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Physicochemical and proximate composition of MK 373, Abujachi and Makowchi groundnut varieties grown in Kwara State, Nigeria

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Abstract

The analysis of the nutritional constituents of crops is of considerable importance especially if such analysis is centered on crops forming part of the diet of many people around the globe. One of such crops that is widely consumed around the world and also has many other forms of benefits for many people is the groundnut. Thus, this work seeks to examine the physicochemical and proximate compositions of MK 373 and two local varieties of groundnut (Abujachi and Makowchi) grown in Nigeria. To ensure precision and accuracy, these investigations were conducted following standardized protocols and methods. Compared to Abujachi (4.76 ± 0.19%), significantly low moisture content was recorded in MK373 (4.31 ± 0.26%) and Makowchi (4.42 ± 0.07%). Makowchi had the highest ash content (2.62 ± 0.08%) while MK373 had the highest crude fat (49.14 ± 0.42%). While MK 373 recorded highest protein, Makowchi ranked the highest in carbohydrate. Crude fiber content was not significantly different in the three varieties. Oil extract from these groundnut varieties were pale yellow and liquid at room temperature (25ºC). Specific gravity at room temperature was 0.91 while refractive index ranged from 1.459 to 1.460. Saponification value was most noticeable for MK373 (193.62 ± 0.98 mg KOH/g), followed by Makowchi (189.22±0.31 mg KOH/g) and Abujachi (186.61±0.29 mg KOH/g). Makowchi had the highest percentage fatty acid and iodine values 12.83 ± 0.14% and 71.45 ± 0.20 mg/100g respectively, followed by Abujachi (12.65 ± 0.16% and 64.83 ± 0.10 mg/100g) and MK373 (7.83 ± 0.00% and 57.37 ± 0.21 mg/100g). These results suggest that the three oil extracts exhibited varying characteristics. It also showed the oil extracted from these groundnut varieties could be useful in industry in their crude form and safe for consumption when properly refined.

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1. Introduction

Several conventional and non-conventional oil seed crops such as palm kernel, olive, cotton, sunflower, canola, sesame and soybean are grown throughout the world (Farhan *et al*., 2013). The oil extracted from these plants have diverse domestic and industrial uses such as the production of snacks, cake, margarine, biscuit, cosmetics, detergent and plastics (Hassan *et al*., 2011). Vegetable oils have made an important contribution to the diet of people in many countries.

It serves as a good source of protein, lipid and fatty acids for human nutrition and function in the repair of worn out tissues, formation of new cells and as useful source of energy (Atasie *et al*., 2009).

In Nigeria, the major sources of edible oils are groundnut and oil palm. However, oil extracted from the former is the most preferred on account of its high quality, ability to withstand high temperature without breaking down characteristic nutty flavor and odor (Passera, 1981; Musa *et al*., 2012).

Groundnut is rich in oil, about 47 to 50 % depending on the variety (Musa and Serap, 2003). The oil has a variety of uses such as using it in cooking, production of soap, margarine, surfactants-cleansing and cosmetics (Upadhaya and Nigam, 1999; Plessis and Steiman, 2004).

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It should be emphasized here that earlier works have revealed that different varieties of groundnut tend to have oil contents with different physicochemical properties. This determines their uses, to large extent, either in industry or for domestic purposes. Much attention has been paid to characterize the oil extracted from conventional and non- conventional oil seed crops (Akanni *et al*., 2005). However, there is little information on characterization of oil extracted from groundnut varieties commonly grown in Southern Guinea savanna zone of Kwara State, Nigeria. To fill this void, the present study was conducted to provide valuable information on the physicochemical properties and some aspects of proximate composition of these groundnut varieties.

2. Materials and Methods

2.1 Collection and seeds preparation

Three varieties of healthy groundnut seeds (MK 373, Abujachi and Makowchi) were used for the experiment. The pods of all the three varieties were collected from Agricultural unit in Patigi Local Government Area of Kwara State. The collected pods were shelled manually and screened to remove bad ones. The seeds were then air-dried under shade for eight days. Seeds were milled using mechanical grinder, packed in an air-tight container and stored in desiccators to avoid moisture re-absorption until they were used for analyses.

2.2 Proximate analysis

Moisture content, ash, crude fat, protein, fiber and carbohydrate content of the air-dried seeds were analyzed according to the methods of Association of Official Analytical Chemists (AOAC, 2000).

2.3 Oil extraction

Milled seeds were dried to a constant weight in an oven at 105ºC. The dried paste of each sample was transferred separately into a thimble. Oil extraction was carried out in a Soxhlet apparatus with petroleum ether as the solvent.

2.4 Physical characteristics of groundnut oil

Specific gravity

Dry and empty specific gravity bottle was cleaned and weighed. It was filled with water maintained at 25ºC and then weighed again. Thereafter, the bottle was emptied, dried and filled with oil and then weighed at the same temperature.

The value of specific gravity was calculated using the equation:

$$\text{specific gravity} = \frac{\text{weight of bottle and oil at } 25°\text{C} - \text{weight of bottle at } 25°\text{C}}{\text{weight of bottle at } 25°\text{C}}$$

Refractive index

The refractive index was determined using a refractometer (Erma hand refractometer) with a range of 0-32 % measuring capacity. A drop of the oil was placed on the surface of the refractometer and the reading was taken (Ayo and Agu, 2012). The colour and odour of the various groundnut oils under investigation were determined at room temperature (25^0C) by visual approach.

2.5 Chemical characteristics of oils

Percentage free fatty acid.

Ten grams (10 g) of each of the groundnut varieties under investigation were boiled with 50ml ethanol. This was allowed to cool and 2 drops of phenolphthalein indicator was then added. Thereafter, it was titrated against 0.1 N NaOH until pink colour was obtained. The value of free fatty acid was calculated with the formula below (Nkafamiya *et al*., 2010).

$$\text{Free fatty acid} = \frac{\text{Titre value} \times 2.82}{\text{Weight of sample}}$$

Saponification value of oil extracts

Oil 0.5g was weighed in a quick-fit-reflux flask and 25 ml alcoholic potassium hydroxide (KOH) was added. It was refluxed for 30 minutes. The flask was cooled and 1ml of phenolphthalein indicator was added and titrated against 0.5 N hydrochloric acid (HCl). The saponification value was calculated using the formula below (Musa *et al*., 2012).

$$\text{Saponification value} = \frac{56.1 \times (b - a) \times N}{\text{Weight}}$$

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

Iodine value

Dam's reagent 5 ml was added to 0.2 g of oil dissolved in 5 ml of chloroform. The mixture was kept in the fume cupboard for 10 minutes. 5 ml of 10% potassium iodide (KI) and 20 ml of water were then added. The mixture was thoroughly mixed and titrated to a colourless end point with 0.025 M of sodium thiosulphate ($Na_2S_2O_3$) solution. A blank (control) was treated in a similar way. The iodine value was calculated according to AOAC (2000).

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

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

2.6 Data analysis

Data were analysed by Analysis of Variance using Statistical Package of Social sciences (SPSS) software version 20.0. Means were separated using Duncan Multiple Range Test (DMRT) at 5% level of probability.

3. Results and Discussion

The results of proximate parameters of the three groundnut varieties seeds are presented in Table 1. The moisture content of the seeds ranged between 4.31 ± 0.26% in MK 373 and 4.76 ± 0.19% in Abujachi. Crude fat contents of the seeds were highest in MK 373 (49.14 ± 0.42%) and followed in descending order of

magnitude by Abujachi (48.90±0.04%) then Makowchi (46.27 ± 0.12%).

The ash contents of the seeds, which is the thorough estimation of the minerals, ranged from 2.23 ± 0.02 in Abujachi to 2.62 ± 0.08% in Makowchi. Protein was highest in MK 373 and lowest in Makowchi. This was in contrast to what was seen in carbohydrate as Makowchi had the highest carbohydrate content and MK 373 had the lowest. As for crude fiber, a relatively similar quantity was observed in all of the three varieties.

The low moisture content in MK 373 as compared to other varieties is indicative of longer shelf-life of the MK 373 seeds (Ogunniyi, 2006). The moisture content in groundnut is also useful in determining such qualities like porosity and bulk density of groundnut (Muhammad *et al*., 2017). The percentage oil and ash contents recorded for the three varieties compared well with other cultivars of groundnuts (Grosso and Guzman, 1995). According to Ayoola and Adeyeye (2010), adequate knowledge of the oil and ash contents is desirable in evaluating the therapeutic and prophylactic potential of groundnut. The protein content of the three varieties are in consistence with those reported by Sarvamangala *et al*. (2011) for groundnut grown in mid-seasons. Plant proteins provides for emulsification, gelation and water-binding in food systems (Thrane *et al*., 2017). The need to generate more proteins of plant origin, as opposed to animals, has gained more consideration in recent years (Diedericks *et al*., 2020). Unlike Boro light and other varieties of groundnut having lower fiber content in the research of Ayoola *et al*. (2012), the three varieties in our study had higher fiber content. This suggests that the three varieties will be better off in laxation and control of cholesterol and blood glucose attributed with dietary fiber (Rasane *et al*., 2015). It is also impressive that the varieties captured in the present research also have appreciable level of carbohydrate. The range of values of carbohydrate content in our findings is similar to those of groundnut varieties in Ghana as recorded by Asibou, *et al*. (2008).

Table 1: Some aspects of proximate composition of three groundnut varieties

Proximate Parameter	MK 373	Abujachi	Makowchi	P value (%)
Moisture content	4.31±0.26b	4.76±0.19a	4.42±0.07b	0.042
Ash content	2.32±0.07b	2.23±0.02b	2.62±0.08a	0.001
Crude fat	49.14±0.42a	48.90±0.04a	46.27±0.12b	< 0.001
Protein	31.71±1.11a	27.33±1.95ab	26.55±1.72b	0.08
Crude fiber	4.36±0.42a	4.16±0.15a	4.65±0.17a	0.04
Carbohydrate	8.16±0.27c	12.61±0.08b	15.49±1.01a	< 0.001

Values are mean ± standard deviation, n=3, superscript with same letters in the same row are not significantly different at p≤0.05

Table 2 depicts the physical properties of the oils in terms of their colour, state, odour, specific gravity and refractive index. The oils extracted were pale, liquid at room temperature and with characteristic nutty odour. Statistical differences were not recorded for the specific gravity and refractive index. However, MK 373 showed lower refractive index when compared to other varieties (Table 2).

The specific gravity value of 0.91 for all the varieties in this study was similar to the results of Musa *et al*. (2012) where the authors reported specific gravity values that ranged from 0.900 to 0.918 in some varieties of groundnut. Specific gravity is of great importance in industries as it allows access to molecular information in a non-invasive way. The refractive index which is more or less 1.460 for all the varieties was relatively lower compared to values recorded in sunflower, soybean and cotton seed which were 1.4750, 1.4730 and 1.4700 respectively (Rahib *et al*., 2015). The relatively lower refractive index obtained in this work is an indication that the fatty acids in the oil contains a lower number of carbon atoms compared to the oil extracts from the aforementioned sources (Bello and Olawore, 2012).

The chemical properties of the oil extracted from the three groundnut seed varieties are presented in Table 3. Significantly highest saponification value was recorded in MK373 (193.62 ± 0.98 mg KOH/g oil) compared to Abujachi (189.22±0.31 mg KOH/g oil) and Makowchi (186.61±0.29 mg KOH/g oil). Iodine value was high in Makowchi (71.45 ± 0.20 mg/100g) and Abujachi (64.83 ± 0.10 mg/100g) when compared to MK 373 (57.37 ± 0.21 mg/100g). Iodine value shows the level of unsaturated bonds. A higher saponification value recorded from MK 373 depicts that its oil has greater proportion of fatty acids of low molecular weight and shorter chain length. Oils with high saponification are good in the making of soap and cosmetics (Onyeike and Oguike, 2003). Hence, the high saponification value of the oil of MK 373 conferred on it the status of the oil with the most suitable ingredient in soap making and cosmetic industry among the three studied varieties. The saponification values in all the groundnut samples compared well with F-mix and Manipintar varieties from Ghana with saponification values of 189.34±0.52 and 194.25± 0.57 respectively (Eshun *et al*., 2013).

Makowchi recorded significantly highest percentage of free fatty acids (12.83 ± 0.14%) followed by Abujachi (12.65 ± 0.16%) and MK373 (7.83 ± 0.00%). The percentage of free fatty acid of oils, like in the present findings, reveals their overall quality in terms of degree to oxidative rancidity (Musa *et al*, 2012).

Table 2: Physical characteristics of oil from three groundnut varieties.

Sample	Specific gravity (at 25^0C)	Refractive index (at 25^0C)	State (at 25^0C)	Colour	Odour
MK373	0.91±0.00[a]	1.459±0.00[a]	Liquid	Pale yellow	Nutty
Abujachi	0.91±0.00[a]	1.460±0.00[a]	Liquid	Pale yellow	Nutty
Makowchi	0.91±0.00[a]	1.460±0.00[a]	Liquid	Pale yellow	Nutty
Total mean	0.91±0.00	1.460±0.00	-	-	-
P value	1.00	0.42	-	-	-

Values are mean ± standard deviation, n=3, superscript with same letters in the same column are not significantly different at $p \leq 0.05$

These values of free fatty acids were respectively higher in comparison those recorded for soybean (0.5 %), melon (2.38%), avocado (0.37), bean (0.79) and cotton seed (0.7 %) as reported by Rahib *et al*., (2015). The consequence of this is that the studied oils have to be refined, for them to be safe for consumption especially

Abujachi and Makowchi. This is because research had shown that the higher the degree of unsaturation (high iodine value), the greater the tendency of the fat to go through oxidative rancidity (Musa *et al.,* 2012; Eshun *et al*., 2013). The low iodine value of MK 373 conferred on the oil lower rate of decomposition compared to other varieties. The iodine values in the studied oil were below 100 and such the oils can be classified as non-drying oil. This non-drying oil qualifies them to be used in paint industry (Akubugwo and Ugbogu, 2007; Asibou *et al*., 2008).

Table 3: Chemical properties of oil from three groundnut varieties

Sample	Saponification value (mg KOH/g oil)	% Free fatty acids (% FFA)	Iodine value (mg/100g)
MK 373	193.62±0.98[a]	7.83±0.00[b]	57.37±0.21[c]
Abujachi	189.22±0.31[b]	12.65±0.16[a]	64.83±0.10[b]
Makowchi	186.61±0.29[c]	12.83±0.14[a]	71.45±0.20[a]
Total mean	189.81±3.11	11.09±2.45	64.54±6.10
P value	<0.001	<0.001	<0.001

Values are mean ± standard deviation, n=3, superscript with same letters in the same column are not significantly different at $p<0.05$.

3. Conclusion

The results of this study have shown the oils from the three groundnut varieties were similar in terms of refractive index, specific gravity, state, colour and odour. However, variation exists in their proximate and chemical properties where MK 373 showed higher saponification value but lower free fatty acid and iodine value compared to Abujachi and Makowchi. In spite of this chemical variability, the oil from these groundnut varieties could be a useful ingredient in the industries like cosmetics and soap industries. It is also safe for consumption if adequately refined.

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