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Effect of local *Arachis hypogaea* oil on physicochemical properties of fried *Ipomoea batatas*

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Abstract
Sweet potatoes and local peanut oils are the nutritional and sensory versatility in terms of its micronutrient contents. This study was carried out to investigate the physicochemical properties of sweet potato fried with three selected peanut oils. Oils were extracted from three varieties of peanut namely; kampala, sabiya and gargajiya. The physicochemical properties of the extracted oil, as well as that of the fried potatoes were carried out using standard AOAC procedures. The acid value for kampala, sabiya and gargajiya were 15.21 ± 0.04 mgKOH/g, 6.77 ± 0.30 mgKOH/g and 1.66 ± 0.07 mgKOH/g respectively while the perioxide value were 7.36 mEq/kg, 10.70 mEq/kg and 8.77 mEq/kg respectively. The fat content of the sweet potato fried with kampala, sabiya and gargajiya oils were 27.3 %, 27.6 % and 28.3 % while the fiber content were 1.05 %, 1.15 % and 1.18 % and protein content were 0.55 %, 0.65 and 0.55 %, the moisture content were 30.6 %, 22.1 % and 18.9 %, ash content were 1.18 %, 1.24 % and 1.47 % and carbohydrate content were 66.5 %, 74.0 % and 77.8 % for kampala, sabiya and gargajiya respectively. All results revealed significant difference ($p<0.05$) between kampala, sabiya and gargajiya. The study showed that oil from gargajiya nut are more preferable for frying sweet potato because it had less adverse effect except for the moisture content which was low while kampala had more adverse effect because it reduced all the nutritional content except the moisture followed by the sabiya nut.

Keywords: *Arachis hypogaea*, sweet potato, peanut, physicochemical properties

1. Introduction
Oils for consumption has contributed great importance to the diet of people in the community, developing human nutrition by regulating good source of fatty acids, protein and fats also generating new cells and essential source of energy [4]. Peanut is one of the most essential edible oil in Nigeria and has been known for decades in the country. Millions of people living in the country consumes peanut regularly [5]. Several research has shown that peanut oils extracted from peanuts seed plants (*Arachis hypogea*), contains some essential element and amino acids such as arginine, thiamine, vitamin E, selenium and zinc, also contain excess potassium than sodium [9].
Local Arachis oils or peanut oils which are derived from the peanut seeds plants are found either refined, unrefined and roasted, with great taste of flavor and aroma due to it relatively high smoke point is generally, mostly used for cooking/frying [8]. Sweet potatoes are tuber with starchy sweet taste which grows in a damped environmental state [11]. They possess a relatively high source of energy with excessive vitamins and carbohydrates. A cooking technique such as frying gives a famous nutritional snack product for consumption with attractive colour, aroma, flavor and taste which are the most accepted palatability of consumers [1]. Oils from different peanut species is widely consumed in Northern Nigeria, without considering the quality of the oil but consumed due to the quantity obtained during extraction. The aim of the study is to determine the effect of three (3) oils from kampala, sabiya and gargajiya on fried sweet potato.

2. Materials and methods
All reagents used were of analytical grade.

2.1 Sampling and sample collection
Three local peanut (sabiya, gargajiya, kampala) and sweet potatoes were obtained from the Mubi metropolitan market of Northern Senatorial Zone of Adamawa State. Sample identification was carried out and authenticated by Agronomist in the Department of Crop Science, Adamawa State University Mubi. The three local peanut were roasted, grind and pressed to extract its oil traditionally, sweet potatoes were washed, peeled and then sliced using a mandolin slicer (Mafter Model 2000, France). The slices were washed or rinsed in water to remove dirt and starch.
The sweet potato (*Ipomoea batatas*) was divided into three groups and each were fried for 5 minutes with the different species of the local peanut oils which was locally extracted from sabiya, gargajiya and kampala at 75ºC.

2.2 Physicochemical properties of fried sweet potato
The fried sweet potato was analyzed three times and was centered on the evaluation of moisture, fiber, protein, lipid, ash as well as carbohydrate content which was carried out according to the standard procedures of Official Methods of Analysis of the Association of Official Analytical Chemists [3]. The determination of moisture was carried out by oven method, while ash content was determined by the sample ashing method in a muffle furnace. The protein content was determined by Kjeldahl method while the fat content was evaluated by extraction of 2 g of dried sample through

Soxhlet apparatus using petrol ether as solvent. Crude fiber was also determined by using the residue obtained from the fat extraction, keeping 1 g of the defatted sample in a muffle furnace at 550ºC for 2 hours after the insoluble matter was extracted using the AOAC methods. The carbohydrate content was also determined by subtracting the following parameters from one hundred percent (100) as illustrated bellow:
Carbohydrate = 100- (Moisture + Ash + Protein + Fiber) following [14].

2.3 Physicochemical Properties of Oils
The local peanut oils was analyzed three times each and was centered on the determination of acid value, saponification value, free fatty acid, specific gravity, ester value, peroxide value.

2.3.1 Acid Value Determination
The method described by [6] was adopted whereby 10 g of oil sample was weighed into 250 ml conical flask and 25 ml of diethyl ether and 25 ml of ethanol was added into same conical flask and few drops of phenolphthalein were added. The resulting solution was titrated against 0.1m of NaOH until a dark pink colour was obtained. The acid value was calculated as:
Acid Value (mgKOH/g) = V × 5.6/ W
Where V = titer value
W = weight of oil used.

2.3.2 Saponification Value Determination
The method described by [6] was also used by weighing 2 g of oil sample into a clean conical flask and 25 ml of alcoholic potassium hydroxide was added, the flask was heated for an hour with frequent shaking, 1 ml of 1% phenolphthalein indicator was added and the hot alkali was titrated with 0.5 m hydrochloric acid until it reached the end point where it turned colorless. The saponification value was calculated as:
Saponification Value = (B-S) × M × 56.1/ W
Where B = titer value of blank
S = titer value of sample
M = Molarity of HCl
56.1 is the molecular weight of KOH.

2.3.3 Ester Value Determination
Ester Value dtermination was obtained by subtracting acid value from saponification value [6].

2.3.4 Specific Gravity Determination
The method described by [13] was adopted for specific gravity determination whereby a clean and dry stoppered bottle of 25 ml capacity was weighed (W_0) and then filled with the oil and reweighed to give (W_1). The oil was then substituted with water after washing and drying the bottle and weighed to give (W_2). The specific gravity was calculated as:

Specific Gravity = $W_1 - W_0 / W_2 - W_0$
Where W_0 = weight of dry empty density bottle
W_1 = weight of density bottle + oil
W_2 = weight of density bottle + water.

2.3.5 Peroxide Value Determination
The method described by [3] was used for whereby 1 g of oil sample was dissolved in 25 ml of a solvent mixture consisting of 60% glacial acetic acid and 40% of chloroform and 1 ml of 10% saturated solution of potassium iodide was added, the flask was shaken and allowed to stand in the dark for 5 minutes which gives a light yellow color and 75 ml of distilled water added. The mixture was then titrated with 0.1N sodium thiosulphate using 2 ml of 1% starch solution as indicator. The peroxide value was calculated as:
Peroxide Value = (Vb – Vs) N × 100 / W
Where Vs = volume of sodium thiosulphate used in test sample titration
Vb = volume of sodium thiosulphate used in blank titration
N = Normality of sodium thiosulphate
W = weight of the sample used in grams.

2.3.6 Free Fatty Acid Determination
The method described by [13] was used which was calculated by dividing Acid value by 2 which gives the free fatty acid.

2.4 Statistical Analysis
The obtained results were subjected to statistical analysis using mean standard deviation and analysis of variance (ANOVA) followed by Duncan multiple range test using SPSS 24 software to determine the level of significance between different samples and, significance was set at $p < 0.05$.

3. Results & Discussion
3.1 Result
Sweet potatoes fried with kampala significantly decreased protein, fibre, fat, ash and carbohydrate but had the highest moisture content (30.6 ± 0.08). Sweet potatoes fried with gargajiya had the highest fat, fibre, ash and carbohydrate but the least protein (0.55 ± 0.01) and moisture content (18.9 ± 0.02) while sweet potato fried with sabiya oil was the moderate as presented in Table 1.
The organoleptic properties showed that the appearance for kampala and sabiya had the highest value than gargajiya, the flavor also showed that kampala and sabiya had the highest value compared to that of gargajiya and result also indicates that aroma, texture and taste for kampala and sabiya had the highest value than gargajiya as all presented in the table. The result also showed that kampala and sabiya had the highest value of general acceptance as shown in Table 2.
The saponification value of the three oils from kampala, sabiya and gargajiya are all in the same range, kampala had the highest free fatty acid and acid value, specific gravity of the oils are all within the same range, while for ester and peroxide value sabiya had the highest value.as shown in Table 3.

Table 1: Physicochemical properties of sweet potato fried with three different varieties of local peanut oils.

Source of oil sample	Physicochemical parameters of sweet potato					
	Fat %	Fibre %	Protein %	Moisture %	Ash %	Carbohydrate %
Kampala	27.3 ± 0.02[a]	1.05 ± 0.01[a]	0.55 ± 0.01[a]	30.6 ± 0.08[c]	1.18 ± 0.01[a]	66.5 ± 0.16[a]
Sabiya	27.6 ± 0.02[b]	1.15 ± 0.02[b]	0.65 ± 0.05[b]	22.1 ± 0.02[b]	1.24 ± 0.02[b]	74.0 ± 0.10[b]
Gargajiya	28.3 ± 0.45[c]	1.18 ± 0.02[c]	0.55 ± 0.01[a]	18.9 ± 0.02[a]	1.47 ± 0.03[c]	77.8 ± 0.01[c]

Values are expressed as mean ± S.D. with different superscript down the column are significantly different ($p< 0.05$)

Table 2: Organoleptic properties of sweet potato fried with three (3) different selected peanut oil

9-Point hedonicscale	Appearance			Flavour			Aroma			Texture			Taste			General acceptance		
	K	S	G	K	S	G	K	S	G	K	S	G	K	S	G	K	S	G
Like extremely	17.5 ± 0.07[b]	17.5 ± 0.07[a]	12.3 ± 0.21[a]	15.0 ± 0.07[b]	20.1 ± 0.14[d]	15.1 ± 0.14[a]	17.4 ± 0.14[c]	15.1 ± 0.14[c]	10.1 ± 0.14[a]	10.1 ± 0.14[a]	17.4 ± 0.14[b]	-	12.3 ± 0.21[a]	12.4 ± 0.07[b]	12.4 ± 0.07[b]	20.1 ± 0.21[c]	25.1 ± 0.21[b]	15.0 ± 0.07[b]
like very much	20.1 ± 0.07[c]	25.1 ± 0.14[d]	12.3 ± 0.07[a]	22.5 ± 0.07[d]	17.4 ± 0.14[c]	20.1 ± 0.21[c]	17.4 ± 0.07[c]	17.4 ± 0.07[a]	15.1 ± 0.14[b]	17.3 ± 0.21[b]	15.1 ± 0.14[a]	17.4 ± 0.14[b]	25.1 ± 0.21[c]	22.4 ± 0.14[d]	22.3 ± 0.21[d]	15.3 ± 0.21[a]	27.4 ± 0.07[c]	17.4 ± 0.14[c]
Like slightly	17.5 ± 0.07[b]	22.4 ± 0.14[c]	12.4 ± 0.07[a]	12.4 ± 0.07[a]	12.4 ± 0.07[a]	20.3 ± 0.14[c]	15.1 ± 0.14[a]	7.4 ± 0.07[a]	17.4 ± 0.07[c]	17.4 ± 0.21[b]	17.4 ± 0.07[b]	15.1 ± 0.14[a]	12.4 ± 0.14[a]	10.1 ± 0.14[a]	10.1 ± 0.14[a]	17.5 ± 0.07[b]	17.4 ± 0.14[a]	7.4 ± 0.07[a]
Like moderately	15.1 ± 0.14[a]	12.4 ± 0.14[b]	12.3 ± 0.07[a]	17.4 ± 0.14[b]	17.4 ± 0.14[b]	17.4 ± 0.14[b]	15.1 ± 0.21[a]	17.3 ± 0.07[a]	15.2 ± 0.07[b]	20.1 ± 0.14[c]	20.0 ± 0.07[c]	25.1 ± 0.21[c]	22.4 ± 0.07[b]	17.4 ± 0.07[c]	17.4 ± 0.07[c]	15.1 ± 0.21[a]	17.3 ± 0.21[a]	22.4 ± 0.14[d]
Neither like nor dislike	15.3 ± 0.14[a]	15.1 ± 0.14[c]	20.1 ± 0.14[c]	15.1 ± 0.07[a]	17.3 ± 0.21[b]	-	15.3 ± 0.14[a]	12.4 ± 0.14[a]	-	20.0 ± 0.07[c]	12.5 ± 0.07[a]	17.4 ± 0.14[b]	-	-	-	15.0 ± 0.07[b]	12.4 ± 0.07[a]	-
Dislike slightly	15.1 ± 0.14[a]	7.54 ± 0.07[a]	17.4 ± 0.14[b]	17.3 ± 0.14[b]	15.1 ± 0.21[a]	-	20.1 ± 0.21[b]	17.4 ± 0.14[b]	15.1 ± 0.21[a]	-	17.4 ± 0.14[b]	15.1 ± 0.14[b]	12.4 ± 0.07[a]	10.1 ± 0.07[a]	10.1 ± 0.14[a]	-	-	17.4 ± 0.07[b]
Dislike moderately	-	-	12.3 ± 0.21[a]	-	-	15.1 ± 0.21[a]	-	-	-	15.1 ± 0.14[a]	-	10.0 ± 0.07[a]	-	10.1 ± 0.14[a]	10.0 ± 0.14[a]	-	-	-
Dislike extremely	-	-	-	-	-	12.3 ± 0.21[a]	-	-	17.4 ± 0.14[b]	-	-	-	15.1 ± 0.14[b]	17.3 ± 0.14[b]	17.4 ± 0.07[b]	-	-	-
dislike very much	-	-	-	-	-	-	-	12.3 ± 0.19[a]	10.1 ± 0.14[b]	-	-	-	-	-	-	17.4 ± 0.14[b]	-	20.1 ± 0.14[c]

Kampala, Sabiya and Gargajiya are represented by K, S and G respectively. Results are percentage (%) values from 40 panelists. Values within the same column having the same superscript are not significantly different at $p<0.05$

Table 3: Physicochemical Properties of three (3) Selected Local Peanut Oils.

Parameters	Kampala	Sabiya	Gargajiya
Acid value (mgKOH/g)	15.21 ± 0.04[c]	6.77 ± 0.30[b]	1.66 ± 0.07[a]
Saponification value (mgKOH/g)	193.6 ± 0.15[a]	195.3 ± 0.20[b]	196.5 ± 0.15[c]
Free fatty acid value (mgKOH/g)	7.57 ± 0.02[c]	3.38 ± 0.02[b]	0.83 ± 0.04[a]
Specific gravity (g)	0.89 ± 0.03[b]	0.87 ± 0.04[a]	0.91 ± 0.03[c]
Ester value (mgKOH/g)	178.5± 0.14[b]	188.5 ± 0.17[c]	164.8 ± 0.15[a]
Peroxide value (mEq/kg)	7.36 ± 0.02[a]	10.70 ± 0.20[c]	8.77 ± 0.15[b]

Values are expressed as mean ± S.D. with different superscript along the row are significantly different ($p<0.0$)

3.2 Discussion

The decreased in the nutrients composition of potato fried with kampala indicates that it had more adverse effect on the nutrient which is due to it low in monounsaturated fat making it less for heat cooking (frying), it also has less health benefits as a result of pure source of vitamin E, its high moisture content indicates that the sweet potato fried will be more prone to microbial attack. The increased in the nutrients composition of potato fried with gargajiya as shown in Table 1 indicates that it had less or no adverse effect on the nutrient due to it being high in monounsaturated fat, making it popular choice for heat cooking (frying) and a good source of vitamin E. The sabiya oil which was used in frying sweet potato appears to be moderate compared to the result obtained [2].

The increased in the organoleptic properties of potato fried with kampala and sabiya as shown in Table 2 and the decreased in gargajiya might be due to their taste or general acceptance and storage of the nuts.

Saponification value of the oils shown in Table 3 have higher value compared to value obtained from [10] due to the intact of fat molecules and presence of greater number of ester bonds which indicates oxidation, the percentage of free fatty acid in the oil is an indication of their level of degeneration and quality also the duration and storage conditions of the seeds. The maximum acid value such as the kampala oil leads to more oxidation of the oil as a result of long time storage, specific gravity of the oils as shown in Table 3 are all in same range with values obtained by [9], high ester value indicates the presence of high amount of ester and low molecular weight fatty acid content which was compared to the values obtained by [6], the values of peroxide for the oils are higher than that of those obtained by [6] but are within the same range with the standard guidelines set by NAFDAC and CODEX which says values should be less than 10 meq/kg.

4. Conclusions

The fried sweet potato analyzed showed that gargajiya oil had less adverse effect on the nutrients which are preferable for frying sweet potato because such oils helps the body build and repair tissues, absorbs certain vitamins and maintain source of energy followed by sabiya. Therefore, gargajiya and sabiya oils are more preferable in frying sweet potato for consumption. The peanuts oil showed that more alkali would be required to enable it neutralize the available free fatty acid liberated by the oil and can also be useful for the production of soap considering the saponification value, and the result of acid value for kampala and sabiya are less required for consumption as their values exceed the normal range. The result on free fatty acid indicate that gargajiya is more preferable for consumption than sabiya and kampala because gargajiya has the lower value which is at the appropriate range for consumption than sabiya and kampala.

These low peroxide values indicate slow oxidation of the oil and the values obtained are in line with the standard guidelines set by NAFDAC and CODEX which says that peroxide value should be less than 10 mEq/kg.

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