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PHYSICOCHEMICAL PROPERTIES OF SOME COMMERCIAL GROUNDNUT OIL PRODUCTS SOLD IN SOKOTO METROPOLIS, NORTHWEST NIGERIA

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ABSTRACT

Groundnut oil, also known as peanut oil or just vegetable oil is widely used in all homes in Nigeria in cooking and in other kitchen processes. The Northern part of Nigeria is also notable for the production of groundnut seed (*Arachis hypogea L.*) which is one of the major sources of groundnut oil in Nigeria. The physicochemical properties of commercial groundnut oils sold in Sokoto metropolis, Sokoto State, Northwest Nigeria were investigated in this study. Four different groundnut oil products purchased from Sokoto main market, Old market, Kara market and Mabera area within the metropolis and one extracted from groundnut seeds in our laboratory were analysed. The oil from Mabera has the highest saponification value of 215.05 ± 1.36 mg KOH/g which is significantly high compared to that extracted in our laboratory (175.78 ± 0.93). Iodine value was significantly higher at ($p< 0.05$) in oil from our laboratory (95.87 ± 0.15 g/100 g) compared to oils from Sokoto main market (43.72 ± 0.21) and Mabera area (45.12 ± 0.35). Groundnut oil from Sokoto main market has the highest acid value of 6.83 ± 0.15 which was above the cut-off value of 5.99, while the oil extracted in our laboratory has the lowest acid value of 1.88 ± 0.15. There was no significant difference at ($p< 0.05$) in the specific gravity of the different oil samples. The range was 0.900 – 0.918. The results show that the oils are of good nutritional value and are good for industrial applications, hence the oils pose no significant health risks to consumers in Sokoto metropolis.

Keywords: *Groundnut oil, Mabera, Sokoto, Physicochemical properties*

INTRODUCTION

Vegetable and edible oils had made an important contribution to the diet of people in many countries, serving as a good source of protein, lipid and fatty acids for human nutrition including the repair of worn out tissues, new cells formation as well as a useful source of energy[1]. In Nigeria, the major sources of edible oils are groundnut and oil palm. These oils are used mainly as cooking oils and for the production of soap, margarine, and cosmetics[2]. Oil quality and its stability are therefore very important for the consumers and in applications to industries[3].Groundnut oil is widely consumed domestically in Nigeria. Studies have shown that groundnut oil, which is obtained from the seed of groundnut plant (*Arachis hypogea*), contains much potassium than sodium and is a good source for calcium, phosphorus and magnesium. It also contains thiamin, vitamin E, selenium, zinc and arginine[4]. Findings have demonstrated that diets high in groundnut oil are as effective as olive oil in preventing heart disease and are heart friendly than very low fat diets[5]. Groundnut oil is of high quality and can withstand higher temperature without burning or breaking down. It has neutral flavour and odour.

It does not absorb odours from other foods[6]. This makes it the most preferred oil in Northern Nigeria and other parts of the country. The nutritional values of groundnut oil are however, affected by the method and period of storage, which consequently affect the acceptability of these oils. Women extract the oil domestically to generate substantial income to support their domestic needs with little or no consideration given to the physicochemical properties of the oils. Most women rely on availability rather than quality[7]. Groundnut (Peanut) oil are classed, among others, as Oleic-Linoleic acid oils seeing that they contain a relatively high proportion of unsaturated fatty acids, such as the monounsaturated oleic acid and the polyunsaturated linoleic acid [8]. They are characterized by a high ratio of polyunsaturated fatty acids to saturated fatty acids (see fig. 1). As a consequence of this, they have relatively low melting points and are liquid at room temperature. Iodine values, saponification values, specific compositions and melting points in addition to other physical properties have been determined on groundnut oil and are widely available in the literature [9].

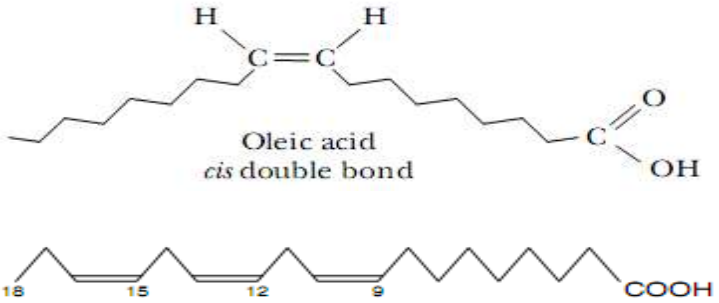

Fig. 1: The structures of Oleic acid (*cis* double bond form) and polyunsaturated Linoleic acid

The chemical composition of fats and oils which confers on them specific properties has made them suitable for use as foods, fuels and lubricants. They are naturally occurring substances which consist predominantly of esters of fatty acids and glycerol.
However, various species of groundnut plant are grown in Nigeria and little consideration is given to these species during the extraction of the oil as oil from more than one species may be extracted and mixed together. This may have an overall effect on the quality and properties of the oil. It is therefore necessary to regularly analyze different samples of the oils sold at different locations in Nigeria in order to identify reasonable changes in the properties of the oils in the market and also to make recommendations to the local authorities, producers and retailers on how best to process and preserve the oil from deterioration and quality diminution[7]. The aim of this study therefore, is to examine the physicochemical properties or characteristics (free fatty acid value, iodine value, saponification value, etc.) of commercial groundnut oils sold in Sokoto metropolis. In this regard, the study will consider the edibility of these oils based on the aforementioned properties.

MATERIALS AND METHODS

Sampling and Sample Collection

5 samples of groundnut oil were collected from different locations within the Sokoto metropolis, Sokoto State Northwest Nigeria. Samples 1, 2, 3 and 4 are collected from Sokoto main market, Old market, Kara market and Mabera area respectively, while the fifth sample was extracted from the seed by solvent extraction using hexane in the laboratory. All chemicals used were of analytical reagent grade.

Determination of Iodine Value

Standard method was used. The method is based on the treatment of a known weight of oil/fat with a known volume of standard solution of iodine monochloride (ICl). Excess ICl is reacted with KI and the iodine liberated is titrated against $Na_2S_2O_3.5H_2O$ with starch as indicator[8]. 0.3g of groundnut oil was weighed accurately. 10ml of CCl_4 and 25ml of Wits solution were added successively and the flask was votexed and allowed to stand in a dark cupboard for 1 hr. 15ml of 10% potassium iodide and 100ml of distilled water were added followed by 1 ml of starch solution. It was titrated against 0.1*N* $Na_2S_2O_3$ until the blue colour disappeared indicating an end point. Blank solution was titrated without the oil sample. The value was calculated (1)[8].

$$\text{Iodine value} = \frac{(b - a) \times N \times 1.269 \times 100}{W} \quad \text{..... eqn (1)}$$

Where b = blank titre value, a = sample titre value, N = normality of thiosulphate, W = weight of sample

Determination of Saponification Value

Saponification number is the amount of mg KOH required to completely saponify 1g of oil. When oil is treated with excess alcoholic KOH, it is saponified and the excess KOH is titrated against 0.5*M*HCl. 0.5g of the oil was weighed in a quick-fit-reflux flask and 25ml alcoholic KOH was added. It was refluxed for 30mins, so that it gets simmer. The flask was cooled and 1ml of phenolphthalein indicator was added and titrated against 0.5*M*HCl. The value was calculated (2)[8].

$$\text{Saponification value} = \frac{56.1 \times (b - a) \times N}{W} \quad \text{..... eqn (2)}$$

Where W= weigh of sample = 0.5g, b = blank titre value, a= sample titre value, N = Normality of HCl.

Determination of Percent Acid Value

It is the percent of free fatty acid expressed as oleic acid. Acid value of oil is determined by titration of a known weight of the oil against 0.25*M*NaOH using phenolphthalein as indicator (3) [8].

$$C_{17}H_{33}COOH + NaOH \longrightarrow C_{17}H_{33}COONa + H_2O \quad \text{..... eqn (3)}$$

Extracted groundnut oil (1.0 g) was weighed in a conical flask and 50ml of denatured alcohol was added, vortexed and 2 drops of phenolphthalein indicator was added and the solution titrated against 0.25*M*NaOH with vigorous shaking until permanent light pink colour was obtained. The value was calculated (4).

$$\text{Percent acid value} = \frac{100 \times 2.82 \times V}{} \quad \text{..... eqn (4)}$$

$$\frac{W \times 1000 \times 4}{}$$

Where W = weight of oil = 1g, V = titre value of 25*N* NaOH, 2.82= equivalent weight of oleic acid.

Determination of Percent Free Fatty Acid

10g of oil was boiled with 50ml ethanol, allowed to cool and 2 drops of phenolphthalein indicator was added. It was titrated against 0.1*N*NaOH until pink colour was obtained. The value was calculated (5) [8], [9].

$$\text{Free fatty acid} = \frac{\text{Titre value} \times 2.82}{\text{Weight of sample}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{ eqn (5)}$$

Determination of Ester value

5ml of the extracted oil was weighed in a quick-fit refluxing flask. About 25ml of alcoholic KOH with 10 drops of phenolphthalein indicator were added. It was then reflux for 1 hr. Cooled and titrated against 0.5*N*HCl. Blank titration was also carried out in the same manner without the oil. The value was calculated using equation (6)]8], [10].

$$\text{Ester value} = \frac{(\text{Blank sample titre value}) \times 0.5 \times 56.1}{W} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{ eqn (6)}$$

Determination of Specific Gravity

Pycnometer, i.e specific gravity bottle was used in measuring the density/specific gravity. The specific gravity of oil is the ratio of the weight in air of a given volume of the oil at a define temperature to that of the same volume of water at same temperature [11].

Cleaned, dried pycnometer was weighed. It was filled with water maintained at 20^0C and weighed again. The bottle was emptied, dried and filled with oil and weighed. The value was calculated using equation (7).

$$Specific\ gravity = \frac{weight\ of\ oil}{weight\ of\ water\ at\ 20^0C} \qquad (7)$$

RESULTS AND DISCUSSION

The results of the physicochemical properties of the five (5) groundnut oil samples analysed are presented in Table 1.

Table 1: The results of the physicochemical properties of the five (5) groundnut oil samples analysed

Sample	Iodine Value	Free Fatty Acid	Saponification Value	Acid Value	Ester Value	Specific Gravity
Sokoto main market	43.72 ± 0.21	3.01 ± 0.12	187 ± 0.61	6.86 ± 0.15	0.78 ± 0.85	0.9 ± 0.86
Old market	84.59 ± 0.20	2.26 ± 0.1	185.13 ± 1.25	3.01 ± 0.12	0.71 ± 0.68	0.918 ± 2.72
Kara market	88.82 ± 0.26	1.32 ± 0.06	201.4 ± 0.45	2.44 ± 0.15	0.52 ± 0.3	0.91 ± 1.59
Mabera area	45.12 ± 0.35	1.5 ± 0.06	215.05 ± 1.36	3.2 ± 0.31	0.31 ± 0.85	0.912 ± 0.57

Lab. extract	95.87 0.15	±	0.94 0.06	±	175.78 ± 0.93	1.88 0.15	±	0.094 0.25	±	0.914 2.35	±	

Iodine Value

Iodine value is a measure of the unsaturation of fats and oils, and is expressed in terms of the number of centigrammes of iodine absorbed per gramme of the sample (i.e. percent iodine absorbed) during oxidation, which consumes the double bonds resulting in a reduction in iodine. It is an indicator for double bindings in the molecular structure, which influences the long term stability properties of the oil (i.e. important for storage). Oils having high iodine number are polyunsaturated indicating the degree of unsaturation and are desired by oil processors, while a lower iodine number is indicative of lower quality[12]. The results show that Sokoto main market and Mabera area oils have low iodine value of 43.72 and 45.12 respectively indicating their low quality. The oil extracted in the laboratory has the highest iodine value of 95.87 ± 0.15 g/100g, indicating that the fatty acid presence is unsaturated, especially oleic oil. This is a measure of fat or oil stability and resistance to oxidation[13].

Free Fatty Acid

Free fatty acid is the percentage by weight of a specified fatty acid (e.g. percent oleic acid) [14], [15]. 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[16]. 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[12]. In refined vegetable oils, the lower the free fatty acid the more acceptable the oil is to man in terms of palatability.
From the results, the percentage of free fatty acid of the oil obtained from Sokoto main market is 3.01 ± 0.12 indicating that the oil is not good for consumption. This could be due to impurities that could cause the hydrolysis of the ester linkage thereby increasing the free fatty acid level. The oil extracted in the laboratory has the lowest free fatty acid value of 0.94 ± 0.06.

Saponification Value

Saponification value is an indication of the size or nature of fatty acid chains esterified to glycerol. In combination with acid values, saponification values are useful in providing information as to the quantity, type of glycerides and mean weight of the acids in a given sample of oil. Saponification is only of interest if the oil is for industrial purposes, as it has no nutritional significance. But due to the fact that each fat has within the limits of biological variation, a constant fatty acid composition, determination of the saponification value is a reasonable means of characterizing the fat[17]. The results also show that highest saponification value was recorded with the oil from Mabera with 215.05mgKOH/g, indicating that the oil can be used industrially for making soap.

Acid Value

Acid value represents the milligram KOH required to neutralize the free fatty acid in 1g of oil. Groundnut oil from Sokoto main market has the highest acid value of 6.83 ± 0.15 which is above the cut-off value of 5.99, while the oil extracted in the laboratory has the lowest acid value of 1.88 ± 0.15. Acid value determination is often used as a general indication of the condition and edibility of the oil. This is because an increase in acid value is accompanied by development of objectionable flavours and odours [7], [18].

Ester Value

Ester value is defined as the number of milligrams of potassium hydroxide required to combine with fatty acid present in glyceride form in 1g sample of oil or fat. In simple term, it is the difference between the saponification value and Acid value.[18] The ester value helps to measure the intactness of the ester bond between the glycerol molecule and the fatty acids present in the oil. Oils having higher ester value are more intact and are less prone to oxidation while low ester value indicates that that the oil is intact and therefore more suitable for consumption and storage.[8], [18] The results further show that Mabera area and oil extracted in the laboratory have the lowest and highest ester values of 0.31 and 1.26 respectively. The higher the ester value, the more intact the ester bond between the glycerol molecule and the fatty acids. Therefore, the oil extracted in the laboratory is of high quality and can be stored for a longer time.

Specific Gravity

Specific gravity is the comparison of the weight of the oil to that of water having the same volume and at a given temperature. Specific gravity measurement can be used in a wide variety of industries. It is particularly useful because it allows access to molecular information in a non invasive way.[14] Studies have shown that the specific gravity of different refined oils varies with their molecular weights which are affected by refining processes[8]. There was no significant difference between the specific gravity of the different oil samples. The range is from 0.900-0.918.

CONCLUSION

The results of this study have shown that the oils, on average have high shelf lives and can be stored for long time. The results also show that the oils are of good nutritional value and are good for industrial application. It can therefore, be suggested that the groundnut oils pose no significant health risks to the consumers in Sokoto metropolis. However, from this study it was observed that there was a poor knowledge on the necessary steps required for long-term storage and preservation of the oil among the local oil traders and consumers. It is highly recommended that more efficient process of the extraction, management, storage and handling of this vital oil should be obviously intensified. Also the local traders should be educated on how to best preserve the oil from deterioration.

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