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Chemical Analyses of Groundnut (*Arachis hypogaea*) Oil

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Abstract: Peanut (*Arachis hypogaea L.*) oil from seeds of six varieties; boro red, boro light, mokwa, ela, campala and guta as well as oil from three geographical zones in Nigeria; northern, eastern and western were investigated. Gas chromatography analysis showed high concentrations of oleic and linoleic acids in the oil samples. Capric (0.0) and Lauric (8.1) acids were absent and highest, respectively in the mokwa variety and hence diagnostic. More so, the comparative chemical analysis of peanut oils from the three zones and some selected refined vegetable oils; sunola, grand, olive and corn oil, indicated that western and grand oils had high iodine value 1.74±0.1 and 2.63±0.1, respectively, compared to others. The northern oil had high acid and fat value than the others (4.49 and 133%, respectively). Furthermore, the saponification value of the local vegetable oils was found to be significantly higher than the refined vegetable oils ($P < 0.05$), the eastern oil having the highest (140.25mgKOH/g). However, the peroxide values for both the local and refined oils were less than the standard peroxide value (10mEqKg^{-1}) for vegetable oil deterioration. Minerals were present and no rancidity was observed in all the samples. In conclusion, the groundnut oil from Nigeria may have a higher shelf life, and serve as a useful substitute in nutrition and industrial applications.

Key words: Acid value, gas chromatography, groundnut oil, iodine value, peroxide value, saponification

Introduction

Edible oils from plant sources are of important interest in various food and application industries. They provide characteristic flavors and textures to foods as integral diet components (Odoemelam, 2005) and can also serve as a source of oleochemicals (Morrison *et al*., 1995). Oleochemicals are completely biodegradable (Kifli and Ahmad, 1986) and so could replace a number of petrochemicals. In Nigeria, the major sources of edible oils are groundnut also called peanut (*Arachis hypogaea L.*) and oil palm (*Elaeis guineensis*). These oils are used mainly as cooking oils and for the production of soap, margarine, and cosmetics (Ong *et al*., 1995). Peanut is an important source of edible oil for millions of people living in the tropics. In Nigeria, 1917 tons of peanuts are being produced annually (Ergül, 1988). Peanuts are among the oldest oil crops in Nigeria and are mostly consumed as snack, after roasting (Bansal *et al*., 1993; Jambunathan *et al*., 1993). Vegetable oil had made an important contribution to the diet 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 (Gaydou *et al.,* 1983; Grosso and Guzman, 1995; Grosso *et al*., 1997, 1999). Oil quality and its stability are therefore very important for the consumers and application industries (Jambunathan *et al*., 1993). Thus, this study investigates the growth and chemical properties of *Arachis hypogaea L.* oils from Nigeria with the objective of evaluating the nutritive and industrial suitability.

Materials and Methods

Plant and oil materials:

Seeds of six varieties of *arachis hypogaea:* Boro Light, Boro Red, Mokwa and Campala, Guta and Ela (Fig.1), as well as refined vegetable oils such as grand and sunola were procured from Mile 12 market, Lagos while olive and corn oil were purchased from Bodija, Ibadan. Locally produced vegetable oils (groundnut oil) were obtained from western (Ilishan-Remo), eastern (Ubakala) and northern (Kaduna) zones of Nigeria.

Preparation of samples for analysis: The seeds were stored under dry and cool condition prior to analysis. Extraction was carried out with soxhlet apparatus using n-hexane as solvent. The peanuts were dried at room temperature, peeled and crushed. 100g of each variety was measured, tied in a cellulose thimble and inserted into the soxhlet apparatus. The apparatus was left to run for 6h and the solvent was eliminated (evaporated) *in vacuo* using the rotary evaporator. Optical density was measured at 470nm using a SpectrumLab 752S uv-visible spectrophotometer.

Fat extraction: Fat extraction was carried out by Soxhlet method according to Pearson's (1981).

Chemical analysis:

Acid value: Acid value was determined by titre metric method of Pearson (1970). 5g of the oil sample was weighed and 75ml of hot neutral alcohol was added with a few drops of phenolphthalein. The mixture was shaken

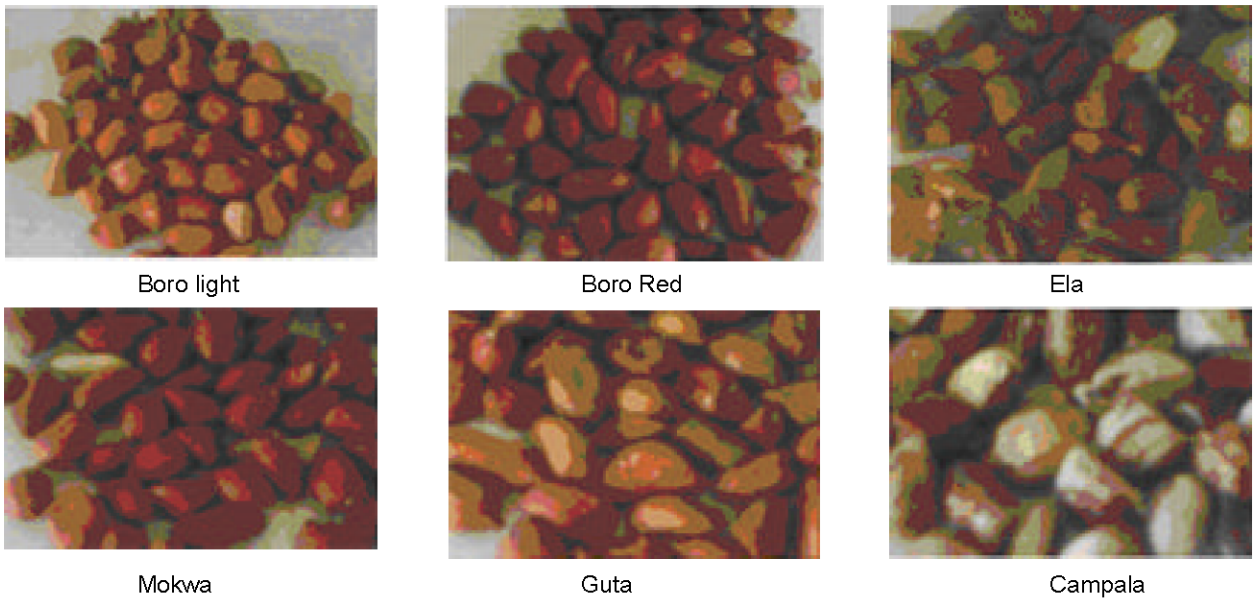

Fig. 1: Varieties of *Arachis hypogaea*

vigorously and titrated with 0.1M NaOH solution with constant shaking until the pink colouration remains permanent. Acid value was calculated using the formula:

$$\text{Acid Value} = \frac{V \times 5.6}{\text{Weight of sample}}$$

Where: V = titration end point value.

Iodine value: Iodine value was determined according to the titre metric method of Pearson (1970). 2g of oil sample was weighed into a dry glass stopper bottle of 250ml capacity and 10ml of carbon tetrachloride was added to the oil. About 20ml of Wij's solution was then added and allowed to stand in the dark for 30 min. 15ml of (10%) Potassium Iodide and 100ml of water was added and then titrated with 0.1M Sodium thiosulphate solution using starch as indicator just before the end point. A blank was also prepared alongside the oil samples. Iodine value was calculated fro the formula:

$$\text{Iodine value (Wij's)} = \frac{(V_2 - V_1) \times 1.269}{\text{Weight of sample (g)}}$$

Where: V_2 = titer value for blank, V_1 = titer value for sample (s)

Peroxide value: Peroxide value was evaluated according to AOAC (1984). 2g oil sample was weighed into a tube and 1g of powdered Potassium iodide with 20ml of solvent mixture (glacial acetic acid and chloroform) was added. This was then placed in boiling water for 30s. The content was poured into a flask containing 20ml of 5% iodide solution. The tube was then washed with 25ml of distilled water and titrated with 0.002N Sodium thiosulphate solution using starch as indicator. A blank was prepared alongside the oil samples. Peroxide was obtained using the formula:

$$\text{Peroxide value} = \frac{2\,(V_1 - V_2)\ \text{mEq/kg.}}{\text{Weight of sample (g)}}$$

Where: V_2 = Blank titre value, V_1 = Sample (s) titre value

Saponification value: The Saponification value was determined according to the titre metric method of Pearson (1981). 2g of oil sample was weighed into a conical flask and 25ml of alcoholic Potassium hydroxide was added. Solution was heated in boiling water for 1h. 1ml of 1% Phenolpthalein was added and titrated with 0.5N HCl. A blank was prepared alongside the oil samples. The value was calculated by the formula:

$$\text{Saponification value} = 56.1\ N\ (A - B)/W$$

where N = Normality of HCl acid used, A = Volume of H_2SO_4, for blank, ml, B = Volume of H_2SO_4, for sample, ml, 56.1= Equivalent weight of potassium hydroxide, W = Weight of oil used (2g)

Qualitative test for rancidity in oil and fat: The test for rancidity of oil was carried out according to Pearson (1981). 10ml of the oil samples was placed in a 100ml test tube vigorously mixed with 10ml of 0.1% Phloroglucinol solution and 10ml of concentrated HCl for 20s.

Table 1: Oil yield and physical properties of the six varieties of *Arachis hypogaea*

Variety	Oil yield (ml)	Color	Odour	State at room Temperature	Absorbance (470nm)
Boro Light	20.8	Bright yellow	Agreeable	Liquid	0.032
Boro Red	20.6	Amber yellow	Agreeable	Liquid	0.057
Ela	19.4	Golden yellow	Agreeable	Liquid	0.398
Mokwa	19.9	Light yellow	Agreeable	Liquid	0.186
Guta	19.8	Light yellow	Agreeable	Liquid	0.166
Campala	18.6	Bright yellow	Agreeable	Liquid	0.035

Table 2: Percentage composition of fatty acids in the varieties of *Arachis hypogaea* following Gas Chromatography

Fatty acids	Boro light (%)	Boro Red (%)	ELA(%)	Mokwa (%)	Guta (%)	Campala (%)
Capric	5.85	5.41	5.31	0.00	5.37	5.46
Lauric	5.80	5.59	5.49	8.10	5.57	5.67
Myristic	0.07	0.08	0.08	0.09	0.07	0.08
Palmitic	4.35	4.18	4.11	4.85	4.10	4.17
Palmitoleic	0.62	0.61	0.60	0.62	0.59	0.60
Stearic	0.69	0.70	0.69	0.67	0.67	0.68
Oleic	42.46	43.30	44.20	41.67	43.04	42.15
Linoleic	20.57	20.77	20.50	19.58	20.63	20.89
Linolenic	0.14	0.14	0.14	0.12	0.14	0.15
Arachidic	1.62	1.64	1.61	1.18	1.73	1.76
Behenic	1.49	1.47	1.44	1.14	1.93	1.96
Lignoceric	0.17	0.10	0.10	0.11	0.17	0.18

Table 3: Chemical analysis of some selected refined and local vegetable oils in Nigeria

Vegetable oils	Fat Content (%)	Iodine Value (wij's)	Peroxide Value (Meq/kg)	Acid Value (%)	Rancidity	Mineral	Saponification value (mgKOH/g)*
Northern (Kaduna)	133±0.5[a]	1.36±0.1	0.80±0.1	4.49±0.0	Nil	Present	129.03±0.3
Western (Ilisan-Remo)	76±0.3	1.74±0.1	0.65±0.0	2.13±0.0	Nil	Present	112.20±0.1
Eastern (Ubakala)	126±0.5	0.66±0.1	0.85±0.0	2.58±0.3	Nil	Present	140.25±0.2
Sunola	88±0.2	1.68±0.1	0.45±0.1	2.24±0.1	Nil	Present	36.46±0.2
Grand	72±0.2	2.63±0.1	1.15±0.1	1.68±0.1	Nil	Present	44.88±0.2
Olive	95±0.2	0.10±0.1	0.85±0.1	3.03±0.1	Nil	Present	50.49±0.3
Corn	90±0.2	0.80±0.1	0.70±0.0	1.46±0.2	Nil	Present	22.44±0.1

[a]Data expressed as mean ± standard error, *Indicates statistically significant at $P < 0.05$

Determination of the presence of mineral oil in fats and vegetable oils: The presence of mineral oil in vegetable oil was carried out according to Pearson (1981). 10ml of the oil sample and 0.5M alcoholic KOH was added into 5ml test tube. It was then heated in a boiling water bath with frequent agitation to ensure complete reaction. 0.5ml of water was added to the hot solution at a time and until 10ml had been added altogether.

Results and Discussion

Vegetable oils now constitute a major component of daily diet consumption and its growth in the market is now considered on the basis of functionality, economy, and acceptability. The oil types indicate that boro light (20.8%) variety had the highest oil yield while campala (18.6%) had the lowest (Table 1). The range of oil yield in the varieties (18.6-20.8%) signified suitability for commercial production. Spectrophometric analysis revealed that ela had the highest absorbance (0.398nm) while boro light had the lowest (0.032nm), Table 1. The gas chromatographic data (Table 2) on percentage composition of the different types of fatty acids present showed that oleic and linoleic acids were the highest ranging from 41.7-44.2 and 19.6-20.9%, respectively. Lauric acid was highest (8.1%) in the mokwa while capric acid was totally absent. More so, the chemical analysis of the iodine values showed that grand and western zone oils were higher compared to others (Fig. 2 and Table 3). The high iodine value denotes high degree of unsaturation of the oil caused by the extent of oxidation and degree of heat treatment during oil processing (Kirk and Sawyer, 1991). The study also indicated that the oil from the northern zone was relatively high in total fat and acid value in comparison with oil from other zones (Fig. 2). According to Demian (1990), acid values are used to measure the extent to which glyceride in the oil has been decomposed by lipase and other actions such as light and heat. The determination is often used as a general indication of the condition and edibility of oil. Furthermore, the refined oils had significantly low saponification value compared to locally produced oils ($P < 0.05$), with the highest value found in the eastern zone oil (Table 3). Denniston *et al.*

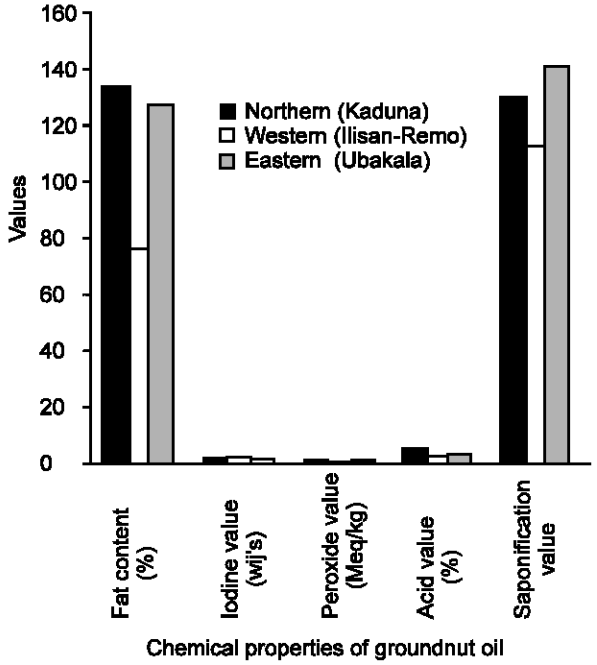

Fig. 2: Chemical analysis of locally produced vegetable oil from three geographical zones in Nigeria

(2004) reported that high saponification value indicated the presence of greater number of ester bonds, suggesting that the fat molecules were intact. Similarly, the peroxide value of local and refined oils was less than the standard peroxide value (10mEqKg^{-1}) for vegetable oil deterioration. Fresh oils have value less than 10mEqKg^{-1} and values between 20 and 40mEqKg^{-1} results in rancid taste (Akubugwo and Ugbogu, 2007). The low peroxide value indicated slow oxidation of these oils. According to Demian (1990), the peroxide formation is slow at first during an induction period that may vary from a few weeks to several months according to the particular oil and temperature (Pearson, 1981). There was no rancidity of oil samples in the course of this study while minerals were present in all the samples (Table 3). This study indicated that vegetable oil from the six varieties of *A. hypogea* and those from three geographical zones of Nigeria may have a higher shelf life, nutritional value and industrial applications.

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