PHYSICOCHEMICAL EVALUATION OF RANCIDITY OF SOME NIGERIAN EDIBLE OILS AND SNACK FOODS

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Abstract

five edible oils (palm kernel, palm, groundnut, soya and olive oils) and eight snack foods (plantain chips, potato chips, 'akara', instant noodles, cashew nut, biscuits, dough nuts and cheese balls) were bought from Mararaba market in Karu Local Government Area ofNasarawa State and were subjected to physicochemical analysis such as peroxide value, acid value, kinetic viscosity, specific gravity and pH. Systematic variations of these parameters within two months storage period under light and dark conditions were observed. The peroxide values of edible oils under dark and light conditions ranged between 1.00 to 3.00 mEq/kg and 1.00 to 3.50 mEq/kg respectively. The acid values ranged between 0.21 to 9.40 and 0.24 to 9.82 mg KOH/g under dark and light conditions. Also, the peroxide values of extracted oils from snacks kept under dark and light conditions range between 1060 to 17 mEq/kg respectively. The result of add value of the snacks also showed that the snacks under dark condition ranged between 1.91 to 6.84 mg/KOH/g and 2061 to 14 mg/KOH/g far snacks in the light. The results suggested that light enhanced/induced the rancidity of the oils and snacks.

Keywords: Physicochemical, rancidity, edible oil,faod snacks,

INTRODUCTION

Edible oils from plant sources are of important interest in various food and application industries. They provide characteristic flavours and textures to foods as integral diet components (Odoemelam, 2005). In Nigeria, the major sources of edible oil are groundnut also called peanut *(Arachis hypogea* L) and oil palm *(Elaeis guineensis).* These oils are used mainly as cooking oils and for the production of soap, margarine, and cosmetics (Ong *et al,* 1995). Peanut is an important source of edible oil for millions of people living in the tropics. Peanuts are among the oldest oil crops in Nigeria and are mostly consumed as snack, after roasting (Bansal *et al,* 1993; Jambunathan *et al,* 1993)

Vegetable oil had made an important contribution to diet in many countries, serving as a good source of protein, lipid and fatty acids for human nutrition including the repair of worn out tissues, new cell formation as well as a useful source of energy (Gaydou *et al,* 1983; Grosso and Guzman, 1995; Grosso *et al,* 1997,1999). Oil quality and its stability are, therefore, very important for the consumers and application industries (Janbunathan *et al.*, 1993).

Rancidity is the chemical decomposition of fats, oils and other lipids. There are two basic types of rancidity. Hydrolytic rancidity occurs when water splits fatty acid chains away from the glycerol backbone in triglycerides. Oxidative rancidity occurs when the double bonds of an unsaturated fatty acid react chemically with oxygen. In each case, these chemical reactions result in undesirable odour and flavour.

Snack foods have become a popular menu world over, as they contain some amounts of fats and oil, they are susceptible to rancidity. Rancidity can be decreased, but not completely eliminated, by storing fats and oils in a cool dark place with little exposure to oxygen or free radicals, as heat and light accelerate the rate of reaction of fat with oxygen. The addition o? antimicrobial agents can also delay or prevent rancidity due to the inhibition of the growth of bacteria or other micro organisms.

With the multiplication of convenience store, packages snack foods are now a significant business. Snacks foods are typically designed to be portable, quick and satisfying. Processed snack foods are typically designed to be less perishable, more durable and or more appealing than processed foods.

However, since these edible oils and snacks contain oil and liable to rancidity, there is need to determine the degree of rancidity over a period of time under different storage conditions in order to know the best method of storage. Also, it has become necessary to protect the health of consumers and ensure a fair practice in production and trade. In this research, rancidity of the oils and snacks has been carried out under different storage conditions (dark and light) so as to know how these affect the quality of edible oils and snacks.

MATERIALS AND METHODS

Sample Collection and Preparation

Five samples of edible vegetable oils: palm kernel, palm oil, groundnut, soya and olive oils were bought from a local market in Mararaba in Karu L.G.A. of Nasarawa State. Also, eight samples of snacks: plantain chips, potato chips, 'akara', instant noodles, cashew nuts, biscuits, doughnuts and cheese balls were bought from shops frying points within New Nyanya, Karu L.G.A of Nasarawa State. The snacks were weighed, crushed and oil extracted from them were used for analysis.

Oil Extraction

Extraction of oils from the snacks was carried out using soxhlet apparatus with hexane as solvent. 100 g of the snacks was weighed, crushed and inserted into the soxhlet apparatus and was left to run for six hours and the solvent was recovered using a rotary evaporator.

Physicochemkal Analysis

Peroxide value

The oil (1 g) was weighed in a clean dry boiling tube. 1 g of powered potassium iodide was added to 20 ml of the solvent mixture consisting of 2 volumes of glacial acetic acid and 1 volume chloroform. It was placed in a boiling water bath and allowed to boil vigorously for more than 30 seconds. The content was poured into titration flask containing 20 ml freshly prepared 5% potassium iodide solution. The tube was washed twice with 25 ml portions of water and the washings added to the titration flask. Titration with 0.002N sodium thiosulphate solution was done using starch as indicator. A blank determination was carried out. The peroxide value in mEq/kg was calculated using the formula:

$$\text{Peroxide value} = \frac{\text{SxNxlOOO}}{\text{Weight of sample}}$$

Where,
S = Volume of litre N = Normality of sodium thiosulphate

Acid value

25 ml diethyl ether was mixed with 25 ml ethanol. Few drops of phenolphthalein indicator was added. 2 g of the oil was dissolved in the neutralized solvent mixture shaken vigorously and then titrated with 0.01N potassium hydroxide solution with constant shaking until the pink colouration remained permanent. The acid value was calculated using the formula: Acid value =

$$\frac{\text{(a b)x NX 56.1}}{\text{Weight of sample}}$$

Where,
a = Volume of titrant used for sample b = Volume of titrant used for blank N = Normality of potassium hydroxide.

pH

The pH of the samples was determined by using Jenway pH meter at 30.2°C

Colour

The colour and state of the samples at room temperature were determined by visual inspection.

Specific Gravity

The specific gravity was obtained by measuring out 2 ml of the sample and weighing it. 2 ml of water was also measured out and weighed. The mass of the sample divided by the mass of the water gave the specific gravity.

Viscosity

The viscometer was cleaned and then charged by introducing the sample through a tube into the lower reservoir. The viscometer was placed into the holder and inserted into the constant temperature bath. It was allowed approximately twenty minutes for the sample to come to bath temperature. With the finger placed over the second tube, suction was applied to the first tube until the liquid reached the centre of the first bulb. Suction was removed from the tube. The finger was removed from the second tube and immediately placed over the first tube until the sample dropped away from the lower end of the capillary into the third bulb. The finger was removed and the efflux time measured. To measure the efflux time, the liquid sample was allowed to flow freely down from the mark below the first bulb to" the mark below the second bulb. The kinetic viscosity of the sample was calculated by multiplying the effluent time by the viscosity constant.

RESULTS AND DISCUSSION

Table 1 shows the physical properties of the edible oils. The characteristic yellow - red colour of most of the vegetable oil is derived principally from orotenoid pigments. The content of carotenoid pigment is lowered by heat

treatment. Colour serves as an index for determining the occurrence of oxidation and oil stability.

"Among the snacks, cashew nuts had the highest oil yield of 37.60% while potato chips had the lowest yield of 3.75% (Table 2). The oils from the snacks were liquid at room temperature except that from biscuits which was solid as it contained mostly fats.

Peroxide value

Peroxide value measures the degree of lipid oxidation in fats and oils; it is defined as the milliequivlents (Meq.) of peroxide per kg of fat or oil. It measures the formation of peroxide or hydro peroxide groups that are the initial products of lipid oxidation.

Fresh oils have less than 10 mEq/kg and values between 20 and 40 mEq/kg results in rancid taste (Akubugwo and Ugbogu, 2007). The low peroxide value indicated slow oxidation of these oils. According to Demian (1990), the peroxide formation is slow at first during an induction period that may vary from a few weeks to several months according to the particular oil and temperature (Pearson, 1981). Table 3 shows the chemical analysis of the edible oils placed in the dark. Palm kernel oil had the least peroxide value of 1.80 mEq/kg while soya had the highest (3.00 mEq/kg). The chemical analysis of the edible oil showed that groundnut oil (in the light) had the highest peroxide value of 3.50 mEq/k while palm kernel oil had the least peroxide value of 1.00 mEq/kg.

In table 4, palm kernel oil contains 15% unsaturated fatty acids and 85% saturated fatty acids. Palm kernel oil has the lowest degree of unsaturation compared with groundnut (83%), soyabean oil (47%) (USADA Handbook, 1979). The presence of unsaturated fatty acids in the oils makes them susceptible to oxidation and concomitant rancidity. There was a gradual increase in peroxide values of the oils kept outside (under light) as compared with those kept in the dark (Tables 3 and 4). That was because ultraviolet rays of light, oxygen, and certaih activities can break double bonds and in turn destroy the structure of polyunsaturated fatty acids. Saturated fatty acids can much more readily, resist these effects (Alais *et al*, 1999). The higher the peroxide value, the higher the degree of rancidity of the oil. Peroxide value is hence an index for monitoring the general quality of the oil, adulteration and primary oxidation. The peroxide values of the standard for fresh oils and by extension the oils were fit for human consumption.

The peroxide value of the extracted oil samples was observed to be highest in cheese ball 37.60 mEq/kg (dark) followed by biscuits (5.90 mEq/kg, dark; 11.30 mEq/kg, light) and lowest in akara 1.6 mEq/kg. cashew nut oil had nil (Table 3 and 4). From the result, cheese balls oil was observed to be rancid. This significant level of rancidity may be attributed to the refining processes the oil underwent in the course of manufacturing the balls and the effect of light

Acid value

Acid value (AV) is an important indicator of vegetable oil quality. AV is expressed as the amount of KOH (in milligrams) necessary to neutralize free fatty acids contained in 1 g of oil(Firstone,19%).

Palm oil had extraordinarily the highest acid value of 9.82 mgKOH/g (light) and 9.40 mgKOH/g (dark) followed by palm kernel oil 0.62 mgKOH/g (light), 0.56 mgKOH/g (dark) and ground nut oil 0.60 mgKOH/g (light) and 0.58 mgKOH/g (dark)(table 3 and 4). The result were within the Codex standard for named vegetable oils (CODEX-STAN 210-1999) which specifies the acid values of refined oils, cold pressed and virgin oils and virgin palm oils as 0.60 mgKOHg oil and further confirmed the edible oils to be fit for human consumption. The inherent stability of the edible oils to rancidity may be attributed to the presence of carotene, vitamin E and other natural anti-oxidations present in the oils. According to Demian (1990), acid values are used to measure the extent which glyceride in the oil has been decomposed by lipase and other actions such as light and heat. The determination is often used as a general indication of the condition and edibility of oil.

From Table 5 and 6, the extracted oil from akara had the lowest acid value of 1.91 mgKOH/g (dark), 4.83 mgKOH/g(light) while potato" chips had the highest acid value of 14.25 mgKOH/g(light), 6.26 mgKOH/g (dark). These results were higher than the recommended standards and thus indicated that the extracted oils were at different degrees of deterioration/rancidity. The susceptibility of the extracted oils from snack food to rancidity may be attributed to the frying temperatures, non-refined oils have a better stability than refined oils as refining steps remove a percentage of tocopherols which acts as natural anti-oxidants in vegetable oils *(Gertzetal.*, 2000; Applewhite, 1978). .

Table 1: Physical properties of the edible oils

Edible oil	Colour	State (at room temperature)
Palm oil	Red	Semi-solid
Palm Kernel	Yellow red	Liquid
Ground nut	Yellow red	Liquid
Soya	Yellow red	Liquid
Olive	Yellow red	Liquid

Table 2: Oil yield and physical properties of the extracted oils

Snack food	Yield (%)	Colour	State at Room Temperature)
Akara	18.20	Yellow	Liquid
Plantain ships	19.00	Light red	Liquid
Potato chips	3.75	Light red	Liquid
Doughnuts	12.27	Yellow red	Liquid
Biscuits	5.73	Light brown	Solid
Cashew nuts	37.60	Golden yellow	Liquid
Instant noodle	17.84	Yellow	Liquid
Cheese balls	13.64	White	Liquid

Table 3: Chemical analysis of the edible oils placed in the dark for 60 days

Edible oil	Peroxide value (mEq/kg)	Acid value (mgKOH/g)	pH (at 30.2°C	Kinetic Viscosity at 37°C (mm^2/s)	Specific gravity at 37° C
Palm oil	1.40	9.40	4.81	62.01	0.90
Palm kernel	1.00	0.56	5.96	35.60	0.85
Ground nut	2.60	0.58	5.80	45.95	0.90
Soya	3.00	0.21	5.66	37.88	0.85
Olive	1.80	0.28	5.07	46.30	0.85

Table 4: Chemical analysis of the edible oils placed in the open (light) for 60 days

Edible oil	Peroxide value (mEq/kg)	Acid value (mgKOH/g)	pH (at 30.2°C	Kinetic Viscosity at 37°C (mm^2/s)	Specific gravity at 37° C
Palm oil	2.00	9.82	4.61	60.09	0.90
Palm kernel	1.00	0.62	5.30	35.50	0.85
Ground nut	3.50	0.60	5.09	45.95	0.90
Soya	3.30	0.24	4.78	38.67	0.85
Olive	3.30	0.34	4.87	43.20	0.85

Table 5: Chemical analysis of the extracted oils placed in the dark for 60 days

Extracted oil from snack food.	Peroxide value (mEq/kg)	Acid value (mgKOH/g)	pH (at 30.2°C)	Specific gravity at 37° C
Akara	1.60	1.91	5.02	0.95
Plantain	1.80	4.12	4.78	0.90
Potato chips	3.60	6.26	4.86	0.90
Doughnuts	3.60	2.61	5.10	0.95
Biscuits	5.90	6.84	3.62	0.95
Cashew nuts	Nil	2.78	5.69	0.90
Instant noodle	2.10	2.24	5.12	0.95
Cheese balls	17.00	3.76	2.66	0.99

Table 6: Chemical analysis of the extracted oils placed in the open (light) for 60 days

Extracted oil from snack food.	Peroxide value (mEq/kg)	Acid value (mgKOH/g)	pH (at 30.2°C	Specific gravity at 37° C
Akara	1.60	4.83	5.01	0.95
Plantain chips	1.80	13.72	4.84	0.90
Potato chips	3.80	14.25	4.76	0.90
Doughnuts	3.70	3.76	5.27	0.95
Biscuits	11.30	9.51	4.60	0.95
Cashew nuts	Nil	2.81	5.30	0:90
Instant noodle	2.70	2.61	5.41	0.95
Cheese balls	37.60	7.24	3.47	0.99

pH

the pH of the edible oils was observed to be lowest 4.61 (light), 4.81 (dark) in palm oil and highest in palm kernel oil 5.30 (light) and 5.96 (dark). On the whole, there was gradual decrease in the pH of the oils placed outside (light) (Tables 3 ;and 4). This may be attributed to the formation of free fatty acids in the process of oil deterioration which is triggered by thepresence of light" ?3 *? Tables 5 and 6 showed that the pH of the extracted oil was lowest in cheese balls (2.66, dark; 3.47, light) and highest in cashew nuts (5,69, dark; 5.30, light). The pH of the extracted oils was observed to be low because the oils used to process the snack foods passed through stages of refinery, heat and water treatment, destruction of natural anti-oxidants thus making them susceptible to rancidity. The production of fatty acids in the extracted oils due to rancidity made the pH low when compared to the edible oils.

Kinetic Viscosity

The kinetic viscosity of the of the edible oil samples was found to be highest in palm oil 62.01 mmVs(dark), 60.09 mm²/s (light)and lowest in palm kernel oil 35.60 mmVs (dark), 35.50 mm²/s (light) (Tables 3 and 4). There was a slight decrease in the kinetic viscosity of the oil samples placed under light (Table 4) as compared to those placed in the dark (Table 3). This is because as the oils deteriorated, they became viscous and slow to flow.

Specific Gravity

Palm oil and groundnut oil had the highest specific gravity of 0.90 while palm kernel, soya and olive oils had a specific gravity of 0.85 each. There was no change in the specific gravity of the oils kept in dark or light condition during the study (Tables 3 and 4).There was no rancidity of the edible oil samples in the course of the study. Cheese balls oils had the highest specific gravity of 0.90, while the oils from cashew nut, plantain and potato chips had the lowest specific gravity of 0.90 each (Tables 5 and 6).

CONCLUSION

The study showed that the edible oils were less susceptible to deterioration and rancidity compare to the extracted oils from food snacks. This may be attributed to the presence of natural anti-oxidants in the edible oils (which imparted stability to the oils), whereas the oils from snack foods had passed through processing and heat treatment which destroyed their anti-oxidants. On the whole, light increased/improved the rancidity of the oils.

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