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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Comparative Study of the Nutrient Composition of Four Varieties of Cowpea (*Vigna unguiculata*) and Their Products (Beans-Based Products)

G.T.O. Otitoju[1], O. Otitoju[2], J.U. Nwamarah[1] and S.O. Baiyeri[3]
[1]Department of Home Science, Nutrition and Dieteties, University of Nigeria, Nsukka, Nigeria
[2]Department of Biochemistry, Federal University Wukari, Taraba State, Nigeria
[3]Department of Crop Science and Horticulture, Federal University, Oye, Ekiti State, Nigeria

Abstract: The study compared the nutrient potentials of four varieties of cowpea (*Vigna unguiculata*) and their products (beans pottage). The four cowpea varieties were obtained from the main market Nsukka, Enugu state. The varieties were: *Potiskum* (black-eye pea), Ife-brown (brown beans), *Orarudi* and *Aloka*. Five hundred gram of each sample was cleaned by hand picking to remove extraneous materials and damaged seeds. The cowpea grains were divided into two portions of 100 and 400 g, respectively. Four hundred gram of each of the varieties was used to prepare beans pottage. The sensory properties of the pottage were evaluated using a nine-point hedonic scale while the Food Attitude Rating Scale was used to access the general acceptability. The raw samples and the pottage were analyzed chemically for nutrient and anti-nutrient composition. The data generated was statistically analyzed using means, Analysis of Variance and Duncan's New Multiple Range Test (DNMRT). In the raw samples Ife-brown was found to have the highest protein content (26.90%) while in the cooked sample *Potiskum* pottage was found to have the highest protein content (15.70%). However, Ife-brown and *Aloka* rated the highest in nutritive value in terms of proximate (moisture, protein, fats, carbohydrate, fibre and ash) and minerals (calcium, zinc, phosphorus, potassium and iron). The pottage had comparable ($p>0.05$) acceptability. However, Ife-brown bean pottage was best preferred to the other pottage.

Key words: Comparative study, nutrient composition, varieties of cowpea, beans-products

INTRODUCTION

In recent times, there is a global increase in the cost of living especially in most developing nations like Nigeria. The implication of this development will obviously affect the type of food and food nutrient availability among the poor populace. A typical African diet is usually high in carbohydrate content and low in animal protein.

Access to adequate food and health are among the universally adopted human rights that are necessary input for human development SCN (2004).

Legumes are food stuffs of great significance to people in tropical developing countries, a large number of species and varieties of legumes are consumed by the teaming population, as they are inexpensive and important source of protein (20-40%), carbohydrate (50-60%) along with other nutrients which have beneficial effects on human health and well being (Lakshmi *et al*., 2010).

Cowpea (*Vigna unguiculata*) is a legume plant that is regarded as a prominent food crop in the 3rd world countries. It is an excellent source of thiamine, folic acid, niacin, riboflavin and biotin (Minussi *et al*., 2003). It plays a great role in alleviating poverty and malnutrition in developing countries. Girma *et al*. (2005) estimated that 3.3 million metric tones of cowpea grain were produced worldwide in 2000. Nigeria produced 2.1 million tones of cowpea making her the world largest producer, followed by Niger (650,000 metric tones).

In many parts of West Africa including Nigeria, cowpea seeds are consumed as boiled seeds or in combination with food such as maize, rice, plantain among others. They are also processed into paste for the preparation of various traditional foods, such as *Akara* (fried cowpea paste) and *moimoi*, steamed cowpea (Henshaw and Sanni, 1995).

As the population of Africa continues to increase at its present annual rate and the low income groups are to be provided with sufficient food to meet their protein requirement, efforts have to be made in several directions to improve the quality and quantity of food supplies (NPC, 2001). Cowpea although an inexpensive and available source of protein and minerals are poorly utilized. Among the legumes, cowpea is the most extensively grown, distributed and traded food crop consumed, more than 50% (Agbogidi and Egho, 2012). This is because the crop is of considerable nutritional and health value to man and livestock (Agbogidi, 2010). They form a major staple in the diet of African and Asian continents (Awe, 2008). The seeds make up the largest contributor to the over all protein intake of several rural

Corresponding Author: G.T.O. Otitoju, Department of Home Science, Nutrition and Dieteties, University of Nigeria, Nsukka, Nigeria

and urban families hence Agbogidi (2010), regarded cowpea as the poor man's major source of protein.

The presence of inherent constraint such as Antinutrients, toxic components and hard to cook phenomenon usually associated with legumes are mainly the reason for their poor utilization (Apata, 2008). Cowpea utilization can be increased through the use of food processing techniques such as: soaking, dehulling, boiling or cooking, autoclaving, germination and fermentation (Oboh *et al*., 2000; Teye *et al*., 2012). Amongst these processing techniques cooking plays an important role as it influences the bioavailability and utilization of nutrient and also improves palatability which incidentally results in enhancing the digestibility and nutritive value of food (Ramakrishna *et al*., 2006; Teye *et al*., 2012). Therefore the focus of this study is to compare the nutrient potentials of four varieties of cowpea (*Potiskum*, Ife-brown, *Orarudi* and *Aloka*) and their products.

MATERIALS AND METHODS

Materials: A total of four varieties of cowpea (*Vigna unguiculata*) were obtained from the main market in Nsukka, Enugu state, Nigeria. These varieties are: *potiskum* (black eyed pea), Ife-brown (brown beans), *Orarudi* and *Aloka*.

Methods

Sample preparation: Five hundred grams of each sample was cleaned by hand picking to remove stones, dirt and damaged seeds. The seeds were divided into two portions 100 and 400 g, respectively. The first portion was kept as the raw sample, while the second portion was washed and used to prepare beans pottage.

Proximate analysis: Portions of Orarudi, Aloka, Potiskum (black eyed pea) and Ifebrown (brown beans) as well as their products (beans-based products) were analyzed for their proximate values using AOAC methods (2005).

Moisture: The moisture content of the samples was determined using the hot oven method as described by Pearson (1976). The percentage moisture content is calculated from the weight loss of the sample:

$$\text{Thus \% moisture} = \frac{\text{Wt of dish+sample-wt of dish+sample after drying}}{\text{Wt of sample}} \times \frac{100}{1}$$

Protein: Total nitrogen was estimated using micro kjeidahl method as described by Pearson (1976).

One gram of sample was digested with concentrated sulphuric acid. The digested samples were distilled and titrated. The crude protein was calculated by multiplying the total nitrogen TN by the conversion factor of 6.25:

$$P = TN \times 6.25$$

Fat: The fat content of the samples were determined using soxhlet extraction method as described by Pearson (1976):

$$\text{Percentage of wt} = \frac{A-B}{C} \times 100$$

where,
A = weight of empty cup
B = weight of cup+fat
C = weight of sample used in grams

Carbohydrate: This was determined by difference:

$$\text{Carbohydrate of (\%)} = 100-(\%\ \text{ash+protein+fat+fibre+moisture})$$

Ash: Ashing was based on AOAC methods (2005). Two gram of the samples was subjected to ashing, in a silica crucible until the food matrix was destroyed. The sample was heated gently at first at about 150°C to clav it and at 500°C in a muffle furnace to completely destroy it:

$$\text{Ash of (\%)} = \frac{C-B}{F} \times 100$$

where,
B = weight of crucible (empty)
C = weight of crucible+Ash
F = weight in grams of sample used

Crude fibre: The fibre content was determined using the AOAC method (1990).

Three grams of sample was defatted by soxhlet extraction or by stirring, setting and decanting with petroleum ether:

$$\text{Fibre of (\%)} = \frac{M_2-M_3}{M_0} \times 100$$

where,
M_2 = weight after drying
M_3 = weight after ignition
M_0 = weight of sample

Vitamins

Vitamin A (β carotene): The method of AOAC (2005) was used.

One gram of the sample was extracted with 50 ml of petroleum ether in triplicate. The ether extract was concentrated and evaporated to dryness. The residue was dissolved with 0.2 ml of chloroform-acetic anhydride (1: 1). Two milliliter of trichloroacetic acid-chloroform (1: 1) was added and the absorbance 620 nm at 15 sec interval.

Vitamin B1 (Thiamine): One ml of the filtrate was transferred into 3 test tubes, 2 ml of water, 0.4 ml of 50% sodium acetate, 0.1 ml of diazotized reagent were added

and shaken 0.2 ml of 5.5% sodium carbonate was added, mixed and the absorbance taken at 540 nm, against a reagent blank.

Mineral analysis

Calcium: Two grams of sample was ashed followed by classical precipitation and titration (Paul and Southgate, 1978).

Iron and zinc: The method of AOAC (2005) was used. Two grams of sample (powdered) is weighed into a crucible and ashed in a muffle furnace at 550°C for 6 h. The percentage of element present was calculated from the absorbance values of the sample and standard solution.

Potassium: Potassium content of the samples were determined using the atomic absorption spectrometric method as described by Collins and Polkinhorne (1952):

$$K = 0.88 \times k_20$$

Phosphate: The method of AOAC (2005) was used 2 ml of sample was transferred into 3 test tubes and 3 ml of water added; the pH was adjusted to 7.0 with dilute ammonia and 2.5 ml of vanadate molybdate reagent added. The solution was made up 10 ml with and after 10 min the absorbance was taken at 470 nm against a blank.

Preparation of pottage: A standard recipe was developed and used for the preparation of the pottage.

Recipe: For each variety:

Cowpea	400 g
Onions	100 g
Palm oil (edible)	100 ml
Crayfish (grinded)	35 g
Salt	To taste
Fresh red pepper	30 g
Magi cubes	16 g (2 cubes)
Water	potiskum (1250 ml), Ifebrown, (1500 ml), Aloka (2000 ml), Orarudi (2, 100 ml)

Methods:

1: Bring water to boiling point
2: Wash each of the cowpea varieties into the boiled water and allow to cook
3: Incorporate other ingredients such as sliced onion grinded crayfish, fresh grinded red pepper, maggi cubes and palm oil into already cooked beans.
4: Add salt to taste
5: Allow the cooked pottage to steam for a while, then bring down and put into thermo flask to retain temperature

Sensory evaluation: The sensory evaluation was conducted at the Food and Diet therapy laboratory, Department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka. A panel of 20 judges were randomly selected from the student of Home science, Nutrition and Dietetics, University of Nigeria Nsukka. The laboratory was large enough to accommodate twenty panelists. Each of the panelists was sited comfortably with windows opened for proper ventilation, with a bright fluorescent lightening and the environment was free from distraction.

The judges evaluated the samples using a nine point Hedonic scale, where 9 was the highest score and 1 the lowest score. The degree to which a product was liked was expressed as like extremely (9 points), like very much (8 point), like moderately (7 point), like slightly (6 point), neither like nor dislike (5 point), dislike slightly (4 point), dislike moderately (3 point), dislike very much (2 point), dislike extremely(1 point). The pottage were presented to each of the panelist as coded in the hedonic scale. Each panelist was given a serving bowl, with spoon and water to rinse the mouth after testing each sample to avoid carry over effect. An ambient room temperature was maintained throughout the testing session. The four samples (pottage) were evaluated by the panelist 20 for flavour, texture, colour and general acceptability.

Data analysis: Data obtained from the study were analyzed statistically. Mean and Analysis of Variance (ANOVA) were used to test for treatment effect (Obi, 1986). Duncan's New Multiple Range Test (DNMRT) was used to test the significance of the differences among means ($p<0.05$).

RESULTS

Table 1 shows the nutrient composition of four raw samples of cowpea varieties. The result shows that moisture content was highest in Ife brown (14.5%) and least in Aloka (11.50%). Protein content ranged from 21.02-26.90% but it was highest in Ife brown. Fat and carbohydrate contents were highest in Aloka 3.2 and 55.74%, respectively. Crude fibre content was highest for Ife-brown (7.01%) but least for Potiskum (3.77%). Vitamin A result shows that Orarudi had the highest content of 1.39 mg/100 g while Vitamin B_1 content ranged from 0.19-0.25 mg/100 g. Ife brown had the highest zinc and calcium content of 4.14 mg/100 g, respectively. The result of the nutrient compositions of Pottage prepared from these cowpea varieties shows that Aloka Pottage (AP) and Orarudu Pottage (OP) had the highest moisture content of 43.15 and 38.50%, respectively. However, Potiskum pottage (PP) had the highest protein content (15.70%) while the least Protein was obtained in AP (4.62%). Generally, there was an increase in nutrient, Vitamin and Mineral content of pottage more than their raw samples. Table 3 shows

Table 1: Nutrient composition of raw cowpea varieties (*Vigna unguiculata*)

	Samples			
	P	I	A	O
Nutrient				
Moisture (%)	13.48^{b}	14.50^{a}	11.50^{d}	12.91^{c}
Protein (%)	26.18^{b}	26.90^{a}	21.02^{d}	26.59^{b}
Fats (%)	3.20^{a}	2.96^{c}	3.25^{a}	3.16^{b}
Carbohydrate (%)	49.37^{b}	45.68^{d}	55.74^{a}	48.67^{c}
Fibre (%)	3.77^{d}	7.01^{a}	5.47^{b}	4.67^{c}
Ash (%)	3.93^{a}	2.95^{c}	3.02^{b}	3.98^{a}
Vitamin A (mg/100 g)	0.63^{c}	0.83^{b}	0.64^{c}	1.39^{a}
Vitamin B_1 (mg/100 g)	0.22^{a}	0.25^{a}	0.19^{a}	0.21^{a}
Calcium (mg/100 g)	322.07^{d}	424.21^{c}	571.68^{a}	471.01^{b}
Zinc (mg/100 g)	2.61^{d}	4.14^{a}	2.87^{b}	3.28^{b}
Iron (mg/100 g)	2.08^{d}	13.61^{a}	7.92^{b}	11.69^{b}
Potassium (mg/100 g)	23.91^{c}	34.78^{a}	28.26^{c}	17.21^{d}
Phosphorus (mg/100 g)	437.90^{d}	638.04^{a}	587.73^{c}	461.98^{c}

Content of raw cowpea is significant at $p<0.05$. Superscript of raw cowpea content is in hierarchy a, b, c, d

For each nutrient, values with similar letter in each row are statistically not significant ($p>0.05$) while those with different letters are statistically significant ($p<0.05$). Key: P: *Potiskum* (Black eyed pea), I: Ife-brown (Brown beans), A: *Aloka*, O: *Orarudi*

Table 2: Nutrient composition of pottage prepared from cowpea varieties (*Vigna unguiculata*)

	Samples			
	PP	IP	AP	OP
Nutrient				
Moisture (%)	31.47^{c}	31.00^{d}	43.15^{a}	38.50^{b}
Protein (%)	15.70^{a}	6.15^{c}	4.62^{d}	8.47^{b}
Fats (%)	5.46^{b,c}	5.66^{c}	5.44^{c}	7.34^{a}
Carbohydrate (%)	29.31^{a}	36.35^{a}	29.00^{c}	24.61^{c}
Fibre (%)	13.21^{a}	15.05^{a}	11.22^{d}	15.09^{b}
Ash (%)	4.85^{c}	4.98^{c}	6.74^{a}	5.99^{b}
Vitamin A (mg/100 g)	0.88^{d}	1.76^{b}	1.95^{a}	1.59^{c}
Vitamin B_1 (mg/100 g)	0.21^{b}	0.025^{b}	3.17^{a}	3.17^{a}
Calcium (mg/100 g)	377.70^{d}	441.55^{c}	582.30^{a}	490.45^{b}
Zinc (mg/100 g)	2.89^{c}	4.27^{a}	2.96^{c}	3.23^{b}
Iron (mg/100 g)	11.31^{c}	18.54^{a}	9.28^{d}	13.07^{b}
Potassium (mg/100 g)	41.67^{b}	26.55^{c}	13.00^{d}	64.75^{a}
Phosphorus (mg/100)	312.81^{d}	508.94^{a}	430.75^{b}	347.20^{c}

Content of cowpea pottage is significant at $p<0.05$. Superscript of cowpea pottage is in hierarchy a, b, c, d

For each nutrient, values with similar letter in each row are statistically not significant ($p>0.05$) while those with different letters are statistically significant ($p<0.05$). Key: PP: *Potiskum pottage* (Black eyed pea), IP: Ife-brown Pottage (Brown beans), AP: *Aloka Pottage*, OP: *Orarudi pottage*

Table 3: Sensory scores of pottage made from four varieties of cowpea

	Samples			
Sensory parameter	IP	OP	AP	PP
Colour	8.15^{a}	7.10^{c}	7.65^{b}	6.85^{d}
Flavour	7.75^{b}	7.05^{d}	7.55^{c}	7.80^{a}
Texture	7.53^{b}	6.45^{c}	7.68^{a}	7.40^{d}
General acceptability	8.10^{a}	7.25^{d}	7.75^{c}	7.80^{b}
Degree of likeness (all sensory modality inclusive)	7.82^{a}	6.87^{d}	7.63^{b}	7.35^{c}

Means not followed by measure better in a row are significantly ($p<0.05$) different. Key: PP: *Potiskum Pottage* (Black eyed pea), IP: Ife-brown Pottage (Brown beans), AP: *Aloka Pottage*, OP: *Orarudi Pottage*

the sensory evaluation scores of respondents administered pottage made from Ife brown, Orandi, Aloka and Potiskum. The result showed that more respondents liked the colour of Ife brown (8.15) followed by Alaaka (7.65). Similarly, the flavor of IP was more preferred than those of OP, AP and PP. There was a general acceptability for IP and PP while OP and AP had the least acceptability.

DISCUSSION

Protein is an essential element in the human diet. Generally, most people assumed that protein is found in animal-based foods and may prefer this source of protein than the plant-based ones. The cost of animal based protein is not easily come by in most developing nations like Nigeria, therefore the need to diversify into other sources. Legumes are good sources of plant

protein but not widely accepted by many. The unacceptability attitude is the basis for this research study.

The proximate composition result of the four cowpea varieties used in this research agreed with the research work done on eight varieties of cowpea by Mokgope (2007) and Agbogidi and Egho (2012). This result was also agreed with a research study on the content of antinutrient and *in vitro* protein digestibility of cowpea plant by Ene-Obong (1995).

The mineral content of the four varieties of cowpea were significantly different ($p<0.05$). However, all the varieties contained high levels of minerals. The high levels in the mineral content of the four cowpea varieties is in accordance with the literature report that legumes are high in minerals (Bressani and Elias, 1974).

Orarudi had the highest tannin content (7.41%). This was attributed to the fact that polyphenols responsible for seed colour are predominantly located in the pericarp and testa of pigmented cultivars of legumes (Ene-Obong and Okoye, 1993). However, it is worth noting that *potiskum* had higher tannin content than Ife-brown contradicting the report that darker coloured seeds have higher levels of tannin (Adebiyi *et al*., 2005). It is likely possible that other factors could have such as year of production, storage, growing conditions influenced the concentration of tannin in *Potiskum*.

There was a slight increase in the moisture content of the varieties increased. This can be linked to the processing technique applied (boiling/cooking). The moisture content of the varieties was slightly lower than that described in the research work by Adebiyi *et al*. (2005). This could be as a result of the moisture content of the dry seeds and diversity in cooking methods. There was significant decrease in the protein content of the pottage. This agreed with a literature reported by Ophardt (2003) that cooking/heat denatures protein. However the drastic differences in the protein content of *Aloka*, Ife-brown and *Orarudi* bean pottage compared to the *Potiskum* bean pottage may be linked to differences in the structure of amino chains. Some structures are more heat labile than others. This result agreed with a research work on proximate composition of cowpeas by (Sanusi and Adebiyi, 2009). The ash content of the four varieties ranged from 4.85-6.74%. These were higher than that reported in a research work on proximate composition of cowpeas by Sanusi and Adebiyi (2009). They reported 2.24% ash in cowpea. The high content of ash in these varieties suggests its richness in minerals.

The carbohydrate content of the pottage decreased from 45.68-54.74% to 29.00-36.35%. The decrease can be linked to the processing technique applied (cooking), because legumes and cereals are high in carbohydrate (Enwere, 1998). The decrease in carbohydrate content of the varieties agreed with the research work by Sanusi and Adebiyi (2009).

There was an increase in the calcium content of all the varieties, *Aloka* pottage had the highest calcium content and this can be traced to its high ash content. Zinc content of *Orarudi* had a reduction after cooking into pottage (3.28-3.23 mg/100 g). The reduction agreed with a research work by Ene-Obong and Madukwe (2001). There was a general decrease in the mineral composition of the cowpea varieties. This decrease agreed with a literature report that food processing may lower the vitamins and mineral values of some foods Rock *et al*. (1998). However the mineral contents of the pottage were all high and this suggests its benefit in decreasing micro nutrient deficiency. It is worth noting that Ife-brown pottage rated highest in zinc, iron and phosphorus while *Orarudi* pottage had the highest content of potassium (64.75 mg/100 g).

The levels of anti-nutrients in the four varieties had a general decrease. This reduction can be linked to cooking methods adopted. Cooking influences bio-availability and utilization of nutrients which incidentally may result in enhancing the digestibility and nutritive value of food (Oboh *et al*., 2000). Egbe and Akanjeley (1990), investigated the effect of boiling on tannin in raw beans and reported that it decreased with increase in cooking time. *Aloka* had the least tannin content (0.12%) while *potiskum* had the highest (1.15%), this correspond with a literature reported by Egbe and Akanjele (1990) that tannin content reduces with respect to increase in cooking time.

The flavour of the pottage was equally liked by the respondents. This agrees with the literature reported by Lakshmi *et al*. (2010) that cooking improves palatability of food and colour. The texture of *Aloka* pottage and Ife-brown pottage were preferred more in comparison with the other pottage ($p<0.05$). This may be due to their softness and swelling capacity. The colour of Ife-brown was liked very much and is significantly different ($p>0.05$) with comparison to the other pottage. The pottage had similar ($p>0.05$) acceptability. The pottage were generally liked and accepted by the respondents. This could be attributed to the fact that they all belong to the same family of cowpea (*Vigna unguiculata*). However, Ife-brown pottage had the highest mean for general acceptability (8.02%). It was liked very much while others were liked moderately. Degree of likeness (colour, flavour and texture inclusive) of the pottage is significant at $p<0.01$. Ife-brown pottage was liked more to the other pottage (7.82%). This agreed with a literature reported by Hussain *et al*. (1984) that the choice of cowpeas by Nigerian women is guided predominantly by the cooking time, swelling capacity, taste and colour.

From this study, the four varieties of cowpea had shown that these beans are excellent sources of food nutrient which can be diversify into food diet of many people. The four varieties have been found to have high nutritive

values in terms of proximate and minerals. Although, Ife-brown pottage and *Aloka* pottage rated the highest in nutritive values. But, *Potiskum* beans pottage had the highest protein. However, the four varieties were all accepted in terms of flavour, colour, texture and general acceptability but with a special preference for Ife-brown pottage.

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