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Proximate and Elemental Analysis of Cowpea, Kidney and Sweet Cowpea Beans Sold in Kawo Market, Kaduna State, Nigeria

***[1]MUKTAR, B; [1]IBRAHIM, A; [2]JIBRIL, M**

**[1]Department of Applied Chemistry, School of Science and Technical Education, Kaduna Polytechnic, Kaduna.*
[2]Department of Agricultural Technology, School of Technology, Kaduna Polytechnic, Kaduna.
**Corresponding Author Email: bgmuktar77@gmail.com*

ABSTRACT: Beans are one of the most popular and essential foods in Africa, especially in Nigeria they are highly recommended for its numerous health benefits and nutritional values. The objective of this paper is to assess the proximate and elemental compositions of three (3) varieties of beans (cowpea, kidney and sweet cowpea beans) marketed in Kawo, Kaduna State, Nigeria using standard procedures and atomic absorption spectroscopy (AAS). The results from this study indicated that the highest results obtained for proximate and elemental analysis in the four (4) samples with the exception of fibre in sweet cowpea beans (2.082%), were found to be: moisture (13.250%), protein (21.420%), Lipids (1.025%), ash (4.814%) in kidney beans while in the case of elemental analysis, the highest concentrations (88.0mg/kg) of Zn was found in (Cowpea bean), (52.5mg/kg) of Mg in sweet cowpea, (75.0mg/kg) of Cu in cowpea beans while Fe (99.5mg/kg) and Ca (99.5mg/kg) were found in kidney beans. All the beans samples analyzed for proximate and elemental analysis from Kawo market are highly nutritious, hence good for human and livestock consumption.

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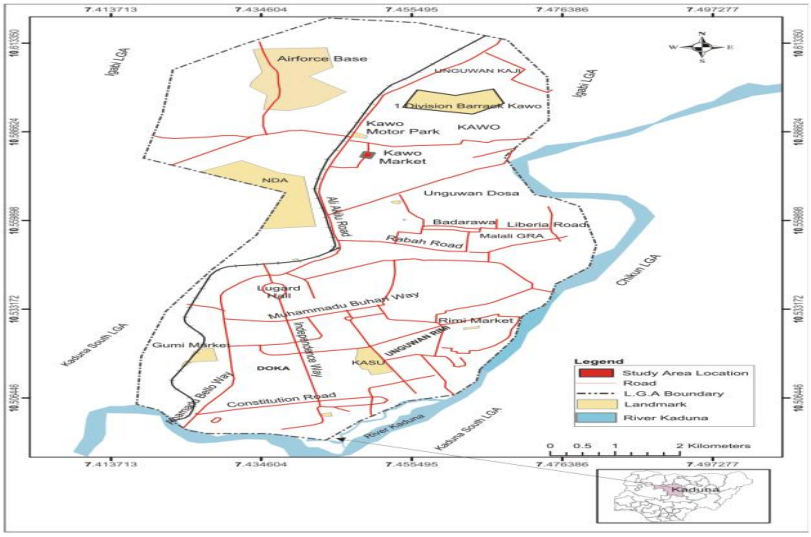
Beans is a leguminous plant which is widely grown by farmers in various varieties and has about 32 species, it is in the plant family of leguminosae. Beans are highly recommended to eat because of its numerous health benefits and nutritional values and also are the main protein source when compared to all other proteinous foods (Bawa *et al.*, 2003). Beans are one of the most popular and essential foods in Africa, especially in Nigeria and the 4th most consumed after cassava, yam, and rice. Beans are large and white, but can come in different colour like brown, red, dark red, black etc. It is kidney shaped and some spherical in shape but irrespective of their shape, size and colour, beans are highly nutritive and contain Vitamin A, protein, iron, vitamin B6, vitamin E and many more (Damaris, 2007). The high cost of animal protein has direct interest towards several leguminous seed proteins as potential sources of vegetable protein for human food and livestock feeds (Esenwah and Ikenebomeh, 2008). Legumes are generally well adapted to a wide range of climates and environmental conditions. In Nigeria, an important factor limiting the rapid development of the livestock industry is the increasing unavailability and consequent high cost of the conventional feed ingredients of protein source like soybean and groundnut cake (Bawa *et al.*, 2003). This has threatened the potential for increasing animal protein production, which is in short supply. Most common plant protein sources for human consumption are also the major sources of plant proteins for livestock feed formation. This results in a high cost of conventional plant protein foods and a generally substandard feed production (Adegbola, 1990). Of the thousand known legume species, only few have been extensively promoted and used. Many other potential legumes are still marginally unknown (Osman, 2007). These potential legumes might be of great importance in many zones of developing countries where there is a pressing need for food sources of high energy and good quality protein (Osman, 2007). The bean is classified by the National Academy of Science (NAS) as potential source of protein that has not been explored yet. In view of this, the use of underutilized legume grains that have low preference as human food and are obtainable at relatively lower costs are being investigated (Bawa *et al.*, 2003). Lablab seed is an example of such unconventional and under-utilized protein source. Lablab seed has low preference as human food (Bawa *et al.*, 2003) have emphasized the need for vigorous research on non-conventional legumes for use in food preparations as protein sources. There have been only limited studies on the use of seeds as livestock feed. Presently, there is much interest in the cultivation of lablab crop because of its

**Corresponding Author Email: bgmuktar77@gmail.com*

attribute as a dual-purpose legume (Ogundipe *et al.*, 2003). Legumes for food are probably as old as agriculture and civilization itself. Lentils are mentioned in the Old Testament, and beans figure in designs on pre-Colombian pottery from New World archaeological sites (Welch, 2000). Remains of beans have been found in diggings as old as 800BC in the Guitarrero cave in Peru. In both the old and the new worlds, legume consumption has evolved in conjunction with cereals: lentils, chickpeas, pigeon peas, grams and cowpeas with wheat, rice, millet and sorghum in the old world, common beans and other *Phaseolus* species with maize in the new world. Thus, the dietary role of legumes should be considered in this importance. Beans could serve as functional food because they contain a number of bioactive compounds such as enzyme inhibitors, lectin, phytates, oligosaccharides and phenolic substance that may play metabolic roles in humans and animals that frequently consume this food (Diaz-Batalla, 2006). The consumption of beans has been associated to several health benefits like reduction of cholesterol level (Rosa, *et al.*, 1998), and coronary heart diseases (Anderson *et al.*, 1999). Favorable effects against cancer decrease of diabetics, obesity, high antioxidant capacity, anti-mutagenic and anti-profilerative effects (Mario *et al.*, 2009). Developing nations, for example, Nigeria have shown mortality rate of 10 – 20 times that of developed countries due to protein – energy malnutrition (PEM) and it has been estimated that 800,000 (Eight hundred thousand) children might die from malnutrition before age of 4 years (Adeyeye and Adamu, 2005). The pertinent role played by Beans as food substance for both man and animals cannot be overemphasized. Dried beans play a prominent role in the diets of many vegetarians and may contribute to some of the health benefits associated with this eating pattern (Haddad and Tanzman, 2003). Their health benefits derive from direct attributes, such as their low saturated fat content and high content of essential nutrients and phytochemicals, as well as to displacement effects when they are substituted for animal products in the diet. Therefore, the objective of this paper is to assess the proximate and elemental compositions of three (3) varieties of beans (cowpea beans, kidney beans, sweet cowpea beans) commonly sold in KawO Market of Kaduna State, Nigeria.

MATERIALS AND METHOD

Sampling and Study Area (Description of the Study Area: Kaduna state is located in the north-western Nigeria on the Kaduna River. Kaduna is a trade centre and a major transportation hub for the surrounding agricultural areas which has rail and road junction. The population of Kaduna was 4,760,084 as of the 2006 Nigerian census, and this is believed to have grown to over 5.8 million as at 2013. The symbol of Kaduna state is the crocodile, called Kada in the native Hausa language (www.onlinenigeria.com, 2016).



Source: Geographical Information and Studies Department, Kaduna State University

Proximate Analysis: The proximate analysis was done according to Standard procedure (AOAC, 2000). All the chemicals used in this study were of analytical grade, unless stated otherwise.

Determination of moisture Contents: Procedure: The moisture dish was accurately weighed. Approximately 1.0g of the sample was added and then re-weighed. It was then kept in vacuum oven for five hours. The dish was then removed from the oven, cooled and reweighed. This was repeated until a constant weight was obtained (AOAC, 2000).

Determination of ash Content: Procedure: Accurately, 7g of the sample was weighed in a crucible which had been dried. The crucible was then dried in oven at 100°C. It was then transferred to muffle furnace and temperature increased to 550°C. This was maintained for 5 hours until a white ash was obtained. The crucible

was removed from desiccator and weighed soon after cooling (AOAC, 2000).

Determination of crude protein: Procedure: The crude protein was determined using micro-Kjeldah method as described by (AOAC, 2002).

$$\%N(wet) = \frac{(A-B) \times 1.4007 \times 100}{weight(g) of\ sample}$$

A = volume (ml) std HCl × normality of std HCl; B = volume (ml) std NaOH × normality of std NaOH

Determination of crude lipid: Procedure: This was done gravimetrically. Exactly 5g of the sample was weighed into thimble. Extraction was carried out using petroleum ether (40-60°C) for 3 hours. The extractant was distilled off and the flask reweighed (AOAC, 2000).

$$\%\ lipid = \frac{weight\ of\ lipid \times 100}{weight\ of\ sample}$$

Sample preparation: The foreign particles present in the beans were carefully removed by method of hand picking. The various samples were grounded using mortar and pestle. The mortar was decontaminated by washing with distilled water, soap and dried after each sample was grounded.

Sample digestion: The sample was digested into solution by the dry digestion method. Twenty grams (20g) of the sample was accurately measured into beaker, 15mL (HCl) and 30mL (HNO_3) (aqua regia 1:2) was added and heat on the hot plate for 10 minutes. It was allowed to cool and later filtered through ash less filter paper and collected in a volumetric flask, rinsed with warm deionized water, hence forming a clear solution. This was emptied into a plastic bottle and taken for AAS analysis.

*Conversion of the sample concentration from mg/L to mg/k*g: This formula below was used for the conversion

$$MC\ (mg/kg) = \left[\frac{(A,\ mg/L) \times (B\ , mL)}{(C,\ Kg)}\right] \times 1000$$

Where MC = metal concentration, A = conc of metal AAS, mg/L; B = volume of sample used, mL; C initial weight of sample

Elemental analysis: The elemental analysis of three (3) varieties of beans (cowpea, kidney and sweet cowpea) was determined by Atomic Absorption Spectrometry according to the method of (AOAC, 2003).

RESULTS AND DISCUSSION

Moisture content: Each variety of the cowpea (cowpea and sweet cowpea) contain certain amount of moisture, the moisture contents were found to be 10.0% (cowpea) and 8.340% (sweet cowpea), with the kidney bean having the highest value of (13.250%). At a moisture level below 10%, respiration in most food grain almost stops, increasing the grain storage life (Sujeetha, 2014). The moisture content of the sweet cowpea (8.340%) was less than 10% and falls within the optimum moisture content range for safe storage than the kidney bean (13.25%). High moisture content in seeds, predispose them to bacterial and fungal attack. As a result of the value of the moisture content of kidney beans is being so high, it cannot be stored for a long period of time. Mustapha and Magdi (2003) reported (8.33- 8.58%) and Abu, (2001) reported 1.20% - 1.92% for moisture content.

Table1: Proximate Analysis of Three (3) Varieties of Beans

Parameters	CB (%)	KB (%)	SCB (%)
Moisture	10.00	13.250	8.340
Protein	19.530	21.420	19.830
Lipid	0.698	1.025	0.389
Ash	3.080	4.814	4.140
Fibre	2.048	2.043	2.082

Keys: Cowpea bean (CB), Kidney bean (KB), Sweet cowpea bean (SCB)

Protein content: The protein content was found to be 19.530% in cowpea beans while that of sweet cowpea is (19.830%), the kidney bean having the highest value of 21.420%. It has been shown that any plant food that provides about 12 % of its calorific value from protein is considered a good source of protein (Effiong *et al*., 2009; Ali 2010). The protein content of all the samples of the bean analysed in this study was higher than the (10.6 -11.7 %) reported by Nyananyo and Nyingifa (2011) and agreed with the findings of Eromosele *et al*., (2008) who reported values of 21-29 % for the protein content and within the range of (9.9-23.7%) of protein values reported by Ameh (2007).

Lipid content: The lipid contents was found to be (0.698%) in cowpea and (0.389%) in sweet cowpea while kidney beans has the highest value of (1.025%). Lipids play important role in diet as important energy source, and also aid the transportation of fat soluble vitamins A, D, E, and K (Inobeme *et al*., 2014). The range of values obtained falls below the range Mustapha and Magdi (2003) 3.58-4.47%; Abu, (2001) 2.22- 3.65%.

Ash content: In the case of ash content, it was 3.080% in cowpea beans while in sweet cowpea and kidney bean they were found to be 4.140% and 4.814%. The ash content of all the samples in Table 1 observed is moderate but higher than those of the wild jack bean 3.0% (Vidivel and Janardhanen, 2001), but lower than melon seeds 3.3% (Omafuvbe *et al*., 2004) and *Vigna ublobata* 3.2% (Khalil and Khan, 1995), castor seeds (*Ricinus communis*) 3.2% (Onyeike and Acheru, 2002). Since all the samples contained fairly high ash content, it may indicate that the legume could provide essential valuable and useful minerals needed for good body development since soya bean which occupies a unique (Temple *et al.*, 1991).

Table 2: Elemental Analysis of Cowpea, Kidney and Sweet Cowpea bean

Elements	CB (mg\kg)	KB (mg\kg)	SCB (mg\kg)	STANDARDS(mg\kg)
Zn	88.0±0.23	15±0.04	12.5±0.07	100 (USDA, 2003)
Mg	17.0±0.30	37.5±0.10	52.5±0.05	10 (USDA, 2003)
Cu	75.0±0.09	72.5±0.02	70.5±0.02	10 (CAC, 1993)
Fe	85.5±0.06	99.5±0.04	0.3±0.04	30 (CAC, 1993)
Ca	40±0.07	75.0±0.10	32.5±0.02	60 (CAC, 1993)

Keys: *Cowpea bean* ***(CB)****, Kidney bean* ***(KB)****, Sweet Cowpea bean* ***(SCB)****, United States Department of Agriculture* ***(USDA)****, and Codex Alimentarius Commission* ***(CAC).***

Fibre content: Crude fiber refers to the indigestible plant material. It lowers blood cholesterol level in humans, prevent cancer, and reduces the risk of developing diabetes, hypertension, and hypercholesterolemia (Oboh and Omofoma, 2008). The fiber content recorded in the current study ranged between 2.043% and 2.082% with 'Kidney bean' recording the lowest values while 'sweet cowpea bean' recorded the highest value (Table 1). These findings are in line with values reported previously (Moses *et al*., 2012). Current results for the three bean samples are also in agreement with findings of Fasoyiro *et al.,* (2006) who recorded values of (1.98-7.20%) fiber for different legumes.

Zinc: The elemental analysis of the three (3) of bean samples in Table 2 indicated that zinc has the highest of concentration of (88.0 mg/kg) in cowpea beans, this value is less than (100 mg\kg) given by (USDA, 2003). Zinc plays an important role in insulin action, carbohydrate and protein metabolism (Lee *et al.,* 2005). The administration of zinc, magnesium, selenium, vitamin A and vitamin E improves tissue response to insulin and increases the efficacy of drugs which act through this pathway (Gunasekera *et al*., 2011). Studies showed higher Zn deficiency in diabetic adults compared to normal adult subjects (Lee *et al*., 2005 and Yoon and Lee 2007). This mineral is crucial to human well-being and an adequate supply of zinc helps to prevent zinc deficiency, and prevalent health concerns of the developing world (Blair *et al*. 2009). According to the World Health Organization (WHO), zinc Vitamin A deficiencies are the most common forms of malnutrition, leading to severe public health consequences (Carvalho *et al*. 2012).

Magnesium: The three varieties of beans showed significant difference for magnesium content. Sweet cowpea bean was having the highest concentration (52.5 mg/kg) and this range of value falls above the range reported by (Inobeme *et al*., 2014). All the concentrations of the three varieties of beans were above the standards by USDA, 2003 (10 mg\kg). Magnesium forms a part of enzyme activator and also a constituent of bones and teeth (Murray *et al*., 1990).

Copper: The concentration of copper which was found to be (75 mg/kg) in cowpea beans which is similar to the report of (Holland *et al*., 1991) but much greater than the one given by CAC 1993 (10 mg\kg). Copper is a key for iron absorption, efficient utilization of oxygen and for combating free radicals that can cause cell damage. It was also found that iron has the highest concentration of (75 mg/kg) in sweet cowpea beans while kidney (72.5 mg/L) and cowpea beans (70.5 mg/kg) concentrations, these values were much higher than the standard (CAC, 1993) 10 mg\kg.

Iron: Beans are a fair source of iron. Iron forms part of cytochrome, enzyme activator used in haem synthesis. It plays a role in the transport of oxygen to tissues (Holland *et al*., 1991). With the exception of sweet cowpea beans (0.3mg/kg), kidney and cowpea beans showed concentrations more than the one described by (CAC, 1993).

Calcium: The concentration of calcium in the kidney beans was found to be (75 mg/kg) while that of cowpea bean and sweet cowpea were 40 mg/kg and 32.5mg/kg respectively. Calcium is an essential macronutrient for humans, which represents approximately 2% of body weight in an adult person (Petrovich *et al*., 2007). Food rich calcium should be consumed for better calcium intake (Miller and Aderson, 1999; Saini and Davar, 2012). With the exception of Kidney beans (75mg/kg), the concentrations of calcium found in the two varieties of beans were much lower than the one by (USDA, 2003).

Conclusion: The proximate and elemental analysis of three varieties of beans showed that cowpea, kidney and sweet cowpea beans were rich in protein, zinc, magnesium, copper, calcium, had high dry matter contents and low moisture, lipid, ash and fat contents. Consumption of these beans may therefore be a useful strategy to overcome protein energy malnutrition, especially in rural areas where malnutrition is common.

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