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Full Length Research paper

Percentage oil yield and physiochemical properties of different groundnut species (*Arachis hypogaea*)

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Percentage oil yield and physicochemical properties of five different groundnut species (Valencia (Gargajiya), Virginia (Kampala Mubi and Michika) and Runner (Kwachamba brown and red) cultivated locally was determined. Results obtained showed that Gargajiya species yielded the highest amount of oil (37.80 ± 2.21%), closely followed by kampala michika (37.40 ± 3.20%) while kwachamba brown yielded the lowest percentage of oil (20.00 ± 2.06). The physicochemical properties of the groundnut oils showed that the crude kampala michika oil had significantly higher free fatty acid and acid values (3.95 ± 0.03% and 7.85 ± 0.28 mg/KOH/g) compare to the lowest value observed in crude kwachamba brown and kwachamba red (1.55 ± 0.03% and 3.09 ± 0.20 mg/KOH/g) respectively. The Saponification and iodine value were highest in crude and refined Gragajiya oil (220.20 ± 0.20 and 97.13 ± 1.56 g/100 g respectively). There was no significant difference at $p < 0.05$ in the refractive index of all the samples. Peroxide value was significantly higher at $p < 0.05$ in crude kwachamba brown (25.03 ± 0.07) compare to the lowest value observed in the same refined kwachamba brown oil (1.30 ± 0.02 mg/kg). Thus suggesting that though Gargajiya and Kampala Mubi yielded highest, Kwachamba brown and kwachamba red are better for human consumption in terms of their physicochemical properties.

Key words: Groundnut, varieties, oil content, chemical and physical properties.

INTRODUCTION

Vegetable oils are widely consumed domestically in Nigeria. It is used primarily as a cooking and salad oil. Studies have shown that groundnut oil 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 (Evans et al., 1974; Hariod, 1990). Findings have demonstrated that diets high in groundnut oil are as effective as olive oil in preventing heart disease and are heart healthy than very low fat diets (Pattee and Young, 1989; Hariod, 1990). Groundnut oil is of high quality and can withstand higher temperatures without burning or breaking down. It has neutral flavour and odour. It does not absorb odours from other foods (Shewfelt and Young, 1977; Passera, 1981). This makes it the most preferred oil in Northern Nigeria.

The nutritional values of the groundnut oil are however, affected by the method and period of storage, which consequently affect the acceptability of these oils. In Northern Nigeria, women usually do extraction of groundnut oil locally. The women extract the oil to generate substantial income to support their domestic needs with little or no consideration given to groundnut species or the physicochemical properties of the oils. Most women rely on availability rather than quality. This study was therefore undertaken to study the percentage yield and physicochemical properties of oils from five different groundnuts species commonly grown in Northern Nigeria with a view to determining their suitability for human consumption.

MATERIALS AND METHODS

Groundnuts were obtained from farms around the Federal University of Technology Yola, Nigeria and they were identified by

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the Botany department of the University.

Extraction and analysis of oil

Seeds were carefully sorted to remove stones and especially mould seeds, heat fried dehusked and blended traditionally (manually blending using stirring stick in wooden motor and pestle). Hot water was added and oil extracted by pressing method. Salt was added to break emulsion and the oil skimmed from the surface. All reagents used for the analyses were obtained from British Drug House (BDH). The reagents were of analytical grades and were not subjected to further purification.

Determination of percentage (%) yield

The percentage (%) yield was calculated using the equation (1)

$$\text{Percentage yield of oil} = \frac{\text{Weight of oil}}{\text{Weight of sample (g/nut)}} \times 100 \quad (1)$$

Refining of oil

The oil was refined according to the standard method described by Rosales (1992); Kanata and Kanade (1993). Both crude and refined oils were analyzed immediately for free fatty acid value, saponification value, iodine value, refractive index and peroxide as described by AOCS (1973) and Nkafamiya et al. (2007b). Briefly the methods are as follows:

Determination of peroxide value (PV)

Five grams of the oil was dissolved in 30 ml of glacial acetic acid: chloroform (3:2, v/v). 0.5 ml of saturated KI was added and I_2 was liberated by the reaction with the peroxide. The solution was then titrated with standardized sodium thiosulphate using starch indicator. The peroxide value (PV) was determined from Equation (2):

$$\text{PV (mEq/Kg)} = \frac{\text{(S-B) x M x 1000}}{\text{Sample weight (g)}} \quad (2)$$

Where S = Sample titre value
B = Blank titre value.
M = Molarity of $Na_2S_2O_3$.

Determination of iodine value (IV)

0.1 M iodine monochloride in acetic acid was added to 0.2 g of the oil dissolved in cyclohexane. The mixture was allowed to stand for ten minutes, to allow for halogenation. 0.1 M of KI solution was added to reduce excess iodine monochloride to free iodine. The liberated iodine was titrated with a standardized solution of 0.1 M sodium thiosulphate using starch indicator. The iodine value was calculated from equation (3):

$$\text{Iodine value (IV)} = \frac{\text{(B-S) x M x 12.69}}{\text{Sample weight (g)}} \quad (3)$$

Where B = blank titre value.
S = sample titre value.
M = Molarity of $Na_2S_2O_3$.
12.69 = Conversion factor from Meq. $Na_2S_2O_3$ to gram iodine, molecular weight of iodine is 126.9 g

Determination of percentage free fatty acids (%FFA)

Two grams of well-mixed sample was accurately weighed into a conical flask in to which 10 ml of neutralized 95% ethanol and phenolphthalein were added. This was then titrated with 0.1 M NaOH, shaking constantly until a pink colour persisted for 30 s. The percentage free fatty acid was calculated from Equation 4:

$$\%\text{FFA} = \frac{V \times M \times 2.82 \text{ mg}}{\text{Sample weight (g)}} \quad (4)$$

Where V=Volume of NaOH
M=Molarity of NaOH
2.82=Conversion factor for oleic acid

Determination of saponification value (SV)

Two grams of the oil sample was added to excess alcoholic KOH. The solution was heated for two minutes to saponify the oil. The unreacted KOH was back - titrated with standardized 0.1 M HCl using phenolphthalein indicator. The SV was calculated from the Equation (5):

$$\text{SV} = \frac{\text{(S-B) x M x 56.1}}{\text{Sample weight (g)}} \quad (5)$$

Where S = Sample titre value
B = Blank titre value
M = Molarity of the HCl
56.1 = Molecular weight of KOH

Physical parameter

The refractive index (RI) was also determined using the methods described by AOCS (1973) and Nkafamiya et al. (2007b). All analysis was carried out in triplicate and data were analyzed by analysis of variance (ANOVA). Duncan's Multiple Range Test was used to compare mean variance. Significance was accepted at 5% level of probability following Steel and Torric (1980) procedures.

RESULTS AND DISCUSSION

Table 1 shows the percentage yield of the different groundoils. Gragajiya species yielded the highest amount of oil (137.80 ± 2.21%) closely followed by kampala Mubi (37.40 ± 3.20%). Result also showed that these values are significantly higher at $P < 0.05$ compared to values obtained in kampala Michika (24.60 ± 1.82%), kwachamba brown (20.00 ± 2.06%) and kwachamba red (21.70 ± 1.40%). The highest percentage yield in Gargajiya and kampala Mubi indicate that they are both for oil yield compared to other species.

The crude oils of all the different groundnut species had

Table 1. Percentage oil yield of the different groundnut species.

Groundnut species	Percentage yield
Gargajiya	37.80 ± 2.21[a]
Kampala Mubi	37.40 ± 3.20[a]
Kampala Michika	24.60 ± 1.82
Kwachamba brown	20.00 ± 2.06[b]
Kwachamba red	21.71 ± 1.40[b]

All results are mean ± SD for 3 determinations.
[a] = Significantly higher compared with other oils at $p < 0.05$.
[b]= Significantly lower compared with other oils at $p < 0.05$.

Table 2. Free fatty acid values of the different oil (%).

Groundnut species	Refined	Crude
Gargajiya	0.69 ± 0.02	2.45 ± 0.17
Kampala Mubi	0.83 ±0.02	2.26 ± 0.03
Kampala Michika	0.98 ± 0.03[a]	3.95 ± 0.03[c]
Kwachamba brown	0.25 ± 0.01[b]	1.55 ± 0.03[d]
Kwachamba red	0.97 ± 0.02[a]	1.55 ± 0.03[d]

All results are mean ± SD for 3 determinations.
[a]= Significantly lower compared to other oils under refined oil ($p < 0.05$).
[c]= Significantly higher compared to other oils under crude oil ($p < 0.05$).
[d]= Significantly lower compared to other oils under crude oil ($p < 0.05$).

Table 3. Saponification value of the different oils (mgKOH/g).

Groundnut species	Refined	Crude
Gargajiya	184.30 ± 0.20	220.20 ± 0.20
Kampala Mubi	180.60 ± 0.20	211.00 ± 1.16
Kampala Michika	181.40 ± 0.20	188.10 ± 0.15[b]
Kwachamba brown	179.50 ± 0.36[a]	221.50 ± 0.21
Kwachamba red	183.30 ± 0.25	206.20 ± 0.15

All results are mean ± SD for 3 determinations.
[a]= Significantly lower compared with other oils under refined ($p < 0.05$)
[b]= Significantly lower compared with other oils under crude ($p < 0.05$).

Table 4. Iodine values of the different oils (g/100 g).

Groundnut species	Refined	Crude
Gargajiya	97.13 ± 1.56[a]	81.94 ± 1.03[c]
Kampala Mubi	95.51 ± 1.09[a]	56.89 ± 1.56
Kampala Michika	90. 56 ±1.49	46.88 ± 1.40[d]
Kwachamba brown	81.21 ± 2.38[b]	57.87 ± 1.76
Kwachamba red	76.36 ± 1.23[b]	81.55 ± 1.44[c]

All results are mean ± SD for 3 determinations.
[a]= Significantly higher compared with other oils under refined ($p < 0.05$).
[b]= Significantly lower compared with other oils under refined ($p < 0.05$).
[c]= Significantly higher compared with other oils under crude ($p < 0.05$)
[d]= Significantly lower compared with other oils under crude ($p < 0.05$).

significant higher free fatty acid value, acid value, saponification value and peroxide value at $p < 0.05$ compared to refined oils. Iodine value was however, lowest in crude oils when compared to refined oils. The crude oil might contain some impurities since they are in a crude form, which could cause the hydrolysis of the ester linkage thereby increasing the free fatty acid level. The high peroxide value in crude oil may also cause the spoilage of oil easily as a result of the concentration of peroxide in the resulting from oxidative rancidity giving the oil an unpleasant odour or flavour (McGinley, 1976; Ronald et al., 1991). The presence of moisture in oil may also encourage hydrolysis and ease of attack by oxygen (Egan et al., 1990; Manji et al., 2006).

Table 2 shows the result of percentage free fatty acid values. Kampala Michika had the highest free fatty acid value in both refine and crude oils (0.98 ± 0.03 and 3.95 ± 0.03%), respectively. Kwachamba brown had the least free fatty acid in both refined and crude oil (0.25 ± 0.01 and 1.55 ± 0.03%), respectively. Probably because crude might contain impurities that could cause the hydrolysis of the ester linkage thereby increasing the free fatty acid level.

Table 3 shows the saponification value of the different oils. Crude kwachamba brown oil and Gargajiya oil (221.50 ± 0.21 and 220.20 ± 0.20 mgKOH/g had higher saponification vales while kampala Mubi had the lowest crude saponification value (188.10 ± 0.15 mgKOH/g).

The high saponification values indicate oxidation and its decrease suggest the unset of oxidation. Rossel (2004) reported similar observation. The high saponification value may be connected to the nature of the oils and the metallic ions present among other factors (Gray, 1978; Magnus, 1992; Nkafamiya et al., 2007a).

The iodine values of the oils are contained in Table 4. Both crude and refined gargajiya oil had significantly higher ($p < 0.05$) iodine value (81.94 ± 1.03 and 97.13 v 1.57 g/100 g, respectively) compared to the lowest value observed in crude kampala Michika oil (46.88 ± 1.40 g/100 g). The high iodine value indicates dehydrogenation. It is a measure of unsaturation in lipid, which again determines the degree of flow. Decrease in iodine value indicates lipid oxidation and this might be due to metallic ions present among other factors, which enhances or promotes oxidation after the formation of hydroperoxide (Joseph, 1977; Tanlor et al., 1983; Chan and Cotton, 1987; Ruize et al., 1995; Rossel, 2004). There was no significant difference in the values of refractive index of all the oils shown in Table 5 suggesting that there was no significance difference in the degree of flow or thickness of all the oils at room temperature (Cocks and Von Rede, 1992).

Table 5. Refractive index of the different oils.

Groundnut species	Refined	Crude
Gargajiya	1.4659	1.4654
Kampala Mubi	1.4685	1.4654
Kampala Michika	1.4690	1.4664
Kwachamba brown	1.4658	1.4661
Kwachamba red	1.4668	1.4659

There is no significant difference in all the value at ($p < 0.05$).

Table 6. Peroxide value of the different oils (mEq/Kg).

Groundnut species	Refined	Crude
Gargajiya	1.73 ± 0.01^b	22.06 ± 0.59^a
Kampala Mubi	1.53 ± 0.02^b	23.33 ± 0.71^a
Kampala Michika	1.33 ± 0.15^b	23.60 ± 0.85^a
Kwachamba brown	1.30 ± 0.02^b	25.03 ± 0.70^a
Kwachamba red	1.60 ± 0.02^b	23.27 ± 0.57^a

All results are mean ±SD for 3 determinations.
[a]= Significantly higher compared to refined oil.
[b]= Significantly lower compared to crude oil.

Table 6 shows the peroxide vales of the oils. The peroxide values of the crude oils are significantly higher (22.06 ± 0.59 - 25.03 ± 0.70 mEq/Kg) compared to the peroxide values of the refined oils (1.30 ± 0.02 - 1.73 ± 0.01 mEq/Kg) at $p < 0.05$. Refined kwachamba brown oil had the least peroxide value (1.30 ± 0.02 mEq/Kg). The high peroxide value in crude oil might be as a result of the effect of moisture, atmospheric oxygen and light on the oils leading to a progressive increase in the peroxide value. The hydroperoxide formation may subsequently decompose into secondary oxidation products on storage, majority of which have unpleasant odours or flavour (Baskon and Morton, 1976; Jambunathan and Reddy, 1991).

Findings from this studies showed that crude groundnut oil contained higher level of all the physicochemical properties tested than the refined oils. Thus suggesting that crude oil may be more liable to be rancidity compared to refined oil. Studies also showed that though gargajiya and kampala Mubi yielded the highest oil, they may not be good for storage. Although, both kwachamba brown and kwachamba red yielded lowest oil, they however, have high storage ability than the other oils tested.

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