EVALUATION OF LEVEL OF RANCIDITY OF EDIBLE OIL IN SOME FRIED SNACKS FOOD

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ABSTRACT

This work evaluated the level of rancidity of edible oil in six (6) fried snacks food, namely, beans cake *(Akara)*, groundnut cake *(Kuli-kuli)*, bread buns, fried fish, fried yam chips and fried potatoes chips, purchased from hawkers in Wukari, Taraba State, Nigeria.. The rancidity indicators and their ranges in the samples obtained, include, Acid Value (4.10 – 6.90 mgKOH/g), Free Fatty Acid (2.05 – 3.45 mgKOH/g), Peroxide Value (12 – 46.60 mEq/kg), Moisture Content (4.00 – 44.30 %), Conductivity (0.14 – 1.58 µS/cm) and Viscosity (26.20 – 56.50 mm^2/S). The results obtained suggested that the fried snacks foods contain hazardous secondary oxidative products, an implication that the oil in the food sample has become rancid and as such, unsafe for human consumption. The reason given for this is that the oil has been used for frying for too many times instead of the recommended two times. The values obtained in this study far exceeded the stipulated standard acceptable ranges given by WHO, FAO and INSO. It is therefore recommended that the public should be advised and educated that oil that has been used for frying twice should be discarded and not used again. Also, Policy makers and relevant authorities should develop a device for in-situ determination for checking of the quality of oil used for fried snacks food in restaurants without going to the laboratory.

Key words: Edible oil, Frying, Rancidity, Snack foods, Toxicity, Restaurants

INTRODUCTION

A snack is usually eaten between meals and generally of smaller size in comparison to main food. The assessment and monitoring of the quality of fat and oil used for preparing foods is of special importance as it affects the taste, odour, texture, and quality of the food. Frying in oils/fats over heat is a very popular method used by many to give a golden brown, tasty and delicious food [1]. Rancidity is the term used to describe the breakdown and deterioration of fats and oils. It involves various chemical reactions and results in unpleasant odours and flavours. Lipid oxidation is one of the major reasons that foods deteriorate and is caused by the reaction of fats and oils with molecular oxygen leading to off-flavours that are generally called rancidity. Exposure to light, pro-oxidants and elevated temperature will accelerate the reaction. Spoilage of fats may occur on storage, particularly if the fats are highly unsaturated, and the conditions of storage are conducive to chemical changes in the fats. Rancidity in fats and oils has a characteristic unpalatable off-flavour and odour in oils, which can be picked up easily by subjective sensory appraisal [2].

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In a study on canola oil stored and characterised for consumer acceptability, a characteristic of rancidity was the detection of a painty odour and taste [3]. This characteristic flavour is generally accepted as detection of rancidity. It is not only the degradation of the unsaturated fatty acids present that contributes to the off-flavours and odours but also some components of the unsaponifiable matter. One of the major uses of oils is for frying of food. There are two types of frying namely, shallow frying (e.g. patties) and deep frying (e.g. potato chips) considered as the combination of frying and cooking [4]. During frying processes chemical and physical changes occur including starch gelatinization, protein denaturation and crust formation. Frying process can also results in the breakdown of some compounds this includes free fatty acids, hydroperoxides, monoacylglycerides, diacylglycerides, cyclic/geometric isomers of unsaturated fatty acids, and of oxidized triacylglyceride monomers, dimers, and oligomers [1,5].

Oxidative changes in unsaturated acryl groups in glycerides and other unsaturated elements occurs as a consequence of overheating (prolong) and / or too much heating (repeated usage above two times) of oils and fats in presence of air which alter the nutritional properties of the fats and oils. These changes (physical and chemical) result in the formation of many oxidized products (hydroperoxides, carboxylic acids), volatile compounds (aldehydes, ketones) and other unfavorable chemical substances [6].

Deep frying is especially of concern because the oil from shallow frying are reused at very high temperatures for longer period which is why high stability oil is preferred for snack foods requiring a long shelf-life [7]. The degradation of the frying oil produces harmful compounds, which are absorbed by the snacks and for this reason the discard point of the frying oil is very important [8-9]. Claims of nutritional implications of the consumption of oxidized fats and oils are varied. The symptoms of rancid fat toxicity are diarrhea, poor growth rate, myopathy (replacement of healthy muscle with scar tissue), hepatomegaly (enlarged liver), steatites or yellow fat disease, hemolytic anemia and secondary deficiencies of vitamins A and E. Evidence exists that dietary oxidation products are involved in arterial injury, artherosclerotic plaque formation and thrombosis/spasm which are potentially dangerous [10]. With the growing concerns for diets and general health, this study was undertaken to investigate the quality of some fried snack foods sold and consumed in Wukari, Taraba State, Nigeria and advise the Residents appropriately based on the findings.

MATERIALS AND METHODS

Materials

All reagents used are of analytical grade.

- ***Sample preparation***

Six different samples (ground nut cake, beans cake, bread buns, fried fish, yam chip and potato chip) were used. The various samples were purchased randomly from hawkers in Wukari Taraba State, Nigeria without further pretreatment. The samples were reduced to sizeable shape and subjected to extraction using soxhlet extractor using n- Hexane as the solvent.

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After the extraction. Concentration of the oil extract was done using rotary evaporator.

Methods

The procedure adopted for the determination of the parameters was according to AOCS official methods [20-21]

- ***Determination of Acid Value***

Acid value is defined as the mg of KOH necessary to neutralize the free acids present in 1gm of fat or oil. Acid value was determined by mixing 50 ml diethyl ether and 50 ml ethanol and 2 ml of 1% phenolphthalein. To the mixture was added 0.1 M KOH for neutralization. Five (5 g) of the sample extracted oil was dissolved in the neutralized solvent mixture. Titration was carried out using 0.1 M KOH as the titrant. The end - point was indicated by a change in colour of the solution to pink colour. Finally, the acid value was calculated based on the sample weight (Equation 1). If the acid value is less than one (1), the oil is safe, and if the value is more than one (1), the oil is unsafe and has become rancid [11].

$$Acid\ Value = \frac{Titre\ value\ x\ 5.61}{Weight\ of\ oil\ used\ \ mgKOH/g} \quad (1)$$

- ***Determination of Peroxide Value***

It is defined as the amount of peroxide oxygen generated per 1 kilogram of fat or oil expressed in milliequivalents or millimoles per kilograms. Peroxides are the intermediate compounds synthesized during autoxidation reaction, the peroxide value is therefore a measure of the degree of oxidation reactions (rancidity) in food samples. Autoxidation is a free radical reaction involving oxygen that leads to deterioration of fats and oils, which is responsible for off-flavour and off-odours.

5 g of the sample extracted oil was added to 30 ml of acetic acid: isooctane (3:2) solution followed by swirling and then addition of 0.5 ml potassium iodide. The solution was swirled again for 1 min. The peroxides oxidized the iodide to iodine, and the iodine was titrated against 0.1 N sodium thiosulfate solution with 1 ml starch (10%) as an indicator. The amount of produced iodine was directly proportional to peroxide value [22]. The peroxide value was calculated with regard to the amount of used thiosulfate (Equation 2). If the value is less than 5mEq/kg, the oil is safe, if the value is between 5‑10, the oil is usable and not preserveable, and if the value is more than 10, the oil is unuseable and rancid.

$$Peroxide\ Value = \frac{2\,(a-b)}{W}\ \text{mEq/kg} \quad (2)$$

Where: a = value of acid with sample, b = value of acid without sample w= weight of oil.

- ***Moisture Content determination***

The moisture content is a measure of the percentage moisture lost due to drying at a temperature of 105ºC. Moisture is necessary for the growth and proliferation of microbes and determines shelf life of snack food products. Ten (10) g of the sample extracted oil was weighed into pre-weighed crucible (W_o) and placed into a

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hot dry oven at 105ºC for 4 hr. At the end, the samples was removed from the oven and placed in desiccator and after getting cool, the samples weighed again to calculate the moisture content in the samples. The process of drying, cooling and weighing was repeated until a constant weight (W_2) is obtained. The weight loss due to moisture was obtained using equation 3:

$$Moisture\ (\%) = 100\ (w_{1\ -}\ w_2\ ) \quad (3)$$

- ***Viscosity Measurement***

The viscosity reveals the rate of flow of the oil. It is an indicator of polymerization after frying. The viscosity of the extracted oil sample was measured using a DV-I Prime viscometer, Spindle number 2 (Brookfield), and constant shear rate = 100 1/s. The viscosity of the oil was carried out at room temperature.

- ***Conductivity Measurement***

Conductivity of oil reveals the electrical properties of the oil. Organic compounds like vegetable oil have low electrical conductivity. The conductivity of the extracted oil sample was measured using a conductivity meter (TSMR 211054 and code: V210002 at 20 µS.

- ***Free Fatty Acid Test***

Free fatty acids (FFA) are the results of fat oxidation. This is a reflection of the amount of specified fatty acids due to triacylglycerol hydrolysis that takes place upon release of water from the food while being fried. The determination of FFA is a simple titration to an endpoint of pH 8.3 with sodium hydroxide, and the results are expressed as % FFA FFA and acid value may be converted from one to the other using a conversion factor. In this study, the FFA of the extracted sample oil was obtained by using equation in which the acid value obtained was divided by two,

$$FFA = \frac{Acid\ Vlue}{2} \quad (4)$$

Where: FFA = Free fatty Acid

RESULTS AND DISCUSSION

The rancidity status of the extracted oil samples analysed is presented in Table 1 using the rancidity parameters *vis a viz* acid value, peroxide value, free fatty acid conductivity, moisture content and viscosity. For ease of description and understanding, the following codes are used respectively for each sample: Groundnut cake (*kuli kuli)* – A, Bean cake (*akara*)- B, Bread buns –C, Fried Fish – D, Fried Yam chips – E , Fried potato chips – F.

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Table 1: Rancidity Parameters of Analyzed Samples and WHO Standards [23].

Parameter	A	B	C	D	E	F	WHO Standard
Acid Value ((mgKOH/g)	6.90	5.61	5.05	5.05	4.66	4.10	0.6
Free fatty acid (mgKOH/g))	3.45	2.81	2.53	2.53	2.33	2.05	0.3
Peroxide value ((mEq/kg)	27.06	12.00	46.60	40.46	13.94	32.20	10.00
Moisture Content (%)	2.00	4.00	2.50	1.00	1.50	5.00	0.2
Viscosity (mm^2/S)	26.20	37.70	56..60	27.70	55.50	33.10	0.05
Conductivity (μS/cm)	1.58	0.56	1.53	0.54	0.54	0.59	-

Discussion

The peroxide value of the oil obtained for the fried snacks food ranged between 12.00-46.61 mEq/kg with a mean value of 28.71 mEq/kg, which is higher than the stipulated standard recommended by WHO and FAO (10 mEq/kg). Similar studies showed that most oil used for fried snacks food have higher peroxide value than the standard limit [4, 12-14]. All the fried snacks depicted peroxide value that is higher than stipulated standard given with groundnut cake having the highest 6.90 and fried potato chips the lowest. Peroxide value gives the initial evidence of rancidity in unsaturated oils and fats. It is also a measure of the extent to which an oil sample has undergone primary oxidation, especially during storage. Freshly refined oils usually have a peroxide value lower than 1 mEq/kg oil, while for peroxide value greater than 10mEq/kg oil, the oil is considered to be oxidized [4]. Quantitative findings showed that most fried snacks food sellers use either the same oil over and over again which leads to the loss of its nutritional value and formation of secondary oxidative products. These secondary oxidative products have health implications and effects which include cancer, heart attack, ageing, oxidative stress and even death. Frying processes in many cases release water / moisture which greatly affect the peroxide value. The presence of moisture water reduces the shelf life of both the oil and the product.

The acid value of the different oil samples from different fried snacks food showed that the degree of deterioration of the oil was very high. The least acid value obtained was 4.10 mgKOH/g and the highest is 6.90 mgKOH/g which when compared to the standard as given by the WHO (≤ 0.6 mgKOH/g) is very high. The United States Department of Agriculture and some European

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Countries have regulatory guidelines on maximum free fatty acid levels in frying oil, ranging from 1.0% to 2.5% [15-16]. Acid value is used as a general indication of the condition and edibility of oil; it also quantifies the acidity of a substance. When oil has low acid value it shows that the nutritional value of the oil is still potent and when used in soap making will give a product that will have high cleansing ability. The results obtained for the acid value in this study showed, that the oil has deteriorated in nutritional value and become rancid. Acid value is a relative measure of rancidity as free fatty acids are normally formed during decomposition of triglycerides. Free fatty acids are produced by the hydrolysis of fats and oil.

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When moisture content ranges from 0.05 to 0.3 in edible oils, it shows that rancidity is likely to occur [17]. The six samples investigated showed high level of moisture content, and high moisture content in a product favours microbial growth and proliferation. Negash et al., [17], reported that fungus species such as *Aspergillus niger* and mucor species survive and reproduce when the moisture content value was higher than 0.2%.

High values were obtained for the viscosity of the extracted oil samples from the fried snacks analyzed in this study. The values range between 26.20 mm^2/S and 56.20 mm^2/S. This suggests a high level of polymerization as a result of high oxidation of the oil [18]. The viscosity of oil is dependent upon its total polar compounds value (TPC) and electrical properties. Oil that is highly viscous affects the health and body system of a person adversely; for instance, causes heart burn and arthritis. Vegetable oil is safer to consume than the saturated fats because of its low cholesterol content compared to the saturated fat [1]. During frying process, some polymerization of the fat may occur, in some case may leads to the formation of foam. Polymerization (thermal or oxidative) can affect the greasiness of fried foods [19].

Vegetable oil is an insulator, which means it does not conduct electricity, as such, it is not expected to have high electrical conductivity. Result obtained from this study suggested that the oil contains electrical charges which indicates that there are foreign bodies present in the oil. When oil conducts electricity or allows the passage of current, it means that the oil contains charge carriers. A charge carrier is any chemical species with a net electric charge. The conductivity of oil is dependent on several factors like water content, other additives and polarity. Vegetable oil or edible oil do not conduct electricity because oil does not contain electrons that will move when energy is applied. Due to the risk accompanied with consuming food products made of oil that contents charge carriers, that INSO, FAO and WHO did not provide any range at which oil conductivity can be accepted because of the change associated with it, this implies that zero electrical conductivity is expected for a good and safe oil for consumption.

CONCLUSION

Most people use oil excessively and this is an agents that bring about rancidity or oil spoilage. This leads to increase in the formation of free

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radicals in the body, which can cause inflammation in the body. This is the root cause of most diseases including obesity, heart disease and diabetes. High inflammation in the body can reduce the body immunity and make an individual susceptible to infections. The results obtained in this study implied that engage in the practice of overheating and or repeated use of the oil continuously, while some just add fresh oil to the old one instead of discarding it. Rancidity parameters values obtained from the study all far exceeded stipulated limit given.

RECOMMENDATION

It is therefore recommended based on these findings that consumers should consider quality of fried snacks food being consumed. Restaurants and individuals should be made aware of monitoring the quality of the oil used in preparing their food. The maximum number of times oil can be reuse for frying should not exceed twice, should be discarded. Policy makers and relevant authorities should develop a device for in-situ determination or checking of the quality of oil used for fried snacks food without necessarily going to laboratory.

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