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Full Length Research Paper

Comparison of nutritional values of brown and white beans in Jos North Local Government markets

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Cowpea is an important bean which play significant role in the diets of Africans. It serves as a major source of protein in the absence of sufficient animal protein for the population. Two varieties (white and brown) of cowpeas (*Vigna unguiculata*) were analyzed for their proximate and elemental contents. These varieties belong to the same species in the family leguminosae. The brown and white seeds were found to be nutritious. Both contained carbohydrate, protein, fibers and minerals such as calcium, magnesium, potassium, sodium, iron, zinc, manganese and copper. The crude protein was found to be 15.62 and 17.91% with the brown seeds having the higher amount. The carbohydrate content analyzed was found to be 56.80 and 60.57% with the white seeds having the higher value. The crude lipid gave the least range which is 2.13 to 2.42%. The other parameters, moisture content, crude fiber and total ash contents were 3.56 to 5.08, 13.54 to 14.15 and 4.07 to 4.27%, respectively. Potassium and copper had the highest and lowest concentration in cowpea varieties ranging from 741 to 768 and 0.58 to 0.60 mg/100 g, respectively. There were significant ($p<0.05$) differences between the potassium, calcium, sodium, magnesium, manganese and zinc concentration of the cowpea varieties, except between iron and copper concentration.

Key words: *Vigna unguiculata,* cowpeas, nutrition, minerals, vitamins.

INTRODUCTION

There are some debates on the geographical origin of cowpeas. Some authorities feel that cowpeas originated either from Southern Sahel of North-Central Africa or in Ethiopia and then spread to Asia and Mediterranean through Egypt. Another view is that they originated in India and were introduced into Africa some 2000 to 3500 years ago. From West Africa, they made their way to the Caribbean and North Africa with the slave trade.

In the early 1970's, cowpea was the second most important crop in Africa after groundnut (Elegbede, 1998). Cowpeas are now grown widely in savannah regions of the tropics and sub tropics, especially in western and central African countries. They are also cultivated extensively in California, the south eastern United State and Puerto Rico. Nigeria is currently the world's largest cowpea producer accounting for about 22% of total production followed by Brazil, which produces about 10% (Dolvo et al., 1984).

Cowpea is an important crop which plays a significant role in the diets of Nigerians. It serves as a major source of protein in the absence of sufficient animal protein for the population. Cowpeas are consumed either alone, or in combination with cereals to enhance the protein value. Cowpea is a subsistence legume "par excellence", extremely versatile and can be used in plain cooking or in processed dishes (Rachie, 1985).

In many parts of West Africa, including Nigeria, cowpea seeds are prepared and taken in various forms. It could be cooked, made into soup or milled mixed with pepper, onions, groundnut oil, fried and taken as *akara* or it is wrapped with leaves and taken as "*moin-moin*"

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(Oyenuga, 1968; Hung et al., 1990).

In Nigeria, cowpea is known by names such as “ewa” in Yoruba language, “wake” in Hausa language and “akidi” in Igbo language. Unlike other legumes, such as soybeans and groundnuts which are oil-protein seeds, cowpeas are starch protein seeds offering a wider pattern of utilization than any other legume in Africa. Cowpea are classified as Kingdom- plantae, Division- magnsliophyta, Class- magnoliopsida, Order- fabales, Family- fabaceae, Sub-family- faboideae, Genus- vigna and Species- *Vigna unguiculata*.

V. unguiculata is an annual herbaceous legume that can reach more than 80 cm in height. Some varieties grow upright, while others have procumbent stems, often tinged with purpled, and trail along the ground. The seeds vary in shape from kidney to round, depending on how tightly packed they are in the pod. Cowpeas are major staple food in many parts of Africa where every part of the plant is eaten. The nutritional value of cowpeas as a source of dietary protein lies in their high protein content, which is 20 to 25% and is double the value of most cereals (Stanton, 1966). The protein in cowpea is rich in the amino acids lysine and tryptophan, as compared to cereal grains. However, it is deficient in methionine and cysteine when compared with animal proteins. Therefore, cowpea seed is valued as a nutritional supplement to cereals and an extender of animal protein (www.abc.net.au), the amino acids in cowpea are complemented by those found in cereals grains. Cowpea grains are also a rich source of mineral (potassium, calcium, magnesium and phosphorus) and vitamins (vitamin A and C, thiamine, riboflavin, niacin, vitamin B6 and pantothenic acid) (Jenkins, 2000). Cowpeas are low in fat and high in fiber. The protein in cowpea reduces low density lipoproteins that are implicated in heart diseases (www.wHfoods.com). In addition, because grain legumes starch is digested more slowly than starch from cereals and tubers, their consumption produces fewer abrupt changes in blood glucose levels (www.wHfoods.com).

The nutritional content of cowpea grain is important because it is eaten by millions of people who otherwise have diets lacking in protein, minerals and vitamins. This study was conducted to compare the nutritional values of brown and white seeds of *V. unguiculata* and to evaluate any net nutritional benefit for some individuals preferentially consuming one and abstaining from the other, these can be achieved by carrying out proximate analysis (moisture, fiber, lipid, ash, carbohydrate and protein content) and elemental analysis.

MATERIALS AND METHODS

Weighing balance (mettler PC 440), oven (Towson and Mercer limited), muffle furnace (Gallen kamp), Soxhlet extractor, heater, water bath, titration set up, distillation set up, Kjeldahl apparatus, atomic absorption spectrophotometer, fume cupboard, digestion flask and desiccators were used. Boric acid, boric acid indicator, hydrochloric acid, sodium hydroxide, ethanol, Kjeldahl catalyst, concentrated nitric acid, concentrated sulphuric acid, petroleum ether, trichloroacetic acid and glacial acetic acid were also used.

Collection of samples

The brown and white cowpeas were bought from terminus market, new market and Faringada market in Jos, Jos North Local Government Area, Plateau State, Nigeria.

Preparation of samples

All foreign particles were removed by picking. The seeds were then ground into fine powder before use.

Proximate analysis

The proximate analysis was done according to the standard procedures (AOAC, 1980). The dry matter (DM) content was determined by heating evaporating dishes to a constant weight using an oven. 2 g of the powdered samples were added into the dishes and reweighed. The dishes and its content were placed in an oven at 150°C and dried to constant weight. The ash content was determined by incinerating 2 g sample in a muffle furnace at 550°C until fully burnt to obtain ash of constant weight. Nitrogen was determined by micro-Kjeldahl method as described by Pearson (1976) and the crude protein content was calculated as N% × 6.25. Carbohydrate was determined by difference.

Elemental/mineral analysis

Mineral elements, calcium, magnesium, potassium, sodium, zinc, iron, manganese and copper were determined using the method of Association of Official Analytical Chemist (AOAC, 1980) with the aid of atomic absorption spectrophotometer (Buck Scientific, 205 Model) using hollow cathode lamp of the elements and a fuel rich flame (air-acetylene). Standard and digested samples were aspirated and the mean signal responses were recorded at each of the element’s respective wave lengths. The blank determination was also conducted.

Statistical analysis of data

Statistical analysis of the data was carried out using Microsoft Excel 2003 with the aids of ANOVA. Significant differences were used to separate means at $P<0.05$.

RESULTS

The results of the proximate analysis of two varieties of *V. unguiculata* (white and brown cowpeas) are presented in Table 1, Figures 1, 2, 3 and 4. The cowpea varieties had a small amount of protein and large amount of carbohydrate. The crude protein was found to be 15.62 and 17.91% with the brown seeds having the higher amount. The ash and moisture content was found to

Table 1. Mean ± S.D. proximate analysis of *V. unguiculata* (per 100 g of seeds).

Parameter	Brown bean	White bean
Moisture	5.08 ± 0.31	3.56 ± 0.19
Crude protein	17.91 ± 0.09	15.62 ± 0.09
Crude fiber	13.54 ± 0.07	14.15 ± 0.06
Lipid	2.42 ± 0.20	2.13 ± 0.19
Total Ash	4.24 ± 0.59	4.07 ± 0.30
Carbohydrate	56.80 ± 0.72	60.47 ± 0.33

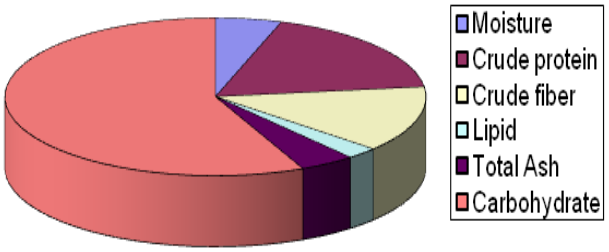

Figure 1. Mean proximate analysis (per 100 g) of *V. unguiculata* (brown) seeds.

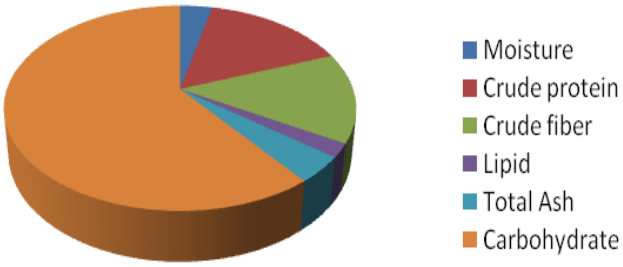

Figure 2. Mean proximate analysis (per 100 g) of *V. unguiculata* (white) seeds.

range from 4.07 to 4.24 and 3.56 to 5.08%, respectively, with the brown seeds having the higher amount. The fiber and carbohydrate content was found to range from 13.54 to 14.15% and 56.80 to 60.47%, respectively, with the white seeds having the higher amount.

The concentrations (mg/100 g) of the elements determined in the seeds are as shown in Table 2. Potassium was the most abundant element in the seeds. It was found to be 741.3 to 768.0 mg/100 g. The least was found to be copper which was 0.58 to 0.60 mg/100 g.

Other elements analyzed were calcium, sodium, magnesium, manganese, zinc and iron and the elemental contents were found to range from 160.40 to 182.0, 78.15 to 84.65, 189.91 to 195.33, 14.27 to 15.83, 4.47 to 5.66 and 5.661 to 5.663 mg, respectively.

DISCUSSION

The proximate composition of the seeds analyzed is shown in Table 1. The moisture content of the two varieties of cowpeas (white and brown) analyzed was found to be 3.56 and 5.08% with the brown seeds having the higher value. The two varieties showed significant difference at $p<0.05$. The white seeds having lower moisture content can be stored for a longer period of time than the brown seeds. High water/moisture content in seeds, predispose them to bacterial and fungal attack. As a result of the value of the moisture content of brown seeds not being so high, it can also be stored for a long period of time. The value for brown seeds falls within the range given by Yagodin (1984) which is 5 to 8%.

The crude protein content of the cowpea varieties was 15.62 and 17.91% with the brown seeds having the higher value. At $p<0.05$, there is significant difference between the two varieties of cowpeas. This range of values falls within the range given by Tobin and Carpenter (1978) which is 15 to 30%. Cowpeas are rich sources of protein. Dietary proteins are needed for the synthesis of new cell, repair of worn out tissues, enzymes, hormones, antibodies and other substances required for healthy functioning and development of the body and its protection (Cheesebrough, 1987) and for the treatment of protein energy malnutrition (Omoruyi et al., 1994).

The crude fiber content of the seeds analyzed was found to be 13.54 and 14.15% with the white seeds having the higher value. The two varieties of cowpeas showed significant difference at $p<0.05$. The fiber content in relation to the diet is adequate, exerting a major influence on the metabolism of the gastrointestinal tract (GIT) and its deficiency is linked to appendicitis, diverticular disease and hemorrhoids (Gibney, 1989). Fiber also slows down the release of glucose into the blood and decreases intercolonic pressure, hence, reduces the risk of colon cancer (Gibney, 1989). This range of values obtained falls within the range reported by Gibney (1989) which is 13 to 19%.

The lipid content obtained from the analysis of the cowpea varieties was 2.13 and 2.42% with the brown seeds having the higher value. Cowpeas have been shown to be low in their lipid content (Davidson et al., 1975). At $p>0.05$, there was no significant difference between the two varieties of cowpeas.

Lipids provide strong energy and transports fat soluble vitamins like vitamins A, D, E and K (Ologhobo, 1988). The range of values obtained falls within the range 2.01 to 2.88% reported by Ologhobo and Fetuga (1988). The ash contents analyzed was found to be 4.07 and 4.24% with brown seeds having the higher value.

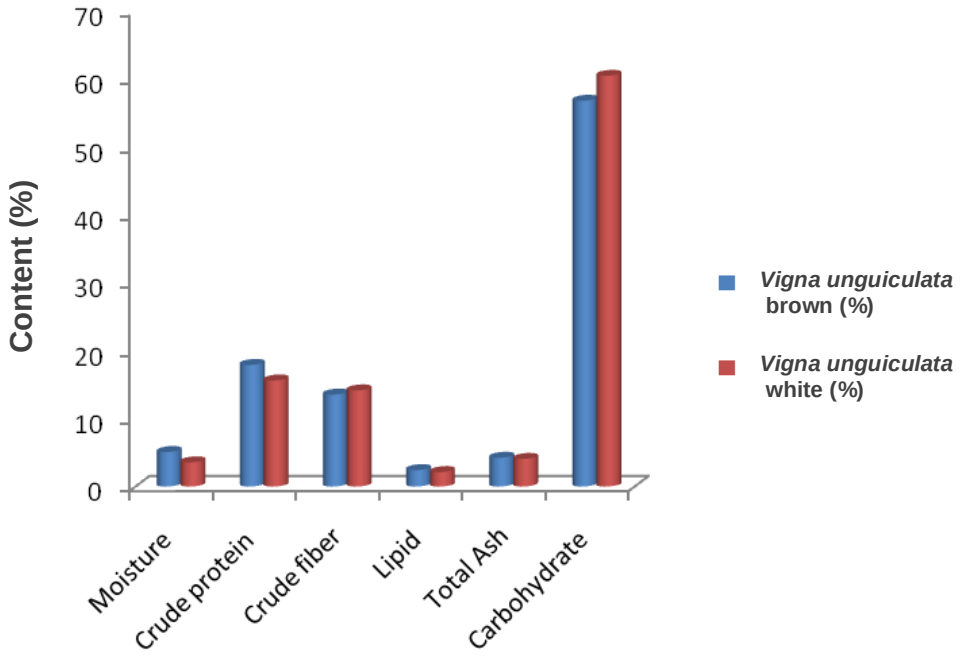

Figure 3. Graphical representation of content (%) of the two *V. unguiculata* seeds.

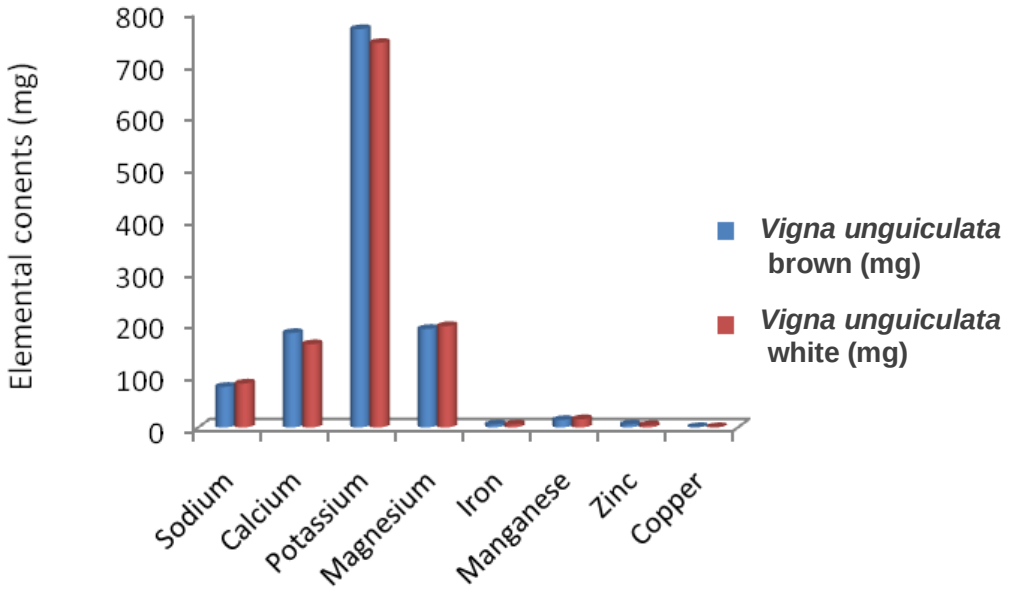

Figure 4. Graphical representation of elemental content of the two *V. unguiculate* seeds.

The two varieties showed no significant difference at $p>0.05$. This range of values obtained falls within the ranges given by Ologhobo and Fetuga (1988) and Yeshajahu (1991) as 4.1 to 4.77 and 2.8 to 4.9%, respectively. With these ranges of values, it means that small amount of inorganic compounds are present in the cowpea varieties. The carbohydrate content analyzed was found to be 56.80 and 60.57% with the white seeds having the higher value. The two seeds showed significant difference at $p<0.05$ for their carbohydrate content. Carbohydrates are good sources of energy, they are stored as glycogen which is the reservoir for glucose (Freedland and Briggs, 1977).

The elemental composition of the seeds is as shown

Table 2. Mean ± S.D. of elemental contents of *V. unguiculata* (raw seeds) mg per 100 g.

Mineral	Brown bean	White bean
Sodium	78.15 ± 0.05	84.65 ± 0.05
Calcium	182.00 ± 1.01	160.40 ± 0.1
Potassium	768.05 ± 1.49	741.29 ± 0.30
Magnesium	189.91 ± 0.00	195.33 ± 0.003
Iron	5.66 ± 0.23	5.66 ± 0.002
Manganese	14.27 ± 0.07	15.83 ± 0.23
Zinc	5.66 ± 0.002	4.47 ± 0.04
Copper	0.60 ± 0.009	0.58 ± 0.07

in Table 2. Potassium was the most abundant and was significantly higher than other elements analyzed and copper was the least. The values for the concentration of potassium in the two varieties were found to be 741.29 and 768.05 mg per 100 g with brown seeds having the higher value. The two varieties of cowpeas showed significant difference at $P<0.05$.

Potassium is essential for the maintenance of normal muscle functioning of the heart, proper nerve stimulation, regulation of water balance and osmotic pressure. It also helps to maintain acid-base balance. Deficiency results in muscle weakness, loss of appetite, nausea, drowsiness, etc. Cowpeas are rich sources of potassium. The concentration of calcium in the cowpea varieties were significantly ($p<0.05$) different; 160.40 and 182.0 mg per 100 g with the brown seeds having the higher value. Calcium ion regulates a number of physiologic and biochemical processes which includes neuromuscular excitability, blood coagulation, secretary processes, membrane integrity, plasma membrane transport neurotransmitters, bone mineralization and maintenance of healthy teeth (Dutcher and Fiela, 1967; Cheesebrough, 1987). The concentration of sodium was found to be 78.15 and 84.65 mg per 100 g with the white beans having the higher value. At $p<0.05$, there was significant difference between the two varieties of cowpeas.

The two varieties of cowpeas showed significant difference at $p<0.05$ for magnesium content. The concentration of magnesium was found to be 189.91 and 195.33 mg/100 g with white beans having the higher value. This range of value falls within the range reported by Ologhobo (1986) which is 148 to 220 mg per 100 g of sample. Cowpeas are good sources of magnesium (Thelma and Klein, 1966). Magnesium forms a part of enzyme activator and also a constituent of bones and teeth (Laestch, 1979; Murray et al., 1990). It also participates in growth metabolism of protein, lipid, carbohydrate and nucleic acid (Harrison and Hoare, 1980; Guthrie, 1989).

The two varieties of cowpeas showed no significant difference at $p>0.05$ for the iron content. The values of the concentration of iron was found to be 5.66 mg per 100 g for the samples of the two cowpea varieties which is similar to those reported by Fisher and Bender (1985) and Holland et al. (1991); 5.36 to 8.93 and 42 to 7.6 mg/100 g of cowpea varieties. Beans are a fair source of iron (Mannerberg and Roth, 1981). Iron forms part of cytochrome, enzyme activator used in haem synthesis. It plays a role in the transport of oxygen to tissues (Henry, 1984)

The concentration of manganese for the two varieties was found to be 14.27 and 15.83 mg/100 g with white seeds having the higher value. Manganese is important in growth, reproduction, skeletal structure and nervous system (Riedman, 1976). The two varieties of cowpeas showed significant difference at $p<0.05$. Manganese deficiency results in depressed reproductive function, abnormalities in the skeletal structures in animals and man. The concentration of zinc was 4.47 and 5.66 mg per 100 g with brown seeds having the higher value. The two varieties showed significant difference at $p<0.05$. Zinc has been shown to promote wound healing, promote attacks in sickle cell anaemia and control of hereditary diseases (Rafelson et al., 1980). Zinc also plays a role in taste, appetite and growth (Delvin, 1993). Its values fall within the values reported by Ologhobo (1986) which is 2.5 to 6.5 mg/100 g and Holland et al. (1991) which is 0.9 to 5.0 mg/100 g.

The concentration of copper which was found to be the least among the other elements was 0.58 and 0.60 mg/100 g in the cowpea varieties with the brown seeds having the higher value. At $p>0.05$, there was no significant difference, which is similar to the report of Holland et al. (1991).

Conclusion and recommendations

From the analysis, there were significant differences between the protein, fiber and carbohydrate content of the two varieties at $p<0.05$, but no significant difference between the lipid and ash contents at $p>0.05$.

From the elemental analysis, there were significant differences between the potassium, calcium, sodium, magnesium, manganese and zinc concentration of the cowpea varieties at $p<0.05$, but no significant difference in the iron and copper concentration at $p>0.05$.

In conclusion, brown cowpeas contain higher protein, calcium, potassium and zinc than white cowpeas, while white cowpeas contain higher carbohydrate and fiber content, magnesium, sodium and manganese than brown cowpeas. Iron content is the same in both varieties.

Based on the above facts, it is recommended that the two varieties should be considered in the diet. Those who consume one more than the other should try to consume the two so as to supplement some of the

nutrients that are reduced in one. People who consume mostly white cowpeas because they are less expensive than brown cowpeas, should try to consume brown cowpeas once in a while, because they contain more protein which is necessary for growth.

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