Determination Of Physico-Chemical Properties Of Bitter Kola (Garcinia Kola)

Oloko S.A., Oyedele O.A.

Abstract— **This study evaluate the proximate composition, mineral composition and anti-nutrient content of (wet and dry) better kola. Colour appearance, shape and size, texture, odour, flavor and colour peeled seed were some of the physical properties observed. From the experimental results of the average value of the physical properties of wet and dry bitter kola samples 1.268g/cm3 and 1.517g/cm3 were recorded as the density, volume and mass of the wet dry bitter kola seed respectively. Carbohydrate of dry bitter kola and carbohydrate of wet bitter kola seeds were 72.84% and 43.94% respectively. The Moisture content of dry (13.78%) was significantly lower than the moisture content of wet (51.97%), while Crude Ash for dry (0.74%) is higher than Crude Ash for wet (0.31%), crude protein for dry (5.32%) is higher than crude protein for wet (1.295%), crude fat for dry (3.37%) is higher than crude fat for wet (1.295) and crude fibre for dry (3.97%) is higher than crude fibre for wet (1.45%) all present in appreciable amounts. The Minerals and Anti-nutrient analysis revealed the nutritional and medicinal values of Bitter kola. The levels of Iron, Zinc, Copper, Lead, Magnesium, Manganese, Sodium, Potassium, Calcium, Phosphorous in dried bitter kola seeds is higher than wet bitter kola seed. The anti-nutrient results obtained showed that Oxalate (7.52mg/100g), Phytate (95.17mg/100g), Tannin (1.04mg/100g) and Alkaloids (4.61mg/100g) were obtained for dried bitter kola while (2.84mg/100g), (104.24mg/100g), (0.62mg/100g), and (1.22mg/100g) were obtained for wet bitter kola seeds. These result suggested and the bitter kola possess nutritional and healthy benefits**

Index Terms— **Physical properties, Chemical properties, Moisture content, Bitter kola.**

I. INTRODUCTION

The engineering properties of foods are important, if not essential, in the process design and manufacture of food products. (Barbosa – canovas and Juliamo, 2009). They are also useful in analysis and determination of the efficiency of a machine or operation, development of new products and equipment and the final quality of products (Mohsenin, 1986). Size and shape are important in determining the method of separation and cleaning especially by pneumatic method, density and specific gravity are needed in calculating thermal diffusivity in heat transfer and Reynolds' number in pneumatic and hydraulic handling separation, and determination of terminal velocity (Mijinyawa and Omoikhoje, 2005). Coefficient of friction of materials on various structural surfaces is important in predicting the movement of the materials in handling and harvesting equipment and the pressure exerted on the walls of storage structures (Mijinyawa and Omoikhoje, 2005).

The basic engineering properties exhibited by agricultural material include the physical, mechanical, thermal, optical and electrical properties (Mohsenin, 1970). These basic properties including chemical properties are widely applicable in the storage packaging, handling, and transportation and processing of agricultural material (Oloko et al; 2009). Garcinia kola (Heckel), an angiosperm, belonging to the family Guittferae, is known in commerce as bitter kola. On chewing, G. Kola seed a bitter astringent and resinous taste, somewhat resembling that of raw coffee, followed by a slight sweetness. Bitter kola is popular in Southern Nigeria. The plant is extensively used in herb medicine and as food. It prevails as a multipurpose to crop in the home gardens of Southern Nigeria (Jazi et al., 2013). Bitter kola is a highly valued ingredient in African ethno medicine because of its varied and numerous uses which are social and medicine, thus making the plant an essential ingredient in folk medicine. Medicinal plants such as Garcinia kola are believed to be an important source of new chemical substances with potential therapeutic benefit (Eisner, 1990).

Garcinia kola is a dicotyledonous plant found in moist rain forest and swamps and grows a medium sized tree up to height of about 12 m high. It is cultivated through the seedlings or with cuttings. The bitter kola plant is found in countries across west and central Africa and it is distributed by man around the towns and villages of such countries like; Nigeria, Ghana, Cameroon, Sierra Leone, Togo, Congo Democratic Republic, Angola, Liberia, Gambia etc. Across the places where it grows it is known by various names such as bitter kola, male (English name), orogbo (Yoruba), Aku ilu (Igbo) and Namijin goro (Hausa). It is also known as false kola mainly due to the absence of stimulus which characterizes the kola seeds. It is also known as male kola due to the reported aphrodisiac properties of Garcinia kola.

II. MATERIALS AND METHODS

2.1 **Sample Source**

About 50 matured of both wet and dried were bought from place market in Ado-Ekiti in Ado Local Government Area of Ekiti State, Nigeria. Samples were weighed on a weighing balance. The chemical properties such as protein, carbohydrate, pat, fibre and ash were analysed at the Science Technology Laboratory of the Federal Polytechnic, Ado-Ekiti, Ekiti State.

2.2 **Methodology**

2.2.1 **Determination of Physical Properties**

2.2.1.1 **Colour and Appearance**

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The colour and appearance of bitter kola was determined through visual observation. Visits were paid to the laboratory where the bitter kola tray was placed and various samples were collected.

2.2.1.2 **Mass Determination**

50 samples each of wet and dried of bitter kola fruit were collected. The samples were weighed individually on the electronic weighing balance.

2.2.1.3 **Size and Shape Determination**

The size and shape of the bitter kola was determined by visual observation. The size was determined using digital vernier caliper (least count 0.01). 50 samples each of both the dry and wet bitter kola was determined by measuring their dimensions to obtain their Geometric Mean Diameter (G.M.D) using equation (1) below:

$$G.M.D = \sqrt[3]{a\ x\ b\ x\ c} \quad \text{..... (1)}$$

(Mohsenia, 1980)

Where:
a = Major diameter
b = Intermediate diameter
c = Minor diameter

2.2.1.4 **Volume Determination**

The volume of the bitter kola seed was determined using measuring cylinder. The measuring cylinder was filled with water to a certain level which was noted, the seed was immersed into the cylinder the level of displaced water was noted, the initial level was subtracted from the final level to get the volume of the seed.

2.2.1.5 **Density**

Mathematically, density is expressed as a ratio of mass and volume of the material. With the result in the masses and the volume of 50 samples each of wet and dry bitter kola seed determined above, the density of each were calculated using equation (2) below:

$$Density\ (kg/m^3) = \frac{Mass\ (Kg)}{Volume\ (m^3)}$$

2.2.1.6 **Sphericity**

The degree of sphericity was calculated using equation (3) below:

$$Sh = \frac{(abc)^{1/3}}{a} \quad \text{..... (3)}$$

(Mosheinin, 1980

Where:
Sh = Shericity
a = major diameter
b = major intermediate diameter
c = minor diameters

2.2.1.7 **Surface Area**

Surface area is defined as the total area over the outside of the bitter kola. Surface area (S) was theoretically calculated as by graphically method.

2.2.1.8 **Bulk Density**

The bulk density was determined by weighing a 100cm^3 cylinders empty. They cylinder was then filled with the bitter kola seeds and reweighed.

$$D_b = M_2 - \frac{M_1}{V} \quad \text{..... (4)}$$

(Baver et al; 1978)

Where:
D_b = is bulk density,
M_1 = is the mass of empty cylinder
M_2 = is mass of cylinder plus bitter kola seeds and
V = is the volume of cylinder.

Five trails were carried out for each set of seed (wet and dry) and their means were recorded.

2.2.1.9 **Porosity**

Based on the relationship for porosity by Mosehnin (1978) the porosity was calculated thus:

$$P_f = 1 - \frac{D_s}{D_b} \quad \text{..... (5)}$$

(Mohsehnin, 1978)

Where:
P_f = is the porosity of grain
D_b = is the bulk density and
D_s = is the solid or bitter kola density of grain.

2.3 **Proximate Analysis**

Proximate analysis was carried out on the samples of bitter kola seed to determine the various nutritional values of the crop such as:

* Moisture content
* Ash content
* Crude protein
* Fat
* Crude fibre
* Carbohydrate

The test was carried out in the Prof. Julius Okojie Central Research Laboratory at Federal University of Technology, Akure.

Also some Anti-nutrient tests on the bitter kola were carried out such as:

* Alkaloid
* Phytate
* Tannin
* Oxalate

2.3.1 **Moisture Content Determination Using Air Oven Method**

The moisture content was determined by the method describe by Association of Official Analytical Chemist (AOAC (1990). Cleaned and well labeled patri dishes were washed, each of the dish were then put inside the desiccators to oven dried and cooled, then weighed and recorded as (W_1). The bitter kola samples (both wet and dry) were placed into the petri dish and the weight of both the samples and the dishes were taken as (W_2). The samples were later oven dried at 105°C for 3 hours. After 3 hours, it was then transferred into the desiccators, cooled for an hour and weighed continuously until a constant weight were attained as (W_3). The moisture content for each samples was calculated using equations (6) and (7) respectively.

$$\%\ Moisture = \frac{loss\ in\ weight\ due\ to\ drying}{Weight\ of\ samples\ before\ drying}\ x\ 100 \quad \text{.. (6)}$$

$$\%\ Moisture\ content = \frac{W_3 - W_1}{W_2 - W_1}\ x\ 100 \quad \text{.... (7)}$$

Where:
W_1 = initial weight of empty petri dish
W_2 = weight of petri dish + bitter kola
W_3 = Final weight of petri dish + bitter kola after drying

2.3.2 **Total Ash Content Determination**

Procedure for ash content determination is as follows:

The total ash content was determined by using the procedure of AOAC method (2002). About 2g of bitter kola as weighed into clean crucible of weighed (W_1) and together weighed as (W_2). The crucible was then placed into a muffle furnace chambers at 600°C. The bitter kola turned into ashes. The crucible were removed from the furnace, it was cooled in the desiccators and allowed to cool to room temperature and reweighed as (W_3).

The ash content was determined using equation (8) below:

$$\%\ Ash = \frac{W_3 - W_1}{W_2 - W_1}$$

%Organic matter = 100 - % Ash ……..…… (8)

Where:

W_1 = Weight of crucible

W_2 = Weight of crucible + bitter kola before drying

W_3 = Weight of crucible + bitter kola after drying

2.3.3 **Crude Protein Determination**

The total crude protein content was determined using Micro Kheldhal Method (Association of Official Analytical Chemist, 2002).

0.2g of bitter kola was weighed into a kjeldhal flask, then ten millimeter of concentrated sulphuric acid was added followed by one kjeltec tablet. The mixture was digested to obtain a clear solution and the digested sample was cooled and 75ml distilled water was added and boiled and 50ml of sodium hydroxide solution was added. The ammonia formed in the mixture was subsequently distilled into 25ml, 2% Boric acid solution containing 0.5ml of indicator methyl red. The distillate collected was then titrated against 0.1M of HCL. Blank titration was also carried out on the reagent and nitrogen in the samples was calculated. The nitrogen content was multiplied by 6.25 to obtain crude protein content. As shown in equations (9) and (10) respectively.

$$\%Nigrogen = \frac{titrate\ value\ x\ M\ x\ 0.014}{Weight\ of\ bitter\ kola}\ x\ 100 \quad \ldots. (9)$$

$$Crude\ protein = \%Nitrogen\ x\ 6.25 \quad \ldots\ldots.(10)$$

Where:

N = Nitrogen

6.25 = conversion factor

2.3.4 **Crude Fat Determination**

Crude fat were determined by the method describe by AOAC method (2002). Crude fat was determined by using soxhlet apparatus. Approximately 3.0 grams of Bitter kola were put into a thimble and extracted with n-hexane for about 6 hours. The solvent were removed from the extracted oil by evaporation. The oil was further dried in a hot – oven at 100°C for 30mins to removed residual organic solvent and moisture. This was cooled in desiccators and weighed. The quantity of the oil was expressed as percentage (%) of the original bitter used. Equation (11) was used to determine the crude fat in the samples used.

$$\%Crude\ fat = \frac{W_4 - W_3}{W_2 - W_1}$$

Where:

W_1 = Weight of thimble

W_2 = Weight of thimble + Bitter kola

W_3 = Weight of round bottom flask

W_4 = Weight of round bottom flask + residual oil

2.3.5 **Crude Fibre Content Determination**

Crude fibre content was determined using a method as described by 2000 or 2002. Association of Official Analytical Chemists (2002). 2.0grams of bitter kola was weighed (W_1) which were extracted with n-hexane. This was transferred into a little flask. Sulphuric acid (1.25%, 200ml) was added and the flask was placed on a hot plate and boiled for 30mins. The content was filtered and the residue was washed with distilled water. The residue was then transferred into ashing dish and dried at 130°C for 30mins and cooled in desiccators and weighed (W_2). This was then ignited at 600°C cooled and re-weighed (W_3). Equation (12) was used to calculate the crude fibre of the same content of samples used.

$$\%Crude\ Fibre = \frac{W_2 - W_3}{W_2 - W_1}\ x\ 100 \quad \ldots\ldots\ldots\ldots (12)$$

Where:

W_1 = Bitter kola weight

W_2 = Bitter kola weighted + dish after drying

W_3 = Bitter kola weighted + dish after ingnited

2.3.6 **Carbohydrate Content**

The carbohydrate content determination was carried out by different method.

In this method carbohydrate content was determined by subtracting the value of the analyzed components i.e. Moisture content, protein, crude fat, ash content, crude fibre, from 100%, and was expressed in percentage i.e. 100% (crude protein + total ash + crude fibre + crude fat + Moisture content).

2.3.7 **Alkaloid Determination**

Alkaloid was determined using Harborne (1973) method:

5g of the samples (Bitter kola) were weighed into a 250ml beaker and 200ml of 10% acetic acid in ethanol was added and covered and allowed to stand for 4 hours this was filtered and the extract was concentrated on a water bath to one quarter of the original volume. Concentrated ammonium hydroxide was added drop wise to the extract until the precipitation was complete. The whole solution was allowed to settle and the precipitated was collected and washed with dilute ammonium hydroxide and then filtered (Obadoni and Ochuko, 2001). The residue is the alkaloid which was dried and weighed.

2.3.8 **Phytate**

Procedure for phytate determination

The Method of Young and Greaves (1990) was used. To determined phytate content of the samples used as shown below:

8g of finely ground bitter kola was soaked in 200ml of 2% of HCL and allowed to stand for 3 hours after 3 hours, it was filtered through layers of hardened filter paper and 50ml pipette from the filtrate into a 400ml beaker and 10ml of 3% ammonium thiocynate solution was added as an indicator. 107ml of distilled water was added to obtain the proper acidity. The solution was filtered with a standard ferric chloride solution containing about 0.00185/ml until a brownish yellow from the amount; phytin phosphorous was

found by multiplying with a factor of 1.19, this was later converted by multiplying with the factors of 3.55 to obtain phytic acid content. Equation (13) was used as shown below:

$$Phytic = Factor\ x\ titre\ x\ \frac{100}{1000}\ x\ weight\ of\ bitter\ kola \quad \ldots\ldots\ldots (13)$$

2.3.9 **Oxalate Determination**

Procedure for oxalate determination

1g of the sample (bitter kola) was weighed into 100ml conical flask. 75ml of 1.5N H_2SO_4 was added and the solution was carefully stirred intermittently with a magnetic stirrer for about 1 hour and then filtered using Whatman N o. 1 filter paper.

25ml of sample filtered (extract) was collected and titrated hot (80 – 90°C) against 0.1N$KMnO_4$ solution to the point when a faint pink colour appeared that persisted for at least 30 seconds (Day and Underwood, 1986).

2.3.10 **Tannin**

Procedure for tannin determination

About 200mg of finely ground sample (bitter kola) was weighed into a 50ml sample bottle. 10ml of 70% aqueous acetone was added and properly covered. The bottles were put in an ice bath shaker and shake for 2 hours at 30°C. Each solution was then centrifuged and the supernatant stored in ice. 0.2ml of each solution was pippeted into test tubes and 0.8ml of distilled water was added. Standard tannin acid solutions were prepared from a 0.5mg/ml stock and the solution made up to 1ml with distilled water.

0.5ml folin reagent was added to both samples and standard followed by n2.5ml of 20%Na_2CO_2. The solution were then vortexes and allowed to incubate for 40 minutes at room temperature after which absorbance was read at 725mm against are agent blank concentration of the samples from a standard tannin acid curve (Makkar and Godchild), 1996).

2.4 **Minerals Content Analysis**

Standard method from AOAC (1990) was used to determined the mineral content of the samples used.

The minerals were analyzed from solution obtained by first dry ashing as follows about 1.5g of the flour samples (bitter kola) was placed in a dish and heated gently on a Bunsen burner in a fume cupboard until the charred mass had encased to emit smoke and it was transferred to muffle furnace at 5500°C. Heating was continued until all the carbon was burnt away. The dish plus ash was transferred to desiccators to cool after which 0.1MN HNO_3 solution 910mls was added to crucible to break up the ash. It was then filtered through acid washed No. 43 Whatman filter paper into 100ml with the same dilute acid solution.

Atomic absorption spectrophotometer was used for the analysis of the following metal, Ca, Fe, and P by Ultraviolent visible spectrophotometer using a yellow method. The standard for each metals using suitable metal salt of each was fixed. All metals analyzed for used hollow cathode lamps and air acetylene flame. The standard for each metal were aspirated into the flames as well as the samples and their respective concentration in mg/l read for each sample while the absorbance of the standard were noted. While Na, K, Ca were obtained by using photometer.

III. RESULTS AND DISCUSSION

3.1 **Results**

3.1.1 **Physical and chemical properties of wet and dry Biter kola**

Experimental analysis were carried out on some selected properties of wet and dry bitter kola such as shape, density, colour, volume, weight, surface area, bulk density, and sphericity. Table 1 shows the result of physical properties of wet and dry bitter kola. The average density is 1.268g/cm^3.

Similarly, the average mean of Major diameter, Intermediate and Minor diameter of wet and dry bitter kola seed were 345.51mm and 29.68, 20.47 and 14.68mm, 17.91mm and 13.34 respectively.

Water displacement method and visual observation were used to determine the volume and appearance of the wet and dried seeds respectively.

Experimental analysis was carried out on chemical analysis of wet and dried bitter kola seeds, using some chemical and reagents. Tables 3, 4 and 5 and Figures 1, 2 and 3 shows the results of chemical composition of wet and dried bitter kola seeds respectively.

Table 1: PHYSICAL PROPERTIES OF BITTER KOLA SEED

PARAMETERS	OBSERVATION
Colour	Hellow Pulp and Brown seed coat
Colour of Peeled seed	Milky
Shape	Eliptical/Oval
Texture	Hard
Odour	Slightly aromatic
Flavour	Bitter

Table 2: AVERAGE VALUE OF PHYSICAL PROPERTIES DATA MEASURED ON WET AND DRY BITTER KOLA SAMPLES

S/N	PARAMETERT	WET	DRY
1.	Major Diameter L (mm)	35.51	29.68
2.	Intermediate diameter B (mm)	20.47	14.68
3.	Minor diameter T (mm)	17.91	13.34
4.	Geometric mean diameter GM (mm)	23.47	17.89
5.	Sphericity	0.66	0.60
6.	Weight (g)	9.482	7.95
7.	Volume (cm^3)	7.540	5.66
8.	Surface Area (mm^2)	139.4	114.4
9.	Density (g/cm^3)	1.268	1.521
10.	Bulk density	1.725	1.517
11.	Porosity	-1.856	-0.252

Table 3: PROXIMATE COMPOSITION OF BITTER KOLA SEED

PARAMETERS (%)	DRY	WET
Moisture Content	13.78	51.97
Ash	0.74	0.31
Crude Protein	5.32	1.295
Fat	3.37	1.06
Fibre	3.97	1.45
Cabohydrate	72.84	43.94

Table 4: ANTI-NUTRIENTS COMPOSITION OF BITTER KOLA

PARAMETERS (mg/100g)	DRY	WET
Oxalate	7.52 mg/100g	2.84 mg/100g
Phytate	95.17 mg/100g	104.24 mg/100g
Tannin	1.04 mg/100g	0.62 mg/100g
Alkaloids	4.61 mg/100g	1.22 mg/100g

Table 5: MINERAL COMNPOSITION OF BITTER KOLA SEED

PARAMETERT	WET	DRY
Iron (Fe)	6.86	12.36
Zinc	8.39	12.36
Copper	37.38	37.95
Lead	0.76	175.44
Magnesium	362.32	497.79
Manganese	6.86	97.09
Sodium	97.09	175.44
Pottasium	373.76	626.65
Calcium	88.26	152.50
Phosporous	7.63	17.65

3.1.2 **Proximate and Anti-Nutrient Properties of Fermented (Wet and Dried) Bitter Kola**

Experimental analysis were carried out on some selected (wet and dried) bitter kola seed such as Moisture content, Ash content, Crude protein, Crude fat, Crude fibre and Carbohydrate. Table 3 shows the proximate analysis of (wet and dried) bitter kola. The Fat content of the seeds is 1.06% and 3.37% dried and wet seeds respectively.

Similarly, the Moisture content, Ash content, Crude protein, Crude fibre and Carbohydrate of wet seeds were 51.97%, 0.31%, 1.295%,. 1.45% and 43.94% respectively. And 13.78%, 0.74%, 5.32%, 3.97% and 72.84% respectively.

Experimental analysis were also carried out on some selected (west and dried) bitter kola seeds such as Oxalate, Phytate, Tannin and Alkaloids. Table 4 shows the result of anti-nutrient analysis of (wet and dried). The Oxalate content of the seeds is 2.84mg/100g and 7.52mg/100g for wet and dried seed respectively. Similarly, Phytate, Tannin, Alkaloids of (wet and dried) seeds were 104.24mg/100g, 0.62mg/100g and 1.22mg/100g, while 95.17mg/100g, 1.04mg/100g and 4.61mg/100g are for dried seeds respectively. Table 5 shows the result for anti-nutrient content.

3.2 **Discussion**

From Table 2 the average volume of wet and dried bitter kola samples measured is 7.540cm^3 respectively. The proximate analysis carried out on Moisture content (13.78%) of dried bitter kola seeds is higher than wet (51.97%) bitter kola seed, and high moisture in any food product can make it viable to microbial attack and this account for most biochemical and physiological reactions in plant foods. Crude protein has been proven to be essential for the survival of humans and other animals (Voet et al; 2008). The bitter kola seed contains a considerable amount of protein. Dried crude protein carried out (5.32) is high than wet (1.295) as shown in Table 3.

Crude carbohydrate was observed to be the most abundant biological molecule in dried bitter kola seed while less in wet bitter kola seeds and carbohydrate plays an important role in the body as sources of energy.

The presence of some anti-nutrient value like Oxalate, (7.52mg/100g for dry and 2.84mg/100g for wet), Pytate (95.17mg/100g for dry and 104.24mg/100g for wet) Tannin, (1.04mg/100g for dry and 0.62mg/100g for wet) and Alkaloids (4.61mg/100g for dry and 1.22mg/100g for wet) this results show that care must be taken in the processing of the seeds before consumption.

IV. CONCLUSION AND RECOMMENDATIONS

4.1 **Conclusion**

The success of any agriculture design effort is largely determined by the availability of adequate data on physical and chemical properties of the materials for which the design is intended. So also is the compatibility of the product with the environment because this greatly enhances the efficiency of the machines.

Also, the proximate analysis carried out on the bitter kola seeds have shown that the bitter kola seeds contain some nutritional constituent that is important in the diet growth and development of human.

The project work has brought to limelight the potential of bitter kola seeds, its strength and weakness, its properties and its nutritional composition that has made it worthy of been commercialized and processed into different end products.

4.2 **Recommendation**

Below are the recommendations given:

√ All the data gotten from experimentation and analysis in this project work should be taking into consideration during fabrication and design of a machine for either pre-harvest or post-harvest of bitter kola seed.

√ Effort should be made to design and fabricate machine for processing of bitter kola into different end products to increase its commercial value.

√ Effort should be made by government or other corporate bodies to encourage farmers to go into bitter kola farming.

√ Garcinia kola can also be useful in the pharmaceutical and medical science to make vaccine and supplements that can prevent cough diseases.

√ Individual should try to incorporate the bitter kola into one of the fruits he consumes and enlighten others about its nutritional value.

√ It can also be useful in various manufacturing industries as raw materials.

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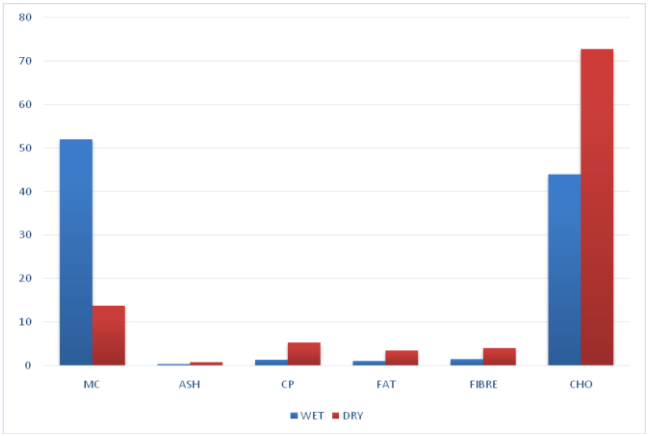

Figure 1: Proximate composition of wet and dry bitterkola seed

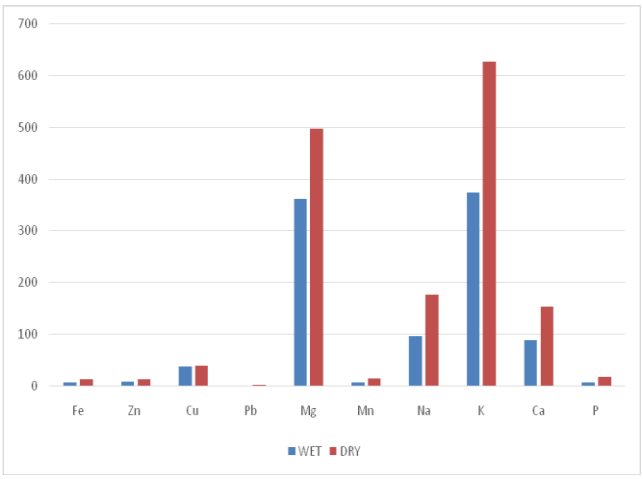

Figure 2: Anti-nutrient composition of Wet And Dry Bitter kola seed

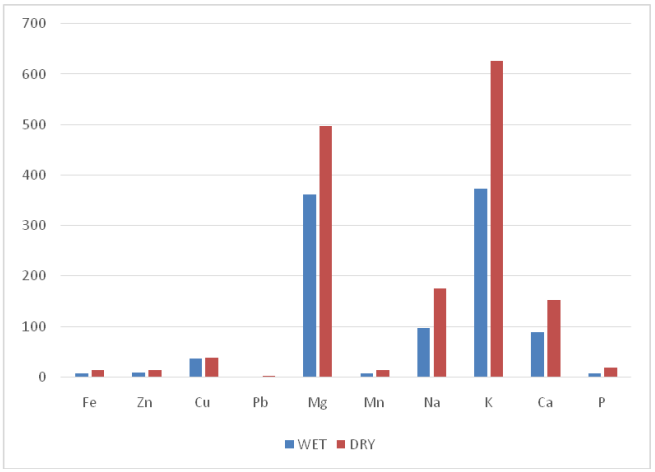

Figure 3: Minerals Result. (ppm) Of Wet And Dry Bitter kola