***ORIGINAL RESEARCH ARTICLE***

**PHYSICOCHEMICAL PROPERTIES OF OIL AND FLOUR FROM SELECTED PEANUT VARIETIES**


## ABSTRACT

Physicochemical properties of oil and flour from selected peanut (*Arachis hypogaea* L.) varieties was investigated. Physicochemical, proximateand mineral properties of the oil and flour from two selected varieties (Samuel 25 and Samuel 24) were assessed following standard procedures. The result of the physicochemical parameters of peanut oil showed that refractive index, iodine value (gl/100g), specific gravity (g/cm$^3$), flash point ($^o$C), fire point ($^o$C), smoke point ($^o$C), cloud point ($^o$C), saponification value (mgKOH/g), % free fatty acid (%) and colour ranged between 1.11 and 1.52, 101.90 and 99.30, 0.94 and 0.92, 240.50 and 237.50, 316 and 301.50, 202.00 and 208.5, -2 and -4, 192.00 and 188.00, 31.21 and 30.71 and light brown to amber milky colour respectively.There were significant (P=.05) differences in the ash (2.28 and 2.09%), moisture (12.19 and 12.14), fat (5.00 and 5.29) and fibre (2.00 and 2.05) contents across the two samples. There were however no significant (P≥.05) differences in the protein (20.92 and 20.95) and carbohydrate (57.60 and 57.48) contents of the two varieties (Samuel 25 and Samuel 24) of peanut flours. The result of the mineral revealed that calcium, iron, potassium and sodium ranged between 26.49 and 26.31, 5.62 and 5.60, 13.99 and 13.84 and 10.37 and 9.92 mg/100g respectively for sample A and Sample B.The current study indicated that Samuel 25 peanut variety had good chemical and physical properties. Hence, its utilization in diet will give best results in combating diseases like cancer, diabetes and cardiovascular diseases based on the results indicated.



*Keywords*: *Peanut, Oil, Flour, Physicochemical, Proximate and Mineral*


## 1. INTRODUCTION

Peanuts *(Arachis hypogaea* L.) are known as groundnuts and are related to the *Leguminosae* family. They are grown for oil extraction and also as food product [1]. More than a third of the peanut varieties grown on a global scale are used as food [2]. Peanuts are considered an important source of oil, folate, antioxidants, protein, and essential fatty acids (linoleic) [3]. Hence, consumers and industry fields have a growing interest in peanuts [4]. Peanuts are ranked fourth in oilseed crops in the world after soybeans, rapeseed, and cotton. In 2015, peanuts made up 8.7% of the total production of oilseed by contributing 45 million tons of world production. It is also an important oilseed crop for the production of vegetable oils [5]. About 2/3 of the world's total peanut production is used to produce oil and the remaining 1/3 is used in food products [6]. Peanut seeds contain about 44 to 56% oil, 22 to 30% protein, and 9.5 to 19.0% carbohydrate as dry weight [7]. In addition, it is a good source of minerals (phosphorus, calcium, magnesium, and potassium) and vitamins (E, K, and B group). Fatty acid composition plays a main role in nutritional and storage qualities of peanuts [8]. Peanut oil contains both saturated (SFA) and unsaturated (UFA) fatty acids [9]. Oleic acid (C18:1) content in peanut genotypes can vary from 21 to 85% and linoleic acid (C18:2) from 2 to 43%. [10] investigated the physicochemical characteristics of the oil and found the specific gravity (0.915 to 0.918), the acid value (3.96 to 4.95 mg g1), the saponification value (226.40 to 246.56 mg g1), and the unsaponifiable matter (3.20 to 4.20 g/100 g).

There are thousands of peanut cultivars around the world. Certain cultivars groups are preferred for particular uses because of differences in flavor, oil content, size, shape, and disease resistance. For many uses the different cultivars are interchangeable however, the most popular cultivars are Spanish, Runner, Virginia and Valencia. Most peanuts marked in the shell are of the Virginia type, along with some Valencias selected for large size and the attractive appearance of the shell. Spanish peanuts are used mostly for peanut candy, salted nuts, and peanut butter. Most Runner are used to make peanut butter [11].

Peanuts have many value-added products that have been developed with a number of applications in bakery, confectionery, and the general consumer market. Among these the most important are peanut

oil and peanut flour. Peanut oil is extracted from shelled and crushed peanuts with a variety of methods such as hydraulic pressing, expeller pressing, and/or solvent extraction. There are generally three types of peanut oil, that is, refined peanut oil, gourmet peanut oil, and 100% peanut oil. In 2008 Asia and Africa contributed 94% of the world's peanut oil production (5.45 million tons), whereas the contribution of America was only 4% [12].

Peanut flours are made from raw peanuts, which have been cleaned, blanched, and electronically sorted to select the highest quality peanuts, the nuts are then roasted and naturally processed to obtain lower fat peanut flour with a strong roasted peanut flavor. Peanut flour is used in confectionery products, seasoning blends, bakery mixes, frostings, fillings, cereal bars, and nutritional bars. Peanut flour, because of its high protein content (45–50%), is a good protein source in addition to its function as a flavoring agent (APC, 2011). Peanut flour at a level of 4–8% in formulation has been found to extend the shelf life of confectionary products [13]. Recent studies reported the rheological, foaming, emulsifying, and water holding properties of peanut flour and declared that peanut flour as a potential additive to increase the protein contents of various food commodities especially baked goods [14].

In Nigeria, the demand for vegetable oil has ever been widening as industrialist rely mostly on the popular vegetable oil such as palm kernel oil, soya bean oil, cotton seed oil and coconut seed oil for preparation of various products [15; 16]. The characteristics of oils from different peanut sources depend mainly on their compositions and no oil from a single species can be suitable for all purposes thus the study of their physicochemical constituents is important. Therefore, the broad objective of this study was to evaluate the physicochemical properties of oil and flour from selected varieties of peanuts.

## 2. MATERIAL AND METHODS

### 2.1 Source of Material

The peanut seeds used for this study was purchased from a retail market in Makurdi, Benue State, Nigeria. Two varieties of peanut (Samuel 24 and Samuel 25) were used for the study

### 2.2 Flour Production from Peanuts

The peanut seed flour was prepared according to the method of Oche *et al*. (2016). It is has shown in chart 1.

### 2.3 Extraction of peanut oil

Peanut oil extraction was achieved by method described by Agomuo*et al*. (2017). The peanut seeds were milled with a laboratory miller and dried to constant weight in a thermostatically controlled oven at 105˚C. The dried paste was transferred into a thimble and oil extraction was carried out using petroleum ether with Soxhlet apparatus. The extracting solvent (petroleum ether) was evaporated leaving the concentrated oil sample for analysis.

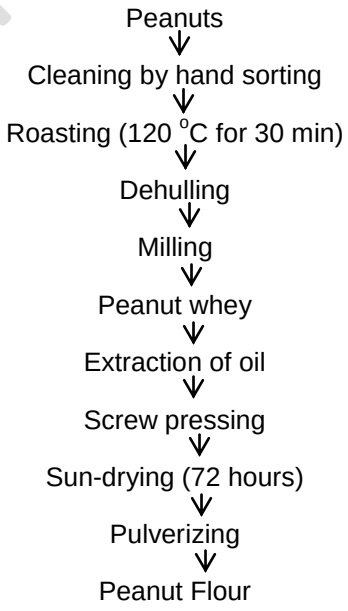


**Chart 1: Flow Chart for the Production of Peanut Oil and Peanut Flour**

Source: [17]

## 2.4 Physicochemical Properties of Oil from selected Peanuts Varieties

### 2.4.1 Colour and state of the oils

At room temperature (25°C), all the oils from the two peanut varieties were evaluated for their colour and state of the oil following methods described by [18].

### 2.4.2 Specific gravity

Specific gravity of the oil was determined according to [19]. The specific gravity bottle was placed in a water bath maintained at 25°C and filled with distilled water. It was removed, wiped dry (outside the bottle) and weighed. The bottle was emptied, dried and again placed in water bath at 25°C. The bottle was refilled with the oil and made to stay in the water bath for 30 min. It will then be removed, cleaned and wiped (outside the bottle) completely dry and weighed. The specific gravity at 25°C was calculated as follows:

$$\text{Specific gravity at } 25/25°C = \frac{\text{weig ht of bottle and oil at } 25°C - \text{weig ht of bottle at } 25°C}{\text{weight of bottle at } 25°C}$$

### 2.4.3 Refractive index

Refractive index of the oil was determined according to the [19]. Several drops of the oil were placed on the lower prism of an Abbe refractometer which will also be adjusted to the same temperature as that of the sample. The prisms was closed and tightened firmly with the screw head, ensuring that the sample came to the same temperature of the instrument. The instrument was adjusted until the most distinct reading possible is obtained and the refractive index read.

### 2.4.4 Percentage free fatty acid

Percentage free fatty acid was determined using the recommended method of the American Oil Chemists' Society [19]. One point four grams (1.4 g) of oil was weighed into a flask containing 15 ml of hot neutralized alcohol and 0.4 ml of phenolphthalein indicator was then be added. The content was titrated with 0.5 N NaOH. Percentage free fatty acid value was calculated (as oleic acid) using the formula:

$$\text{FFA (as oleic)} = \frac{V \times N \times 28.2}{W}$$

Where, V = volume (ml) of NaOH solution, N = normality of NaOH solution, W = weight of oil sample.

### 2.4.5 Iodine value

Iodine value was determined according to [19]. An amount of 0.2 g of the oil was accurately weighed into a 500 ml flask. Fifteen milliliters (15 ml) of carbon tetrachloride was added to the sample and swirled to ensure that the sample completely dissolved in it. Twenty five milliliters (25 ml) of Wij's solution was then be pipetted into the flask containing the sample. The flask was stoppered and swirled to ensure complete mixing.The sample was then placed in the dark for 30 min at room temperature. The flask was removed from storage and 20 ml of 10 % KI solution added, followed by 150 ml of distilled water. The mixture was titrated with 0.1 N $Na_2S_2O_3$ solution, adding gradually and with constant and vigorous shaking until the yellow colour had almost disappeared. One and half millilitres (1.5 ml) of starch indicator solution was added and the titration continued until the blue colour disappeared. A blank determination was conducted simultaneously.

The iodine value was calculated using the formula:

$$\text{Iodine value} = \frac{B - S \times N \times 12.69}{\text{Weight of oil}}$$

Where, B = blank titre value, S = sample titre value and N = normality of $Na_2S_2O_3$.

### 2.4.6 Saponification value

Saponification value was determined according to [19]. Two grams (2.0 g) of the oil was weighed into a flask. Twenty-five milliliters (25 ml) of alcoholic KOH was pipetted and allowed to drain for about 1 min into the mixture. A blank determination was prepared and determined simultaneously with the sample. A condenser was connected to the flask and the mixed sample was allowed to boil gently and steadily for 45 min for complete saponification. The flask and condenser will then be cooled but not

sufficient to form a gel. The condenser was disconnected and 1 ml of phenolphthalein indicator was added to the content of the flask. The solution was titrated with 0.5 N HCl until the pink colour just disappeared. The saponification value was calculated using the formula:

$$\text{Saponification value} = \frac{\text{B - S} \times 56.1 \times \text{N}}{\text{weight of oil sample}}$$

Where, B = Blank titre value, S = sample titre value and N = normality of HCl.

### 2.4.7 Flash Point

Flash points were measured using the Cleveland Open Cup method [19]. The oil sample was heated to the specified level and the correct size of the test flame was periodically directed to the vapor of the sample. The temperature of the oil in which the steam explodes was marked as a flash point.

## 2.5 Determination of Proximate Composition of Flour from selected Peanut Varieties

### 2.5.1 Moisture content determination

The moisture content was determined by hot air oven method as described by [20]. Empty crucible was weighed and 2g of the sample was transferred into the crucible. This was taken into the hot air oven and dried for 24 hours at $100^0$C. The loss in weight was regarded as moisture content and expressed as:

$$\% \text{ Moisture} = \frac{W2\text{-}W1}{W} \text{ X } 100$$

Where:

$W_2$=Weight of the crucible and dry sample;

$W_1$=Weight of empty crucible

W=Weight of the sample

### 2.5.2 Crude protein determination by Kjeldahl method

The Kjeldahl method as described by [20] was used to determine the percentage crude protein. Two (2) grams of sample was weighed into a Kjeldahl digestion flask using a digital weighing balance (3000g x 0.01g 6.6LB). A catalyst mixture weighing 0.88g (96% anhydrous sodium sulphate, 3.5% copper sulphate and 0.5% selenium dioxide) was added. Concentrated sulphuric acid (7 ml) was added and swirled to mix content. The Kjeldahl flask was heated gently in an inclined position in the fume chamber until no particles of the sample was adhered to the side of flask. The solution was heated more strongly to make the liquid boil with intermittent shaking of the flask until clear solution was obtained. The solution was allowed to cool and diluted to 25 ml with distilled water in a volumetric flask. Ten (10) ml of diluted digest was transferred into a steam distillation apparatus. The digest was made alkaline with 8 ml of 40% NaOH. To the receiving flask, 5 ml of 2% boric acid solution was added and 3 drops of mixed indicator was dropped. The distillation apparatus was connected to the receiving flask with the delivery tube dipped into the 100 ml conical flask and titrated with 0.01 HCl. A blank titration was done. The percentage nitrogen was calculated from the formula:

$$\% \text{ Nitrogen} = \frac{(S\text{-}B) \times 0.0014 \times 100 \times D}{\text{sample weight}}$$

Where, S = sample titre, B = Blank titre, S - B = Corrected titre, D = Diluted factor

% Crude Protein = % Nitrogen x 6.25 (correction factor).

### 2.5.3 Crude fat determination

Crude fat content was determined using Soxhlet method as described by [20]. Samples were weighed into a thimble and loose plug fat free cotton wool was fitted into the top of the thimble with its content inserted into the flat bottom extractor of the Soxhlet apparatus. Flat bottom flask (250 ml) of known weight containing 150 – 200 ml of 40 – 60°C hexane was fitted to the extractor. The apparatus was heated and fat extracted for 8 h. The solvent was recovered and the flask (containing oil and solvent mixture) was transferred into a hot air oven (GENLAB, England B6S, serial no: 85K054) at $105^o$C for 1 h to remove the residual moisture and to evaporate the solvent. It was later transferred into desiccator to cool for 15 minutes before weighing. Percentage fat content was calculated as:

$$\% \text{ Crude Fat} = \frac{\text{weight of extracted fat}}{\text{Weight of Sample}} \text{ x } 100$$

### 2.5.4 Ash content determination

The [20] method for determining ash content was used. Two (2) grams of sample was weighed into an ashing dish which had been pre-heated, cooled in a desiccator and weighed soon after reaching room temperature. The crucible and content was then heated in a muffle furnace at 550°C for 6-7 h.

The dish was cooled in a desiccator and weighed soon after reaching room temperature. The total ash was calculated as percentage of the original sample weight.

$$\% \text{ Ash} = \frac{(W3-W1)}{(W2-W1)} \times 10$$

Where: W1 = Weight of empty crucible, $W_2$ = Weight of crucible + sample before ashing,
$W_3$ = Weight of crucible + content after ashing.

### 2.5.5 Crude fiber determination

The method described by [20] was used for fibre determination. Two (2) grams of the sample was extracted using Diethyl ether. This was digested and filtered through the california Buchner system. The resulting residue was dried at 130 ± 2$^{o}$C for 2 hours, cooled in a dessicator and weighed. The residue was then transferred in to a muffle furnace (Shanghai box type resistance furnace, No.:SX2-4-10N) and ignited at 550$^{o}$C for 30 minutes, cooled and weighed. The percentage crude fibre content was calculated as:

$$\% \text{ Crude fibre} = \frac{\text{Loss in weight after incineration}}{\text{Weight of original food}} \times 100$$

### 2.5.6 Carbohydrate content determination

Carbohydrate content was determined by difference according to (Ihekoronye and Ngoddy, 1985) as follows:

$$\% \text{ Carbohydrate} = 100 - (\%\text{moisture} + \%\text{Protein} + \%\text{Fat} + \%\text{Ash} + \%\text{Fibre})$$

## 2.6 Determination Minerals Composition of Flour from Selected Peanuts Varieties

### 2.6.1 Calcium, iron and Potassium

Calcium, iron and magnesium was determined by Atomic Absorption Spectrophotometry (Agte*et al*., 1995). One gram (1 g) of the sample was dry-ashed in a muffle furnace at 550°C for 5 h until a white residue of constant weight is obtained. The minerals were extracted from the ash by adding 20.0 ml of 2.5% HCl, heated to reduce the volume to 7.0 ml, and this was transferred quantitatively to a 50 ml volumetric flask. It was diluted to the mark (50 ml) with distilled water, stored in clean polyethylene bottles and magnesium content was determined using atomic absorption spectrophotometer.

### 2.6.2 Sodium

The sodium determination was done based on the method described by [18]. Two grams of the sample was ashed in muffle furnace preheated to 600°C for 2 h. The ash was dissolved in 5 ml of 5 M $H_2SO_4$. Four milliliters (4 ml) of 2% ascorbic acid and 4 ml of 4% ammonium molybdate was added to the resulting solution and shaken for uniform mixing. The absorbance of each sample was determined with a UV spectrophotometer.

## 2.7 Statistical Analysis

The data generated was subjected to T-test statistics and significance difference was tested at 5 % level of probability.

# 3. RESULTS AND DISCUSSION

## 3.1 Physico-chemical Properties of oil from Selected Peanut Varieties

The result of the physico-chemical properties of oil from selected peanut varieties is shown in Table 1. The refractive index was 1.11 and 1.52 in the selected groundnut varieties respectively. Refractive index of an oil is the ratio of speed of light at a defined wavelength to its speed in the oil/fat itself. This value varies with wavelength and temperature, the degree and type of unsaturation, the type of substitutions of component fatty acids and with accompanying substances. Refractive index is widely used in quality control to check for the purity of materials and to follow hydrogenation and isomerization [21]. The selected groundnut varieties oils studied have their refractive index values within the acceptable range of 1.4677 to 1.4707 for virgin, refined and refined-pomace oils according to Codex Standards for fats and oils from vegetable/plant sources [22].

The iodine value is a measure of the degree of unsaturation and it is an identity characteristic of peanut oils, making it an excellent raw material for soaps cosmetics industries [23]. For the peanut oils, iodine value was 99.30 gl/100g in sample B peanut oil and 101.90 gl/100g in sample A peanut oil. The iodine value could be used to quantify the amount of double bond present in the oil which reflects the susceptibility of the oil to oxidation. Oils with iodine value less than 100 gI/100g of oil are non-drying oils; correspondingly, [16] reported that the lower the iodine value the lesser the number of

unsaturated bonds; thus, the lower the susceptibility of such oil to oxidative rancidity. Therefore, non-drying oils are not suitable for ink and paint production due to their non-drying characteristics but may be useful in the manufacture of soaps [24] and can be regarded as liquid oil. A good drying oil should have iodine value of 130 and above. Thus, the peanut oils in the study may not be suitable as alkyl resins for paint formulation or use as varnisher since they cannot be grouped as drying oil because of their iodine values. High iodine value is a pointer to the presence of high percentage of unsaturated fatty acids in the peanut oil; as such amount of iodine that will be absorbed by the unsaturated acids would be higher [25] and peanut oils with such characteristic may therefore be find useful as raw materials in the manufacture of vegetable oil-based ice cream [26].

The specific gravity was 0.94 in sample A and 0.92 in Sample B. The result showed that the peanut oils are less dense than water and therefore would be useful in cream production as it will make the oils flow and spread easily on the skin [27]. According to [28], specific gravity is commonly used in conjunction with other figures in assessing the purity of oil.

The flash point is one of the important properties in liquid fuels. The flash point is the lowest temperature where a liquid produces a sufficient amount of steam to ignite. A higher flash point makes the fuel more difficult to burn. The study showed that, the flash point of Samuel 25 (sample A) is 240.50$^{o}$C while the flash point of Samuel 24 (sample B) was 237.50$^{o}$C. The result of the flash point obtained in this study is similar to that reported by Gebremedhin *et al.* (2018) in their study on physicochemical and functional properties of Ethiopian (Roba Variety) Peanut (*Arachis hypogaea* L.) for Industrial Use. Fuels which have a flash point less than 37.8°C (100.0 °F) are called flammable, whereas fuels having a flash point above that temperature are called combustible. Lower flash points are the indicators of good flammability and volatility. The high flash points of the peanut oils therefore signified that peanut oils are not flammable and volatile.

The fire point is the lowest temperature at which the vapor will keep burning after being ignited and the ignition source removed. The fire point is higher than the flash point, because at the flash point the vapor may be reliably expected to cease burning when the ignition source is removed. Result on Table 1 showed that sample A had fire point of 316.00$^{o}$C while sample B had fire point of 301.00 $^{o}$C. Hence the peanut oils considered for this study are not a better choice as lubricating oil.

Smoke point also referred to as the burning point, is the temperature at which an oil or fat begins to produce a continuous bluish smoke that becomes clearly visible, dependent upon specific and defined conditions. The result of the smoke point of two varieties of peanut is presented in Table 1. The smoked point of the two samples ranged from 202.00$^{o}$C to 208.5$^{o}$C for sample A and sample B respectively. Smoke point values can vary greatly, depending on factors such as the volume of oil utilized, the size of the container, the presence of air currents, the type and source of light as well as the quality of the oil and its acidity content, otherwise known as free fatty acid (FFA) content [16]. The more the free fatty acid oil contains, the quicker it will break down and start smoking [29]. The lower the free fatty acid, the higher the smoke point. It is important to consider, however, that the FFA represents typically less than 1% of the total oil and consequently renders smoke point a poor indicator of the capacity of a fat or oil to withstand heat. A general rule is that, fats with a higher smoke point are better suited for deep frying, whilst fats with a smoke point below 200°C are not [30].

The result of the cloud point of peanut oils is shown in Table 1. Sample A had cloud point of -2$^{o}$C while sample B had a cloud point of -4$^{o}$C. Cloud point is the temperature at which wax (paraffin) begins to separate when oil chilled to a low temperature, and it serves as an important indicator of practical performance in automotive applications in low temperatures. This result of cloud points obtained from this study is similar with that reported for oils extracted from Some Nigerian plant foods by [16].

The saponification value for sample B was 188.00 mgKOH/g and 192.20 mgKOH/g for sample A peanut oil. Saponification value is a measure of oxidation during storage, and also indicates deterioration of the oils. An increase in saponification value in oil increases the volatility of the oils. It enhances the quality of the oil because it shows the presence of lower molecular weight components in 1 g of the oil which will yield more energy on combustion [30]. The high saponification value is an indication that the oil may be suitable for soap making, oil-based ice-cream and shampoos. It has been reported by [31] that oils with high saponification values contain high proportion of lower fatty acids. Therefore, the high saponification value of the selected peanut oils under study indicated that they contain low proportion of higher fatty acid and can be regarded as edible oils.

Free fatty acid is the percentage by weight of a specified fatty acid (e.g., percent oleic acid) [32]. High concentrations of free fatty acids are undesirable in crude vegetable oils because they result in large losses of the neutral oil during refining. In crude fat, free fatty acids estimate the amount of oil that will be lost during refining steps designed to remove fatty acids [33]. High levels of free fatty acids especially linoleic acids are undesirable in finished oils because they can cause off-favours and shorten the shelf life of oils. The quantity of free fatty acid in oil is an indicator of its overall quality. They may be formed through hydrolysis or in the advanced stages of oxidation. An excessive amount of free fatty acids lowers the smoke point of oil and will cause 'popping' of the oil during cooking. High quality oils are low in free fatty acids [30]. In refined peanut oils, the lower the free fatty acid the more acceptable the oil is to man in terms of palatability. From the results of the selected peanut oils, the percentage of free fatty acid ranges from 30.71 to 31.21 in sample B and sample A peanut oils respectively.

Color is one of the most key physical appearances of food materials since it influences consumer preferences and responsible for a final decision for purchasing by the consumer [16]. Color is one of the parameters that are used for process control during processing because the brown pigments will appear as the browning and caramelization reactions progress. As indicated in Table 1, the colors of the peanut oils were light brown and amber milky for sample A and sample B respectively. These are acceptable colors of vegetable oils as reported by [34].

## Table 1: Physicochemical Properties of Oil from Selected Peanut Varieties

| SAMPLE | A | B | P-value |
|---|---|---|---|
| Refractive index | 1.11±0.00 | 1.52±0.01 | 0.324 |
| Iodine value (gl/100g) | 101.90±1.10 | 99.30±0.57 | 0.095 |
| Specific gravity (g/cm$^3$) | 0.94±0.01 | 0.92±0.01 | 0.07 |
| Flash point ($^0$ C) | 240.50±2.12 | 237.50±0.71 | 0.198 |
| Fire point ($^0$ C) | 316.00±7.07 | 301.50±0.71 | 0.102 |
| Smoke point ($^0$ C) | 202.00±1.41 | 208.5±0.71 | 0.028 |
| Cloud point ($^0$ C) | -2 | -4 | |
| Saponification value (mgKOH/g) | 192.20±1.34 | 188.00±1.25 | 0.085 |
| % Free fatty acid (%) | 31.21±0.15 | 30.71±1.02 | 0.559 |
| Colour | Light brown | Amber milky | |

*Values are means ± standard deviations of triplicate determinations. Means in same column with p-value less than 0.05 are significantly different

**Key:** A = Samuel 25, B = Samuel 24

### 3.2 Proximate Composition of Flour from Selected Peanut Varieties

The result of the proximate composition of the selected varieties of groundnut is shown in Table 2. The ash contents were between 2.28 % and 2.09%, moisture content (12.19% and 12.14%), fat (5.00% and 5.29%), fiber (2.00% and 2.05%), protein (20.92% and 20.95%) and carbohydrate content (57. 60% and 57.48%) for sample A and B respectively.

Sample B had the highest ash content of 2.28% while sample B had the least ash content of 2.09% respectively. All the results differed significantly ($p \leq 0.05$). The ash content of food material could be used as an index of mineral constituents of the food because ash is the inorganic residue remaining after water and organic matter have been removed by heating in the presence of an oxidizing agent

[35; 36]. Hence, the sample with high percentage ash content as noticed in the study is expected to have high concentrations of various mineral elements.

The moisture content of peanut flours is presented in Table 2. Sample A recorded moisture content of 12.19% while sample B had moisture content of 12.14% and were significantly different (P<0.05) from one another. The high moisture content of the samples could be attributed to the greater water holding capacity of the flours. This is similar to the findings reported by [37] in their study on the comparative assessment of some physicochemical properties of groundnut and palm oils sold within Kaduna Metropolis, Nigeria.

The results of the fat content of the peanut flours showed significant differences (p≤0.05). Sample B had the highest value of 5.29 % while sample A had lowest fat contents of 5.00 %. The results of these values are lower than the values of 10.37 to 18.01 % reported by [38] for maize flours fortified with pigeon pea concentrate but higher than the values of 0.59 and 1.58 % reported by [39] for flours from maize and soybean. The high fat contents of sample B as compared to the other sample maybe due to varietal differences as the two samples were subjected to same processes and processing conditions [40].

The fibre content of sample A was 2.00% while that of sample B was 2.05%. The average crude fibre contents in this result indicate the ability of the peanut flour to maintain internal distension for a normal peristaltic movement of the intestinal tract: a physiological role which crude fibre plays. Diet low in crude fibre is undesirable and may cause constipation and that such diets have been associated with diseases of colon like piles appendicitis and cancer. The result showed that sample B is significantly (P<0.05) richer in crude fibre than sample A. the result of crude fibre in this study is lower than 2.83 and 2.43 reported by [41]. The crude fibre obtained in this study was higher since no chemical reaction which can alter the composition was initiated.

The results of the protein content of the peanut flours showed no significant differences (p>0.05). Sample A had protein content of 20.92% while sample B had protein content of 20.95 % respectively. The results of these values are comparable with the values of the protein content of 24.70, 21.80 and 18.40 reported by [41]. The higher protein contents in the blended samples would be useful in eliminating the challenges of protein deficiencies notably among children of the low-income group [42; 43] if used in food formulations. Proteins are essential of all body tissues, which help to produce new tissues. They are therefore extremely important for growth, pregnancy and when recovering from wounds [44].

The results of the carbohydrate content of the peanut flours showed no significant differences (p>0.05). Sample A had carbohydrate content of 57.60% while sample B had carbohydrate content of 57.48 % respectively. The carbohydrate contents reported for both sample A and sample B in this study are higher compared to 17.4-36.11 % reported for groundnuts by [41]. Carbohydrate provides heat and energy for all forms of body activities and as such its inadequacy can cause the body to divert proteins and body fat to produce needed energy and this might lead to depletion of body tissues [42].

**Table 2: Proximate Composition (%) of Flour from Selected Peanut Varieties**

| SAMPLE | A | B | P-value |
|---|---|---|---|
| **Ash** | 2.28±0.02 | 2.09±0.01 | < 0.001 |
| **Moisture** | 12.19±0.01 | 12.14±0.01 | 0.004 |
| **Fat** | 5.00±0.02 | 5.29±0.01 | < 0.001 |
| **Fibre** | 2.00±0.01 | 2.05±0.02 | 0.011 |
| **Protein** | 20.92±0.02 | 20.95±0.02 | 0.121 |
| **Carbohydrate** | 57.60±0.06 | 57.48±0.07 | 0.087 |

*Values are means ± standard deviations of triplicate determinations. Means in same column with p-value less than 0.05 are significantly different

**Key:** A = Samuel 25**,** B = Samuel 24

### 3.3 Mineral Composition of Flours from Selected Peanuts Varieties

The result of the mineral properties of flours from selected varieties of peanut is presented in Table 3. The calcium, iron, potassium (K) and sodium (Na) were 26.49 and 26.31 mg/100g, 5.62 and 5.60, mg/100g, 13.99 and 13.84 mg/g and 10.37 and 9.92 mg/100g. There were significant differences ($P$=.05) across the mineral elements except for the iron content which exhibited no significant difference ($P$≠.05).

The result of the mineral analysis of flours from selected peanuts shows that Samuel 25 (sample A) is a rich source of calcium, iron, potassium and sodium than sample B this may be due to the higher ash content of sample A recorded in the study. The result of these findings is consistent with findings by [41] where similar mineral contents were reported for raw groundnut flour. The good availability of calcium, iron, potassium and sodium is a good indication that the peanut flours are so rich in the minerals for bone formation. Calcium is very essential in blood clotting, muscles contraction and in certain enzymes in metabolic processes. Iron plays a role in electron transferring reactions of the mitochondria. It is an important component of haemoglobin which is an oxygen–carrying pigment in the blood [45].

Potassium has been reported to play vital role in maintaining fluid balance and proper functioning of the essential organs such as the brain, nerves, heart and muscle [46]. Low potassium intake has been associated with a lot of non-communicable diseases including hypertension, cardiovascular diseases, chronic kidney stone formation and low bone- mineral density in children [47]. Potassium aids nerve impulse transmission and it is a major cation of the intracellular fluid. High potassium to low sodium ration in food may be imperative in diet formulations for patients with high blood pressure and oedema [48]. The body uses sodium to maintain fluid levels. A balance of fluid and sodium is necessary for the health of the heart, liver, and kidneys. It regulates blood fluids and prevents low blood pressure.

**Table 3: Minerals Composition (mg/100g) of Flour from Selected Peanuts Varieties**

| SAMPLE | A | B | P-value |
|---|---|---|---|
| **Ca** | 26.49±0.02 | 26.31±0.02 | < 0.001 |
| **Fe** | 5.62±0.02 | 5.60±0.01 | 0.091 |
| **K** | 13.99±0.01 | 13.84±0.04 | 0.004 |
| **Na** | 10.37±0.02 | 9.92±0.02 | < 0.001 |

*Values are means ± standard deviations of triplicate determinations. Means in same column with p-value less than 0.05 are significantly different

**Key:** A = Samuel 25, B = Samuel 24

## 4. CONCLUSION

This study established that the two selected varieties (Samuel 25 and Samuel 24) generally recorded good physicochemical, proximate, functional and mineral compositions. The result of the physicochemical parameters of peanut oil showed that refractive index, iodine value (gl/100g), specific gravity (g/cm$^3$), flash point ($^o$C), fire point ($^o$C), smoke point ($^o$C), cloud point ($^o$C), saponification value (mgKOH/g), % free fatty acid (%) and colour ranged between 1.11 and 1.52, 101.90 and 99.30, 0.94 and 0.92, 240.50 and 237.50, 316 and 301.50, 202.00 and 208.5, -2 and -4, 192.00 and 188.00, 31.21 and 30.71 and light brown to amber milky colour respectively.The two samples are good sources of nutrients. However, Samuel 25 peanut oil variety displayed higher amounts of minerals such as calcium, iron, potassium (K) and sodium (Na).The current study indicated that Samuel 25 peanut variety (Sample A) has good chemical and physical properties which are acceptable for the consumer. Therefore, the utilization of Samuel 25 variety in diet will give best results in combating diseases like cancer, diabetes and cardiovascular diseases based on the results indicated. In addition, knowledge of the refractive index, iodine value, specific volume, flash point, fire point, smoke point, cloud point, saponification value, % free fatty acids and colour of the peanut

variety will help to optimize the processing parameters during processing and handling of peanut seed and peanut oil without affecting the desired quality.

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