COMPARATIVE ASSESSMENT OF PHYSICOCHEMICAL PROPERTIES OF LOCALLY AND MECHANICALLY PRODUCED GROUNDNUT (*ARACHIS HYPOGAEA*) OIL STORED OVER A PERIOD OF TIME

ORHEVBA, B. A.; OLORUNSOGO, S. T. & JIMADA, S. A.
Department of Agricultural & Bioresources Engineering,
Federal University of Technology, Minna, Niger State, Nigeria
E-mail: borhevba@yahoo.com, olorunsogo@yahoo.com, Phone No: +234-806-168-8880

Abstract
Groundnut oil was extracted using both local and mechanical methods of extraction. 5litres of each of the oil samples were measured into a plastic gallon and kept in a cool and dry place (average temperature of 28^{O}C). The effect of extraction method and Period of storage were examined. The oil samples from both methods of extractions were analyzed for physicochemical and proximate composition at fresh state and subsequently during storage, using standard methods. The result revealed that free fatty acid, Peroxide value, Saponification value, Iodine value, Viscosity, and Crude Protein were significantly (P<0.05) different during the storage periods and between the extraction methods. The result showed that the physicochemical characteristics of the oil samples extracted from both local and mechanical method were FFA 7.393, 5.61; Peroxide value 1.8, 1.2, Saponification value 193.2, 189.51; Iodine value 95.71, 92.46; Specific gravity 0.9305, 0.91, Viscosity 88.68, 84.24 and Refractive index 1.473, 1.475 respectively. The oil extracted locally had higher value in FFA whereas the mechanically extracted oil had lower value even after six months of Storage. Similar trends were observed in most of the other physicochemical properties.

Keywords: Crude Protein, Groundnut oil, Physicochemical Properties, Proximate Composition, Storage Period

Introduction

Groundnut, *Arachis hypogeal L,* also known as peanut or earthnut is native to a region in Eastern South America (Weiss, 1983). It is grown as an annual crop principally for its edible oil and protein rich kernel seeds, borne in pods which develop and mature below the soil surface. Groundnut is herbaceous and has varieties. It is common in the United States, grows up to 30-46 cm high and does not spread. Runner varieties, the most common in West Africa are shorter and run along the ground for 30-60cm (Asiedu, 1992). Groundnut is now grown worldwide in the Tropics and temperate zones primarily as an oil seed crop (Bansal *et al*., 1993). Groundnut seed makes important contribution to the diet in many countries. The fat content in groundnut has been largely studied. In general, groundnut contains 50-55 % fat of which approximately 30 % is linoleic acid, 45 % is oleic acid. High oleic groundnuts rather than normal groundnuts have increased shelf life and thus improve the oxidative stability of groundnut products (Isleib *et al*., 2006).

Groundnut oil is an organic material oil derived from groundnut, noted to have the aroma and taste of its parent legume. Groundnut oil is most commonly used when frying foods, because its high smoke point is relative to many other cooking oils. Most vegetable oils such as groundnut oil, sunflower oil, soybean oil and corn oil are rich in mono-and polyunsaturated fatty acids such as alpha-linolenic acid, and w-3 fatty acid, and linoleic acid, and w-6 fatty acid. Groundnut seeds are rich in proteins, lipids, and fatty acids for human nutrition. (Grosso *et al.*, 1997 and Sanders, 2002).

Groundnut oil is pale yellow in colour with distinctive nutty taste and odour obtained from the processing of peanut kernel. Its odor is almost removed with refining (Sanders, 2002). It has a high oleic content that has good oxidative and frying stabilities. It is non-drying oil that solidifies from 0 to 3 ^{0}C (Padley, *et al.*, 1994, Young, 1996 and O´Brien, 2004). It is considered a premium cooking and frying oil due to its high smoke point and excellent oxidative stability relative to many other cooking oils (O´Brien, 2004).

Materials and Methods

Sample Collection and Preparation of Samples

Groundnut seeds used for the extraction of oil were obtained from a farm at Gidan Kwanu village, Minna-Bida road, Niger State, Nigeria. The collected seeds were properly cleaned by careful visual inspection; dirt, discoloured seeds, shells and stones were removed. The clean groundnut seeds were thereafter subjected to oil expression using both local and mechanical methods. The fresh oils were then left to clarify. The physicochemical properties and proximate compositions were initially determined using the methods described by the Association of Official Analytical Chemists (AOAC), 2005. The fresh oils were filled into 5 L gallon each and stored at an average temperature of 28 ^{0}C. During the period of storage, the extent of variations in both the proximate value and physico-chemical properties were determined at interval of one month for six months

Local Extraction Method

The groundnut seeds were roasted lightly in a pan over fire. The roasted nuts were then skinned by pouring them over a mat and rolling a wooden batting over them, and winnowing them to separate the skin from the nuts. Thereafter, the skinned nuts were then pounded with mortar and pestle to obtain a smooth paste (little quantity of water was sprinkled on the nuts to make pounding easier). The paste was then kneaded and pressed by hand to express the oil-water mixture. The oil-water mixture was finally fired to remove most of the water by evaporation, since the boiling point of groundnut oil is higher. The boiling point of groundnut oil falls within 130^{0}C-150^{0}C and this decreases with increase in treatment temperature (Makeri, *et al.*, 2011).

Mechanical Extraction Method

The groundnut seeds were first fed into an electrical toaster for roasting. After proper toasting, the seeds were then transferred into the screw press expeller through the feeding hopper. The expeller consisted of worm shaft, cylindrical barrel, feeding hopper, gear box, cake outlet, cake tray, oil outlet, and main frame. The groundnut seeds introduced into the machine through the feeding hopper, were conveyed, crushed, ground and pressed inside the cylindrical barrel with the aid of the worm shaft until oil was squeezed out of the seed. The oil extracted was then drained through the oil channel into the oil tray where it was collected; the residual cake was discharged at the cake outlet and collected at the cake tray. The oil was allowed to settle and clarify before measuring into a 5 litre gallon.

Determination of Physiochemical Properties of the Extracted Oils

All the physicochemical analysis of the oils with the exception of viscosities and refractive indices were carried out at the laboratory of the Department of Animal Production Technology, Federal University of Technology, Minna, Niger State, Nigeria. The refractive indices and viscosities of the oils were determined at the laboratory of the Department of Chemistry, Federal University of Technology, Minna, Niger State, Nigeria. The physicochemical properties which included; refractive index, specific gravity, viscosity, colour, odour, free fatty acid, Peroxide value, Saponification value, and iodine value were determined using the methods of the Association of Analytical Chemists (AOAC, 2005).

Determination of Proximate composition of the Extracted oils

The proximate composition of the groundnut oils was determined at the Laboratory of the Animal Production Technology department, School of Agricultural and Agricultural Technology, Federal University of Technology Minna, Niger State, Nigeria. The analyses were determined using the method described by the Association of Analytical Chemists (AOAC, 2004).

Results and Discussion

Table 1: Effect of extraction method and period of storage on proximate composition of groundnut oil

Treatment	Moisture (%)	Crude Protein (%)	Crude Fibre (%)	Ash (%)
Extraction method (E)				
Local	1.56a	10.69a	0.00	0.00
Mechanical	0.94b	8.97b	0.00	0.00
SE	0.01	0.01	0.01	0.01
Storage Period (S) (Months)				
1st	1.24a	12.31a	0.00	0.00
2nd	1.23a	11.25	0.00	0.00
3rd	1.24a	10.89c	0.00	0.00
4th	1.26a	9.38d	0.00	0.00
5th	1.26a	8.03e	0.00	0.00
6th	1.27a	7.13f	0.00	0.00
SE	0.01	0.01	0.01	0.01
Interaction				
E X S	NS	**		

Values followed by the same letter(s) in a column do not differ significantly by Duncan Multiple Range Test (DMRT) at 5% level of probability
SE = Standard error, NS = Not Significant Interaction, ** = highly Significant Interaction

Table 2: Effect of extraction method and period of storage on physicochemical properties of groundnut oil

Treatment	FFA	PV	SV	IV	SG	Viscosity	RI
Extraction Method (E)							
Local	11.43a	2.02a	197.53a	96.92a	0.9363a	86.27a	1.467a
Mechanical	9.89b	1.55b	195.6b	93.3b	0.9075b	75.29b	1.467a
SE	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Storage Period (S) (Months)							
1st	8.82f	1.60e	192.24f	94.13f	0.9091c	85.86a	1.472a
2nd	10.16e	1.69d	194.08e	94.45e	0.9158b	84.47b	1.471a
3rd	10.5d	1.71d	198.71b	95.01d	0.9142bc	78.93c	1.467b
4th	11.22c	1.82c	196.98d	95.31c	0.9286ab	78.60d	1.465c
5th	11.46b	1.92b	198.34c	95.84b	0.9293ab	78.44e	1.462c
6th	11.80a	1.97a	199.04a	95.95a	0.9344a	78.38f	1.463c
SE	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Interaction							
E X S	**	NS	**	**	NS	**	NS

Values followed by the same letter(s) in a column do not differ significantly by Duncan Multiple Range Test (DMRT) at 5% level of probability
SE = Standard error, NS = Not Significant Interaction, ** = highly Significant Interaction

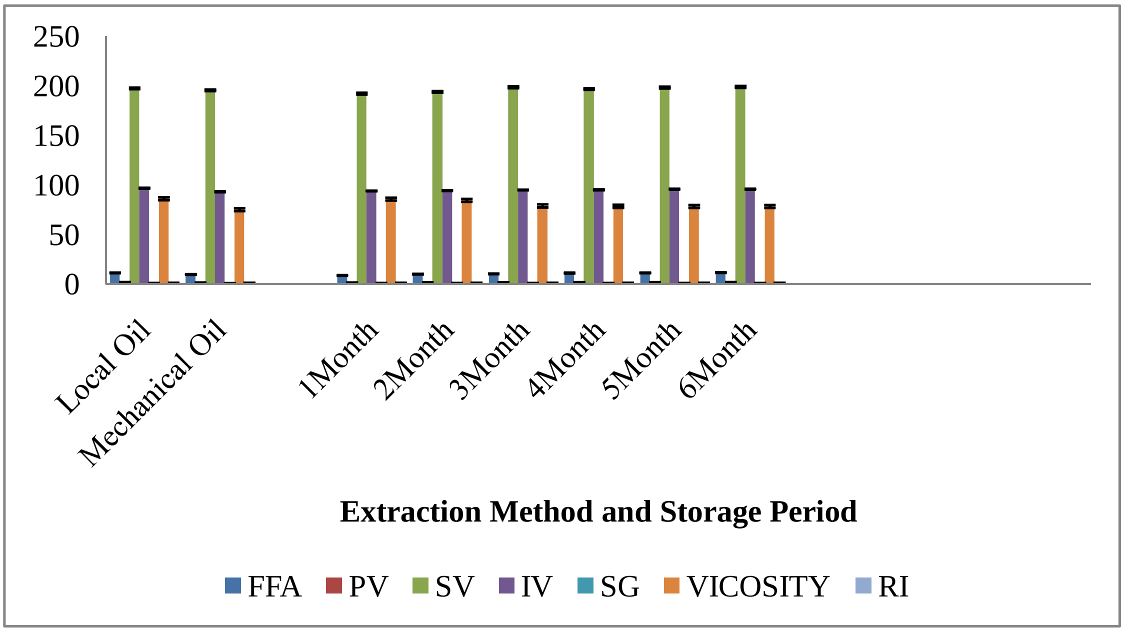

Figure 1: Effect of extraction method and period of storage on physicochemical properties of groundnut oil

Results of the physico chemical properties and proximate composition of groundnut oil samples extracted using two methods and stored over a six month period are presented in Tables 1and 2. From Table 1, it can be seen that the method of extraction had a significant difference on the moisture content and crude protein of the oil samples; although the period of storage did not affect the moisture content significantly. Significant differences were observed in the crude protein content over the storage period.

From Table 2, significant differences were observed in the values obtained for FFA, peroxide value, saponification value, iodine value, specific gravity and viscosity using both methods of oil extraction. There was no significant difference in the refractive indices of the two oil samples. Significant differences were also observed in the values of FFA, peroxide value, saponification value, iodine value, specific gravity and viscosity over the storage period. The value of 13.64 % obtained could be compared with 13.01% obtained by Atasie, *et al.* (2009). The high value of crude protein in the locally produced oil could be attributed to the improper removal of the sludge impurities from the oil, which is believed to be rich in Nitrogen.

Similarly, from Table 1, it can be seen that storage period had a significant effect on crude protein composition with the one month storage accounting for the highest value and subsequently decreased as the storage period increased. This could possibly be attributed to the depletion in Nitrogen composition present in the polymer of amino acids when it reacted with the oxygen and moisture absorbed by the oil forming oxides and Nitric acids during hydrolysis (AOAC, 1998). At the end of the storage period, locally produced oil still maintained a higher crude protein composition.

Moisture content differed significantly between the oil samples, such that locally produced oil had higher moisture than the mechanically produced groundnut oil. The moisture content obtained for both oils fell within the range of 0.94% and 1.56% which is in agreement with that reported by Atasie, *et al.* (2009). The characteristic higher moisture content of the locally produced oil could be attributed to its characteristic high FFA, leading to the fast rancidity as a result of hydrolysis and oxidation. Furthermore, storage period had no significant effect on this parameter, even though the fluctuations in the moisture were not constant during the storage period. This could be as a result of correspondent fluctuation in the room temperature and humidity.

From Table 2, it can be seen that the FFA for both oil samples differed significantly with the locally extracted oil having higher value of 11.43 compared to the mechanically extracted oil with the value of 9.89. Both values fall within the limit set by the Codex Alimentarius Commission for groundnut seed oils for groundnut oil (Abayeh, *et al.,* 1998). The FFA obtained for both extraction methods is slightly lower than that obtained for Olive oil 17mgKOH/g (Davine and Williams, (1961) and higher than Shear nut fat 10.49mgKOH/g reported by Oyedele (2002). The higher value of FFA recorded for locally produced oil may be as a result of the extraction method used. Moreover, the locally produced oil might have been subjected to more hydrolysis considering the fact that it has higher initial moisture content. Also, during the period of six months storage, the FFA had experienced an unprecedented increase from 8.82mgKOH/g to about 11.80mgKOH/g. The quantity of FFA in oils is an indicator of its overall quality irrespective of the storage period (Overhults, *et al.,* 1974).

The mean Peroxide value measured for locally produced groundnut oil was higher in comparison to the mechanically produced oil. The values obtained for locally produced oil is very much close to the 2.26MeqKOH/g obtained by Hook *et al.* (2011), while that of mechanically produced oil is lower (1.55). However, during the period of storage there was no significant difference in the peroxide values throughout the months. Generally, PV of oils may be influenced by much exposure of the seeds to sunlight and heating during drying and frying respectively, causing the lipid oxidation resulting from absorption of oxygen which increases the formation of peroxide (Cheftel & Cheftel, 1992). Peroxide value of the two oil samples were lower than that reported by Ebuehi and Avwobobe (2006). The low peroxide values of the oils gave an indication that they have good storage potential. There was a significant difference as the storage period of the oils increased. However, there was a slight decrease in the peroxide value after one month storage and then increased partially as the storage period was prolonged which could be due to the oxidation of unsaturated fatty acid in the oils.

The result of the saponification values obtained for both oil samples compared favorably with 199.42mgKOH/g of cotton seed reported by Warra *et al.* (2011) and lower than 213mgKOH/g in neem seed oil (Akpan *et al.,* 2000). This indicates that the oils can be used in soap making since its saponification value falls within the range of these oils. Higher saponification value justifies the usage of fat or oil for soap production (Warra *et al.,* 2011). The saponification value was also influenced by the extraction method with the locally produced sample having the highest value. This could be attributed to the characteristic high FFA obtained in the oil. The saponification value at the sixth month gave the highest value which is consistent with the increasing behavior of the FFA.

The iodine value of the oils (96.92 & 93.30) was less than 100gI_2/100g which shows that the oils belong to the class of non-drying oils which are useful in the production of soap and margarine (Odoemelam, 2005). The iodine value of the oil samples were also lower than 104.3g I_2/100g reported for sesame seed oil by Warra *et al.,* (2011) and higher than 84.8gI_2/100g for groundnut oil (Warra *et al.,* 2010). The iodine values significantly differed during the period of storage with the highest value recorded at the sixth month.

The refractive indices of the oils are well compared with 1.460-1.465 obtained by Odoemelam (2005) and also in close agreement with those reported for other conventional oils for soyabean (1.466-1.470) and Palm kernel (1.449-1.451) (Hook *et al.,* 2011). The high refractive indices of these oils seem to confirm the number carbon atoms in their fatty acids (Falade *et al.,* 2008) and it increased as the double bond increased (Eromosele & Pascal, 2003). There was no significant difference in refractive indices of the oil samples during the period of storage and even between the extraction methods. The refractive indices remained almost the same throughout the period, only slight changes were recorded which could have been caused by loss in viscosity and contamination with impurities.

The specific gravities for both samples ranged from 0.9075-0.9363, this is close to 0.918 reported by Akpan *et al.* (2000). The specific gravity slightly increased during the period of storage even though the differences were not significant.

The viscosity recorded for both oil samples were higher than those of soyabean (31cSt), cottonseed oil (36cSt) and sunflower (43cSt) at 300^{0}C (Kammann & Philips, 1985). However, the viscosity of both forms of oils differed significantly, with the locally produced oil recording higher value of 86.27 compared to the 75.29 of the mechanically produced oil. It was observed that as the period of storage increased, the value gradually decreased for both oils.

Conclusion

This study showed that the proximate composition and physicochemical properties of groundnut oils were affected by the method of extractions and the period of storage. The FFA and other physicochemical properties of the two samples are comparable to those of some conventional oils. The groundnut oils are unsaturated and can be classified in the oleic-linoleic acid group. The increase in FFA was more notable compared to other properties towards the last 3 months of storage for both oils. The difference of the increase of those values in the two samples could be explained by the absorption of light into packaging material, the degradation of oil compound due to initial oxygen concentration, hydrolysis due to moisture and permeability of oxygen through the 5L gallon. The studies also showed that locally produced was of lower quality and was prone to go rancid faster compared to the mechanically produced oil, which could be attributed to its characteristic high moisture content and FFA. It is concluded from this study that the stability of groundnut oil is dependent on the method of production and its initial physical and chemical properties, time and storage condition.

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