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COMPARATIVE STUDIES OF THE EFFECTS OF TEMPERATURE DENATURING VEGETABLES OILS DURING FRYING

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ABSTRACT

Vegetable oils are popular cooking medium in many parts of the world. Despite problems related to the intake of excessive calories and health concerns regarding the ingestion of trans-fatty acids, the flavor and texture of fried food continue to be greatly appreciated. The result of the rate of change of the various chemical parameters with increasing temperature of the fried sample were recorded, the refractive index has the highest value of (1.477-1.495 ml/g) in palm oil, soybean oil (1.482- 1.492 ml/g)

Introduction:
Vegetable oils are popular cooking medium in many parts of the world. Despite problems related to the intake of excessive calories and health concerns regarding the ingestion of trans-fatty acids, the flavor and texture of fried food continue to be greatly appreciated. Refractive index and peroxide value are some of a very long list of parameters, physical and chemical properties

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which is found to be moderate, but lowest in peanut oil with the value of (1.463-1.477 ml/g). The acid value in palm oil (2.7377-6.0619ml) which is the highest, then peanut oil (1.2000-3.490ml) and lowest in soybean oil (1.1732-2.8940ml). The peroxide value in palm oil is (4.613-9.0844ml/g) which also showed the highest value, then peanuts oil with the value of (3.7406- 7.4813ml/g) but was found to be lowest in Soybean oil which is (3.1172-5.7000ml/g). The iodine value was highest (12.0178-13.7879ml/g) in soybean oil, then palm oil with values of (10.669-13.6481ml/g) and lowest (10.3409-12.5768ml/g) in peanut oil. The changes in chemical properties of the oils after heating has provided a clue to the deteriorative effects, at high temperature in the oil sample and this shows that soybeans oil have better resistivity to temperature than peanuts oils and palm oils. According to the result obtained, soybeans oil has higher nutritive value even at higher temperature over the palm and peanut oil. Soybeans oil should be encouraged to be used in food processing that requires frying at higher temperature.

Keywords: Effects, Temperature, Denaturing, Vegetables Oils, Frying.

respectively, carried out on oils to verify their quality and degree of rancidity. One of the easiest and time efficient foods is the fries. These are relatively easy and convenient to prepare. Deep frying is the most common cooking method of preparing fried snacks such as potato chips, cassava chips, and fish balls, chicken, among others. Deep frying is mainly done by cooking the food material at about 120°C – by dipping the largest percent of it in fully heated oil. Various food products such as potato chips, chicken patties, are prepared at large scale by this frying process. Fried food is considered to be tastier than non-fried. Being unpropitious area cooking oil used for frying is usually heated repeatedly. Anytime one cook food; it runs the risk of creating heat-induced damage; frying with vegetable oils are among the most susceptible phenomena. The cooking

oils one chooses to cook with must be stable enough to resist the rigors of chemical changes when heated to high temperatures. One of t

The ways cooking oils can inflict damage is by converting our good cholesterol into bad cholesterol—by oxidation (Goswami *et al.*, 2015).

The aroma and taste or flavor present in deep-fried foods makes the food more enticing and appetizing for consumption. Worldwide, the major concern with cooking oil is the level of cholesterol in form of LDL which is associated with cardiovascular disease and blockage of arteries but there are several equally dangerous concerns which are yet to receive the necessary attention. Such concerns include the dangers of prolonged use, reuse of cooking oil. From the point when the cooking oil is introduced the heated frying pan, subsequent physical and chemical changes to the oil are initiated which at higher temperatures lead to other changes. Cooking oil of plant and animal origin or synthetic fat is used in frying, baking, and other types of cooking. It is also used in food preparation and flavoring not involving heat, such as salad dressings and bread dips, also termed edible oil. Cooking oils are liquid, although some oils that contain a high amount of saturated fat, such as coconut oil, palm oil, and palm kernel oil, are solid at room temperature. (Goswami *et al.*, 2015).

Most cooking oils on the market are harvested from plants species that include olive, maize, sunflower and many other species. Different types of cooking oil include olive oil, soybean oil, palm oil, sunflower oil, corn oil, groundnut oil, safflower oil, peanut oil, sesame oil, and other vegetable oils, as well as animal-based oils like butter and lard. Most refined cooking oils on the market are fortified with vitamin A with the main aim of supply where it is deficient; other companies fortify cooking oil with vitamin E. In most African countries like Uganda, Nigeria, Zimbabwe, etc., vegetable oil market is dominated by palm oil, sunflower oil, sesame oil, groundnut oil, etc., largely, due to their affordability. Sunflower oil, though not very expensive, is mainly consumed by the medium (Gorin, 2016).

MATERIALS AND METHODS

Sample collection

The oil samples Palm oil, groundnut oil and soya bean oil were bought at central market Bauchi for analysis, care was taken to avoid air contact during Analysis to prevent oxidation reactions. The parameters analysis was performed using AOAC Method (2010) and Standard method of Oil Analysis by Parker (2003).

Heating Procedure

The three oil samples were heated into three different temperatures separately and the Refractive index, peroxide Value, Acid Value and iodine Value of each sample was measured and recorded, the procedure was carried out are as follows;

About 200ml of Each Oil Sample was measured using measuring cylinder, and transferred to a 250ml Pyrex conical flask, heated using a heating mantle at initial temperature of 60°C for 10 minute and cooled for one hour respectively, 50ml of each oil sample was Removed and the refractive Index, Peroxide value, Acid value, and Iodine Value of each oil was determined.

The procedure was repeated again at 120°C for 10 minute and cooled for one hour respectively, 50ml was removed from each oil sample again and the Refractive Index, Peroxide Value, Acid value, and Iodine Value of all were determined. The same procedures were repeated at Temperature of 180°C and The Refractive Index, Peroxide Value, Acid Value, and iodine value were measured and recorded.

Determination of Refractive index

The refractive index (RI) was determined using Abbe 60 Refractometer as described by the AOAC. Method (2010). A double-prism was opened by

means of the screw head and few drops of oil was placed on the prism. The prism was closed, tightened firmly with the screw-head and allowed to stand for 1 minute after which the determination of RI value was recorded. The refractometer was cleaned between measurements by wiping off the oil with a smooth tissue paper; the prism was regularly cleaned with petroleum ether and then allowed to dry by use of a clean tissue.

Determination of Acid Value

The Test Involves are; (Chemical preparation, sample preparation, titration and calculation).

Chemical preparation

i. Preparation of Phenolphthalein indicator: Phenolphthalein indicator was prepared by dissolving 2g of phenolphthalein indicator powder into 100ml distilled water and mixed with constant shaking.

ii. Preparation of 0.1 normal sodium hydroxide: About 0.1 normal sodium hydroxide solution was prepared by dissolving 4g of sodium hydroxide pallets into 900ml distilled water, heated and cooled. Then distilled was added to make the final volume of 1000ml.

Sample preparation

About 10 .228 gram of the oil sample was taken in glass which have an expected acid value in the range of 1- 4. About 50ml of 99% Ethanol was measured and poured into 150 ml conical flask, 2 drops of phenolphthalein solution was added in to the solution and the solution was neutralized by adding 0.1 normal sodium hydroxide until the solution turn pink, the neutralized solution was added to the sample and shaked to obtain a

homogenous mixture the sample was heated using hot plate for 10 minutes until the sample dissolved completely while heating the flask with constant shaking to facilitate the rapid dissolving of the sample completely Eunice (2015).

Titration

About 0.1g sodium hydroxide (NaOH) was transferred in to a 50ml burette, the initial burette reading was recorded, before starting the titration 2 drops of phenolphthalein indicator was added. Titration was carried out with vigorous agitation of the flask to get accurate result the titration was stopped when the solution turned pink.

Calculation

Calculation was done using the standard formula AOAC (2000)

$$\text{Acid value} = \frac{\text{Mw (NaOH)} \times V \times N}{WS}$$

Where Mw NaOH = Mass of sodium hydroxide

V = volume of the sample consumes

N = normality of the sample

Ws = weight of the sample

Determination of Peroxide Value

The tests involves are: (chemical preparation, sample preparation, titration and calculation)

Chemical preparation

i. Acetic acid chloroform mixture Ratio (3:2): A reagent bottle was labeled acetic acid chloroform, 90ml of acetic acid was poured into

the bottle and 60ml of chloroform was measured and poured into the bottle and the mixture was shaked to obtain homogenous mixture.

ii. 1% starch solution preparation: About 50ml of distilled water was measured and transferred to 100ml beaker and heated until the water boils 0.5gram of starch was transferred into the boiling water the solution was stirred with a glass rod while boiling until the solution becomes clean and transparent the solution was filtered immediately using a filter paper for 30 minutes the filterate was collected and labeled as 1%starch solution.

iii. Preparation 0.01nomal sodium thiosulfate: About 0.25gram of sodium thiosulphate was dissolve in 80ml distilled water and mixed with 0.02gram sodium carbonate with constant shaking, the solution was heated to ensure a completely dissolution of sodium thiosulphate cooled at room temperature, the remaining 20ml of distilled water was added to complete the 100ml.

iv. Saturated potassium iodide: 2ml distilled water was taken in a test tube, potassium iodide was added to the solution until there is sediment of the non-dissolve potassium iodide left at the bottom of the tube. UIRI (2010)

Sample preparation

About 11.228gram of the oil samples were taken in an Erlenmeyer flask 30ml of acetic acid-chloroform mixture was poured into the Erlenmeyer flask containing the sample flask, shakeed to mixe the sample with the chemical mixture. 1ml saturated mixture of potassium iodide was added into the solution and shaked in both clockwise and anti-clockwise direction for 1 minute to make a homogenous mixture, 30ml of distilled water was added and shaked again for 1 minute to mix well. Anwesa *et al;* (2015):

Titration

About 0.01N sodium thiosulphate was poured in a burette the initial burette reading was noted the titration was started after adding 0.5ml of starch solution as an indicator which makes the sample turns black. The titration was carried out with vigorous hesitation of the flask to get accurate result the titration continued until the solution turned white the final burette reading was noted and recorded. Richard (2008).

Calculation

The peroxide value was calculated using

$$Pv = \frac{V \times N \times 1000}{Ws}$$

Where V= volume of sodium thiosulphate consume by the sample

N= normality of the solution

Ws= weight of the sample

Determination of Iodine Value

The test involves are; (chemical preparation, sample preparation, titration and calculation)

Chemical preparation

i. Preparation one (1%) starch solution: about 50ml of distilled water was measured and transferred to 100ml beaker and heated until the water boils. 0.5gram of starch was transferred into the boiling water the solution was stirred with a glass rod while boiling until the solution becomes clean and transparent the solution was filtered immediately using a filter paper for 30 minutes the filterate was collected and labeled as 1%starch solution.

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ii. Preparation of 0.1N sodium thiosulfate: About 2.5gram of sodium thiosulfate crystal was dissolve in 80ml distilled water and 0.02gram sodium carbonate was added, mixed well with constant shaking it was then heated to ensure a completely dissolution of sodium thiosulfate cooled at room temperature the remaining 20ml of distilled water was added to complete the 100ml.

Sample preparation with blank

About 2.7243gram of the oil sample was measured and a sample blank was prepared without taking sample into it. 25ml carbon tetra chloride was added into the sample flask and closed immediately same amount was added into the blank flask and closed immediately. 25ml of Wij's solution was added into the both solution and closed with the stopper the flasks were shaked both clockwise and anti-clockwise direction to mix properly potassium iodide crystal was added around the flasks surface of the stopper then the flasks were kept in the dark for 30 minute, 100ml distilled water was used to washed the surface of both samples.

Titration

Exactly 0.1N sodium thiosulfate was poured in the burette, the initial burette reading was recorded and titrated against the sample, and 1% starch solution was added when the solution color becomes lighter the titration was resume with vigorous hesitation of the flask until the color changes to milky white the final burette reading was recorded. The same procedure was repeated for the blank solution with the initial and final burette reading recorded.

Calculation

The iodine value was calculated using

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$$Pv = \frac{12.69 \times (Vb-Vs) \times N}{Ws}$$

Where Vb = volume of sodium thiosulfate of blank
Vs = volume of sodium thiosulfate of sample
N = normality of sodium thiosulfate
Ws = weight of the sample

RESULTS

Table 1: Showing the Refractive index of oil samples

Temperature in °C Refractive index (AOAC STD)	Peanuts oil 1.44-1.46	Palm oil 1.44-1.47	Soybeans oil 1.47-1.48
Before frying	1.453	1.475	1.472
At 60°C	1.467	1.479	1.485
At 120°C	1.469	1.495	1.489
At 180°C	1.478	1.495	1.492

Table 2: Showing the acid value of the oil samples

Temperatures in °c Acid value (AOAC STD).	Peanuts oil 1.19-1.22	Palm oil 1.99-2.99	Soybeans oil 1.10-1.22
Before frying	1.2000	2.7377	1.1732
At 60°C	1.9560	3.7153	1.3660
At 120°C	2.8550	5.0059	2.0727
At 180°C	3.4990	6.0619	2.8940

Table 3: Showing the peroxide value of the oil samples

Temperatures in °c Peroxide value (AOAC STD).	Peanuts oil 3.33-3.99	Palm oil 3.78-4.80	Soybeans oil 3.11-3.23
Before dying	3.7406	4.6312	3.1172
At 60°C	5.0765	5.6090	3.7406

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At 120°C	5.7891	7.1250	5.0766
At 180 °C	7.4813	9.0844	5.7000

Table 4: Showing the iodine Value of the oils samples

Temperature in °c Iodine value (AOAC STD).	Peanuts oil 10.2-10.4	Palm oil 10.4-10.70	Soybeans oil 12.10-12.19
Before frying	10.3409	10.669	12.0178
At 60°C	11.0874	11.738	12.3904
At 120°C	11.8315	12.5768	13.2289
At 180°C	12.5768	13.6481	13.7879

DISCUSSION

During frying condition and thermal induce molecular orientation, there is an increase in the Chemical properties of the oil. The refractive index of the oil increases with increase in temperature looking at the table 1. Palm oil have the highest refractive index at 180°C ranges from 1.477 to 1.495 an increase of 0.018, groundnut oil increase by 0.015 from minimum temperature than palm oil while soybeans oils have a negligible increase value of 0.010. Which is the minimum refractive value. The refractive index shows a negligible variation in the three oils with the standard even at high temperature of 180°C with palm oil having the highest value of 1.495 followed by soybean oil 1.492 with and peanuts oil having the lowest value 1.478. The standard refractive index in palm oil given by AOAC (2010) 1.44-1.46 tallies with the result before heating and at 60°C but the value deviate from the ranges as the temperature increase to 120°C and 180°C respectively, the same result was observed with peanuts oil but the refractive index increase at 60°C-180°C respectively, while soybeans oil deviate from the standard value at 120°C and 180°C only the variations in

result may be due to the method abducted, sources of the vegetables or chemical constituents of the vegetables oils.

In table 2; The acid value also increases with increase in temperature but soybean oil also proves to show minimum value with increase temperature compare to palm oil and peanut oil which are greatly altered by temperature with palm oil proving to be susceptible to temperature increased. The highest acid value was observe with palm oil with the value 6.0619 followed by peanuts oil with the value of 3.4990 and soybeans oil which has the lowest value of 2.8940, the acid value show greater deviation from the standard temperature with temperature increase and soybeans oil shows minimum effects. Comparisn of the standard acid value described by AOAC (2010) the result of the findings is within the range before heating with the exception of soybeans oil having 1.1732 which is not within the range (1.10-1.22) of the standard value. This may accounts to either the chemical composition of the oil or method used.

Peroxide value is the amount of peroxide oxygen per 1kilogram of fat or oil and is traditionally measured in mille equivalents per kilogram of oil or fat. Heating causes an increase in peroxide value oils that are more unsaturated are oxidized more quickly than the less unsaturated oils. From the peroxide value table there is an increase in the level of hydro peroxide for all the three oils. Palm oil shows maximum increase in the peroxide value with soybean oil having least increment from 3.1172 to 5.7000. The peroxide value also did not align with the standard value and palm oil shows weak thermal resistivity as the peroxide value increase from 4.6312 to 9.0844 followed by peanut oils which increase from 3.7406 to 7.4813 and soybeans oil show greater thermal resistivity which increases from 3.1172 to 5.7000. Therefore the peroxide value is greatly altered with temperature increase which shows a deviation from the standard value. Therefore the results of the findings is within the standard peroxide value

before heating in the three vegetable oils used, with deviation observe at higher temperature of 120°C and 180°C respectively and this changes may be due to the increase in temperature or degradation of some chemical composition of the oils.

During heat treatment a progressive decrease in saturation was observed in all the oils by the measure of the iodine values. This decrease can be attributed to the destruction of double bonds by oxidation, scission and polymerization, there is also an increase in the iodine value of the oils with highest increase observed in soybean oil increasing from 12.0178 to 13.7879 and groundnut oil having the minimum increase due to increase in temperature, palm oil have a mean value of 12.1579 which is the minimum increase the oil was observed throughout the research work. The iodine value of the oils also shows significant increase in all the oils with temperature alteration, compare to the standard value all the three oils were within the standard before heating and the values increase as the temperature also increase palm oil have highest value here increasing from 10.669 to 13.6481 this shows that palm oil is greatly altered by temperature than peanuts oil and soybeans oil.

Conclusion

In conclusion it was observed that, an increase in temperature leads to an increase in the Refractive index, acid value, peroxide value, and iodine value of all the oil samples. But soybean oil showed little effects. Palm oil has the maximum increase with temperature elevation.

Recommendation

The changes in chemical properties of the oils after heating has provided clue to the deteriorative effects causes by high temperature in the oil sample and this shows that soybeans oil has better resistivity to temperature than peanuts oils and palm oils. This makes it more nutritive for frying than palm oil and groundnuts oil.

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