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Effect of Microwave Heating On Fatty Acid Profiles of Three Nigerian Vegetable Oils

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Abstract: *The effect of microwave heating on the Fatty Acid Profiles (FAPs) of three Nigerian Vegetable oils (soya, groundnut and palm oils) was studied. Samples of the oils were separately heated for thirty minutes in a microwave oven. FAP of each oil was analyzed before and after microwave heating using gas chromatograph. Comparative study of the FAPs of the three oils before and after microwave heating showed that the microwave heating had a very marginal impact on the compositions of their fatty acids. Very slight quantitative changes were observed on the composition of the fatty acids, the proportion of Unsaturated fatty acid (USFA) and Saturated fatty Acid (SFA) in the three oil samples as a result of the microwave heating.*
Key words: *Microwave Heating, Fatty Acid Profile, Nigerian Vegetable Oil*

I. Introduction

Vegetable oils are oils derived from plant sources like palm, groundnut, soybean etc. Their applications can be for domestic or industrial purpose. The domestic application is mainly for consumption, and those that fall in this category are referred to as edible oil. Edible oils play very vital role in human diet, because they supply essential fatty acids (EFA) which are needed by the body to maintain the integrity of its cell membranes. The EFA are also needed in the synthesis of some hormones such as prostaglandins which are very essential for some biochemical reactions in the body[1]. Vegetable oils also provide energy and essential linoleic and linolenic acids which are responsible for growth [2].The application of oils either for consumption or industrial purpose is a function of many factors among which are Triacylgycerol (TAG) and Fatty Acid profile. Invariably, the physical and chemical properties of oils depend on the TAG and the composition of Fatty acids in them [3].

The use of microwave heating as a method of cooking is fast taking over the traditional methods such as kerosene stove and gas in Nigeria. This is predominant in our cities, especially among the elites who have very tight schedule with respect to their job activities. One major reason advanced for the increasing growth in the use of microwave energy is the relatively less time of cooking [4]. No doubt this is a good advantage; however some disadvantages are also associated with microwave cooking. Albi et al.[5] reported that greater oxidative changes were observed when sunflower , olive oil and lard were microwave heated than when these oils were heated under the same conditions using the conventional oven. Similar results were obtained when Zhang et al. [6] subjected soybean and palm olein into microwave and conventional heatings.Yoshida et al.[7] also reported that microwave heating of vegetable oils and fatty foods led to loss of some vitamins, fatty acids isomerization and thermo oxidative degradation in the oils. An increase in the levels of free fatty acids in vegetable oils heated in microwave oven was also reported by Yoshida et. al.[8]. All these show that microwave heating has some degradative effects on the quality and composition of oils and fatty foods. However, Osawa et al.[9] in their own study reported a very small changes in the fatty acid profile and low formation of trans-isomers in the cottonseed oil used in the frying of chicken using microwave oven. Slight decrease in the linoleic acid after microwave heating recorded in their study was attributed to experimental error which probably arose from the integration of the chromatographic peak. In the same trend, Ali et. al[10] also reported that the compositions of Palm Oil and Coconut Oil which were microwave heated were not significantly affected in a very short period and at a low heating rate.

Thus, it appears that the effect of microwave heating on fatty acid profile of oils and foods is still a subject of debate. Although, some notable studies have been carried out on the effects of microwave heat on oils and foods in advanced countries of the World, there appears to be scanty literature information on this for Nigerian vegetable oils and foods. This paucity of information therefore necessitates this research. Thus, this study examines the impact of microwave heating on the fatty acid profiles of three Nigerian Vegetable oils.

II. Materials And Methods

Materials

Three brands of edible oils, which include palm oil(PO), soybean oil(SO) and groundnut oil(GO) were purchased at a local market called Wazobia market situated along Ogbomoso – Ilorin road in Ogbomoso, Nigeria. Two liters (2L) each of the samples were purchased and used for the study.

III. Microwave Heating

The microwave oven is a Haier Thermocool (23L) model with 800 W effective power output. 250ml each of the edible oil samples was weighed and treated in the microwave oven at 100% power level (800W) for 30 minutes. 20ml of each of the oil samples was placed in a beaker, and heated in the microwave oven for thirty minutes. Each sample was removed from the oven and immediately placed in a dessicator to cool it down to room temperature. Thereafter, each of the cooled samples was kept in a dark vial in a refrigerator pending analysis.

IV. Fatty Acid Methyl Ester Analysis

Preparation of Fatty Acid Methy Esters (FAMEs) was carried out according to the modified method of Dauqan et al.[3]. Summarily, 50mg of the sample was esterified for five (5) minutes at 95^0C with 3.4ml of the 0.5M KOH in dry methanol. The mixture was neutralized by using 0.7M HCl, followed by addition of 3ml of 14% boron triflouride in methanol. The mixture was heated for 5 minutes at the temperature of 90^0C to achieve complete methylation process. The Fatty Acid Methyl Ester was thrice extracted from the mixture with redistilled n-hexane. The content was concentrated to 1ml for gas chromatography (GC) analysis.

Gc Analysis

The gas chromatography conditions of analysis are: 0.1µL of the clear supernantant of the prepared FAME was injected into the injection port of Hewlett Packard 6890 Gas Chromatography equipped with flame ionization dectector (FID) and powered with HP ChemStation. The oven temperature was programmed as follows: initial temperature at 60^oC. First ramping at 12^oC/min for twenty minutes and maintained for 2 minutes. This was followed by second ramping at 15^oC/min for three minutes and maintained for 8 minutes. Injector and detector temperatures were 250^oC and 320^oC respectively. Identification of the FAMEs peaks was based on comparison of their retention times with those of a standard mixture supplied by the instrument manufacturer. While the results are expressed in % of areas of the methyl ester peaks

V. Results And Discussion;

The effects of microwave heating on fatty acid profiles of three vegetable oils in Nigerian market are as shown in Table 1.The untreated soya oil had eleven different types of fatty acids and the percentage distributions of these fatty acids are also shown in the Table1. The most abundant of the fatty acids is Linoleic Acid $C_{18.2}$ (46.20%) followed by Oleic Acid $C_{18.1}$ (35.69%), while the least is Margaric Acid $C_{17.0}$ (0.02%). In the microwave heated sample , the percentage distribution of the fatty acids shows Linoleic Acid $C_{18.2}$ (46.78%) as the highest followed by Oleic Acid $C_{18.1}$ (37.14%) and the least is Margaric Acid $C_{17.0}$ (0.02%).Comparing the control and treated samples , it is seen that Linoleic Acid $C_{18.2}$ and Oleic Acid $C_{18.1}$ in the heated sample experienced a slight increase in their concentrations, while Myristic Acid $C_{14.0}$, Linolenic Acid $C_{18.3,}$ Arachidic Acid $C_{20.0,}$ and ,Behenic Acid $C_{22.0,}$ have their concentrations decreased slightly. The concentrations of Margaric Acid $C_{17.0}$ and Lignoceric Acid $C_{24.0}$ are unaffected by the Microwave heating.

The results of fatty acid profiles of the samples of groundnut oil before and after microwave heating for 30 minutes are as presented in Table 1. In the control sample, fatty acids with relatively high concentrations are Oleic Acid $C_{18.1}$ (42.24%), Linoleic Acid $C_{18.2}$ (35.19%), and Palmitic Acid $C_{16.0}$ (12.29%), while Myristic Acid $C_{14.0}$ has the least concentration(0.38%). In the heated sample, the concentration of Oleic Acid $C_{18.1}$ and $C_{18.2}$ increased to 44.04 and 36.96% respectively while the concentration of Palmitic Acid $C_{16.0}$ decreased to 10.02 %. Other fatty acids in the sample of the groundnut heated, that experienced a decrease in concentration are Myristic Acid $C_{14.0,}$ Stearic Acid $C_{18.0}$, Arachidic Acid $C_{20.0}$ and Behenic Acid $C_{22.0.}$ The concentration of Myristic Acid $C_{14.0,}$ was mostly affected as it reduced from 0.38% to 0%.

In palm oil sample, nine fatty acids namely; Myristic ($C_{14.0,}$), Palmitic ($C_{16.0}$), Palmitoleic ($C_{16.1}$),Stearic($C_{18.0}$),Oleic($C_{18.1}$),Linoleic($C_{18.2}$),Linolenic($C_{18.3}$),Arachidic($C_{20.0}$),Behenic ($C_{22.0}$)were detected in the untreated (control) sample,Table 1. The most abundant of these fatty acids are palmtic and oleic acids with percentage concentrations of 41.36 and 40.23 respectively. The fatty acid profile of the unheated palm oil used in this study was similar to the result of the study of Egbal et al[8]. on Palm oil. A minor disparity in the result of this study and that of Egbal[8] is the detection of very little quantities of Caprylic,arachidic and Tricosanoic

acids in palm oil sample in their own study. Analysis of sample of palm oil subjected to 30 minutes microwave heating showed that the fatty acid composition of the oil remained unchanged in terms of number and type. However, a change in the proportion of each of the fatty acids was noticed. Thus, the effect of the heating was quantitative only, as no quanlitative change was observed on the composition of the oil(Table 1). Myristic, palmitic, stearic, arachnid and behenic acids experienced a decrease in their quantities when the oil was microwave heated for thirty minutes. On the other hand, palmitoleic, oleic,linoleic acid had a slight increase in their concentrations as a result of microwave heating for thirty minutes.

Generally, it can be inferred from Table 1. that the Fatty acid Profiles of the three Nigerian vegetable oils studied were not drastically modified by microwave heating. This inference is similar to the results of the study of Alfaia et al.[11] on beef. In their study of the effect of different methods of cooking, they showed that each method of cooking they used had a moderate impact on the Fatty acid Profiles of the beef. Ali et al.[10] also showed that no significant difference in the levels of some degradative indices were noted when palm olein was microwave heated for some minutes. Dostalova et al. [12] also reported that no substantial difference in Fatty acid profiles of some oils occurred during microwave heating. They ascribed the oxidative stability of vegetable oils to high content of linoleic acid.

Figure 3, shows comparison of %concentration of USFA and SFA before and after heating. There appears to be very little difference in the USFA and SFA of the samples before and after been heated by microwave oven. This observation is in agreement with the findings of Rodriguez-Estrada et al [13] who reported a very slight decrease in the ratio of USFA/SFA in the beef hamburgers which were cooked by microwave heating. Van de Vort et al. [14] also reported a decrease in degree of unsaturation of some edible oils subjected to microwave heating at 630Mw.

VI. Conclusion

This study shows that microwave heating of the three Nigerian vegetable oils for 30 minutes caused a marginal decrease in the total SFA leading to a marginal increase in total USFA. Qualitatively, no change was noticed in the FAPs of the three oils after microwave heating except, in GO, where microwave heating led to disappearance of $C_{14.0}$ in the heated GO. Very slight quantitative changes were observed in each of the fatty acids in the three oils after microwave heating. It thus, implies that microwave heating does not have adverse effect on the fatty acid profiles of the three Nigerian oils (SO, GO and PO).

VII. Appreciation

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Sample	**Time (min)**	**Fatty acid**										
		$C_{14.0}$	$C_{16.0}$	$C_{16.1}$	$C_{17.0}$	$C_{18.0}$	$C_{18.1}$	$C_{18.2}$	$C_{18.3}$	$C_{20.0}$	$C_{22.0}$	$C_{24..1}$
SO	0	0.48	10.72	0.40	0.02	4.87	35.69	46.20	0.73	0.34	0.22	0.34
	30	0.27	9.45	0.39	0.02	4.38	37.14	46.78	0.72	0.29	0.21	0.34
GO	0	0.38	12.29	0.45	-	3.80	42.24	35.19	0.63	2.43	2.59	-
	30	0.00	10.02	0.76	-	3.27	44.04	36.96	0.66	2.11	2.16	-
PO	0	0.94	41.36	0.20	-	5.78	40.23	10.76	0.23	0.19	0.31	-
	30	0.22	38.29	0.45	-	4.07	44.13	11.81	0.87	0.01	0.16	-

SO = Soybean Oil; GO =Groundnut Oil; PO = Palm Oil

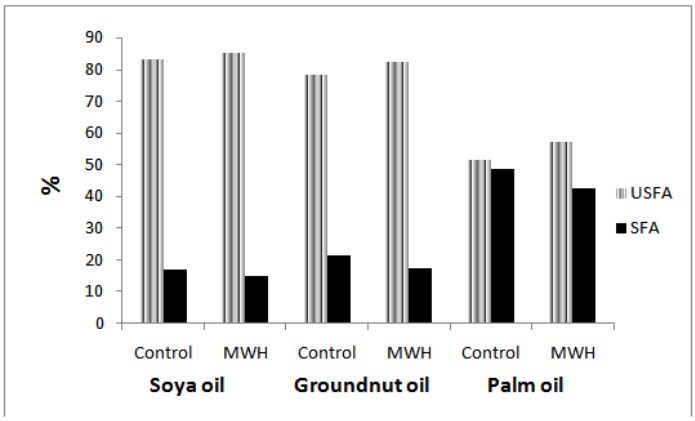

Figure 1: Effects of Microwave Heating on the Usaturated and Saturated Fatty Acids in the Samples of the Oils

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