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Effect on Lipid Composition of Groundnuts Roasted in Electromagnetic Waves of Microwave Oven

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Abstract. The effect of short waves of electromagnetic energy on the lipid composition of peanut oil was studied when peanut seeds were roasted in a microwave oven. The results showed that heat treatment (in microwave oven) caused a slight change in nutritional quality of the oil in respect of fatty acids. Unsaturated and polyenoic fatty acids decreased with the increase of monounsaturated fatty acids in the oil of microwave heated peanut seeds. The oil extracted from the seeds before microwave roasting contained capric, lauric and myristic acids in traces. The oil contained 8.2% palmitic acid, 3.9% stearic acid, 59.87% oleic acid, 22.9% linoleic acid, 1.3% linolenic acid, and 3.7% arachidic acid. The microwave roasted peanut seed oil showed some changes in the fatty acids composition as stearic, linoleic, linolenic and arachidic acids reduced with the increase in the concentrations of oleic, capric, lauric and myristic acids.

Keywords: microwave heating, microwave oven, polyenoic fatty fraction, groundnut oil, peanut oil, groundnut roasting, electromagnetic waves, microwave heating

Introduction

Peanut, also called groundnut *(Arachis hypogaea)*, belongs to the plant family Leguminosae. Through originally a native of Brazil, it is now cultivated in all tropical and subtropical countries (Chopra, 1970). Peanut is the second largest oil seed crop after rapeseed, in Pakistan (Din *et al.,* 1999). The nut is normally composed of 25-35% shells and 65-70% kernels. Peanut seeds contain per 100 g, 4-13 g moisture, 21.0-36.4 g protein, 35.8-54.2 g fat, 6.0-24.9 g carbohydrates, 1.2- 4.3 g fibre, 1.8-3.1 g ash, 49 mg Ca, 409 mg P, 3.8 mg Fe, 15 mg carotene and 1mg ascorbic acid (Sewern, 1979; Eckey, 1954; Thrope and Whileley, 1947). Peanut oil is used for cooking, making margarines, in salad dressings, for deep-frying, as shortening in pastry and in bread, pharmaceutical soaps, cold creams, pomades, pest control emulsions, and fuel for diesel engines (Martin and Ruberte, 1975). Young peanut pods may be consumed as vegetable. It is prudent that the natural superior nutritional quality of oils is maintained during processing and cooking. Recent years have seen an increasing trend in the use of microwave ovens for cooking or reheating of foods. It was, therefore, deemed appropriate to investigate the changes, if any, produced in the peanut seed oil when heated in microwave as it would help evaluate the changes produced during this cooking/processing treatment.

Materials and Methods

The oil of raw and roasted peanuts was extracted, hydrolyzed, methylated and their fatty acids compositions determined by gas chromatography using the usual standard procedures.

Peanut seeds were procured from the local market. Comparative studies were undertaken to determine the changes occurring in lipid composition of oil extracted from peanuts roasted in microwave oven in comparison with the oil extracted from raw peanuts. The temperature during the microwave oven roasting was 250 °C.

Extraction of oil. For the extraction of oil, peanut shells were removed. Clean, dry and pulverized seeds, 50 g each of the microwave roasted and raw peanuts, were extracted with 450 ml chloroform : methanol solvent mixture (2:1, v/v) by shaking on magnetic stirrer for 2 h at room temperature (Devine and Williums, 1961). After filtration, the residual material was retreated three times with 100 ml of the same solvent mixture. All the extracts were combined. The oil extract was given three repeated washings with Folch solution (Folch *et al.,* 1957) to remove the non-lipid impurities. After removal of the solvent solution under reduced pressure, the extracted oil was stored in an inert atmosphere.

Physicochemical values of the oil. The physicochemical values, such as saponification value, iodine value, ester value, and free fatty acids were determined (BSS 684, 1958). Refractive index was determined with Abbe's refrectometer.

Saponification of the fatty matter and liberation of fatty acids. For the isolation of fatty acids, the fatty matter (3 g) of each sample was separately refluxed on waterbath with 0.5 N

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alcoholic potassium hydroxide solution (50 ml) for 3 h. The solvent was removed under reduced pressure and the residual soaps were washed thrice with petroleum ether to remove the unsaponified matter. The soaps were dissolved in water, acidified with 0.2 N sulphuric acid (25 ml), and refluxed on waterbath for one h (Devine and Williums, 1961). The liberated fatty acids were extracted with diethyl ether and dried over anhydrous sodium sulphate. The removal of solvent yielded the fatty acids fraction.

Methylation of fatty acids and purification of methyl ester. The fatty acids were treated with boron triflouride-methanol (Morrison and Smith, 1964) for the formation of methyl esters. The esters were extracted with hexane and stored at low temperature for the gas chromatographic analysis.

Identification of fatty acids by GLC. The obtained methyl esters were analyzed on Shimadzu GC-4A gas chromatograph equipped with flame ionization detector and polar (PEG) capillary column (25 m x 0.2 mm i.d.). The temperature programming of the oven column was 180 °C - 3 °C/min-220 °C. Nitrogen was used as carrier gas with a flow rate of 2 ml/min. The temperature of injector and detector was 230 °C and 250 °C, respectively. The peaks were recorded on Shimadzu CR-4A chroma-topac and identified by comparing their retention times with those of standards run similarly.

Results and Discussion

The lipids of raw and microwave roasted peanuts were found to have good colour and smell. Raw peanut seeds contained slightly higher percentage of oil, as compared with microwave-roasted peanut seeds (Table 1). Other physical values like specific gravity, refractive index and solidifying point were also found to differ slightly. These changes may have been due to the localized point effect of temperature during microwave heating. The specific peanut flavour was dominant in the oil of raw peanuts, not so in the oil of microwave roasted peanuts. This decrease in flavour may be attributed to the volatile carbonyl components, which may have been destroyed when peanut seeds were roasted in microwave oven as reported by Pattee *et al.* (1965).

The chemical charactristics of oil from raw and roasted peanut seeds are shown in Table 2. Iodine value, saponificatin value, ester value and INS value decreased, while peroxide value, free fatty acids and acid value increased when peanut seeds were roasted in microwave oven in comparison with oil of raw peanut seeds. The decrease in iodine value indicated a decrease in the unsaturation of oil, which was also confirmed by GLC analysis. The GLC analysis revealed a decrease in the percentage of polyunsaturated fatty acids (linoleic, linolenic acids). Change in saponification value indicates that some of the fatty acids having high molecular weight broke down into lower molecular weight fatty acids. As a result there was an increase in the value of free fatty acids and acid values of microwave roasted peanut seed oil. More or less similar trends have also been reported in another spectrophotometric study of different microwave treated vege-table seed oils (Francesco *et al.,* 2003).

Oxidation in the peanut oil occurs in triglycerides and polar lipids. The peroxide value in roasted peanut oil was greater than the raw peanut oil, which may be due to the formation of epoxide as a result of oxidation process. Oxygen attacks the double bonds of fatty acids and converts these into single bonds, which results in a decrease in unsaturation and ultimately decreases the iodine value of the oil. Oxidation in both neutral and polar lipids of peanuts has been reported (St. Angelo and Granes, 1986).

The fatty acids profile of peanut oil, of both raw and roasted peanut seeds, showed higher percentage of oleic acid among the unsaturated fatty acids and of palmitic acid among the saturated fatty acids (Table 3). Higher percentage of unsaturated fatty acids is the characteristic of good vegetable oils. The fatty acids composition further revealed that the oil of

Table1. Physical attributes of oil extracted from raw and microwave oven roasted peanut seeds

Physical characteristics	Raw peanut seeds	Microwave oven roasted peanut seeds
Yield of oil (%)	38.96	38.42
Refractive index at 40 °C	1.4633	1.4629
Specific gravity at 15 °C	0.9166	0.9169
Solidifying point (°C)	1.1 °C	0.8 °C
Smell	highly nutty odour	low nutty odour

Table 2. Chemical characteristics of oil of raw and microwave oven roasted peanut seeds

Chemical characteristics	Raw peanut seeds	Microwave oven roasted peanut seeds
Iodine value	95.68	92.33
Saponification value	187.32	162.40
Peroxide value	3.74	3.98
Free fatty acids as oleic acid (%)	0.17	0.24
Unsaponifiable matters (%)	0.018	0.0135
Acid value	0.34	0.47
Ester value	186.97	161.93
INS value	91.64	70.07

both raw and microwave oven roasted peanut seeds had health promoting attributes due to the lower amounts of such fatty acids as capric, lauric and myristic, which were present only in traces and of palmitic 7.8- 8.2%. The oil, however, showed slight increase in capric, lauric and myristic acids, and a slight decrease in palmitic acid in the oil of microwave oven roasted peanut oil (Table 3). These acids have the ability to increase the cholesterol level in the blood, but their rather low concentration in the microwave oven roasted oil was a useful indicator for controlling cholestrol levels. Oleic acid was present in large amounts, both in the raw and microwave oven roasted peanut seeds, 59.87% and 61.6%, respectively. This is a good contributor for lowering the level of LDL (low density lipoprotein), while maintaining the HDL level (high density lipoprotein), which is useful to minimize the chances of the risk from cardiovascular diseases (Mata *et al.,* 1992; Mattson, 1985). Linoleic acid was also present in good quantity in both types of oil. This fatty acid is useful for the proper growth of human body (Gunstone *et al.*, 1989; Devel, 1957). The raw seed oil had higher concentration of linoleic acid as compared to the microwave oven roasted peanut oil, 22.9% and 20.0%, respectively. Similar trend was observed in the values of linolenic and arachidic acids. It was noted that oil from the microwave roasted peanuts contained higher amounts of saturated fatty acids, 17.1%, as compared with 16.1% in the oil from raw peanut seeds (Table 4). This also means that the unsaturated fatty acids decreased as a result of roasting in the microwave oven indicating a small reduction in the nutritional quality of this oil.

Table 3. Fatty acid composition of lipids of raw and microwave oven roasted peanut seeds

Fatty acids	Raw peanut seeds	Microwave roasted peanut seeds
Capric acid ($C_{10:0}$)	tr	1.5
Lauric acid ($C_{12:0}$)	tr	1.6
Myristic acid ($C_{14:0}$)	tr	1.4
Palmitic acid ($C_{16:0}$)	8.2	7.8
Palmitoleic acid ($C_{16:1}$)	tr	tr
Stearic acid ($C_{18:o}$)	3.9	3.0
Oleic acid ($C_{18:1}$)	59.87	61.6
Linoleic acid ($C_{18:2}$)	22.9	20.0
Linolenic acid ($C_{18:3}$	1.3	1.2
Arachidic acid ($C_{20+higer}$) or above	3.7	1.8

tr = traces

Table 4. Saturated and unsaturated fatty acids of lipids of raw and microwave oven roasted peanut seeds

Fatty acids	Raw peanut seeds	Microwave oven roasted peanut seeds
Saturated fatty acids (%)	16.1	17.1
Unsaturated fatty acids (%)	83.8	82.8

The changes observed in the oil of seeds roasted in microwave oven did not seem to affect the nutritional quality of the oil and thus were not expected to pose serious health hazards at the levels at which the oil is commonly consumed. However, this risk cannot be altogether ignored in countries like Pakistan where this is the only edible oil (dietary fat) consumed as the main source of energy and of essential fatty acids, which are necessary for the regulation of lipid oxidation, reduced accumulation of triglycerides in the skeletal muscles, and the formation of cell walls.

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