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Impact of frying on iodine value of vegetable oils before and after deep frying in different types of food in Kenya

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Abstract

Vegetable oils are triglycerides extracted from plants. Most of these oils are extracted from seeds or fruits of plants and are classified as edible and non-edible oils. Deep frying is one method which involves submerging the food in hot oil. Five types of food were deep- fried in five types of oil for 6 hrs. The oils were then divided into two portions; one portion was stored at room temperature and the other portion under refrigeration (40 ºC) for 5 days. Frying was repeated using these oils after 5 days for another 6 hours making the total frying time to be 12 hours. Iodine value was determined according to Wijs method. Fresh palm oil had relatively lower iodine value of 45.58 g of iodine/100g of oil while corn and soybean showed higher values of 131.98 g of iodine/100g of oil and 129.44 g of iodine/100g of oil respectively. The main objective of the study was to evaluate the iodine value and storage conditions of selected vegetable oils after deep frying different types of food in Kenya. The study concluded that soybean oil is susceptible to oxidation.

Keywords: Iodine value, Frying, Storage conditions.

INTRODUCTION

Vegetable oils are substances extracted from plants which are obtained from oil containing seeds, fruits, or nuts by different pressing methods, solvent extraction or a combination of these [1]. There are numerous vegetable oils derived from various plants such as soybean, cottonseed, peanuts, sunflower, palm, palm kernel, coconut seed, castor seed and rapeseed oil. These oils can be further classified as edible and non- edible; edible oils are mostly used in cooking. Over the years, vegetable oils have been used in various methods of cooking. They are used in deep-frying, baking food processing etc. Deep frying involves submerging the food in hot, liquid fat at a high temperature of 150^0C-190^0C [2]. It is primarily a dehydration process, which means that water and water-soluble substances are extracted from the product being deep fried and transferred to the cooking fat [3]. In this method of cooking; water, oxygen and heat are the main factors, which determine the kinetics of oxidation and polymerization processes [4]. As deep fat frying is normally carried out at high temperatures (between 150^0C and 190^0C) and in the presence of air and moisture, these frying oils and fats will undergo physical and chemical deterioration which will affect their frying performance and the storage stability of the fried products [5]. During deep-frying, the fat and oil decompose forming volatile, non-volatile, monomeric and polymeric, oxidised or non-oxidised compounds [4]. These products are formed as a result of oxidation of unsaturated fatty acids. The intensity of these reactions depends on duration, method of heat treatment, frying medium and type of product [6].

Foods commonly prepared by deep frying in Kenya include fish, chicken, French fries, mandazi and sausages. After deep frying, many people are tempted to keep the oil to be reused for long periods of time. This causes adverse effects on flavour, stability, colour and texture of fried product and may be harmful to human health [7]. There is convincing evidence that replacing dietary saturated fats with polyunsaturated fats (PUFA) decreases risk of cardiovascular diseases [8]. Therefore, PUFA rich foods such as vegetable oils, fatty fish, and marine omega-3 supplements are recommended. However, PUFA are easily oxidizable when heated and there is concern about possible negative health effects from intake of oxidized lipids. Little is known about the degree of lipid oxidation in such products [9].

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A high consumption of *omega*-6-polyunsaturated fatty acids (PUFAs), which are found in most types of vegetable oil, may increase the likelihood that postmenopausal women will develop breast cancer [10]. A similar effect was observed on prostate cancer in mice [11].

Deterioration in the vegetable oils is reflected by the decrease in iodine value. Iodine value is used to measure unsaturation or the average number of double bonds in fats and oils. It is defined as the number of grams of iodine that could be added to 100 g of oil, which is measured with the AOCS Method cd 1-25. A high, iodine value indicates high unsaturation. The chemical reaction associated with this method of analysis involves formation of the diiodo alkane.

$$R_1\text{-CH=CH-}R_2 + I_2 \longrightarrow R_1\text{-CHI-CHI-}R_2$$

MATERIALS AND METHODS

Sample Collection

Vegetable oils were collected in the supermarkets in Nakuru, Kenya. Food was collected in the local market.

Sample Preparation

Chips: Fresh potatoes were peeled and sliced to a thickness of 2mm using a mechanical slicer.
Fish: Fresh fishes were washed with warm water and sliced into sizeable portions.
Chicken: Chicken were placed in the sink and rinsed off with cold water to clean it. Each piece of chicken was then sprinkled with the seasoning.
Sausages: Sausages were cut into $1^1{}_{/2}$ to 2 inch sections.
Mandazi: Egg, milk, oil and water was mixed up in one bowl (watery stuff). The flour, baking powder and sugar (dry stuff) was also mixed up in a different bowl. All the dry stuff was then poured into a large bowl. A hole was made in the middle and the watery stuff poured slowly. After putting half of the watery stuff, stirring was done. This continued until dough that could be rolled out was obtained. It was left to rest for about 20 minutes. The dough was placed on a flat surface and rolled into a large round shape then cut into pieces ready for frying.

Frying Process

About 5 litres corn, peanut, palm, sunflower and soybean were each heated in a domestic fryer at a temperature of 160-190^{0}C and allowed to equilibrate at this temperature for 10 minutes. About1kg of chicken, chips, mandazi, fish and smokies were each fried intermittently in the heated oils for 20 minutes at intervals of 30min for a period of 6 hours. After 6 hours, about 250ml of the heated oil was drawn for analysis. The remaining was left to cool at different temperature conditions; 2 litres at room temperature and the remaining 2 litres refrigerated at about 4^{0}C.After 5 days, the procedure was repeated using the stored oils but the ratio of food to oil was considered. The oil samples were put is bottles and stored ready for analysis.

Determination of Iodine Value

About 5g of oils was weighed into conical flask and 20 ml of carbon tetrachloride added to dissolve the oil. About 25 ml of Wijs reagent was added to the flask using a measuring cylinder in a fume chamber. It was then stopped and the content of the flask vigorously swirled. The flask was then placed in the dark for 1 h. At the end of this period, 20 ml of 10% aqueous potassium iodide and 100 ml of water was added using a measuring cylinder. Excess iodine was then titrated with 0.1M sodium thiosulphate solution. About 1% starch was used as an indicator. The same procedure was used for the blank test. The Iodine Value (I.V) is given by the expression;

$$\text{Iodine Value (IV)} = \frac{12.69C\,(V_1 - V_2)}{M}$$

Where C = concentration of sodium thiosulphate
V_1 = volume of sodium thiosulphate used for blank
V_2 = volume of sodium thiosulphate used for determination
M = mass of sample
12.69= Constant.

Statistical Analysis

Data obtained was presented in form of a table and chart. All statistical analysis was done using STATA 13. Results of analysis were displayed in form of mean and standard deviations.

RESULTS AND DISCUSSION

Iodine Value

Iodine value is used to measure unsaturation or the average number of double bonds in fats and oils. Decrease in iodine value shows decrease in the number of double bonds and it indicates oxidation of the oil.

Iodine value recommended standards are as follows (g of iodine/100g of oil): Palm 50-55, corn 103-135, soybean 120-143, sunflower 110-143 and peanut 84-105 [12]. After frying different types of food, palm oil was found to have relatively lower iodine value of 45.58 (table 2). The highest I.V observed was in sunflower (120.60), corn (115.29) and soybean (101.45) oils (table 2). In terms of food, smokies and chips recorded relatively higher amounts of Iodine (98.59 and 98.41) respectively. The least value recorded was in food type fishes (91.37). The iodine values of oils before and after frying food were compared and out of this, it was found that there was decrease in I.V in all the oils after frying food. This was in agreement with the finding [13] that there is decreasing trend in iodine value of the oil during deep-fat frying. The decrease in IV with time of frying could be attributed to the changes in fatty acids taking place with duration of frying [14]. The highest decrease in I.V was observed in soybean after frying the five types of food and the values were as follows chicken 27.0, chips 22.0, Fish 35.5, mandazi 38.1 and smokies 17.3. The least decrease was indicated by palm after frying food as follows: chicken 5.1, chips 4.6, fish 7.6, mandazi 2.0 and smokies 6.6). These values were measured in g of iodine/ 100g of oil. A decrease in IV is an indicator of lipid oxidation [15] and is consistent with the decrease in double bonds as oil becomes oxidized [16]. Soybean recorded the highest decrease in IV with respect to all types of food fried.

Iodine values of fresh oils ranged from 50.76-129.9 (table 1). All the oils recorded a decrease in I.V when subjected to different frying and storage conditions (table 3). The highest decrease was observed in the oils used for frying after storage for 5 days at room temperature. The oil samples used frying for 6 hours recorded a small decrease (table 3). Refrigerated oils recorded relatively lower decrease in iodine values (table 3). This was in comparison with fresh oils. Iodine value of the oils decreases versus frying time due to consumption of double bonds by oxidation and polymerization [7]. Palm and peanut oils had relatively lower contents of I.V as compared to soybean, corn and sunflower. The greater the degree of un-saturation (or high I.V), the more rapid the oil tends to be oxidized, particularly during deep-fat frying [16].

Table 1: Iodine values of oils before and after frying food

Type of Oil	Fresh oil	Chicken			Chips			Fish			Smokies					Mandazis				
		6hrs	2ndfrRT	2ndfrR	6hrs	2ndfrRT	2ndfryR	6hr	2ndfrRT	2ndfrR	6hr	SRT 5d	2ndfr RT	R 5d	2ndfr R	6hrs	SRT 5d	2ndfr RT	R 5 d	2ndfr R
Palm	50.8±0.72	48.2±2.45	43.1±2.94	45.7±2.69	48.2±3.18	45.1±3.36	45.1±2.29	45.7±2.20	40.6±2.37	43.14±1.22	48.2±1.63	43.1±0.82	40.6±1.63	45.7±1.22	43.1±1.39	50.8±1.47	50.8±1.80	48.2±1.22	48.2±0.82	45.7±1.78
Corn	132.0±0.40	124.4±1.50	109.1±1.80	121.8±2.04	124.5±3.51	114.2±4.41	116.7±4.65	116.7±4.16	98.9±3.92	104.1±3.43	122.9±3.27	116.7±2.94	114.2±2.78	121.8±2.69	116.7±1.22	124.4±2.61	116.7±3.18	86.3±3.27	122.9±3.26	121.8±3.02
Peanut	104.1±3.32	99.0±2.69	96.4±3.18	99.0±2.44	101.5±1.80	93.9±2.20	99.0±2.37	98.9±2.45	86.3±2.61	96.4±2.78	101.5±1.88	96.4±1.91	86.3±1.87	98.3±2.04	96.4±1.39	96.4±2.45	88.8±1.22	83.8±1.63	93.9±1.88	88.8±1.91
Soy-bean	129.4±1.00	121.8±3.02	98.9±1.22	86.3±1.63	116.7±2.94	104.1±1.88	101.5±2.04	111.7±2.29	78.7±1.39	91.4±2.20	126.9±1.91	114.2±1.39	99.0±2.86	116.7±1.47	104.1±1.88	96.4±2.12	91.4±1.91	86.3±2.94	93.9±2.04	88.8±1.47
Sunflo-wer	126.9±1.67	124.4±1.91	119.3±2.12	121.8±3.18	124.4±2.78	119.3±2.86	121.8±2.45	121.8±1.47	116.7±2.86	119.2±1.91	124.4±3.02	121.8±1.63	119.3±1.22	124.4±1.80	121.8±1.46	121.8±2.20	116.7±1.91	114.2±1.88	119.2±2.69	116.1±2.86

6hrs: Used for frying for 6hrs
SRT 5 days: Stored at 25^{0}C for 5days
2nd fr RT Used for frying after 5days of storage at room temp (Total frying time: 12hr)
R 5 d: Stored at 4^{0}C for 5days
2nd fr R: Used for frying after 5days of storage at 4^{0}C (Total frying time: 12hr)

Table 2: Mean Iodine values of oils after deep frying food (g of iodine/100g of oil)

	Food fried for a total of 12 hours in the five types of oil					
Type of oil	**Chicken**	**Chips**	**Fish**	**Mandazi**	**Smokies**	**Mean**
Corn	118.44±8.1	118.49±5.4	106.60±9.2	114.43±15.9	118.47±3.7	115.29
Palm	45.68±2.5	46.17±1.8	43.15±2.5	48.73±2.1	44.16±2.9	45.58
Peanut	98.14±1.5	98.14±3.8	93.91±8.9	90.35±4.9	95.80±5.7	95.27
Soybean	102.37±18.0	107.44±8.2	93.90±16.6	91.37±4.0	112.18±10.8	101.45
Sunflower	121.82±2.5	121.82±2.5	119.29±2.5	117.76±2.9	122.33±2.1	120.60
Mean	97.29	98.41	91.37	92.53	98.59	95.64

Table 3: Mean Iodine values of oils based on storage conditions (g of iodine/100g of oil)

Type of oil						
Storage	**Corn**	**Palm**	**Peanut**	**Soybean**	**Sunflower**	**Mean**
Fresh oil	131.98±0.4023	50.76±0.7207	104.06±3.3244	129.44±1.001	126.90±1.6734	108.63
6 hrs	122.58±3.3244	48.22±1.7946	99.49±2.1234	114.72±11.6858	123.35±1.3901	101.67
Refri 5days	122.36±0.5380	46.95±1.2680	96.10±2.1930	105.33±11.4210	121.82±2.5380	98.51
SRT 5days	116.71±0.0308	46.95±3.0870	92.63±3.0850	102.79±11.4210	119.29±2.5380	92.87
2nd fry ref	116.24±6.5004	44.56±1.1720	95.9364±5.3893	94.4136±7.0700	120.30±2.0304	94.29
2nd fry ord	100.56±10.6958	43.5±2.8924	89.33±4.9213	93.40±9.4171	117.77±2.0268	88.91
Mean	118.40	46.01	96.26	102.92	120.81	97.48

CONCLUSION

Iodine value is of major interest in regard to oxidative stability of oils after deep frying food. From this study, it was established that soybean oil recorded a large decrease in iodine value based on the food fried and storage conditions. This shows relatively higher oxidation in soybean oil. Palm and peanut oils proved to be relatively stable since they recorded small decrease in iodine values. In terms of storage conditions, it was observed that storage conditions had significant effects on the oil. This finding demonstrates that there is need to refrigerate oils after use. This is because oils refrigerated were more stable than the ones stored at room temperature.

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