin, Sokoto white (big and small) were characterized based on their biofunctional properties and nutrients composition. The biofunctional properties examined were rate of water absorption, water absorption capacity and swelling capacity. Anti-nutrients, mineral nutrients, proximate composition, saturated fatty acid and essential amino acids of the seeds of the cowpea varieties were determined using standard procedures. The result showed that cowpea varieties which were rough and wrinkle (Drum - small and big) were loosely attached to the cotyledons, while the seed coat of cowpea which were smooth and wrinkle remain moderately firm and intact. Drum (big) variety had highest Rate of Water Absorption and Water Absorption Capacity, Sokoto white (big) had the highest Swelling Content. Antinutrients (alkaloid, tannin, total soluble sugar, and ascorbic acid) and most of the saturated fatty acid content were observed to be present in larger amount in the Oloyin variety. Highest mineral elements were obtained in Drum (big) and Sokoto white (small) varieties. Protein, carbohydrate, fats, ash and crude fibre were more in Sokoto white (small) variety. Sokoto white (big) had the highest arginine and leucine contents while Drum (big) had the highest lysine, tryptophan and phenylalanine contents. Biofunctional properties and nutrients composition varied considerably among different varieties of cowpeas, thus, the choice of the cowpea seeds to consume between the varieties is dependent on the actual nutrient being sourced for.

Keywords: Antinutrients; Essential Amino Acids; Mineral Nutrients; Proximate Composition; Saturated Fatty Acid; *Vigna unguiculata*.

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1. Introduction

Cowpea (*Vignaun guiculata* L. Walp) is a dicotyledonous plant which belongs to the family Leguminosae, subfamily Faboideae, tribe Phaseoleae, genus Vigna, subgenus Ceratotropisand species unguiculata [1]. It is one of the extensively grown crops in the lowlands and mid-altitude regions of Africa sometimes as the sole crop but more often intercropped with cereals such as sorghum and millet. Cowpea is the most indigenous grain legume in Nigeria and is a valuable crop due to its nutritional composition and multiple uses. It is an important item in the diet of most Africans and Nigerians in particular. It is a rich source of plant protein [2], containing about 25<10 protein, at present, more than 70% of the world cowpea production is concentrated in three countries -Nigeria, Brazil and Niger [3].

Cowpea plays an important role in both human and animal nutrition [4, 5, 6]. It is often referred to as poor man's meat due to the high levels of protein found in the seeds and leaves. Cowpea seeds provide a rich source of proteins and food energy, as well as minerals and vitamins. This complements the mainly cereal diet in countries that grow cowpeas as a major food crop. A seed can consist of 25% protein and has very low-fat content. Cowpea starch is digested more slowly than the starch from cereals, which is more beneficial to human health. The grain is a rich source of folic acid, an important vitamin that helps prevent neural tube defects in unborn babies. It is deficient in methionine and cystine when compared to animal protein, but additionally contain lysine, a supplement that is moderately lacking in most stable weight control plans [7]. This makes them a decent supplement to maize, rice, vegetables, banana, cassava or potatoes to give a fair eating routine [7]. However, it does contain some antinutritional elements, notable phytic acid and protease inhibitors, which reduce the nutritional value of the crop. The young leaves, green pods and green seeds of Cowpea are eaten as vegetables whereas dry seeds are used in a variety of food preparations. The haulms are also very nutritious, containing about 15 to 17% protein, which is highly digestible and useful as a fodder for livestock [8, 9, 10]. It also has the useful ability to fix atmospheric nitrogen through its root nodules, and ascertained to grow well in poor soils [5].

There are lots of food crops with promising nutritional properties that are very much unexploited in Nigeria [11]. Although this is not the case in most leguminous plant like the cowpea. Studies have shown that legumes are staple foods for a large number of persons in different parts of the world and the seeds have an average of twice as much protein as cereals by percentage and usually contain more balanced profile of essential amino acids [5, 11]. They range from lesser-known ones like Sphenostylis stenocarpa, Mucuna cochinchinensis and Mucuna flagellipes to the highly utilized legumes such as Glycine max, Arachis hypogaea, and Vigna unguiculata. Various cowpea varieties are grown in Nigeria, each possessing distinct characteristics and potential nutritional properties [12]. Common cowpea accessions grown and consumed in Nigeria are drum, Sokoto white and oloyin. There is usually a misconception in the nutrient constituents of these varieties of cowpea. Some eaters in Nigeria believe that either one of the accessions drum, Sokoto white and oloyin is more nutritious and thus preferable, while others think otherwise. The study on the functional properties and nutritional components between these accessions is lacking. Thus, this current study is aimed at bridging this gap by providing information on the various morphological features as well as documenting their nutrients composition.

2. Materials and Methods

2.1 Plant source and identification

Cowpea seeds of Drum (small and big varieties), Oloyin and Sokoto white (small and big varieties) were utilized for this study. These seeds were collected from the Department of Crop Production and Protection, Faculty of Agriculture, Obafemi Awolowo University Ile-Ife, Nigeria. The seeds were collected in plastic zip lock bags, washed severally with running tap water and then washed twice with distilled water in the laboratory. Thereafter, the seeds were stored in airtight bags at room temperature for further studies.

2.2 Determination of Functional Properties of the Seeds

2.2.1 The texture and degree of attachment of seed coat

The texture and degree of attachment of seed coat to the cotyledons were determined as described by the methods of [13]. The seed textures were checked using a hand lens in order to determine its rough, smooth or wrinkle surface. Thereafter, the seeds were scratched with finger nails to check for attachment of seed coat to the cotyledons. The attachment of seed coat to the cotyledons was further checked by soaking the seeds in cold water for 24 h. After 24 h of soaking, the seeds were carefully washed with tap water and examined. A peeled seed coat was termed loosed, while unpeeled is seed coat was termed firmed.

2.2.2 Determination of Water Absorption and Swelling Capacity of the Seed

Water Absorption Capacity and Swelling Capacity of the seeds were determined as described by [14]. Twenty seeds from each accession of the same size and shape were first weighed using Sartorius analytical balance (Tecator 6110 balance). Thereafter, the seeds were soaked in 20 mL of tap water for 24 h to allow for water imbibition. The seeds were then removed and weighed again. Both the initial and final weights were recorded. Water Absorption and Swelling Capacity of the seeds were determined using the below formula:

Water Absorption Capacity= Final Weight (after seed soaking) – Initial Weight
Swelling Capacity=(Final Weight (after seed soaking) – Initial Weight)/(24 h)
Rate of Water Absorption=(Final Weight (after seed soaking) – Initial Weight)/(24 h) ×100

2.3 Determination of Mineral Nutrient Composition

One g of crushed seeds samples of each of the cowpea varieties were placed in separate crucibles and then ashed in a muffle furnace at a high temperature of 550 oC for 5 hrs after which they were transferred to a desiccator to allow them cool down. The ashed samples weredissolved in 1 mL nitric acid (HNO3) and 1 mL hydrochloric acid HCl and then made up to 100 mL [15]. The resulting sample extracts were analyzed for nutrient concentrations using chemical titrations, flame photometry and other standard analytical methods as appropriate [15]. Sodium (Na) and Potassium (K) contents were analyzed by flame atomic emission spectrophotometer. Phosphorus (P) was determined with Jenway 6100 spectrophotometer at 420 nm using Vanadium Phosphomolybdate (vanadate) colorimetric method with KH2P04 as the standard. The concentrations of calcium (Ca), magnesium (Mg), Iron (Fe), Manganese (Mn) and Zinc (Zn) in the solutions were determined using Atomic Absorption Spectrophotometer (AAS 969 Bulk Scientific, MODEL VGB 210/211) [15].

2.4 Determination of Antinutrients

2.4.1 Determination of Tannin content

Tannin content was determined spectrophotometrically by the acidified vanillin method of [16], as modified by [15] using tannic acid as the tannin standard. Approximately 2 g sample was extracted in 10 ml 0.1% acidified (HCl) methanol in a capped tube at 24 oC within 20 min of continuous shaking using a wrist-action shaker (model 75, Burrell Corp. at position 6). The mixture was centrifuged at 17,000 revolutions for 10 min. Therafter, 5 mL 2% vanillin-HCl reagent (2 g vanillin was dissolved in 100 ml 4% acidified methanol) was added to 1 mL of extract supernatant and the mixture was vortexed for 30 min. After standing for 20 min, absorbance was read at 500 nm. A standard curve was also prepared using tannic acid.

2.4.2 Determination of Vitamin C (Ascorbic Acid)

10 g of the sample slurry of each of the cowpea varieties was weighed into a 100mL volumetric flask and diluted to 100mL with 3% metaphosphoric acid solution (0.0033M EDTA). The diluted samples were filtered using a Whatman Filter Paper No. 3. 10mL of the filtrate was pipetted into a small flask and titrated against a standardized solution of 2.6 dichlorophenol-in-dophenol to a faint pink end point. The ascorbic acid content of the seeds was calculated using the formula below:

Ascorbic acid content=(V x TW)/(W) x 100, where V = volume (mL) of dye used for titration of aliquot of diluted sample; T = ascorbic acid equivalent of dye solution expressed as mg per ml of dye andW = Weight in gram of sample in aliquot titrated.

2.4.3 Flavonoids Determination

0.50 g of finely ground sample of each of the seeds of cowpea varieties was weighed into a 100 mL beaker, 80 mL of 95% Ethanol was added and the mixture was stirred with a glass rod to prevent lumping. The mixture was filtered through a Whatman No.1. filter paper into a 100 mL volumetric flask and made up to mark with Ethanol. 1mL of the extract was pipetted into 50mL volumetric flask to which four drops of Conc. HCl added via a dropping pipette. 1 g crushed seeds of each of cowpea varieties was weighed into a graduated clean dry beaker; 10 mL of distilled water was measured into the sample and stir, 15 mL of 52 % perchloric acid was added and stir frequently for about 30 min with a glass rod, the glass rod was rinsed with distilled water to make a dilution which was made up to 100 mL.The mixture was then stirred and filtered into a graduated 250 ml flask using Whatman's filter paper No. 1, The tubes were placed in a boiling water bath for 12 min. It was allowed to cool to a room temp and the absorbance was read at 650 nm.

2.5 Determination of Proximate Composition

2.5.1 Determination of ash content

The determination of inorganic substances as residue after ignition of the samples at a specific temperature is the basis of ashing [15]. Two grams of milled flour of seeds of cowpea varieties was weighed into a clean pre-weighed porcelain crucible and pre-ashed by charring on a hot plate inside a fume hood until all the dark fumes were eliminated. The sample was then transferred into a pre-heated muffle furnace at 600 oC and ashed for 6 hours. The ash content was calculated as follows: % Ash = (Weight of crucible + ash – Weight of empty crucible)/(Weight of sample) x 100

2.5.2 Determination of protein content

0.25 g sample was weighed into a Hach digestion flask and 4 ml of conc. H2SO4 was added. The sample was transferred to the fume hood and heated for 5 minutes at 440 oC. To the charred sample was added 16 mL of H2O2 to clear off the brown fumes and make the digest colorless. The H2O2 was boiled off by heating for one more minute. The flask was taken off the heater, allowed to cool and the content made up to the 100 ml mark with deionized water and mixed. To 1 mL of the digest, 3 drops of mineral stabilizer was added and 3 drops of polyvinyl alcohol dispersing agent. It was mixed, made up to 25 mL and 1 mL of Nessler‟s reagent was added. The resulting color was read within 5 minutes at 460 nm on the Hach spectrophotometer against deionized water blank. The absorbance gives mg/L apparent Nitrogen. The true Kjeldahl nitrogen was then calculated as follows: % N = 0.0075 x A B x C

Where A = mg/l (reading displayed); B = weight (mg) of sample digested and C = volume (in mL) of digest analyzed.

% Protein = % N x 6.25

2.5.3 Determination of crude fiber content

The method of [15] was used. To 1 g of defatted sample in a digestion beaker was added 100 mL of TCA digestion reagent. This was placed on the heating unit of digester and water supply was opened to reflux condenser. The mixture was brought to boiling and refluxed for exactly 40 minutes counting from the time boiling commenced. The beaker was removed from the heater, cooled a little bit and filtered through Whatman No.4 (15 cm in diameter) filter paper. The residue was washed six times with hot water, once with industrial spirit and transferred to apreviously ignited and pre-weighed dish. The residue was dried overnight in an oven at 105 ºC, transferred to a desiccator and weighed after cooling. It was ashed in a muffle furnace at 600 ºC for 6 hours, allowed to cool and re-weighed. The crude fiber content was calculated as follows: % Crude fiber = Loss in weight on ashing x 100

2.5.4 Determination of crude fat content

The methods of [13] were used. Dried and ground sample weighing about 2-3 g of each of the seeds of cowpea varieties was loaded into different thimbles and plugged with cotton wool. To the dried and weighed extraction cups containing boiling chips, 25-50 mL of the solvent was added into each cup and inserted into the Soxtec HT and extracted for 15 min in boiling position and for 30-45 mins in "Rinsing "position. The solvent was afterwards evaporated and the cups were released and dried at 100 ºC for 30 min. Cups were allowed to cool in a desiccator and then weighed.

Weight of the cup with the extracted oil = W3. Weight of the empty cup = W2

Weight of sample % fat/oil = ((W3 – W2))/W1 x 100

2.6 Determination of Fatty Acids Composition

Cowpea samples were mixed sufficiently to obtain the triacylglycerol (fat) and fatty acids using vortex [15]. It was methylated to fatty acid methyl ester using methanol. 5 mL of 5% (w/v) methanolic sodium methoxide solution was added to each tube and vortex for 10 seconds. It was allowed to stay for 180 seconds (time starts when sodium methoxide is added) before adding 2 mL of hexane. It was allowed to stand for 210 seconds and 10 mL of neutralization solution (10% disodium hydrogen citrate/15% sodium chloride in water) was added. It was gently shaken using vortex mixer and the mixture centrifuged at 1750 rpm for 5 min. It was then subjected to AOAC Method 2012.13 using a 100 m SP-2560 that identified the fatty acids of choice, and quantified the total fatty acid content of choice.

2.7 Determination of Essential Amino Acids

The protein content of each of the cowpea accessions was determined according to the Association of Official Agricultural Chemists (AOAC) International method 954.01[15]. The results are presented as grams of protein per hundred grams of sample dry weight (g/100 g dw). For amino acids quantifications, the cowpea seeds were hydrolyzed in 6 M HCl for 24 h at 110 °C in the presence of Phenol, 3,3′-dithiodipropionic acid (DDP), and Norvaline (Nva). Phenol was added to prevent halogenation of tyrosine. Nva was added as a major internal standard. Cystine and cysteine derivatives were first converted to S-2-carboxyethylthiocysteine (XCys) by DDP. After hydrolysis and neutralization, amino acids and XCys are derivatized with 6-aminoquinolyl-N-hydroxysuccinimidyl carbamate (AQC). Derivatized AAs are separated using reversed phase UHPLC with UV detection at 260 nm. The same thing is repeated for leucine and lysine at 100 °C and 90 °C respectively before passing through the same final process using changing excitation, 202 nm; emission, 296 nm for 5.0 min (for tramadol with retention). During acid hydrolysis, asparagine is converted to arginine and phenylalanine respectively. Thus, the values represent the combined values of the two at different temperatures 10 °C. Tryptophan is degraded by acid hydrolysis and can be analyzed by addition of NaOH before taking the spectrophotometric reading.

2.8 Statistical Analysis

The data obtained for the functional properties, mineral and proximate compositions, antinutrients, fatty acid and essential amino acids for each accession were subjected to one way ANOVA using Statistical Analytical Software (SAS) version 9.2. Results obtained were presented using descriptive and inferential statistics on tables. All the analyses were carried out at 5% level of significance with $p \leq 0.05$.

3.Results and Discussion

3.1 BioFunctional Properties of Common Nigerian Cowpea

The biofunctional property of the common Nigerian cowpea accessions is shown on (Table 1). The attachments of the seed coats of all the cowpea accessions to the cotyledon were firm. After soaking for 24 hours, the attachment of the seed coat to the cotyledon was moderate in the Sokoto white (small and big) and Oloyin accession, and loose in the Drum accession. The seeds of both the big and small Drum accessions have the highest Rate of Water Absorption and the least was observed in the seeds of Sokoto white (big). Water Absorption Capacity was found to be highest in the seeds of Drum (big) and lowest in Sokoto white (small) as well as the Drum (small) accession variety. The seeds of Sokoto white (big) had the highest Swelling Capacity while the seeds of Sokoto white (small) had the lowest. A significant difference ($p \leq 0.05$) was observed in the Rate of Water Absorption, Water Absorption Capacity and Swelling Content among the cowpea accessions.

Table 1.BioFunctional Properties of Common Nigerian Cowpea

Accessions	Attachment to the cotyledon	After 24 hours soaking	Rate of water absorption	Water absorption capacity	Swelling capacity
SokotoWhite(small)	Firm	Moderate	0.34^{b}	0.31^{d}	0.30^{d}
Oloyin	Firm	Moderate	0.31^{c}	0.35^{c}	0.34^{c}
Drum (big)	Firm	Loose	0.45^{a}	0.51^{a}	0.45^{b}
Drum (small)	Firm	Loose	0.45^{a}	0.31^{d}	0.30^{d}
Sokoto white (big)	Firm	Moderate	0.30^{d}	0.45^{b}	0.48^{a}
$LSD_{0.05}$			14E-10	3E-8	63E-11

Means with the same letter along the same column are not significantly different at $p \leq 0.05$

3.2 Mineral Nutrients of Common Nigerian Cowpea

The content of Phosphorus (P), Potassium (K) and Sodium (Na) were highest in Drum (big) accession compared to other accessions. The highest content of Calcium (Ca) was obtained in Drum (small) variety, Magnesium (mg) content in seeds of Sokoto white (small), while the seeds of Sokoto white (big) has the highest Iron (Fe) content. The lowest P, Ca and Mg was recorded in Sokoto white (big), K in Sokoto white (small) and Fe in Drum (small) variety. There was significant difference ($p \leq 0.05$) in the mineral content among the cowpea accessions (Table 2).

Table 2. Mineral Nutrients of Common Nigerian Cowpea

Accessions	P	K	Na	Ca	Mg	Fe
Sokoto White(small)	21.21^{a}	4.53^{e}	2.66^{e}	2.00^{b}	0.96^{a}	2.73^{b}
Oloyin	37.60^{b}	5.23^{b}	3.13^{b}	2.24^{c}	1.16^{c}	2.14^{d}
Drum (big)	39.00^{c}	5.46^{a}	3.35^{a}	2.79^{d}	1.24^{d}	2.36^{c}
Drum(small)	35.05^{d}	5.13^{c}	3.02^{c}	2.14^{a}	1.06^{b}	1.13^{e}
Sokoto white (big)	24.32^{e}	5.12^{d}	2.78^{d}	2.46^{e}	1.28^{e}	3.58^{a}
$LSD_{0.05}$	0.00	0.00	1E-8	0.00	0.00	28E-9

Means with the same letter along the same column are not significantly different at $p \leq 0.05$

3.3 Antinutrients of Common Nigerian Cowpea

From the results of the analysis conducted, high proportion of antinutrients such as alkaloids, phenol, saponin, tannin, total soluble sugar and ascorbic acid (Vitamin C) was recorded in all the seeds of the cowpea accessions. The results revealed a significant difference ($p \leq 0.05$) in the antinutrients among the cowpea accession. The highest amounts of alkaloids, tannin, total soluble sugar and ascorbic acid (Vitamin C) were obtained in Oloyin variety; highest phenol content was recorded in Drum (big) variety while highest saponin content was recorded in Sokoto small variety. The minimum amounts of Alkaloids, Phenol, Saponin, Tannin and Ascorbic acid (Vitamin C) were recorded in Drum (small) variety. The lowest amount of Total soluble sugar was obtained in Sokoto big variety (Table 3).

Table 3. Antinutrients of Common Nigerian Cowpea

Accessions	Alkaloids	Phenol	Saponin	Tannin	Total soluble sugar	Ascorbic acid (vitamin)
Sokoto White (small)	1.01^{d}	0.41^{c}	0.90^{a}	2.22^{e}	2.68^{d}	0.74^{c}
Oloyin	1.44^{a}	0.48^{b}	0.11^{c}	6.16^{a}	9.98^{a}	2.20^{a}
Drum (big)	1.38^{b}	0.52^{a}	0.23^{b}	3.33^{c}	4.34^{b}	1.22^{b}
Drum(small)	0.87^{e}	0.34^{d}	0.08^{d}	2.31^{d}	3.44^{c}	0.54^{d}
Sokoto white (big)	1.29^{c}	0.54^{a}	0.20^{b}	4.90^{b}	2.49^{e}	0.26^{e}
$LSD_{0.05}$	0.0217	0.0217	0.0555	2E-8	0.00	0.00

Means with the same letter along the same column are not significantly different at $p \leq 0.05$

3.4 Proximate Composition of Common Nigerian Cowpea

From the result obtained on the proximate composition of common Nigerian Cowpea, percentage protein, fat and carbohydrate contents were found to be higher in the seeds of Sokoto white(big); the seeds of Oloyin had the highest Crude fibre;, while ash content was highest in the seeds of Sokoto white (small) variety. The lowest percentage content of protein, carbohydrate, fat and crude fibre were obtained in Sokoto white (small), while and the least percentage ash content was recorded in the Oloyin variety. Significant difference ($p \leq 0.05$) was observed in the percentage protein, fat, crude fibre, carbohydrate composition and ash content among the cowpea varieties (Table 4).

Table 4.Proximate Composition of Common Nigerian Cowpea

Accessions	Protein	Fat	Carbohydrates	Crude fibre	Ash
Sokoto small	17.23^{e}	0.43^{c}	5.04^{d}	4.37^{e}	3.03^{a}
Oloyin	19.82^{c}	0.75^{b}	5.10^{c}	5.30^{a}	1.88^{e}
Drum big	21.67^{b}	0.63^{c}	5.22^{b}	4.67^{d}	2.53^{b}
Drum small	17.55^{d}	0.54^{d}	5.08^{cd}	4.76^{c}	2.01^{d}
Sokoto big	23.08^{a}	0.87^{a}	5.35^{a}	4.94^{b}	2.33^{c}
LSD	0.00	0.445	0.0434	0.0485	98E-10

Means with the same letter along the same column are not significantly different at $p \leq 0.05$

3.5 Fatty acid Composition of Common Nigerian Cowpea

All the cowpea accessions have appreciable amounts of fatty acid such as Linoleic acid, Stearic acid, Oleic acid and Palmitic acid. The results obtained for the contents of these fatty acids of the cowpea varieties revealed that Linoleic acid, Stearic acid and Oleic acid were found to be highest in the seeds of Oloyin variety,Palmitic acid was observed to be highest in the seeds of Drum (big) variety. The contents of Linoleic acid and Stearic acid were found to be lowest in Drum (small) variety; Oleic acid content was lowest in Sokoto white (small) while the least content of Palmitic acid was observed to be lowest in the seeds of the Oloyin variety. The contents of Linoleic acid, Stearic acid,Oleic acidand Palmitic acid among the cowpea was observed to be significantly different ($p \leq 0.05$) (Table 5).

Table 5.Fatty acid Composition of Common Nigerian Cowpea

Accessions	Linoleic acid	Stearic acid	Oleic acid	Palmitic acid
Sokoto small	36.12^{b}	2.46^{d}	2.56^{c}	0.13^{d}
Oloyin	38.58^{a}	3.89^{a}	6.15^{a}	0.11^{e}
Drum big	34.60^{c}	3.46^{b}	4.47^{c}	0.43^{a}
Drum small	26.88^{e}	2.05^{e}	3.32^{d}	0.14^{c}
Sokoto big	32.70^{d}	2.81^{c}	3.44^{b}	0.15^{b}
LSD	0.00	1E-8	0.0099	0.0034

Means with the same letter along the same column are not significantly different at $p \leq 0.05$

3.6 Essential amino acid Composition of Common Nigerian Cowpea

The composition of essential amino acids such as Arginine, Lysine, Leucine, Tryptophan and Phenylalanine varies among the cowpea varieties. The content of Arginine among the cowpea varieties ranged from 2.44 µg/mL in the seeds of Drum (small) to 3.46 µg/mL in the seeds of Sokoto white (big). The content of lysine among the cowpea varieties ranged from 0.69 µg/mL in the seeds of Drum (big) to 0.44 µg/mL in the seeds Sokoto white (small). Leucine content ranged from 0.62 µg/mL in the seeds of Sokoto white(small) to 0.77 µg/mL in the seeds of Sokoto white (big).The value obtained for Tryptophan ranged from 0.18 µg/mL in the seeds of Sokoto white (small) to 0.33 µg/mL in the seeds of Drum (big) while the content of Phenylalanine among the cowpea varieties ranged from 0.05 µg/mL in the seeds of Drum (small) to 0.21 µg/mL in the seeds of Drum (big) variety. Significant difference was observed in essential amino acids among the cowpea varieties ($p \leq 0.05$) (Table 6).

Table 6. Essential amino acid Composition of Common Nigerian Cowpea

Accessions	Arginine	Lysine	Leucine	Tryptophan	Phenylalanine
Sokoto small	2.86^{c}	0.44^{e}	0.62^{d}	0.18^{c}	0.07^{d}
Oloyin	2.76^{d}	0.55^{c}	0.69^{b}	0.26^{b}	0.11^{c}
Drum big	3.19^{b}	0.69^{a}	0.66^{c}	0.33^{a}	0.21^{a}
Drum small	2.44^{e}	0.50^{d}	0.64^{cd}	0.27^{b}	0.05^{e}
Sokoto big	3.46^{a}	0.63^{b}	0.77^{a}	0.31^{a}	0.17^{b}
LSD	0.0622	0.0409	0.0217	0.0336	0.0225

Means with the same letter along the same column are not significantly different at $p \leq 0.05$

4. Discussion

The attachment of seeds coat to the cotyledon of the cowpea species showed that all the seeds coat were firm to the cotyledon. After soaking in water for 24 hours, the seed coat of the cowpea accession which were rough and wrinkle i.e. the Drum (small and big) varieties were loosely attached to the cotyledons, while the seed coat of the cowpea which were smooth and also wrinkle still remain moderately firm and intact. It was also observed that all the seed coat of the drum varieties seeds were loose after 24 hours of soaking. This implied that the attachment of seeds to the cotyledon is variety dependent. The seed coat which still remains intact after soaking as observed in the light brown, dark brown and brown cowpea accession might be due to higher content of pectin, which is regarded as the intercellular cementing substance between the cotyledons and the seed coat. This finding was not in agreement with the report of [16] that cowpea accession with rough testa was more firmly attached to the cotyledons than those with smooth tests. Consequently, the firmly attached seed coat observed in Sokoto white and Oloyin accessionwould require more energy in form of abrasive force to dry dehull than the rest. Since seed coat removal, particularly if done by the traditional manual wet dehulling process, is time consuming [17], the moderately attached seed coat varieties with the exception of those that had their seed coats intact even after 24 h soaking, would be preferred [2].

Functional properties represent the ability of a product to associate with water under conditions where water is limited, for example,dough and pastes[18]. In this study, the seeds of Drum both the big and small varieties have the highest Rate of Water Absorption Also, the big variety of the Drum has the highestWater Absorption Capacity. Both Sokoto white (small) and Drum (small) varieties had the least water absorption capacity. This might be due to the thickness of pericarp on chemical composition of grain [16, 18]. Meanwhile, seeds with a loosely attached seed coat absorbed more water than firmly attached seed coats [2, 19]. The findings in this workis in accordance withthe report of [19] who attributed increased water absorption of cowpea seeds to larger seed size. High value Rateof Water Absorption (RWA) and Water Absorption Capacity (WAC) is desirable for the improvement of mouth feel and viscosity reduction in food products [20].

Swelling content plays an important role in the evaluation of the quality of products derived from seeds [19]. Swelling content is an important factor in dehulling, related to cooking quality of beans. The seeds of Sokoto white (big) had the highest Swelling Content, while the seeds of Sokoto white (small) and the seeds of Drum (small) has the lowest Swelling Content. This might be attributed to hydration capacity of the seed which depends on the thickness of pericarp and on chemical composition of grain.

The anti-nutritional contents of the cowpea accession showed that anti-nutrients such as alkaloid, tannin, total soluble sugar, and ascorbic acid (Vitamin c) were observed to be present in larger amount in the Oloyin variety compared to other cowpea accession. Also, phenol was found to be in larger amount in Drum (big) and saponin in Sokoto white (small). Minute quantities of alkaloid, tannin, phenol, saponin, total soluble sugar, and ascorbic acid (VitamnC) were detected in Drum (small) and Sokoto white (small and big) cowpeaaccession. The low values of anti-nutritional contents of the accessions in the current study could be attributed to the high nutrient quality. Higher values of phytochemicals have been reported by a previous study. This brought about a decrease in the dietary composition of cowpea seeds thereby negatively affecting the enzymes responsible for the digestion of proteins and carbohydrates [23]. Meanwhile, these compounds act as protective scavengers against oxygen-derived free radicals and reactive oxygen species (ROS) that play a healing role in aging and various disease processes. This implies that these accessions may have stringent and slightly purgative qualities.

Most of the mineral elements evaluated in this study were obtained to be highest in Drum (big) and Sokoto white (small) accessions. The higher contents of mineral constituents such as P, K, Na, Ca, Mg and Fe obtained in these cowpea varieties were comparable to those documented in some previous studies [12, 24,25].. This implies that these cowpea accessions, that is, Drum (big) and Sokoto white (small) contained the required amount of mineral nutrients to meet the daily recommended percentage if consumed alone. It also implies that the cowpea accessions were rich sources of P, K, Na, Ca, Mg and Fe, and can be used for nutritional or dietary supplements. Other macronutrient components such as protein, carbohydrate, fats, ash and crude fiber of the studied cowpea accession seeds were more in Sokoto white (small) variety than those obtained in other accessions. This difference in the mineral composition may be attributing to variation in the mineral content among the varieties. This implies that Sokoto white (small) variety will supply the daily nutritional needs of both children and other adults.

The results obtained in this study revealed that the seeds of Oloyin cowpea accession contain the highest saturated fatty acid composition, except for the palmitic acid which was observed to be highest in the Drum (big) variety. Majority of these fatty acid acts as defense systems of the body in the processes involved in lipid metabolism,an imbalance in these elements usually leads to nutritional disorders and complications of nutritionally related diseases such as diabetes [23]. This implies that the Oloyin cowpea accession can assist in amelioration of the attendant macro-vascular complications, anti-hyperglycemic activity, anti-cholesterol and anti-hypoglycemic.

There was variation in the essential amino acids such as arginine, lysine, leucine, tryptophan and phenylalanine among the cowpea accessions. This might be as a result of the assertion that cowpea has high protein which is about twice the quantity in cereals or other crops. Another possible explanation for this could be the type of fibers (soluble or insoluble) present and grain composition (particle size, amylose, amylopectin, and viscosity), which affects the metabolism of amino acids of the cowpea seeds. This implies that all the varieties can supply the essential amino acids needed by the human body and can help to improve the protein intake.

5.Conclusion

The results obtained in this study indicated that the common cowpea accessions such as Drum (big and small), Oloyin cowpea, Sokoto white (big and small) consumed in Nigeria especially in Southwestern part of Nigeria, have good functional properties with the ability to associate with water under conditions where water is limited. These accessions also contain higher proportion of anti-nutrients, mineral nutrients, proximate constituents, saturated fatty acid and essential amino acids. They can therefore provide essential minerals, protein and energy requirements to the daily diet of vulnerable groups of people in rural communities. The variations observed in the anti-nutrients, mineral nutrients, proximate, saturated fatty acid and essential amino acids contents of the accessions imply that nutrients composition of these accessions is varietal dependent.

The investigations carried out among the cowpea varieties have shown that biofunctional properties vary considerably among different varieties of cowpeas available. Biofunctional properties of cowpea seed varieties as determined would serve as the basis for upgrading the traditional methods of processing cowpeas, and show their suitability for processing. From the findings in this study, the white and brown accessions of the big and small cowpea (*Vigna unguiculata* (L.) Walp) contained varied amounts of nutrients and the misconception previously had about these varieties that one is better than the other should be disregarded except in the case of comparing a particular nutrient or choosing a particular nutrient of interest.

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