# Physicochemical Changes of Repeatedly Used Oils for Food Frying Collected From Some Restaurants in Sudan

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## Abstract

This research was conducted to study the effect of repeated use of frying oil on physicochemical properties of cottonseed oil and sunflower oil as common edible oils used for food frying in Sudan (check pea (tammiya) , potato chips and fish ) . Samples were collected randomly from different restaurants in Khartoum State for three days in the morning and evening, then the following tests were carried out (viscosity, refractive index, colour, smoking point, free fatty acid, polymer content, peroxide value and iodine value) All physical properties (viscosity, smoking point, and colour) of the collected cottonseed and sunflower oils used for frying check pea, potato chips and fish during the morning were significantly different from those collected samples of the same products during evening from the same restaurants. Also it was noticed that all chemical properties which were carried out (iodine value, polymer content, peroxide value and free fatty acids) of the collected cottonseed oil and sunflower oils used for frying check pea, potato chips and fish during the morning were significantly different from those collected samples of the same products during evening from the same restaurants located in Khartoum State. It was concluded that all the collected samples of the used oils were deteriorated and should be discarded.

## Introduction

Frying is one of the oldest and most popular cooking methods in existence. Deep-fat frying is a method to produce fried food where an edible

fat heated above the boiling point of water serves as the heat transfer medium, fat also migrates into the food providing nutrients and flavour (Fan *et al.*, 2005; Shakak *et. al.*, 2015 ) These conditions lead to high heat transfer rates, rapid cooking, browning, texture, and flavour development. Therefore, deep-fat frying is often selected as a method for creating unique flavours, colours, and textures in processed foods . However, surface darkening and many adverse reactions take place during deep-fat frying because of high temperature. Due to the pressure lowering, the boiling points both of the fat and moisture in the foods are lowered. Depending upon temperature and the duration of the deep-frying process, the heating of fats and oils will change the composition of the medium and eventually lead to the degradation of the fat. On the other hand fat degradation is not reversible, the processing must aim at obtaining and maintaining optimal conditions for the production of tasty food for as long time as possible. Frying process has many problems due to, various reactions such as oxidation, polymerization and hydrolysis occur in the cooking oil (Fritsch, 1981 and Shakak *et. al., 2015*). As these reactions proceed the functional sensory and nutritional quality of the fat changes and may eventually reach a point where it is no longer possible to prepare high quality fried products and the frying fat will have to be discarded.

Health effects from toxic substances and some polymers (carcinogens) formation. Consumers have concept that the fried food in restaurants pose a potential hazard to human health and nutrition, as result of repeating use of oil in frying. In The Sudan there are many claims about fried foods such as check pea (tammiya), fish and potato chips, which are popular foods in Sudanese restaurants. The frying cost and scarcity of good vegetable oil raised the doubt about the type and quality of continuous use of frying oil for such fried foods. The objective of this study is to determine the physicochemical changes of such repeatedly used oils.

## 1. Materials

Both refined bleached and deodorized cottonseed oil and sunflower seed oil were used in frying, potato chips, check pea and fish these samples were collected randomly from local restaurants in Khartoum, Sudan. .

Three samples of 100volume of repeatedly used frying oils were collected two times a day (morning and evening) after frying potato chips, check pea and fish from three different local restaurants in Khartoum. The collected samples were kept in refrigerator and checked for physicochemical properties.

## 2. Methods

Refractive index (RI), peroxide value (PV), free fatty acids (FFA), iodine value (IV) smoking point and colour were determined according to the AOAC method (2010). The viscosity of oil samples was determined by using Oswald — u- Tube, viscometer No 7647 (A.O.C.S, 2010) and polymer content was determined according to Peled *et al.*, (1975)

## Results and Discussion

### 1. Changes in physical properties of repeatedly used cotton seed oil for frying (check pea and potato chips) in the restaurants during morning and evening time.

Table 1 shows that the collected samples of the repeatedly used cottonseed oil in frying in the morning check pea and potato chips were significantly different ($P < 0.05$ ) in viscosity from those repeatedly used oils for frying during evening time. The results after frying check pea was 73.4 and after frying chips was 71.3 cp which were higher than ( Kabashi 2000 ) , (Ping Tan 2010 ) and Mohammed and Hassan (2013 ) who obtained 29.7 to 32.1 , 50.0 and 28.0 cp respectively .The refractive index for the collected samples of the used cottonseed oil in frying check pea and chips

were significantly different in used oil ,it was 1.4950 after frying check pea and after frying chips was 1.4780. They were no significant difference when compared to Shakak *et. al*.,( 2015) and Kabashi (2000 ) which were 1.459 and 1.4680 to 1.4700 , respectively . Changes in smoking points for the collected samples of the used cottonseed oil in frying check pea and chips were significantly decreased in smoking point ($P < 0.05$ ) , the results were changed in frying check pea from 217 in the morning to 190 ◌̊C in the evening, in frying chips changed from 216 in the morning to 191◌̊C in the evening . Changes in colour for collected sample of used cottonseed oil after frying check pea red was 5.33 and yellow was 23 , in frying chips red was 1.4 and yellow was 22 .The colour increased significantly ($P<0.05$) in redness and yellow during evening in case of check pea frying which were higher than (Mohammed ,2013) , (Kabashi, 2000) and ( Hamed *et.al*, 2010) in which they recorded 25.33, 35.00 and 1.80 respectively. Yellow colour 70.66, 35.00 and 10.00 respectively.

**Table 1: Changes in physical properties of the repeatedly used cottonseed oil for frying of check pea and potato chips in restaurants during morning and evening time.**

| Sample | Viscosity(cp) | | Refractive index | | Smoking point(C $^0$) | | Colour | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | R | | Y | |
| | Frying | | | | | | | | | |
| | In the morning | In the evening | In the morning | In the evening | In the morning | In the evening | In the morning | In the evening | In the morning | In the evening |
| Check pea | 65.63$^c$ ±1.06 | 73.43$^a$ ±1.05 | 1.474$^d$ ±0.0 | 1.479$^a$ ±0.0 | 217.00$^a$ ±1.00 | 191.30$^b$ ±1.53 | 1.400$^b$ ±0.10 | 5.33$^a$ ±0.31 | 29.67$^a$ ±1.53 | 23.00$^b$ ±2.65 |
| Potato chips | 67.07$^a$ ±1.00 | 71.00$^b$ ±1.00 | 1.475$^c$ ±0.0 | 1.478$^b$ ±0.0 | 216.00$^a$ ±1.00 | 191.00$^b$ ±1.00 | 1.40$^b$ ±0.10 | 1.367$^b$ ±0.06 | 28.67$^a$ ±1.53 | 22.00$^b$ ±2.65 |
| **Lsd$_{0.05}$** | 1.936* | | 0.0005954* | | 2.174* | | 0.3206* | | 4.068* | |

Values are mean±SD.

Any two mean value(s) sharing same superscript(s) are not significantly different (P >0.05)

Where:

* = Significantly different

n . s = no Significantly

**4.2 Changes in physical properties of the repeatedly used sunflower oil for frying (fish) in restaurants during morning and evening time.**

Table2 shows that the collected samples of the used sunflower oil after frying fish in the morning compared to evening were significantly different ($P < 0.05$) in viscosity . The viscosity changed from 56.77during the morning to 62.50 cp in the evening, these results were high when compared to Jar alnabi (2001), Ping Tan (2010) and Mohammed and Hassan (2013) who found 4.68, 50.00 and 28.19 ,respectively . Changes in refractive index for collected samples of used sunflower oil after frying fish were insignificantly different between samples collected during morning 1.4866 and those collected during evening time 1.4874 also no difference was noticed when compared to Shakak *et. al.* (2015) and Jar alnabi (2001) which were 1.459 and 1.4724 respectively. Smoking point for collected samples of used sunflower oil after frying fish was highly significantly decreased from 224°C in the morning to 195 °C in the evening. The colour of the used oil was increased significantly after fish frying during morning where red colour recorded 2.13 and 7.00 during evening time. While yellow colour of used oil recorded 31.73 during morning and 29.00 during evening There were high significant difference in redness reading while it was insignificant difference in yellow colour during both morning and evening, these results were high than Hamed *et al.*, (2010) and Jar alnabi (2001) which were 10.00 and 25.00 in yellow and 1.08 and5.70 in red colour, respectively .

**Table 2: Changes in physical properties of the repeatedly used sunflower oil for frying of fish in restaurants during morning and evening time.**

| Sample | Viscosity(cp) | | Refractive index | | Smoking point(C $^0$) | | Colour | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | R | | Y | |
| | Frying | | | | | | | | | |
| | In the morning | In the evening | In the morning | In the evening | In the morning | In the evening | In the morning | In the evening | In the morning | In the evening |
| Fish | 56.77 ±1.00 | 62.50 ±1.21 | 1.4866 ±0.001 | 1.48743 ±0.001 | 224.00 ±1.00 | 196.00 ±1.00 | 2.13 ±0.15 | 7.43 ±0.38 | 31.73 ±2.83 | 29.00 ±1.00 |
| P-value | 0.042$^{*}$ | | 0.4661$^{n.s}$ | | 0.0017$^{**}$ | | 0.0019$^{**}$ | | 0.2518$^{n.s}$ | |

Values are mean±SD.

**4.3 Changes in chemical properties of repeatedly used cottonseed oil for frying (check pea and potato chips) obtained from restaurants during morning and evening time.**

Table .3 shows that the collected samples of the used cottonseed oil used in frying potato chips and check pea obtained from different restaurants. The free fatty acids as oleic was significantly increased in frying check pea, in the morning was 0.24% and in the evening was 0.73% ,but in case of frying chips in the morning was 0.17 and in the evening was 0.15% . These results were less than those reported by Mohammed (2013) and Kabashi (2000) which were 0.29% and from 0.22% to 0.37% respectively. Changes in free fatty acids as palmatic of cottonseed oil repeatedly used in frying potato chips and check pea were significantly increased during frying process. Also high changes in polymer content (PC) were noticed for collected samples of used cottonseed oil after frying of check pea and chips during morning and evening which were significantly increased. Check pea frying oil changed from 0.73 in the morning to 6.7 % in the evening, while for potato chips frying oil changed from 0.82 in the morning to 5.3% in the evening, these results were similar to Shakak *et. al.,* (2015), Kabashi (2000) and Hamed *et al.,* (2010) which were 1% to 4% , 0.02 to 3.5% and 2.02 % , respectively . Changes in peroxide value (PV) for collected samples of used cottonseed oil were significantly increased of used oil in frying process of check pea and chips. Kabashi, (2000) was noted that the rate of formation of peroxides was faster in used cottonseed oil compared with other vegetable oils. The results were increased in frying process of check pea from 7 in the morning to 10 in the evening and in frying of chips was 9 in the morning to 11 in the evening, these results were same when compared to Serjouie, (2010) , Kabashi, (2000) and Shakak *et. al.,* (2015), who found that the (PV ) after frying of chips was 8 mgO\kg, 8.9 to 21.8 mgO\kg and 12 mgO\kg

respectively. The PV of oil reflects the quality of the food ingredient that fried with such oil. Changes in iodine value (I V) for collected samples of used cottonseed oil used in frying check pea and chips were significantly decreased by frying process, in frying check pea the results changed from119 in the morning to 108 in the evening ,and after frying chips changed from 121 in the morning to 110 in the evening These results were similar as Kabashi (2000) and Shakak *et. al.*, (2015), which were 102.0 to 109.0 and 63 respectively. Decrease in IV of oil by frying was reported by Khattaab *et al.*, (1974 ) in groundnut ,cotton seed and sesame oil.

**Table 3: Changes in chemical properties of the repeatedly used cottonseed oil for frying of tammiya and potato chips in restaurants during morning and evening time. .**

| Sample | F.F.A (%) | | | | Iodine value (mg/kg) | | Peroxide value (m OEq/kg) | | Polymer content (%) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | as oleic % | | as palmatic % | | | | | | | |
| | Frying | | | | | | | | | |
| | In the morning | In the evening | In the morning | In the evening | In the morning | In the evening | In the morning | In the evening | In the morning | In the evening |
| **Check pea** | $0.24^{b}$ ±0.01 | $0.74^{a}$ ±0.01 | $0.23^{d}$ ±0.01 | $0.68^{c}$ ±0.01 | $119.00^{b}$ ±1.00 | $108.00^{d}$ ±1.00 | $7.00^{c}$ ±1.00 | $10.00^{ab}$ ±1.00 | $0.71^{c}$ ±0.05 | $6.50^{a}$ ±0.20 |
| **Chips** | $0.17^{c}$ ±0.01 | $0.15^{d}$ ±0.01 | $1.14^{a}$ ±0.01 | $1.04^{b}$ ±0.01 | $121.60^{a}$ ±0.95 | $110.00^{c}$ ±1.00 | $9.00^{b}$ ±1.00 | $11.00^{a}$ ±1.00 | $0.83^{c}$ ±0.02 | $4.23^{b}$ ±0.12 |
| **$Lsd_{0.05}$** | $0.0005954^{*}$ | | $0.0005954^{*}$ | | $1.86^{**}$ | | $1.883^{*}$ | | $0.2228^{*}$ | |

Values are mean±SD.

Any two mean value(s) sharing same superscript(s) are not differ significantly (P≤0.05).

**4.4 Changes in chemical properties of the repeatedly used sunflower oil after frying fish in the restaurants during morning and evening time.**

Table .4 shows that the collected samples of the used sunflower oil for frying fish were significantly increased ($P < 0.05$) in free fatty acids as oleic changed from 0.45 in the morning to 1.26% in the evening .These results were high compared to those obtained by Jar alnabi, (2001), Mohammed (2013) and Kabashi (2000) which were 0.92 ,0.2997 and 0.22 to0.37 % , respectively. Changes in free fatty acids as palmatic for collected samples of used sunflower oil in frying fish changed from 0.36 in the morning to 1.15 % in the evening .The free fatty acids as palmatic significantly increased. Changes in polymer content for collected samples of used sunflower oil for frying fish were significantly increased with high percentage of polymers, results were changed from 0.74 in the morning to 4.45 in the evening and no difference was found when compared to Jar alnabi (2001) and Hamed *et al.*, (2010) who found 3 to 4 % and 2.02 , respectively. Changes in peroxide value for collected samples of used sunflower oil used for frying fish were insignificantly increased during frying process of fish. The results were changed from 8 in the morning to 12 in the evening ,there is big difference in results compared to Serjouie (2010) and Jar alnabi (2001) who reported 8.00 mg\kg and 1.60 ,respectively. Changes in iodine value for the collected samples of the used sunflower oil for frying fish was significantly decreased. The results were changed from 116.5 in the morning to 113.0 in the evening , which were high compared to Jar alnabi (2001) who was reported 106 to 101.0 .Decrease in IV of oil by frying process was reported by ( Khattaab *et al.*,1974 ) for groundnut, cotton seed and sesame oils.

**Table 4: Changes in chemical properties of the repeatedly used sunflower oil for frying of fish collected from some restaurants during morning and evening time.**

| Sample | F.F.A | | | | Iodine value (mg/kg) | | Peroxide value (m OEq/kg) | | Polymer content (%) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | as oleic % | | as palmatic % | | | | | | | |
| | Frying | | | | | | | | | |
| | In the morning | In the evening | In the morning | In the evening | In the morning | In the evening | In the morning | In the evening | In the morning | In the evening |
| Fish | 0.45 ±0.01 | 1.26 ±0.01 | 0.36 ±0.015 | 1.15 ±0.01 | 116.50 ±1.10 | 113.00 ±1.00 | 8.00 ±1.00 | 12.00 ±1.00 | 0.74 ±0.01 | 4.45 ±0.13 |
| P-value | $0.0002^{**}$ | | $0.0002^{**}$ | | $0.102^{n.s}$ | | $0.0572^{n.s}$ | | $0.0004^{**}$ | |

Values are mean±SD.

Any two mean value(s) sharing same superscript(s) are not differ significantly (P≤0.05)

### 5.1 Conclusions

- The use of edible oil for frying purpose affects their physicochemical attributes through increase in viscosity, colour, free fatty acids, peroxide value (PV) polymer content (PC) and decrease in smoking point and iodine value (IV) .
- Edible oils differ in their thermal susceptibilities to frying process.
- Potato product induced less change in physicochemical properties of oil than check pea and fish.
- The oils collected from different restaurants were deteriorated.

### 2.5 Recommendations

1. Sudan is considered potentially rich source of different types of oil seed crops, more wise polices are needed to secure the production and lowering cost .
2. The used fried oil in restaurants should be renewed instead of continuous cycling of the same deteriorated oil.

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