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Physico-Chemical Analysis of Oil from Two Cultivars of Groundnut Seeds (*Arachis hypogea* L.)

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Abstract

Groundnut (Arachis hypogaea L.) is mostly grown as an annual crop purposely for its oil content and protein rich seeds. This research was conducted with aim of evaluating the physico-chemical properties of two cultivars of groundnut seeds. The seeds of groundnut were obtained from local farmers in Mada village of Gusau local government Zamfara State. The seeds were grounded into powder using mortar and pestle in preparation for analysis. Physico-chemical properties of groundnut seed oil were analyzed in Biochemistry laboratory of Federal University Gusau Zamfara State using standard procedures. Result of physical analysis of Yarbahausa groundnut showed the highest oil yield of 48.0 %, followed specific gravity which measured 1.57±1.2. Results of chemical properties revealed that, saponification value had the highest value of 168.8±0.14 followed by iodine and acid value of 81.5±0.3 and 12.3±0.35 respectively. Peroxide value and free fatty acids showed the lowest values of 4.43±0.45 and 1.56±0.41. Results of physical properties of Yarchina groundnut revealed that, specific gravity had the highest value 67.9±116.1, followed by oil yield of 46.2%. Chemical properties of oil showed that, saponification value had the highest value of 137.48±111.7 followed by iodine of 96.5±0.14. Peroxide value and free fatty acid showed the lowest value of 2.0±.96 and 1.53±0.39. Findings from this study revealed that, the oil extracted from seeds of groundnut is a good source of oil and should be used for both domestic and industrial applications based on their physical and chemical properties.

Keywords: Physico-chemical, Oil, Cultivars, Groundnut, Seeds, Zamfara.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a native to eastern region of south America. It is grown as an annual crop purposely for its edible oil and protein rich seeds. The groundnut is a herbaceous plant with many cultivars, common in the united states, grow up to 30-46 cm high. Runner varieties, the most common in the West African countries are shorter and run along the ground for 30-60 cm (Atasie *et al*., 2009). The peanut plant produces yellow, orange or white flowers which produce 'pegs', characteristic floral structures which sink into the ground to grow the pod. The pods can reach up to 10 cm in length and can contain between 1 and 5 seeds, depending on the varieties (Krapovickan *et al*., 2007). Vegetable oils are widely consumed domestically in Nigeria and other parts of the world. It is used primarily as a cooking and salad oil. Studies have shown that groundnut oil

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contains potassium and sodium and is a good source for calcium, phosphorus and magnesium. It also contains thiamin, vitamin E, selenium, zinc and arginine. Groundnut oil is of high quality and can withstand higher temperatures without burning or degradation (Nkafamiya *et al*., 2010).

Fat and oils have nutritional importance because they form one of the major classes of food. Oils are used in a variety of ways at both domestic and industrial levels. They are used for food texturing, baking purposes, and frying and also used in some industries in the manufacture of soap, detergents, cosmetics and paints. In plants, oil is deposited in the endosperm of the seeds along with carbohydrates where they jointly feed the embryo (Birnin-Yauri and Garba, 2011). Seed oils are important sources of nutritional oils, industrial and pharmaceutical importance. There are many vegetable oils derived from various sources, these include the vegetables oils such as cotton seeds, groundnut seeds, soybean, and sun flower oils. They also include less commonly known oils such as rice bran oil, tiger nut oil, and many others. Their yields, different compositions and their physical and chemical properties determine their usefulness in various applications (industrial) apart from edible uses. The features of oils from different sources depends largely on their compositions and no oil from a single source can be suitable for all purposes (Wara *et al*., 2011). The importance of analyzing oil cannot be over emphasized. In analyzing vegetable oils, the major features that determine the application of such oils are obtained. The world-wide application of vegetable oils for both domestic use (cooking oil) and as industrial raw materials is on the increase. Pharmaceutical industries use oils as either additive or as raw materials in the production of drugs. Oils are used as raw materials in paint production in paint factories, while the cosmetic industries use oils as raw materials for different products such as soap and detergents. These different applications of oils motivate the search for vegetables and seed oils that are of high quality to meet up with the increasing rate of its demand world-wide (Kayode *et al*., 2015). Many works have been carried out in the previous years and many are still been carried out by lipid analyst to explore the potential applications of vegetable oil, but none has been done on groundnut in the study area. The groundnut cultivars selected for this research were commonly cultivated in the study area, therefore, there is need to evaluate the physico-chemical properties of their oil. This research focuses on physical and chemical characterization of oil from two cultivars of groundnut in Gusau metropolis Zamfara State Nigeria.

MATERIALS AND METHODS

Study Area

This research was conducted in Biochemistry laboratory of Federal University Gusau. Gusau Zamfara State is located at an elevation of 442 meters above sea level and its population amounts to 3,602,356. Gusau is located in North-western part of Nigeria and lies between latitude 12°9'46.01"N, and longitude 6°39'40.86"E. Latitude position: Equator ⇐ 1352km (840mi) ⇐ Gusau ⇒ s8655km (5378mi) ⇒ North pole. Longitude position: Prime meridian ⇒ 724km (450mi) ⇒ Gusau. GMT: +1h.

Sample Collection and Preparation

The seeds of groundnut were obtained from local farmers in Mada village of Gusau Local Government Zamfara State Nigeria. The seeds were grounded in to powder using mortar and pestle in preparation for extraction.

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Extraction Procedure
The sum of 54.5 g of grounded seeds were placed in a cellular paper cone and extracted using petroleum ether in a soxhlet extractor for 6 hours. A rotary evaporator was used in recovering some of the solvent and the residual solvent was removed by placing the oil/solvent mixture on a water bath at 100°C for about 2 hours.

Physical Analysis of Oil

Determination of Oil yield
The oil from groundnut seeds was obtained by complete distillation. The oil which was obtained by complete distilling of most of the solvent on a heating mantle was transferred to a beaker. The beaker was then placed on water bath for complete evaporation of solvent for about 2 hours and volume of the oil was recorded and expressed as oil content (%) (Aliyu *et al*., 2015).

$$\text{Oil content (\%)} = \frac{\text{Oil weight}}{\text{Sample weight}} \times 100$$

Determination of Specific Gravity (Relative Density)
The sum of 10ml of the oil was measured in a pre-weighed measuring cylinder. The weight of the cylinder and oil was measured; the weight of the oil was then obtained by subtracting the weight of the cylinder from the weight of the oil and cylinder (Aliyu *et al*., 2015). The relative density of the oil was obtained using equation below:
Density of oil = Where W1 = weight of empty measuring cylinder + oil.
Wo = weight of measuring cylinder, Vo = volume of oil used.

Chemical Analysis of oil

Determination of Acid Value
Exactly 2.0g Ba $(OH)_2$ was added to 0.1M KOH solution and left for 5 min. The solution was cooled, filtered and stored in a plastic bottle. The resulting solution was standardized using 0.10M $KHC8H_4O_4$ (potassium hydrogen phthalate) solution. The solvent mixture was neutralized with standard 0.1M KOH solution until persistent faint pink colour appeared. Then 1.25g of the oil was transferred into a 250ml conical flask and 125ml of the solvent mixture was added to the sample. This was dissolved by agitation and warming on a steam bath. At this point the pink colour disappeared and a clear solution was obtained. The solution was titrated against the 0.1M KOH solution. The end point was obtained by the restoration of the pink colour. The procedure was repeated three times and the average end point was obtained (Birnin-yauri and Garba, 2011).

Determination of Peroxide Value
Peroxide value is used as a measure of the extent to which rancidity reactions have occurred during storage. The quality and stability of fats and oils can be indicated by using the peroxide value. In the study, soybean oils and palm oil showed the lower peroxide values in the range of 1-2 meq O2/kg oil which indicates a relatively good quality of these oils. On the other hand, mustard oils, castor oil, almond oil, olive oil showed higher the values in the range of 5-13 meq O2/kg oil. There is a successive increase in peroxide value indicates the rancidity of oils due to relative higher oxidation in oils. Peroxide value ranges are closely related to the standard value of 10 meq O2/kg as specified (Sabir *et al*., 2016).

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Determination of Iodine Value

The iodine value of oils was determined according to AOAC method (1984). About 0.25 g oil sample was taken in a conical flask and dissolved in 10 ml CCl_4. Similarly, 30 ml hanus solution was added and the mixture was allowed to stand for 45 min in dark with occasional shaking. 10 ml 10% KI solution and 100 ml distilled water were added and washed down any free iodine on the stopper. The iodine was titrated with previously standardized $Na_2S_2O_3$ solution which added gradually with constant shaking until yellow solution turned almost colorless. Few drops of starch indicator was added and titration was continued until blue color entirely disappeared. Bottle was shaken violently so that any iodine remaining in solution in the CCl_4 might be taken up by the KI solution. The volume of $Na_2S_2O_3$ solution required for the experiment was noted. A blank experiment was conducted along with the sample. Percent weight of iodine absorbed by the oil sample was calculated by the following formula:
1 ml 1N Na2S2O3 = 0.127 g I2 (B-A) × N × 0.127 × 100 Iodine value = W B = ml of 0.1N $Na_2S_2O_3$ required by blank A = ml of 0.1N $Na_2S_2O_3$ required by oil sample N = Normality of $Na_2S_2O_3$ W = Weight of oil in g.

Determination of Saponification Value

The saponification value is determined by taking 1.0 g of oil sample in a conical flask with addition of 25 ml 0.5 N alcoholic KOH heated under a reserved condenser for 30–40 min to ensure that the sample was fully dissolved. After cooling the sample, phenolphthalein was added and titrated with 0.2 N HCl until a pink end point was reached (Sabir *et al*., 2016).
Saponification value = W B= ml of HCl required by blank T= ml of HCl required by oil sample N= Normality of HCl W=Weight of oil in gm**.**

Determination of the Free Fatty Acids

To 20ml of ethanol-diethyl ether (1:1 v/v) mixture, 2ml of 1% phenolphthalein solution was added and the mixture was neutralzed using 0.10M NaOH solution. Then 5g of each oil sample was added to the neutralized mixture and titrate against 0.10M NaOH solution with constant shaking until a pink colour developed and persisted for 15 minutes. The titre values were used to obtain the free fatty acid value (Birnin Yauri and Garba, 2011).

Statistical Data Analysis

Data obtained were statistically analyzed using SPSS Statistical Software platform. Results were expressed as Mean ± Standard deviation of the triplicate values.

RESULTS

Physicochemical analysis of oil extracted from two cultivars of groundnut was evaluated. Result of physical analysis of Yarbahausa groundnut showed the highest oil yield and specific gravity of 48.0 % and 1.57±1.2 respectively. Results of chemical properties revealed that, saponification had the highest value followed by iodine and acid of 168.8±0.14, 81.5±0.3 and 12.3±0.35 values respectively. Peroxide value and free fatty acids showed the lowest value of 4.43±0.45 and 1.56±0.41 (Table 1). Results of physical properties of Yarchina groundnut revealed that, specific gravity had the highest value followed by oil yield of 67.9±116.1 and 46.2%. Chemical properties of oil showed that, saponification value had the highest value followed by iodine value with 137.48±111.7 and 96.5±0.14. Peroxide value and free fatty acid showed the lowest value with 2.0±0.96 and 1.53±0.39 (Table 2).

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Table 1: Physicochemical Properties of oil extracted from Yarbahausa groundnut

S/N	Parameters	Test Result
1.	Colour	Yellow
2	Oil yield	48.0%
3	Specific Gravity	1.57±1.2
4	Iodine Value	81.5±0.3
5	Free Fatty Acid	1.56±0.41
6	Acid Value	12.3±0.35
7	Saponification Value	168.8±0.14
8	Peroxide Value	4.43±0.45

Values are mean and standard deviation of the triplicate determinations for specific gravity, iodine value, free fatty acid, acid value, saponification value and peroxide value not for oil yield (%).

Table 2: Physicochemical Properties of oil Extracted from Yarchina Groundnut

S/N	Parameters	Test Results
1	Colour	Yellow
2	Oil yield	4.2%
3	Specific Gravity	67.9±116.1
4	Iodine Value	96.5±0.14
5	Free Fatty Acid	1.53±0.39
6	Acid Value	6.04±3.65
7	Saponification Value	137.48±111.7
8	Peroxide Value	2.0±0.96

Values are mean and standard deviation of the triplicate determination for specific gravity, iodine value, free fatty acid, acid value, saponification value and peroxide value not for oil yield (%).

DISCUSSION

The results for the physicochemical properties of oil extracted from two cultivars of groundnut seeds were given in table 1 and 2. The percentage of oil yield of the seeds 48.0% and 46.2% respectively. This high percentage of oil yield in this study showed that, the industrial processing of oil for soap making and edible purposes would be viable. The saponification value is higher in the two samples of groundnut oil, this shows that, the oil is suitable for soap making. This findings corroborates the findings of Kayode, 2015, who worked on extraction and physicochemical characterization of oil extract from the seeds of Umbrella tree (*Terminalia mentalis*). Acid value in Yarbahausa groundnut is higher than than Yarchina groundnut (12.3±0.35 and 6.04±365). According to Aremu *et al*., 2015, low acid value of oil indicated that oil will be stable over a long period of time and protect against rancidity and peroxidation. This could be attributed to presence of natural antioxidants in the seeds such as vitamin C and A as well as other possible phytochemicals like flavonoids. Acid value is used as an indicator for edibility of an oil and suitability for use in the plant and soap industries. High acid value in oils showed that the oils may not be suitable for use in cooking (edibility), however, may be useful for production of paints, liquid soap and shampoos. In this present study, Yarbahausa groundnut had the highest acid value and may not be suitable for use in cooking, however be useful for cosmetic industries.

Meanwhile, peroxide value is higher in Yarbahausa groundnut than Yarchina (4.43±0.45 and 2.000±0.96). High values of peroxide values are indicative of high levels of oxidation and rancidity of oils thus suggesting absence or low levels of antioxidants. W.H.O/F.A.O (1994) stipulated a permitted maximum peroxide levels of not more than 10 mequivalent of oxygen/Kg of the oils. Furthermore, iodine value in Yarchina is higher than Yarbahausa (96.5±0.14 and 81.5±0.3). The iodine value could be used to quantify the amount of double bond present in the oils to oxidation. Oils with low iodine value less than 100g l2/100g of oils are non-drying oils, the lower the iodine value the lesser the number of unsaturated bonds, thus the lower the susceptibility of such oils to oxidative rancidity. Therefore, non-drying oils

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are not suitable for ink and paint production due to their non-drying characteristics, but may be useful in the manufacture of soap. Yarchina and Yarbahausa groundnuts have iodine value less than 100 g l2/100 kg. Therefore, oils extracted from these groundnuts are not suitable for ink, but may be useful in soap making. This finding greed with findings of Wara *et al*., 2011, who worked on extraction and physicochemical analysis of some Northern Nigerian industrial oils.

CONCLUSION

Findings from this study showed that, the oil extracted from seeds of groundnut is a good source of oil due to the oil yield obtained and is capable of meeting the increasing need for quality and potent oil in industries and domestic applications based on their physical and chemical properties.

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