

# Proximate Analysis, Characterisation and Utilization of Bambara Nut Oil (Mmanu – Okpa)

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**Abstract-** This work is on Proximate analysis, characterization and utilization of bambara nut oil (Mmanu –Okpa). Bambara groundnut was collected from a local market and analysed. The bambara groundnut has many content, such as carbohydrate, protein ash, water, and oil. The emphasis of this study is on the oil. From the analysis it shows that bambara nut is not an oily seed. As it has high carbohydrate and protein, it is very nutritious and good for human consumption. It can serve as a food supplement. Hence it is good to cultivate the bambara nut in a large quantity to supplement the availability of food in the society.

## I. INTRODUCTION

There are many plants that produce their reserve food in form of oil, these plants store their food either in seed or in their fruits. These seeds or fruits may be edible or non-edible. Some of them are useful in many aspects, example: in production of soap, or cosmetics, some are essentially grown for human consumption. The seed that contain oils are called oil seed. Fats and oils have found their ways into almost all the activities of man. The main sources of these fats and oils have always been from animals and plants. While fats are obtained from animals like fishes etc. The oil from plants and animals are collectively called “fixed oils”, while the oils from plants are more precisely referred to vegetable oil, and can be isolated from plants like the oil plam, olive, soyabean, cotton, groundnut, coconut, Bambara and host of others. There are also, the essential or ethereal oil which are volatile and found in some plants. Previously, the only oil and fats used by man were those obtained from animals. Experiments to find suitable alternatives to animal oil and fats were made in 19<sup>th</sup> century when population of Europe was expanding so rapidly that there were insufficient animal oils and fats to meet the growing demand.

Biological seeds contain oil and more research works are carried out on them. Fats and oils are essential for good health. These oils can be utilized as edible fats, for salad, cooking oil, margarine and confectionary purpose.

Presently in Nigeria, Industries depend on palm oil, groundnut oil and beni-seed oil for vegetable cooking oil, soaps, cream and margarine manufacture. There is need to provide other sources of oil for these productions such as from Bambara nut seed. To extract oil from Bambara nut seed, characterize the oil, carry out the proximate analysis and apply it in some of the appropriate industrial uses, is the basis of this work.

## II. BRIEF DESCRIPTION OF THE PLANT.

Bambara nut (*Voandzeia subterrenea*) belongs to the family; leguminosae, sub family, pailionoidae. The crop is first mentioned in the 17<sup>th</sup> century literature where it is referred to as Mandudi d’ Angola. In 1968, Livinaeus described it in species platitinium and named it glycine subterranean, in accordance with this system of nomenclature. Bambara groundnut is a popular crop in the whole of sub-saharan African. The species is endemic to the Southern Sahelian and Northern Sudania ecozones of Chad, Mali, Niger, North Nigeria, North Cameroun, North Central African Republic, Egypt, Republic of Sudan, East Africa and Madagascar.

Bambara(also spelled Bambarra) groundnut has many common names such as Congo groundnut, Congo goober, Madagascar, Groundnut, Earth pea, Baffin pea, Njugo bean and Under-ground bean. Bambara ground is a herbaceous, intermediate, animal plant with creeping stems at a ground level. Stem branching begins very early about 1 week after germination and as many as 20 branches may be produced. The plant has a well developed taproot with profuse geotropically lateral roots. The flowers are borne on having peduncles which arise from the stems. The flower has a pair of hairy epicalyxes. The calyx consists of five hairy sepals (four on the upper side and one on the lower side).

Apparently, reproductive development is not completely inhibited to light. The pod grows first and reaches its mature size about 30 days after fertilization. The pod usually develop underground and may reach up to 3.9cm, depending on the number of seeds they contain. The pods are indehiscent, often wrinkled, ranging from a yellowish from a reddish dark brown colour. Seeds colour also varies from white to creamy, yellow, brown, purple, and red or black. Various testa patterns are found, including mottled, blotched to stripped, in addition to the predominantly uniformly coloured seed. Mean temperature during the season influences the time taken to achieve physio – logical maturity. Bunch types tend to mature earlier than the spreading types. photoperiod also influences fruit development. Long Photo periods delay or even prevent fruit set in some cultivators.

## III. USES OF BAMBARA GROUNDNUT (NMUKPURU OKPA)

Bambara groundnut is essentially grown for household diet and selling as cash crop. The seed makes a complete food as it contains sufficient quantities of protein, carbohydrate and fat.

Despite the relatively low oil content, some tubes in Congo reportedly roasted the seeds and pounded them for oil extraction. The gross energy of Bambara groundnut seed is greater than that of other common pulses such as cowpea, lentil and pigeon pea. Bambara groundnut seeds are consumed in many ways. They can be eaten fresh or grilled while still immature. At maturity, they become very hard and therefore require boiling before any specific preparation. In many west African countries, the fresh pods are boiled with salt and pepper and eaten as a snack. In Cote d' Voire, the seed is used to make flour which makes it more digestible.

In East Africa, the beans are roasted, then pulverized and used to make a soup, with or without condiments. Bread made from Bambara groundnut flour has been reported in Zambia seeds can also be pounded into flour and used to make a stiff porridge. Bambara is used to make a paste out of the dried seeds, which is then used in Nigeria for the preparation of various fried and steamed products such as 'akara', 'moi-moi', and 'okpa'. It is also used to make milk. It is also used as animal feed and the seeds have been used to feed chicks. The leaves were reported to be rich in nitrogen and phosphorous and therefore suitable for animal grazing.

#### IV. COLLECTION AND PREPARATION OF THE SAMPLE

The Bambara nut (*voandea subteranea*) was collected from Eke Awka Market in Awka South Local Government Area of Anambra State. The Bambara used is matured and creamy in colour. The weight of the Bambara nut was 3.8Kg. The seed were first of all ground and spread under the sun for few hours for the elements of water in the powder to evaporate.

#### V. EXTRACTION OF BAMBARA OIL

There are two methods of extracting oil; mechanical extraction and solvent extraction methods.

Solvent extraction is chosen for this experiment. Soxhlet extractor was used in the extraction of the oils.

The seeds were first of all ground and spread under the sun for few hours for the elements of water in the powder to evaporate. The solvent for the extraction (benzene) was placed in the flat bottomed flask. The ground seed was packed in the thimble and put in a chamber and heat was applied with electric heater. The solvent has boiling point of about 54°C – 60°C with the electric heater therefore the temperature is regulated for efficient and gradual extraction. When the solvent was heated to a temperature of about 58°C or above, it started to vaporize, moved through the soxhlet arm to the condenser where it condenses and dropped into the soil, this involves reflux action. The solvent coming in contact with the solid (ground seed in the thimble) affects the extraction.

The mixture of the oil and the benzene (solvent) was removed for distillation after several series of extraction. The solution (mixture of benzene and the oil with different boiling point) were separated using distillation methods. The solution was heated in a flask so that the solvent vaporized. The vapour

formed is passed down a condenser which is cooled by circulating water in its outer jacket.

Thus recondenses the vapour (benzene) into a liquid called the distillate, which is then collected in a receiver.

In this case, benzene having a low boiling point compared to those of the oils will evaporate first leaving the oil behind. The following analyses were carried out on the same.

#### VI. TREATMENT OF EXTRACTED OIL

Crude fats and oil contain variable amount of non-glycosides impurities. Some such as sterols are relatively inert. Some like tocopherols are desirable but some like free fatty acids, phosphatides, and mucilaginous material or foots and certain pigments are objectionable, tending to make the fat or oil dark coloured, susceptible to foaming and smoking on heating, and liable to precipitation of solid material when the oil is heated during processing operation. Foots refer to those impurities that precipitate during storage and then settle to the bottom of the container.

The objective of refining is to remove the objectionable impurities with minimum damage to the neutral oil (glycerides) and to copherols and minimum loss of oil. These are various degree and methods of refining and the one chosen is dictated by the end uses. Solid contaminants of oil are removed simply by filtration or decantation. The main refining operations are degumming, de – acidification, de – colorizations, deodorizations acid washing and bleaching.

#### VII. ANALYSIS OF THE SAMPLES

Determination of Saponification value

1g of oil was weighed and placed in a flask. 50cm<sup>3</sup> of potassium hydroxide KOH solution and a few pieces of porous pot were added. The flask was then fit with a reflux condenser and the solution was boiled for forty-five minutes after which the solution becomes clear.

The solution was titrated against hydrochloric acid (HCL) to find the volume of potassium hydroxide KOH solution which was used.

$$\text{Saponification value} = 28.01 \times \frac{A-B}{C}$$

A = Blank determination value in cm<sup>3</sup>

B = Sample titrated in cm<sup>3</sup>

C = Sample weight in grams.

#### VIII. DETERMINATION ACID VALUE

**MATERIAL:** Oil from the sample, 0.05m potassium hydroxide, Diethyl ether and ethanol.

**PROCEDURE:**

1.0 gram of the oil was weighed out. 30cm<sup>3</sup> of a mixture of ethanol and Diethyl ether was measured out in the ratio of 1:1, and poured into the oil. The solution was titrated with 2 drops of 0.5m of alcoholic phenolphthalein. The solution was titrate while shaking with 0.5m alcoholic potassium hydroxide solution until it remains Just pink. The process was repeated three times using the same oil.

$$\text{ACID VALUE} = 28.01 \times \frac{B}{C}$$

B = sample titrated in  $\text{cm}^3$

C = grams of the oil used.

### IODINE VALUE DETERMINATION

**APPARATUS** – Burette,  $250\text{cm}^3$  volumetric flask, chemical balance,  $250\text{cm}^3$  measuring cylinder, corks, pipette and filter paper stopper bottle.

#### **MATERIAL:**

Oil from the sample, iodine solution, carbon tetrachloride, starch indicator, potassium iodide solution

#### **PROCEDURE:**

0.25 gram of the extracted oil (Bambara oil) was measured out and put into a dry glass stopper bottle of about 250ml capacity. About 10ml carbon tetrachloride was added to the oil.  $25\text{cm}^3$  of iodine solution was added with the pipette into the container containing oil and carbon tetrachloride and whole content was allowed to drain for the same time. During this time, excess of iodine will be absorbed and the content was left in dark for about 30 minutes at a room temperature.  $0.20\text{cm}^3$  of potassium iodide solution and  $100\text{cm}^3$  of water was then added.

The iodine solution was titrated with 0.1m sodium thiosulphate solution using starch as an indicator. 0.1m sodium thiosulphate was added gradually until yellow colour of the solution has fairly disappeared and 2 drops of starch indicator was added and titration continued until blue colour has entirely disappeared.

At the end, the flask was stopped and the content was shaken vigorously to make sure that any remaining iodine in the carbon tetrachloride solution is taken up by the potassium iodide solution.

$$\text{Iodine value} = 12.6 \times \frac{(B - A) M}{C}$$

A = Volume ( $\text{cm}^3$ ) of  $\text{Na}_2\text{S}_2\text{O}_3$  solution required for titration of the sample.

B = Volume ( $\text{cm}^3$ ) of  $\text{Na}_2\text{S}_2\text{O}_3$  solution required for the titration of the blank

C = Grams of the sample used.

M = Molarity of the  $\text{Na}_2\text{S}_2\text{O}_3$  solution

### PEROXIDE VALUE DETERMINATION

1g of the oil sample was dissolved in 30ml of the solvent containing 12ml of chloroform and 18ml of glacial acetic acid. 0.5ml of saturated aqueous solution of potassium iodide was added, stopped and allowed to stand for one minute in the dark. 30ml of water was titrated with 0.002N sodium thiosulphate solution until the yellow colour disappeared, 1ml of starch solution was then added disappeared. The same thing was done for a blank solution containing no oil.

$$\text{Peroxide value} = 1000 \times \frac{(S-B) N}{W}$$

S = Volume in ml of sodium thiosulphate solution used up by the sample.

B = Volume in ml of sodium thiosulphate used up by the blank.

N = Normality of sodium thiosulphate and

W = Weight in gram of the sample

### Free fatty Acid (FFA)

This is calculated thus =  $\frac{\text{Acid value}}{2}$

### SPECIFIC GRAVITY DETERMINATION

A 25ml specific gravity bottle was filled with oil and weighed and the mass of the oil was noted as  $W_1$  similarly, the bottle was filled with water and weighed and the mass of water  $W_2$  was noted specific gravity =  $\frac{W_1}{W_2}$

### PROMIMATE ANALYSIS

#### **Determination of Percentage (%) fat.**

250ml flask was dried in an oven at  $100^\circ\text{C}$ , allowed to cool in a dessicator and weighed. 2g of Bambara was put inside a thimble and this was plugged with wool, the thimble was placed into extractor for extraction period of 60 minutes afterwards, the thimble was removed. The flask was then disconnected and was placed in an oven at  $100^\circ\text{C}$  for 2 hours after which it was cooled and weighed.

$$\text{Percentage Oil} = \frac{\text{Increase in mass} \times 100}{\text{Mass of sample used.}}$$

#### **Determination of Moisture Content**

2 petri dishes were washed and dried in an oven, cooled in a dessicator and weighed. 2g of the sample was added to a separate dish labeled 1 and 2 and transferred to the oven set at  $100^\circ\text{C}$  and left for 24 hours – period, they were poured, cooled in the dessicator and reweighed.

Mass of the sample x Dish before drying – Mass of the sample x Dish after drying

= Total Mass of the moisture percentage mass

$$= \frac{\text{Total mass of moisture} \times 100}{\text{Mass of the sample} \quad 1}$$

### DETERMINATION OF ASH CONTENT

A Crucible were washed, dried in an oven, cooled in a dessicator and weighed empty and labeled A1. 2g of mashed Bambara was added into another crucible labeled A2. They were charred in oven for about ten minutes. The crucible and the content were transferred into a furnace for two hours at  $600^\circ\text{C}$ , after which period, the temperature was allowed to return to about  $200^\circ\text{C}$ . The sample was then removed from the furnace with tongs into a dessicator for further cooling. After this, the sample was then reweighed to get the weight of both crucible and ash.

#### **Calculation**

Mass of crucible + Ashed sample – Mass of empty crucible = Total mass of ash

$$\text{Percentage mass of ash} = \frac{\text{Total mass of Ash} \times 100}{\text{Mass of sample used.}}$$

### DETERMINATION OF PROTEIN CONTENT

(a) Digestion : - 2g of the sample each were added into Kjeldahl flask. The following are then added separately into the flasks: half of copper tablet, a pinch of selenium power, 25ml of Conc.  $\text{H}_2\text{SO}_4$ . The flask was placed on an electric coil heater in a fume chamber until blacking occurs. Heating is continued for about one hour after the solution has cleared. When all the black specks have been disappeared indicating complete digestion, the

content was transferred into 25ml volumetric flasks and was then made up to the mark. After cooling, the flasks were then shaken thoroughly.

(b) Distillation: - 5ml of Boric Acid was placed in a 100ml conical flask. The conical flask was placed under the condenser such that the condenser tip is under the liquid. 5ml of the digested sample (ground Bambara) was placed each into the distillation apparatus separately and rinsed down with distilled water. The cup was closed with a rod, and 5ml of 60% NaOH was put into it. This was then let in very carefully leaving behind little to prevent ammonia from escaping. Steam was then let through for 4 to 7 minutes (until the amount of liquid in the conical flask was about twice what it was at the beginning of the distillation).

The boric acid indicator was then titrated with HCL to end point.

$$\text{Percentage protein} = \frac{T \times 0.000140 \times 20 \times 6.25 \times 100}{\text{Sample (w)} \times 1000}$$

Where,

W represents the weight of food stuff,

T represents the titre value.

#### DETERMINATION OF CARBOHYDRATE CONTENT OF SEED BY DIFFERENCE

##### Calculation

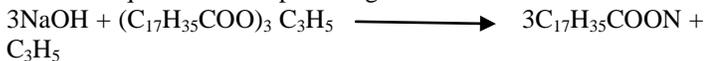
The carbohydrate content for Bambara seed was calculated from the percentage content of protein, moisture, Ash and fat  
% Carbohydrate = 100 – (% Protein + % Ash) + % Moisture + % Fat.

#### DETERMINATION OF CALORIC VALUE OF THE SEED USING THE CALCULATION METHOD AS GIVEN BELOW, THE Caloric value of Bambara seed is:

Caloric value = ( % Protein x 4) + ( % Fat x 9) + ( % Carbohydrate x 4)

#### SAPONIFICATION (MAKING SOAP).

1.5M OF NaOH was prepared by dissolving 60g of NaOH in 150ml of water in a beaker. Then, 100ml of my oil was poured into another beaker. The prepared sodium hydroxide solution was in the beaker in the presence of a red litmus paper with vigorous string until the litmus paper turned blue indicating the complete saponification of the seed. A white solid soap was obtained Equation for soap making:



#### SALTING OUT

The soap produced was redissolved with water and concentrated salt solution was added while heating with vigorous stirring. A pure soap was precipitated while the spent lye (water, glycerol, and salt) stayed at the bottom. This was separated using a separating funnel. Excess brine was used to wash off the remaining glycerol and dirt thus, making the colour of the soap whiter.

#### ADDITION OF SAOP ADDICTIVES TO THE PURE SOAP

The pure soap was redissolved and the following was added; 5ml perfume was added to give the soap a fine odour and sodium silicate and sodium phosphate was added as a builder to soap.

Then, the soap was poured into a mold and allowed to stay to solidity; the soap has a rectangular shape.

Table 2.1 Cream produced from Bambara oil

Product Formulation	Composition in g
Bambara oil	3.0
Croada wax	2.4
Stearic acid	1.2
Cetyl alcohol	0.8
Water	10
Glycerol	1.1
Soap Flakes	4.0
Methyl Parabean	3.0

#### FORMULATION OF CREAM FROM BAMBARA OIL

3g of Bambara oil, soap flakes and water were heated together to a temperature of 70°C.

2.4g of Croada wax, stearic acid, Cetyl alcohol and glycerol were also heated to a temperature of 70°C

The two mixtures were mixed together and stirred continuously until it cooled to 40°C. Methyl parabean was the added as preservatives.

#### RESULTS OF THE EXPERIMENT

The result of physio-chemical analysis is given on table 3.1 below

TABLE 3.1.1 RESULTS OF EXTRACTION AND ANALYSIS

CHARACTERISTICS	RESULTS IN %
Saponification Value	260.4
Iodine Value	58.97
Acid Value	5.04
Peroxide Value	6.0
Specific gravity	0.89
Free Fatty Acid	2.52

TABLE 3.1.2 PROXIMATE ANALYSIS RESULT

CHARACTERISTICS	RESULTS IN %
Ash Content	2.25
Moisture Content	7.4
Percentage Fat	5.0
Protein	17.51
Carbohydrate	67.84
Caloric Value	386.4

#### DISCUSSION

The results of the experiment were tabulated above and it is seen that Bambara does not contain much oil (5%).

From table 3.1.1 above, Bambara oil has high saponification value which gives an indication of the average molecular mass of the fatty acid in fat and its higher saponification value indicating that most bonds are saturated at ordinary temperature.

Its Acid value indicates the amount of free acid value which can form soft film after exposure to air and they are good for manufacture of soap. Again, the low Acid value of the oil proved that the oil have a long-shelf life. The oil colour golden yellow and remain liquid at ordinary room temperature. Iodine value serves as the measure of the relative proportion of unsaturated fatty acid. The iodine value result showed that the oil is non-

drying oil and can best be utilized in the manufacture of soap, cream and in confectionary.

Low peroxide value indicates that the oil cannot undergo oxidative deterioration on keeping for a longer period (free from rancidity).

From Table 3.1.2, Ash is incombustible residue left after the complete combustion of any substance. It consists of constituents of inorganic substance. Bambara nut has a higher ash content showing that it contains more inorganic matters.

Finally, Bambara nut contains very high carbohydrate and caloric value showing that it gives energy and is very good for human consumption. Also, that bambara has very low moisture content which is the quantity of water in a sample which shows that they are durable.

## IX. CONCLUSION

From the results of the proximate analysis, characterization and utilization of Bambara nut oil, it is obvious that Bambara is not an oily seed.

Bambara has high carbohydrate and protein content showing that it is very nutritious and therefore good for human consumption. It is not an important raw material for our industry for it contains little oil. Because of its proteins and carbohydrate content, it is there suitable for incorporation in livestock feed

Bambara has high nutritive value and after extraction of the oil, the residue cake still has food value which make it the most valuable livestock cakes of commerce.

As benzene was used as solvent in this study, I recommend the use of other solvents for the extraction of the oil in order to determine the nutritive value of Bambara oil.

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