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Physicochemical Properties of Groundnut Oil Produced from Maibargo Groundnut Seed

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ABSTRACT

An improved groundnut oil kneader was fabricated and used to extract oil from Maibargo groundnut seeds. A sample of groundnut oil extracted from the same variety was collected from local processors using the conventional groundnut oil kneader in a rural community in Kano state. The physicochemical properties of the two samples were investigated. Iodine value was significantly higher at ($p < 0.05$) in groundnut oil extracted from an improved kneader (103.01 ± 0.006 g/100g) when compared to that one collected from the local processor (98.31 ± 0.061). The moisture content (%) of the oil from the local processor was significantly higher (0.12 ± 0.006) compared to kneader extracted oil (0.02 ± 0.00). The Acid value in the oil collected from the local processor was significantly higher (12.12 ± 0.013) than the oil extracted with an improved kneader (2.24 ± 0.061). There was no significant difference at ($p < 0.05$) in the specific gravity of the two groundnut oil samples, but was differ ($p < 0.05$) in the coliform count of the kneader extracted oil (8×10^2) and local oil processor (1.5×10^4). The highest peroxide values were observed in the oil extracted by a local processor (21.71 ± 0.013 meq O_2/kg) while the lowest was observed in the groundnut oil extracted with improved kneader (6.73 ± 0.011 meq O_2/kg). The aerobic plate count of the groundnut oil extracted from an improved kneader was significantly lower (1.4×10^5) than that of a local groundnut oil processor (1.8×10^6). Relevant institutions should engage in necessary awareness to sensitize the local groundnut oil processors on the importance of quality groundnut oil production.

INTRODUCTION

Groundnut oil is derived from groundnut (*Arachis hypogaea*) seeds which is an edible oil that is consumed in almost every household in Nigeria. Groundnut is a member of the genus Arachis in the family Leguminosae. It is a very important oil seed and food crop around the globe for its nutritional and trade values (Shankarappa *et al.*, 2003; Olaomi, 2008).

Although the production of groundnut has improved over the years, Nigeria is still a net importer of vegetable oil. National annual output of groundnut products from 1996-2003 shows that there is a slowly increasing trend in the outputs, with an annual average production of 2,652 mt of unshelled groundnuts, 456 mt of groundnut oil and 713 mt of groundnut cake. Locally processed groundnut oil is about 25% of the total vegetable oil produced in Nigeria (FAO, 2003). Not all of the 25% is generally accepted because they do not meet the requirement of the Standard Organization of Nigeria (SON, 2000) which is the sole statutory body that is vested with the responsibility of standardizing and regulating the quality of all products in Nigeria.

The whole issues centre on how hygienic the process of extracting groundnut oil is by the local groundnut oil processors. For quality control, many factors such as peroxide value, iodine value, specific gravity, moisture content, acid value and free fatty acid value are important parameters of interest because they assist in establishing the shelf-life quality and hence the economic value of oils (Endo, 2018; Decker *et al.*, 2010). There are no strict regulations or institutions in Nigeria to check the compliance of local oil processing to standard. The process of extracting groundnut oil involves the roasting of groundnut seeds and crushing to as fine as possible homogenous substance; this is known as groundnut paste. Thereafter, the crushed groundnut paste is poured into a kneader and warm water is poured into it. This period is when the process is most exposed to environmental contaminants. Local groundnut oil processors in the rural area of Kano state are unaware of the quality of oil, they extract groundnut oil without paying attention to hygiene and hence this investigation could be a guideline for local groundnut oil processors, to understand the quality of groundnut oil by comparing its iodine value, moisture content, acid value, specific gravity, coliform count, peroxide value, and aerobic plate count were investigated.

MATERIALS AND METHODS

Materials

The improved groundnut kneader was used to extract groundnut oil from Maibargo groundnut seed varieties and the sample was taken. The same variety was given to a local processor to extract groundnut oil and the sample was collected. The two samples were taken to Fortune Oils laboratory for investigation.

Methods

Moisture Content

AOAC (1980) method was used for the determination of moisture content. Ten grams (10g) of the groundnut

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oil sample was placed in a weighed moisture dish. The sample was dried for 1 h to constant weight in an oven set at 120 °C and then allowed to cool in a desiccator for 15 min finally, the difference was calculated using the following equation:

$$\text{Moisture content (\%)} = \frac{W_1}{W_2} \times 100\% \text{ -------------------------- } (3.30)$$

Where:

W_1 = weight loss (g) upon drying, W_2 = weight (g) of the groundnut oil sample.

Peroxide Value

Five grams (5g) of the groundnut oil sample was weighed in a round bottom flask, 30 ml of Glacial Acetic acid/ Chloroform solution (3:2) was added to the groundnut oil sample, and the solution was swirled until it dissolved. 0.50 ml of saturated KI solution was added and allowed to stand for 1 minute with occasional shaking. 30 ml of distilled water was added and titrated with 0.01 N Na_2SO_3 using 0.5 ml starch as an indicator. Blank titration was performed. The peroxide value was calculated as follows:

$$\text{Peroxide value (mEq/kg)} = \frac{(S - B) \times N \times 1000}{Wt} \text{ ---------------------- } (3.31)$$

Where:

S = Titration value of sample, B = Titration value of blank,

N = Normality of Na_2SO_3,

Wt = Weight of sample

Iodine Value

A mixture of 0.2 g of groundnut oil sample and 15 ml chloroform was added into 25 ml of iodine solution, the conical flask was closed with a ground glass stopper, mixed and allowed to stand at about 20^{0}C for 1 hour in the dark. 20 ml of a 10% aqueous KI and 150 mL of water was added to transform leftover iodine into iodide. The final content was titrated with 0.1 N sodium-thiosulphate ($Na_2S_2O_3$) solutions using starch as an indicator, two determinations and blank were conducted in the same manner as a sample but without oil (using distilled water instead of oil) (Musa *et al.*, 2012; Atasie *et al.*, 2009). The iodine value was calculated as follows:

$$\text{Iodine value} = \frac{(B - S) \times N \times 0.1269 \times 100}{Wt} \text{ -------------------- } (3.32)$$

Where:

B = ml of 0.1 N $Na_2S_2O_3$ required by the blank,

S = ml of 0.1 N $Na_2S_2O_3$ required by oil sample,

N = normality of $Na_2S_2O_3$, W = weight of groundnut oil sample in gram.

Acid Value

A mixture of 10 mL of oil sample and 100 ml of ethyl-alcohol was heated until the content started boiling. The hot content was cooled and titrated with 15% KOH solution using phenolphthalein as an endpoint indicator (Kupwade & Desai, 2019). The acid value was calculated as follows:

$$\text{Acid value} = \frac{V \times N \times M.wt}{Wt} \text{ ---------------------------- } (3.33)$$

Where:

V = volume of standard KOH solution in ml,

N = normality of standard KOH solution,

M.wt (molecular weight) of KOH=56.1 g/mol,

W = weight of groundnut oil sample in grams.

Free Fatty Acid (FFA) (%)

The groundnut oil sample was weighed (W=1.0 g) and dissolved with 50ml of ethanol in a conical flask. The flask was then heated in water-bath for 30min. Two drops of phenolphthalein indicator were added after cooling and titrated to the pink endpoint (which persisted for 15min) with 0.1N KOH. The value of % of FFA was calculated with the equation below:
Where:
% FFA = % of free fatty acid, AV = Acid value.

Specific Gravity

The specific gravity of oil is the ratio of the weight in air of a given volume of oil at a defined temperature to that of the same volume of water at the same temperature (AOAC, 1980.). A dry pycnometer was used to determine the specific gravity of the groundnut oil. Specific gravity was measured by the relative density of oil to water. Distilled water was added to the pycnometer and measured using an electronic balance. Similarly, oil weight was measured with the pycnometer. The value was calculated using the relationship below:

$$\text{Specific gravity} = \frac{W_{oil}}{W_{water}}$$

Where:

W_{oil} = weight of the oil (g), W_{water} = weight of distilled water (g)

Statistical Analysis

The extracted groundnut oil sample analyses were conducted in triplicate. The results presented are the mean and standard deviation of the obtained values. The values of the means were statistically analyzed using a t-test by SPSS computer software (version 17.0).

RESULTS AND DISCUSSION

Physicochemical Properties

The results from the analysis of the physical and chemical properties of the mechanically and locally extracted oils are shown in Table 1.

Moisture Content

The moisture content is an important factor in overall groundnut oil quality both during processing and after processing. The value is part of the factors used in determining the shelf life of vegetable oils. Both moisture

Table 1: Physicochemical properties of extracted oil and sample obtained from the local processor

S/N	Parameters	Mean values of groundnut oil samples		Sig.
		Extracted	Local sample	
1	Moisture content (%)	0.02 ± 0.03	0.12 ± 0.04	0.001
2	Peroxide value (mEq/kg)	6.73 ± 0.05	21.71 ± 0.06	0.001
3	Iodine value (g/100 g oil)	103.01 ± 0.02	98.31 ± 0.05	0.001
4	Acid value (mg/KOH/g)	2.24 ± 0.004	12.12 ± 0.003	0.001
5	Free fatty acid (%)	1.12 ± 0.11	6.61 ± 0.05	0.001
6	Specific gravity	0.91 ± 0.01	0.91 ± 0.01	0.21

content values in this study are below the Code-stan 1999 value of 0.2%. The extracted groundnut oil sample value (0.02%) from the improved kneader is significantly lower in value than the groundnut oil sample obtained from the local processor (0.12%). The difference in the two values might be a result of the difference in the quantity of hot water added during extraction.

Peroxide Value

The high peroxide value of the oil is a hint of a weak oil resistance to peroxidation during storage and a signal of a deterioration level (Mohammed & Hamza, 2008; Adebayo *et al*., 2012; Zahran & Tawfeuk, 2019). It could also be used as an indication of the quality and stability of fats and oils (Ekwu & Nwagu, 2004). The higher the peroxide value the higher the levels of oxidative rancidity which suggest low levels of antioxidant. The peroxide value of the extracted groundnut oil sample from the improved groundnut oil kneader (6.73 ± 0.002) is significantly lower than the groundnut oil sample obtained from the local groundnut oil processor (21.71 ± 0.006) which is significantly higher than 10 meqO_2/kg maximum value recommended by NIS (1992). Peroxide value gives an indication of the degree of fat oxidized (Ononogbu, 2002; Okashi *et al*., 2013; Chibor *et al*., 2018). This could be a result of higher water content observed in the local oil samples

Iodine Value

The maximum iodine value as recommended by NIS (1992) is 100 g/100 g oil, and both groundnut oil samples are within the range 98.31 ± 0.05 – 103.01 ± 0.02 g/100 g which is desirable by oil processors. According to Overhults *et al*. (1974), oils having high iodine numbers are polyunsaturated indicating the degree of unsaturation and are desired by oil processors, while a lower iodine number is indicative of lower quality. The groundnut oil sample extracted by the improved kneader has a higher iodine value of 103.01 ± 0.02 g/100g which means that the fatty acid present is unsaturated; this is a measure of fat or oil stability and resistance to oxidation (Asiedu, 1989; Musa *et al*., 2012).

Acid Value

Acid value affect the quality of oil because it indicates the quality of fatty acid in the oil. The Nigeria Industrial Standard (1992) recommended a maximum value of 0.6 mg KOH/g for edible oils but the acid value obtained for the groundnut oil sample collected from a local groundnut oil processor was found to be higher (12.12±0.003) than the recommended value. The acid value for the extracted groundnut oil from the improved groundnut oil kneader (2.24±0.006) was found to be significantly lower ($p<0.05$) than the sample collected from the local groundnut oil extractor (12.12±0.003). According to Badmos *et al*. (2019), a low acid value is an indication of the stability of oils over a long period of time, as well as, protection against rancidity and peroxidation and Aremu *et al*. (2006) said that an acid value is also used as an indicator for the edibility of an oil and suitability for use in the paint and soap industries.

Free Fatty Acid

The free fatty acid (FFA) of the extracted groundnut oil sample with improved groundnut oil kneader was found to be 1.122%, this is significantly lower than the groundnut oil sample obtained from the local processor 6.61%. The groundnut oil sample extracted with an improved groundnut oil kneader and the oil sample collected from a local processor were higher than the maximum allowable value of 0.3% for vegetable oils (NIS, 1992; CODEX, 1999). It means that the extent of hydrolytic rancidity in these oils is appreciable (Angaye & Maduelosi, 2015; Chibor *et al*., 2018).

Specific Gravity

Specific gravity measurements can be useful in various ways in industries, and it is particularly useful because it allows access to molecular information in a non-invasive way (AOCS, 1973). From the Table, the specific gravity of both sample oil samples was the same which indicates no significant difference between both the extracted groundnut oil with improved groundnut oil kneader and the sample obtained from a local processor. The values gotten were closely related to the standard range of 0.898 – 0.907 approved by the Standard Organization of Nigeria (SON, 2000).

CONCLUSION

Ground nut oil kneading machine had been designed, fabricated and evaluated. This conserves energy, enhances hygiene and increases output capacity as compared with the local method of oil extraction. This machine is the first of its kind to collect oil continuously during kneading operation since existing mechanical kneaders are batch extraction. The physicochemical parameters of the extracted oil were analysed. It was observed in this study that the extracted groundnut oil from improved groundnut oil kneader fulfils most of the factors provided by NIS which means it is suitable for consumption. Some parameters such as peroxide value and acid value from the groundnut oil sample collected from the local processor were way higher than the NIS recommended values, these make the oil quality to be low and unfit for consumption. The low quality can be attributed to the materials used in the fabrication of the machine for processing groundnut oil and poor handling during processing. Hence, relevant authorities should step in to regulate the oils in Nigerian markets and provide the necessary public awareness related to oil quality.

RECOMMENDATION

The following recommendations were made for future research:

i. Extraction of oil from other ground nut varieties should be carried out using this machine.

ii. Research should be carried out on the effect of the machine on oil extraction from other nut such as Bambara, sesame seeds, melon seeds etc

iii. Further research should be carried out on the modelling, optimization and validation of operating parameters of this machine.

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