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RESEARCH ARTICLE

EFFECTS OF HEATING ON PHYTONUTRIENTS IN COOKED AQUEOUS EXTRACT OF *VIGNA UNIGULCULATA* (BLACK EYED BEAN)

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Abstract

Objective: To investigate the effects of heating on phytonutrients of cooked *Vigna unigulculata*.
Methods: The consequences of heating on *V. unigulculata* were investigated by phytochemical analysis (qualitatively and quantitatively), alongside analysis of proximate contents. Five phytochemicals were quantified and nutrient contents determined.
Results: Results revealed that phytochemicals in raw sample were significantly ($p<0.05$) higher than cooked sample. Alkaloids, saponins and flavonoids in raw black-eyed bean (RBEB) were significantly ($p<0.05$) higher than cooked black-eyed bean (CBEB). Meanwhile, apart from crude fat content, others (carbohydrate content, ash content, protein and fiber content) of CBEB *V. unigulculata* were significantly ($p<0.05$) higher than RBEB *V. unigulculata*.
Conclusions: Cooking by heating influenced a reduction of phytochemicals but an increase in proximate content in *V. unigulculata*.
Keywords: Black eyed bean, extracts phytonutrients, food content, health benefits.

INTRODUCTION

V. unigulculata like other legumes is an essential legume in human nutrition, particularly considered as rich protein and other nutrient source, such as carbohydrates, dietary fiber, minerals and vitamins for the poor of low-income earners, in low-income countries[1,2]. *V. unigulculata* is rich in nutrients. It is composed of minute fat, cholesterol and trans-fat; appreciable amounts of Fe, Mg and K (as minerals); vitamins such as folate[3]. *V. unigulculata* like other cowpeas as well has considerable amounts of tannins, phenols and flavonoids, reported to be responsible for its inflammatory modulatory actions[4]. Black-eyed bean is loaded with phytochemicals, which play vital role in fortification of health, prevention of disease and serve as active components in production of drug. Phytochemicals, in their function as antioxidants, excite immune system in humans; stimulate mobilization of protective enzymes in the liver and chunk free radical damage to the gene[5]. Some foods are better eaten unprocessed while others are healthier when cooked. However, for healthy eating, both unprocessed and cooked foods should be eaten to achieve total benefits[6]. Food cooking is reported to destroy food bound enzymes. Enzymes are very sensitive to heat and can be deactivated at temperature above 50^0C[6]. Therefore, for digestion to be complete, the body may need to furnish the process with the required enzymes which may result in enzyme deficiency[6,7]. The various types of food processing by heating such as boiling, steaming, stir-frying and roasting are reported to affect the bioavailability of mainly the water soluble vitamins (C and B), but does not affect the lipid soluble vitamins[8,9], affect the bioavailability of iron and agonist factors to adequate absorption of mineral[10]. Tannins are not destroyed by cooking in cowpeas but are however slightly lost in the bean soup or broth and a little amount are broken down at cooking[11,12]. Thus, raw food may contain more nutrients such as vitamins C

and B[9]. Cooking of food enhances chewing and subsequent digestion of food for easy absorption of nutrients by the body. Weakness of reproductive function and decreased energy are commonly associated with people whose choice is raw-foodist life-style[13]. Cooking legumes such as *V. unigulculata* helps to diminish the amount of phytate and other anti-nutrients in them. Phytate like other anti-nutrient is capable of hindering plants' nutrients from been absorbed in the body[14]. Half cooked or raw legumes contain precarious toxins known as lectins which can be removed by proper processing of soaking and cooking[6]. Cooking of foods like vegetables has been reported to improve the accessibility of antioxidants phytochemicals such as lycopene, beta-carotene, polyphenols and lutein[15]. Antioxidant functions of lycopene from cooked food is linked to reduced heart disease and reduced risk of prostate cancer, lowers chances of chronic diseases and prevent the body from free radical attack[15]. Cooking of food was reported to efficiently kill pathogens that may cause food borne disease such as bacteria, fungi and other harmful microorganisms arising from inappropriate handling[16]. Thus, for the claim that nutrients in food are lost in cooking, this present study seeks to investigate the phytochemicals and food contents in raw and cooked samples of *V. unigulculata*, to evaluate the effects of heating on *V. unigulculata*.

MATERIALS AND METHODS

Materials

V. unigulculata (black eyed bean) seeds were identified and authenticated and a voucher number of UNH no 443 assigned by Mr. Onyeukwu CJ, a plant Taxonomist, Department of Plant Science and Biotechnology, University of Nigeria, Nsukka, Enugu state.

Raw black-eyed bean (rbeb) Sample Preparation

Seeds were made ready for use by drying under mild sunlight after removal of stones and dirt, and moderately washed. Homogenized pulverized sample was made from 500 g of dried bean seeds and using appropriate label, it was stored in dry airtight bottles until needed for further analysis.

Cooked black-eyed bean (cbeb) Sample Preparation

Preparation of CBEB sample was done by cooking with an adequate amount of water to produce a squashy soupless mixture, in order to conserve some phytochemicals that might be lost in broth. With careful supervision for 15 days, the cooked bean was dried under moderate sunlight and 500 g was drudged into powder, stored in dry airtight bottle with appropriate label until needed.

Dry Extract Preparation from Samples

This was achieved by weighing 200 g from the pulverized sample into distilled water (700 ml), stopped with foil and left for two days (to allow for adequate extraction). Using whatman filter paper, this was then filtered and at 70ºC, filtrate was concentrated in water bath.

Qualitative phytochemical screening of raw black eyed bean (rbeb) and cooked black eyed bean (cbeb) samples

From the cooked and raw bean samples, nine phytochemicals were qualitatively identified which include; phenols, flavonoids, alkaloids, saponins, glycosides, tannins, reducing sugars, anthraquinones and steroids using the methods of Harbone[17]; Trease and Evans[18], with some modification.

Quantitative phytochemical screening of raw black eyed bean (rbeb) and cooked black eyed bean (cbeb) samples

Alkaloids Determination

The method of Harbone[17] was employed for the determination of alkaloids in RBEB and CBEB. Briefly, into a 250 ml beaker, 5 g of the sample and 200 ml of 10% acetic acid in ethanol were put. The mixture was stopped and stayed for 4 hours at 25^{0}C, after which it was filtered. Concentration of the filtrate was done in a water bath through evaporation of ¼ of the whole volume. Alkaloid in the sample was precipitated by addition of drops of concentrated aqueous ammonium solution to the ¼th fraction. Into a weighed filter paper (W1) was added the precipitated alkaloid and was washed using 1% ammonia solution and at 80ºC, the solution was dried in an oven. In a desicator, the residue in the filter paper was cooled and weighed as (W2). Calculation of alkaloid in sample was expressed as % weight of the sample.

Formula used to calculate alkaloid in sample:

$$\% \text{ Alkaloid} = W1+W2-W1$$

Flavonoid Determination

The method of Boham and kocipai-Abyazam[19] was followed for the determination of flavonoid in sample. Into a 250 ml conical flask was 10 g of sample added followed by 100 ml of 80% aqueous methanol and using an auto-shaker, the mixture was thorough stirred for 3 hours. Into a pre-weighed beaker was the mixture filtered and in a water bath, the mixture was dried by evaporation, then weighed until constant weight was obtained.

Flavonoid in sample was calculated as % by the formula:

$$\% \text{ Flavonoid} = \frac{W2-W1}{W2} \times \frac{100}{1}$$

W1=weight of empty beaker and W2=weight of residue (weight of empty beaker with sample after drying).

Saponin Determination

Using the method of (AOAC)[20], saponin in raw and cooked *V. unigulculata* was determined. In a conical flask containing 10 g of powdered *V. unigulculata* (raw and cooked) was added 100 ml 20% aqueous ethanol. Within 30 minutes, this was mixed meticulously and into a 250 ml conical flask was content emptied and appropriately stopped. This was then put in a 90ºC pre-heating water bath with constant shaking in four hours. Using whatman filter paper filtration of the mixture, the solid residue was separated from supernatant and 100 ml 20% ethanol was added and mixture was heated for another four hours. After filtering the solution, the resultant filtrate was mixed with the previously filtered solution and the resultant solution was heated at 90ºC

to 20% concentrated solution (CS) of the initial volume in a hot water bath. Into a 250 ml separating funnel containing the 20% CS was added 10 ml of diethyl ether (DE) while mixing resolutely, and the solution separated into DE layer which was meticulously discarded after left standing. This procedure of purification was repeated and 60 ml n-butanol was added which produced an upper layer (recovered) and a bottom layer (discarded). Then 10 ml of 5% NaCl solution was used to wash n-butanol extract and at 50°C, the upper layer was heated in a water bath to solvent evaporation, resulting in semi-dried paste.

Calculation of % saponin in sample was done with the formula:

$$\% \text{ Saponin} = W_2 - W_1 \times 100$$

W_1=weight of empty beaker and W_2=weight of beaker + sample after drying

Glycosides Determination

The method of Amadi *et al*.,[21] was employed for the determination of glycosides in raw and cooked *V. unigulculata*. Briefly, into a 250 ml conical flask containing 5 g of sample was 100 ml distilled water added, soaked and stirred within three hours. Then solution was filtered and sample extract collected. In a test tube containing 2 ml of the extract was added 2 ml of 10% DNS reagent and test tubes were put inside a beaker of boiling water and was heated for 20 minutes until boiling. Sample absorbance was read using UV-Vis Spectrophotometer, DHG-9101 at 540 nm after cooling test tubes in cold water bath.

Calculation of % glycoside in sample was done by the formula:

$$\% \text{ Glycoside} = \frac{\text{Absorbance} \times \text{total volume of extract} \times 100}{1000 \times \text{weight of sample used}}$$

Tannin Determination

The method of Amadi *et al.*, [21] with some modifications was used to determine tannin in *V. unigulculata*. Into a 250 ml conical flask (V1) containing 0.5 g *V. unigulculata* was 50 ml of distilled water added and swerved within one hour. The solution was filtered and into a 50 ml volumetric flask (V2) was pipette 5 ml of the filtrate and 5 ml of 0.1 % tannic acid added. Into a 50 ml volumetric flask (V3) was added 5 ml distilled water for blank solution. The flasks were made up to 50 ml mark with distilled water and were incubated in a water bath at 20°C for $1^{1/2}$ hours. Using UV-Vis Spectrophotometer, DHG-9101 sample absorbance was read at 760 nm.

Tannin concentration in sample was calculated by the formula:

$$\text{Tannin (mg/l)} = \frac{X - Y}{Z - Y}$$

X= concentration of extract; Y=concentration of tannic acid (standard); Z=concentration of blank.

Proximate analysis

The proximate analysis of *V. unigulculata* samples was done using standard prescription described by (AOAC) [20]; Obdoni and Ochuko[22].

Moisture Content Determination

The method of Obdoni and Ochuko[22] was used to determine the moisture content of the raw and cooked *V. unigulculata.* Into a clean petri-dish pre-dried at 98°C for 1 hour, was 10 g of pulverized *V. unigulculata* put and at 100°C, sample was heated overnight to dryness in a hot hair oven for three hours. A constant weight was obtained and % moisture in *V. unigulculata* was calculated from the difference between the initial sample weight (W_I) and the final sample weight after drying (W_D).

Moisture content of *V. unigulculata* was calculated in percentage using the formulae;

$$\% \text{ Moisture} = \frac{WI - WD}{WI} \times 100$$

W_I – Initial sample weight; W_D – Final sample weight

Crude Ash Content Determination

Ash content of *V. unigulculata* was determined by the method of Obdoni and Ochuko[22]. Within one hour, in a muffle furnace, a platinum crucible was heated to 600°C and weighed as W_1 after cooled in a desiccator. A second crucible W_2, containing 2 g of the dried sample of W_1 was heated until organic matter turns char. This charred substance was heated to a grayish white ash for eight hours in a muffle furnace, and weighed as W_3 after cooled in a desiccator. Ashing was completed by heating the crucible for another 30 minutes, cooled and weighed.

Ash content was calculated in percentage by the formula:

$$\% \text{ ash content} = \frac{(W3 - W1) \times 100}{(W2 - W1)}$$

W_1–Weight of crucible; W_2–Weight of dry matter with crucible taken for ashing; W_3–Weight of crucible with ash.

Total Protein Determination

The method described by (AOAC)[20] was used to determine total protein *V. unigulculata* raw and cooked samples. Into varied test tubes were even dilution solutions of 0.2 to 1 ml, prepared from the working standard pipette. Into two other test tubes was added 0.5 ml and 1 ml extract respectively and fill up with distilled water to 2 ml. Also, blank tube was filled with 2 ml distilled water. All tubes had 3 ml of biuret reagent added, swerved very well and incubated for 15 minutes at 37°C. At 520 nm, the colour change was spectrophotometrically measured.

Protein in sample was calculated by the formula:

$$\text{Protein concentration (mg \%)} = \frac{\text{OD (test)}}{\text{OD (std)}} \times \frac{\text{Conc (std)}}{\text{Aliquot (test)}} \times 100$$

Crude Fat Determination

Using soxhlet apparatus, crude fat in raw and cooked *V. unigulculata* was determined by the methods described by Obdoni and Ochuko[22]; Pearson[23]; James[24]. Into a thimble, inserted in a soxhlet apparatus was 10 g (W_1) of dry *V. unigulculata* measured and plugged with cotton on the top. Into a flat-bottom flask that has been previously weighed as W_2 was added 0.5 ml ether and distilled for sixteen hours. After cooling the apparatus, little ether was used to rinse the flask while filtering the solvent and ether evaporated leaving the fat when mixture was heated at 80-100°C in desiccators, the flask was cooked and weighed as W_3.

The percentage of fat content was calculated using the formula:

$$\text{Fat content (g/100\%)} = \frac{(W3 - W2) \times 100}{W1}$$

Where, W_1–Weight of dry matter taken for extraction; W_2–Weight of flask bottom flask; W_3–Weight of flask with flat.

Carbohydrate Determination

The methods described by Obdoni and Ochuko[22]; Pearson[23] were employed to determine carbohydrate in raw and cooked *V. unigulculata*. The working standard solutions were prepared in serial dilution of (0.2, 0.4, 0.6, 0.8 and 1) ml and pipette respectively into various test tubes. Into two other test tubes was added 0.1 ml and 0.2 ml extract respectively and fill up with distilled water to 1 ml. Phenol solution (1 ml) and 96% Sulphuric acid (5 ml) were added respectively into each tube and veered properly and put in water bath for 20 minutes at 30ºC this was then removed and left for 10 minutes. At 490 nm, colour complex was read. With the aid of standard graph, carbohydrate in sample was calculated.

Using formula, % total carbohydrate was calculated thus:

Absorbance corresponding to 0.1 ml of the test =X mg of glucose

100 ml of the sample solution contains= $\frac{X}{0.1} x100mg\ of\ glucose$=% of total carbohydrate present.

Determination of crude fiber

The crude fiber of raw and cooked *V. unigulculata* was determined by the method described by Obdoni and Ochuko[22]. Briefly, for 30 minutes, 2 g of dried *V. unigulculata* was mixed with Sulphuric acid (200 ml) with bumping chips. With muslin sheet, the resultant mixture was filtered and residue washed with boiling water until there was no more acid in residue. For 30 minutes, 200 ml NaOH solution was used to boil the residue then filtered using muslin sheet. Residue was washed using boiling 1.25% H_2SO_4 (25 ml), 50 ml water and rinsed with ethanol (25 ml). Into a pre weighed crucible (W_1) was the residue emptied and at 130±2ºC, within 2 hours, it was dried. Crucible was cooled in a desiccator and weighed as W_2. After which it was heated at 600±15ºC within 30 minutes, cooled again and weighed as W_3.

Calculation of crude fiber in % in *V. unigulculata* was done by the formula:

% Crude fiber in sample =

$$\frac{\text{Loss in weight on ignition } (W2 - W1) - (W3 - W2)}{\text{Weight of the sample}} \times 100$$

Statistical analysis

Results are written as mean±standard deviation. Analyses were done in triplicate while average data calculated were appropriately expressed their required units. With the aid of the software package of International Business Machine (IBM) statistical package for social sciences (SPSS) for Windows version 23, and one way ANOVA (Analysis of variance) was used to analyze collected data. Means with significant difference at $p<0.05$ were identified with Bonferroni post hoc test.

Table 1: Outcomes of qualitative phytochemical screening of RBEB and CBEB *V. unigulculata.*

S.N.	Parameter	RBEB	CBEB
1.	Alkaloids	+++	++
2.	Flavonoids	ND	ND
3.	Glycoside		
	• Cyanogenic	+++	++
	• Cardiac	ND	ND
4.	Phenols	+++	+++
5.	Steroid	ND	ND
6.	Tannins	++	ND
7.	Reducing Sugar	ND	ND
8.	Anthraquinone	ND	ND
9.	Terteoids	++	++
10.	Saponins		
	• For Frothing	+++	ND
	• For Emulsion	ND	++

Very deeply present (+++), deeply present (++), present (+), and not detected (ND), Raw black eyed beans (RBEB) and Cooked black eyed beans (CBEB).

RESULTS

Table 1 show results of phytochemical qualitatively screened from aqueous extracts of both samples. It reveals that alkaloids were very deeply present (+++) in RBEB and deeply present (++) in CBEB; Flavonoids were not detected (ND), Frothing Saponins were very deeply present (+++) in RBEB and not detected in CBEB and emulsion form of saponins were deeply present (++) in CBEB and not detected in RBEB; Cyanogenic glycosides were very deeply present (+++) in RBEB but deeply present (++) in CBEB; Cardiac glycosides were not detected in both samples; Phenols were very deeply present (+++) in both samples; Steroids were not detected in both samples; Tannins were deeply present (++) in RBEB but not detected in CBEB; Reducing sugars and anthraquinones were not detected (ND) in both samples and Terteoids were deeply present (++) in RBEB and CBEB. Quantitative phytochemicals in CBEB and RBEB (Table 2) revealed the following trend of phytochemicals in a decreasing order distribution: Alkaloids in RBEB (16.5±0.49%) > CBEB (8.85±0.06%); Flavonoids in RBEB (10.01± 0.01%)>CBEB(1.16±0.01%);Saponins in RB EB(3.18±0.01%)>CBEB(2.13±0.01%); Tannins in CBEB (1.05±0.017mg/l)>FBEB and Glycoside in CBEB(1.51±0.01%)>RBEB (1.52±0.02%).

Table 2: Outcome of quantitative phytochemical screening of RBEB and CBEB *V. unigulculata.*

S.N.	Parameter	RBEB	CBEB
1.	Alkaloids %	16.5±0.49	8.85±0.06
2.	Tannins (mg/l)	ND	1.05±0.017
3.	Saponins %	3.18±0.01	2.13±0.01
4.	Flavonoids %	10.01±0.01	1.16±0.01
5.	Glycosides %	1.51±0.01	1.52±0.02

Results are Mean±Standard deviation for duplicate analysis; the mean difference is significant at $P<0.05$. Raw black eyed beans (RBEB) and cooked black eyed beans (CBEB).

Table 3 shows the proximate contents of *V. unigulculata.* Results revealed that moisture content of RBEB (9.47±0.121%) was higher than CBEB (4.98±0.222%); ash content of CBEB (14.25±0.002%) was higher than RBEB (12.06±0.003%); protein content of CBEB (7.92±0.342%) was found to be higher than RBEB (9.06±0.752%); crude fiber of CBEB (8.39±0.001%) was higher than RBEB (6.29±0.463%); crude fat of RBEB (13.23±0.294%) was found to be higher than CBEB (7.92±0.342%) and carbohydrate content of CBEB (95.47±0.468%) was found to be higher than RBEB (63.94±0.588%).

Table 3: Proximate analysis result of *V. unigulculata* RBEB and CBEB.

S.N.	Parameter	RBEB	CBEB
1.	Moisture content %	9.47±0.121	4.98±0.222
1.	Crude Ash Content %	12.06±0.003	14.25±0.002
2.	Crude fat%	13.23±0.294	7.92±0.342
3.	Protein Content%	9.06±0.752	65.66±0.302
4.	Crude fiber%	6.29±0.463	8.39±0.001

Results are Mean±Standard deviation for duplicate analysis; the mean difference is significant at $p<0.05$. Raw black eyed beans (RBEB) and cooked black eyed beans (CBEB).

DISCUSSION

V. unigulculata seed is a nutritious food with high contents of rich phytochemicals and proximate properties. However, methods of processing may contribute to the unavailability and availability of these nutrients and phytochemicals[1]. Quantification of some of the phytochemicals showed that alkaloids content was higher followed by flavonoids and then saponins in raw *V. unguiculata* while tannin content was higher followed by cyanogenic glycoside in cooked *V. unguiculata.* This is consistent with the findings of Idoko *et al*[25], were alkaloids in cooked *P. vulgaris* was lower. Alkaloid content in raw sample was higher than cooked *V. unguiculata* in this study. Alkaloid was reported to be high also in *Balanites aegyptiaca* kernel[26]. Alkaloids applications in medicine are reported to be spectacular in their physiological functions due to their non toxicity[27]. The pharmacological properties of alkaloids are reported to include hypoglycaemic, hypotensive, analgesic and anti-tumor properties[28]. Tannin content in cooked sample was more than the raw sample. This is inconsistent with the findings of Jasraj and Kiran[29], on their posit that household cooking methods including pressure cooking and boiling, significantly destroyed antinutrients in *V. unguiculata.* Tannins, trypsin and phytate have been known to be antinutrients in most legumes. Thus, these phytochemicals in *V. unguiculata* are likely not reckon with any nutritional value[29]. Tannins and other antinutrients in legumes, as inhibitors to protein digestion are said to be destroyed by cooking thereby increasing protein digestion and its quality and also promote the functions of protease and amylase[30]. Antinutrients are higher in raw plants' foods and consuming raw foods make these antinutrients to impede metabolic process. Thus, from this study, it becomes imperative to thoroughly soak, cook, fry and boil legumes and some plants' food to eliminate antinutrients[29]. In this study, saponin content was higher in raw sample than in cooked sample. However, the saponin content in this study of both samples is lower than that reported by Alhassan *et al*[26]. A very high saponin level is reported to result in gastroenteritis linked dysentery and diarrhea[31]. Saponins are greasy and bitter taste phytochemicals with glycoside bonds found abundantly in plants[31]. The hepatoprotective, hypoglycaemic, anti-inflammatory, hypolipidaemic, anti-diabetic and anti-HIV potentials of saponins have been reported[28].

The amount of flavonoids in raw *V. unguiculata* was higher than that in cooked *V. unguiculata*. This is contrary to the report of Idoko *et al*, [25], were cooked *P. vulgaris* was higher. The higher value of flavonoids in raw sample over cooked could be attributed to the claim that higher temperature is capable of destroying volatile bionutrients and therefore reduce their quantity[6]. Flavonoids abound in many plants and they contribute immensely to the color and flavor widespread variety of beans[32]. The six subclasses of flavonoids reported to be found in beans include, anthocyanins, flavanones, isoflavonoids, flavanols, flavonols and flavones. Hesperetin glycosides and naringenin are the two most important flavanones among the nine branded flavanones in widespread bean types reported[32]. Huber *et al*, [33] reported elevated levels of antioxidant activities and concentrations of phenolic compounds due to heat action on beans. Flavonoids in beans are known for their antioxidant and pharmacological activities in human health, this include; anti-inflammatory, anti-carcinogenic, anti-mutagenic, antimicrobial, anti-diabetic, anti-allergic and anti-diarrheal activities[28]. However, the flavonoid content of both samples in this work was

discovered to be lower than that accounted by Idoko *et al*.,[25] and Huber *et al*., [33] in *P. vulgaris.* The percentage proximate composition of cooked black eyed bean has higher ash content than that of raw black eyed bean. This result is contrary to what was reported for boiled *V. unguiculata* by Omenna *et al*.,[34] and for boiled *Vigna. Sesquipedalis*, which was reduced by 21%[35]. Ash content of an organic matter presents a brilliant indicator for its nutritional value and mineral content measurement and therefore better yield of biogas and biofertilizer[36]. Thus, high ash content of cooked *V. unguiculata* sample suggests that cooking makes the valuable minerals and nutrients much available[6]. The crude fat in raw black eyed beans is quite higher than that of cooked black eyed beans. This is consistent with the report of Nzewi and Egbuonu[35] were boiling was found to reduce crude fat in *V. Sesquipedalis*. Crude fat in *Balanites aegyptiaca* seed oil was said to be a good source of liquid cleansing agent and biofuel Ubwa *et al*.,[36] and it was reported to have several medicinal application[38].

In raw *V. unguiculata,* crude protein was observed to be lower than the cooked sample. The higher content of crude protein in cooked *V. unguiculata* was different to the previous report[39], in which protein content was found to be reduced when *P. Vulgaris* bean seed was cooked. However, the higher protein content in cooked bean sample could be due to complete destruction and elimination of antinutrients which would have interfered with protein[6] and also support the claim that *V. unguiculata* and other legumes are proteinous and thus, the reason low income earners depend on it for protein source[2]. In this sense, *P. Vulgaris* (raw and cooked), was reported to possess potential of improved kidney function in albino wistar rats, attributed to its healthy nutrients contents, especially protein[25,40]. Similarly, crude fiber in cooked sample was higher than raw sample of *V. unguiculata*. High crude fiber content in cooked black eyed beans could improve bowl movement and eliminate constipation. This would possibly reduce the often associated allergic reaction to beans consumption[41]. The content of moisture in cooked *V. unguiculata* was observed to be lower than the raw sample, which was similar to that reported by[35]. Low moisture content may reduce microbial activity, enhances and elongate storage and reduce free fatty acids and low acid value[42,43]. This was consistent with the account of Omenna *et al*,[34], who observed that pressure cooking of *V. unguiculata* bean seed yielded higher crude carbohydrate than the raw sample and boiling *V. Sesquipedalis* for 40 minutes increased carbohydrate content by 8%[35]. The level of resistant starch was found to be increased after cooked legume was cooled for 24 hours in the refrigerator, which resulted in recrystalization of the starch molecules[41]. The proximate composition of the cooked black eyed beans of this study indicates it is vastly healthful as it is composed of much protein composition, thus may well enhance extra protein supplies which include, groundnut and peas, and could increase protein composition when cooked with rice particularly in winter and in dry areas[2]. Thus, the constant increase in the price of proteins from animal like meat, egg, fibre and milk could be reduced by processing this cooked beans and used as a protein supply for both humans and animal's nutrition.

CONCLUSIONS

From this investigation, it may be concluded that cooking of *V unigulculata* bean seed improves its protein content, carbohydrate content, ash content and fiber content, and therefore makes its consumption safer with better antioxidant effects. However, phytochemicals in *V unigulculata* that could not withstand heat were found to be reduced in the cooked sample and the high nutritive value of cooked *V unigulculata* could serve as a better source of antioxidants thereby improving healthy life when eaten cooked. The increased concentration of phytochemicals in raw *V. unigulculata* may obviously be due to the absence of heat action.

AUTHORS' CONTRIBUTION

Idoko A: study design, writing original draft. **Chigbue PO:** literature survey. **Patrick UO:** methodology, formal analysis. **Emmanuel UEG:** data interpretation. **Ngozi AP:** visualization, editing. **Nebolisa OA:** critical review. The final manuscript was read and approved by all authors.

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CONFLICT OF INTEREST

Authors declare no conflict of interest as it relates this study.

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