



ISSN: 0975-833X

Available online at <http://www.journalcra.com>

INTERNATIONAL JOURNAL
OF CURRENT RESEARCH

International Journal of Current Research
Vol. 10, Issue, 12, pp.75893-75896, December, 2018
DOI: <https://doi.org/10.24941/ijcr.33290.12.2018>

RESEARCH ARTICLE

EFFECT OF FRYING ON PHYSICOCHEMICAL PROPERTIES OF GROUND NUT OIL

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ARTICLE INFO

Article History:

Received 04th September, 2018
Received in revised form
29th October, 2018
Accepted 18th November, 2018
Published online 29th December, 2018

Key Words:

Acid value
Peroxide value,
Refractive index,
Relative density.

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Citation: Rasha Khalid Abbas. 2018. "Effect of frying on physicochemical properties of ground nut oil", *International Journal of Current Research*, 10, (12), 75893-75896.

ABSTRACT

Refined groundnut oil was used in the frying of chicken. The physicochemical properties of both raw and fried oils were studied under similar conditions. Chemical tests of the fried groundnut oil showed a rise in the acid value from 3.81% to 4.54% as oleic, the saponification value which decreased after frying from 144.45 to 88.35 mg KOH/100g, due to the broken of the ester bonds by the heat during frying, the iodine value decreased from 7.29 to 4.88 g/100g as a result of thermal oxidation of the unsaturated fatty acids and an increase in the peroxide value from 1.4 meq/kg to 2.6 meq/kg. Physical tests showed changes in the fried oil, an increase the viscosity after frying from 37.95 to 40.91 centipoises. However slight increase in the refractive index and the relative density.

INTRODUCTION

Deep frying food is defined as a process where food is completely submerged in hot oil at temperatures typically between 350 °F (177 °C) and 375 °F (191 °C). (Bittman, 2015). After the food is submerged in oil, the surface of it begins to dehydrate and it undergoes Maillard reactions which break down sugars and proteins, creating the golden brown exterior of the food. Once the surface is dehydrated, it forms a crust which prevents further oil absorption. The heat conducts throughout the food causing proteins to denature, starches to undergo starch gelatinization, and dietary fiber to soften (Study finds eating deep-fried food is associated with an increased risk of prostate cancer, 2015). The process of deep frying food is generally detrimental to its nutritional value, the oils that foods absorb in their batter typically contain large amounts of fats, especially saturated fats and trans fats. Consumption of large amounts of saturated and trans fats has been linked to a higher risk for some cancers including prostate cancer (Nancy, 2015). Eating deep-fried foods has also been linked to higher cholesterol levels (Davis, 2015), obesity, heart attacks, and diabetes (Bruso, 2015). Deep-fried foods cooked at certain temperatures can also contain acrylamide, a carcinogen (Farombi, 2003).

Additionally, fat degradation processes during deep frying results in the loss of nutritional value in deep-fried foods (IARC, 2010). Overheating or over-using the frying oil leads to formation of rancid-tasting products of oxidation, polymerization, and other deleterious, unintended or even toxic compounds such as acrylamide (from starchy foods). Recent research suggests fat deterioration may be worse when fat or oil is fried with food (Granda, 2004). Deep-frying under vacuum helps to significantly reduce acrylamide formation, (Peng, 1991). Some useful tests and indicators of excessive oil deterioration are the following: Sensory – darkening, smoke, foaming, thickening, rancid taste and unpleasant smell when heating. Testing strips – decide when to change oil depending on FFA (free fatty acids) only (Baeuerien, 1968). Oil tester – measurement tool to exactly define the point of change oil by TPM/TPC (Total polar material/compounds) Laboratory – acidity, viscosity, total polar compounds, polymeric triglycerides.

Objective of this work include

- Determined changes in the physicochemical characteristics of the oils that occur during frequent frying process.
- Determined stability indices which reflect suitability of suspected abused oils for human use.

Raw and fried oil; acid value; peroxide value; saponification value; iodine value; viscosity; refractive index and the relative density

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MATERIALS AND METHODS

Experiment

The experiment was executed at Faculty of Agriculture Department of food technology Khartoum University Sudan. Refined groundnut oil was purchased from the local market some are used in the frying experiment of chicken.

Chemical characters of the oil

Acid value

The acid value was determined according to the method described in British Standard Institute Methods (British standards Institute Methods, 1958). Ten gram of oil were dissolved in 50 ml of the solvent and titrated against 0.1N sodium hydroxide with continuous shaking using phenolphthalein as indicator until pink color which persists for 15 seconds was obtained.

The acid value was calculated as follows:

$$\text{Acid value (\% oleic acid)} = 56.1 \times N \times V \div W$$

Where:

V: Volume (ml) of sodium hydroxide
N: Normality of sodium hydroxide
W: Weight of sample (g)

Saponification value

The saponification value was estimated according to method described in the British Standard Institute Methods [11] Two gram of oil were weighed in 200 ml conical flask. Twenty five ml of 0.5N potassium hydroxide were added. The mixture was refluxed in a water bath for one hour with continuous shaking. Excess hot alkali was then titrated against hydrochloric acid. A blank test was carried out using the same procedure without oil.

$$\text{Saponification value} = (v_2 - v_1) \times N \times 56.1 / W$$

Where:

V1: Volume (ml) of hydrochloric acid used in the sample
V2: Volume (ml) of hydrochloric acid used in the blank
W: Weight of sample (g)
N: Normal of hydrochloric acid.

Iodine value

The iodine value was estimated according to pearson (Pearson, 1970), method. One gram of oil was accurately weighed and placed in a dry bottle. Twenty ml of carbon tetrachloride from a dry measuring cylinder was used to dissolve the oil. The content was mixed and exactly 25 ml of wijs solution from a pipette was added. And allowed to stand in dark for 30 minutes. Twenty ml of 0.1N potassium iodide solution was added. The solution was swirled and titrated carefully with 0.1N sodium thiosulphate solution. with continuous shaking. Two ml of starch solution was added and the titration was continued. until the end point was reached when the blue color disappeared:

$$\text{Iodine value} = (B - A) \times 12.69 \times N / W$$

Where:

B: Volume (ml) of 0.1N sodium thiosulphate used in blank
A: Volume (ml) of 0.1N sodium thiosulphate used in blank
W: Weight of oil in (g)

Peroxide value

The peroxide value (PV) of the oil was determined according to wail *et al* [13] method. Five gram of the sample was dissolved in 30 ml of the mix solvent and then shaken to dissolve the sample. Point five ml of saturated potassium iodide was added then shaken for exactly 1 minute. Thirty ml of distilled water was added and 5ml of starch solution (2%) was added and the titration was continued with vigorous shaking until the blue color disappeared. The content was swirled and titrated with 0.1N standard sodium thiosulphate with continuous shaking until a yellow colour was almost discharged. The same operation was carried out under the same condition but without the sample is called the blank.

$$\text{Peroxide value of the sample} = 1000(V_1 - V_2) \times N / W$$

Where;

V1 ; reading of the oil (ml).
V2 ; reading of the blank (ml).
W ; original weight of the sample in (g).
N ; normality of sodium thiosulphate.

Physical characters of the oil

Refractive index

The refractive index of oils was determined by the Abbe 60 Refract meter as described by wail *et al*. (1995) method. After calibration of the instrument, few drops of the oil Were placed between the prisms of the refract meter in such a way that the space between the prisms was completely filled. The oil was then allowed to assume the temperature of the prisms 32=2C. the refractive index was then read.

Relative density

The relative density was determined according to British standard institute Methods (ritish standards Institute Methods, 1958) method. The relative density of the liquid (specific gravity) is the weight of a given volume of the liquid at the specified temperature, compared with the weight of an equal volume of water at the same temperature. All weighing being taken in air.

Viscosity

The viscosity of the oil samples was determined by using Ostwald-U- tube viscometer according to cocks and Van Bade (Cocks, 1966) method. the instrument was filled with the oil under test exactly to the mark at the top of the lower reservoir, by means of a pipette inserted into the sidearm, so that tube wall above the mark was not wetted. The oil was allowed to attain the temperature of the both 23C. By means of suction on the respective arm of the tube. The oil moved into the other arm, so that the meniscus was one cm above the mark at the top of the upper reservoir. The oil was then allowed to flow freely through the tube and the time required for the meniscus

to pass from the mark above the upper reservoir to that at the bottom of the upper reservoir was recorded.

Calculations:

Relative viscosity of the oil = $T - T_0 / T_0$

Where:

T: flow time of the oil (sec)

T₀: flow time of the distilled water (sec).

RESULTS AND DISCUSSION

Several reports of deep fat frying oils have shed light on undesirable constituents produced on repeated use that pose health hazards. Table 1 show the chemical properties of the raw and fried oil, such as, the acid value, of the raw sample was found to be 3.81 and increased in the fried oil to 4.54, this result agree with the previous study found that increase the acid value in fried oil as the result of the development of free fatty acids in oil is usually considered to be one of the main parameters to use in evaluating the quality of oil .especially in the state of storage and heat. Since water is introduced to the system by the fried food then the higher acid value is indicative to a higher hydrolytic tendency of the oil (Sonia, 1983).

Table 1. The chemical properties of the raw and fried oil

Chemical properties	Raw groundnut oil	Fried groundnut oil
Acid value	3.81	4.54
Saponification value	144.45	88.35
Iodine value	7.29	4.88
Peroxide value	1.4	2.6

Table 2. The physical properties of the raw and fried oil

Physical properties	Raw groundnut oil	Fried groundnut oil
Refractive index	1.47	1.55
Relative density	0.91	0.95
Viscosity	37.96	40.92

The increase in acid value in the fried sample is expected in reference to the raw sample as put an increased rate of formation of acid is undesirable (Farombi, 2003). Also showed that in the raw sample had high saponification value compared to the fried one. the saponification value of the raw oil was 144.45 and after frying this greatly decreased to 88.35 mgKOH/100g, the ester bonds may be broken by the heat during frying which results in a low saponification value, this result agree with the previous study found that the saponification value indicate the presence of greater number of ester bonds (Denniston, 2004). The iodine value indicated that the fried oil has low iodine value (4.88 g/100g) than the raw one (7.29g 100g). and this is similar to the study reported that the iodine of cottonseed oil and groundnut oil decreased when the oil is subjected to heat. it is well known that the iodine value decrease progressively with frying globally attributed to the consumption of the double bonds primarily by both oxidation and polymerization reactions the high iodine value denotes high degree of instauration of the oil caused by the extend of oxidation and heat treatment^[18]. The peroxide value of raw groundnut oil was 1.4 and increased to 2.6 meq/100g with frying which is similar to previous study found that, exposure of the oil to light and heat caused significant increase in the peroxide value of oil and fat (Arya, 1969), Although the

peroxides are possibly not directly responsible for the taste and odor of rancid fats. Their concentration as represented by the peroxide value is often useful for assessing the extent to which spoilage has advanced (pearson, 1970). The peroxide value of oil is not always a reliable indication of the degree of oil oxidation. Because the high oxidized oil may have low peroxide value if the peroxides formed have been decomposed l (Arya, 1969).

In Table 2 show the physical properties, there was an increase in the refractive index of the groundnut oil due to its subjection to frying from 1.47 to 1.55 it is one of the most rapid and sensitive method available used for the determination of identity purity and as control for changes in fats and oils during processes and storages. the relative density of raw groundnut oil was 0.91 g/ml and increased with frying to 0.95 g/ml. After frying it was observed that the relative density was slightly increased due to heating, a slight increase in viscosity of groundnut oil with frying from 37.96 to 40.92. Viscosity can be relied on an important parameter in the overall assessment of the quality of edible oil.

Conclusion

This work comes to conclude that repeated frying of oil highly affect the physicochemical properties of the oil and so health. I recommended further studies for it.

Acknowledgment

The authors would like to express their deepest thanks to the laboratories of Food technology and Biochemistry Faculty of Agriculture, Khartoum University, Sudan for their help in analyzing the samples.

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