

## **EFFECT OF THERMAL PROCESSING AND TYPES OF FOODS ON STABILITY OF COTTONSEED OIL PROPERTIES AND FORMATION OF TRANS COMPONENTS DURING DEEP FRYING**

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### **ABSTRACT**

This investigation was carried out to study the effect of heat treatment at 170°C and 200°C at different times (0, 15, 45 and 90 min.) and different types of fried foods (fish, Taamia and Potatoes) on stability of some properties of cottonseed oil before and after thermal processing and identification of cis and trans ethylenic double bonds. The results indicated the following points:-

1. Refractive index increased in oil used for frying fish than both Potatoes and Taamia at 170°C for 90 min., while at 200°C for 90 min. it was higher in fried Potatoes oil than Taamia and fish samples frying oil.
2. Acidity and acid value of deep fried fish oil increased at 170°C for 90 min. than both frying oil of Taamia and Potatoes samples. But at 200°C for 90 min. data revealed that increase of frying oil of Taamia than both Potatoes and Fish samples oil frying.
3. Decreasing iodine value for Fish frying oil than both frying oil of Potatoes and Taamia at 170°C for 90 min. While, data indicated that increase of iodine number at 200°C for 90 min. for Taamia than fish deep frying oil, contrast iodine value decrease at 200°C for 90 min. for Potatoes deep frying oil, due to natural chemical composition.
4. Increased in peroxide value in frying oil of Taamia and Potatoes samples, while peroxide value decreased in oil deep frying of fish samples at 170°C for 90 min. On the other hand data revealed increased in peroxide value in deep frying oil of Taamia than of frying oil of Potatoes and Fish samples at 200°C for 90 min.
5. The red and yellow color increased at 170°C for 90 min. for deep frying oil of Taamia than Potatoes frying oil, while data revealed that darkening of color for oil frying of fish samples. At 200°C for 90 min. red and yellow color was 4.75 and 35 respectively for fried oil of Potatoes, but darkening color for both Fish and Taamia and difficult determination.
6. Using IR and UV instruments showed that trans ethylenic double bonds (carcinogenic) formed at 200°C for 90 min. but disappeared at 170°C at 90 min. for all fried oil samples. The amount of trans-ethylenic double bonds was higher in fried fish, Taamia and Potatoes respectively. The results indicated that successive frying of oil cause formation of carcinogenic and harmful substances to human health for all kinds of foods, especially fish samples, Taamia and Potatoes respectively, for 90 min. at 200°C compared with control samples. The most effect for producing such substances had been due to heat degree and frying periods.

### **INTRODUCTION**

During use of deep-frying temperatures, frying oil are very prone to oxidative and thermal degradation with the formation of volatile and non volatile decomposition products some of which in excessive amounts may be

harmful to human health. Chang *et al.*, (1978) found that up to 26 percent of polymeric triglycerides could be formed under deep-fat frying conditions at 185°C for 74 hours.

Cottonseed oil are now used widely for deep frying because of the association between heart disease and saturated fats, it contain certain fatty acid components which are essential nutrients (FAO, 1978).

Aurand, *et al.*, (1987) indicated that oxidation is the most important cause of fat spoilage because all edible fats, as such or as components of foods, contain unsaturated triglycerides. Oxidative deterioration of fat results in the destruction of vitamins (A, D, E, K, and C), destruction of essential fatty acids, and the development of a pungent and offensive off-flavor.

Pearson, (1976) indicated that refractive index at 40°C was 1.458 - 1.466, Acid value mg KOH/g max was 0.6 and peroxide value m Eq/Kg max was 10 as recommended codex standards for edible cottonseed oil.

Egan *et al.* (1981) indicated that the double bonds in most fatty acids of natural vegetable oils and fats are in Cis configuration and are isolated, i.e. they are not conjugated with other double bonds. During partial hydrogenation or oxidation the configuration may change to the trans form.

Aurand *et al.*, (1987) said that temperature has a marked effect on the rate of autoxidation. At ordinary temperatures, the effect of increasing temperature on the rate of autoxidation is slightly greater than for most chemical reactions because increasing temperatures accelerates both the chain propagation reactions and peroxide decompositions. Peroxides are the first compounds formed when fat or oil oxidizes.

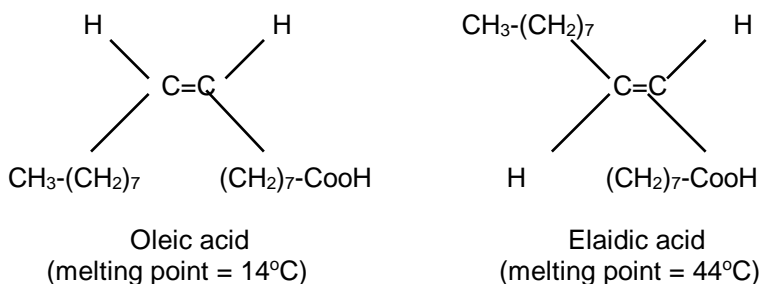
Generally, heat and oxidative deterioration of fat or oil results in destruction of vitamins (A, D, E, K, and C), destruction of essential fatty acids, and the development of a pungent and offensive of-flavor. Also, the hydroperoxide products (isomeric conjugate cis, trans-hydroperoxides) are unstable and undergo decomposition to form short-chain acids, alcohols, aldehydes and ketones. The formation and accumulation of non-volatile decomposition products are responsible for some physical and chemical changes such as increase in color and viscosity and increases in free fatty acids and decreases in unsaturation (Pamela, 1991).

Owon (1999) indicated that after frying process (2 hr) for potato and steaks, increase in oil properties such as refractive index from 1.4720 to 1.4856, peroxide value from 6.5 to 17.10 meq/Kg oil and acid value from 2.2 to 14.90 gm KOH/g while iodine value was decrease from 210.0 to 193.80 in the popular oils (cottonseed and sunflower oil) 1:1, v/v mixture refined oils, before and after deep frying respectively.

Habib *et al.*, (1986) studied the physical and chemical characteristics of cottonseed oil and show that refractive index was 1.4641, iodine value 108.3 and acid value was 0.74.

Potter (1986) indicated that fatty acids, like other organic compounds, exhibit isomerism. Fatty acids isomers have the same numbers of carbon, hydrogen and oxygen atoms but in different geometrical arrangements, which result in different chemical and physical properties. In this case, hydrogen atoms or other groups attached to the carbon of the double bond can be on the same side of the double bond (Cis isomer) or on opposite sides of the

double bond (trans isomer). Thus oleic acid (Cis form) can be converted to elaidic acid (trans form):-



The present study was designed to clear the effect of heat processing at different times, and type of frying foods on cottonseed oil stability and identification Cis and Trans ethylenic double bonds in deep frying oil. It worth that users want frying fat or oil with maximum stability, but also with low melting points to minimize greasiness in the mouth.

## MATERIALS AND METHODS

### Materials:-

1. Pure cottonseed oil 12 L. (Zamzam) production of Tanta oil and Soap Co., purchased from local of Mansoura City, was used for frying.
2. 15 Kg of fresh fish (*Oreochromis niloticus*) are washed, gutted and then skinned, cut to fish steak and breaded stuffs, convey to oil frying for several times (0,15,45 and 90 min.) at 170°C and 200 ± 5 °C (8 -6 min for each batch).
3. Potatoes (15 Kg) are washed, skin removal, manually and then sliced into sticks using Brawn kitchen machine and kept submerged in salin solution to reduce the browning enzymatic reactions by oxidation, then convey to oil frying for several time (0, 15, 45, and 90 min.) at 170°C and 200 ± 5 °C (5 - 3 min for each batch).
4. Oil fried bean's cake (Taamia) consist of: 15 Kg Broad bean (*Vicia faba* L.) seeds were washed with tap water and then soaking for 12 hr at room temperature, mincing the soaked seeds with some green vegetables (garlic, onion, Egyptian leek, celery, salt and spices), dividing the paste into disc shape round and then fried in hot cottonseed oil for (0, 15, 45 and 90 min.) at 170°C and 200 ± 5 °C respectively until appearing of brown color (6 - 4 min for each batch) (as described by Abd El-Hady *et al.*, 1996). All materials above were obtained from the local market of Mansoura City, Egypt.

### Methods:-

#### Heating treatment:

Cottonseed oil heated without any addition, the steak of fish, Taamia and Potatoes for, 0, 15, 45 and 90 min. at 170°C and 200 ± 5 °C respectively.

**Deep-frying:-**

Cottonseed oil heated and Taamia, Fish and Potatoes as sticks were placed into heated oil until suitable color for each samples. Temperatures were 170°C and 200 ± 5 °C before frying which decrease during adding of food samples. After deep frying time, all samples of cottonseed oil were filtrated through thin cloth to remove the residue of fried particles after that oil samples kept at 4°C until analysis.

Refractive index at 40°C, Iodine value, peroxide value (as milliequivalent/ Kg oil), Acid value and Acidity (FFA) (as oleic acid percent) were determined as described in AOAC (1990).

The color of cottonseed oil was measured using Lovibond Tintometer (Model E, Engeland) using one inch according to AOCS (1981).

**Infrared spectroscopy:-**

Infrared spectra of frying oil were recorded by MATTSON 5000 FTIR Spectrometer in the Faculty of Science, Mansoura University, Spectral Analysis Unit. All samples were desolved in pure-dry carbon tetrachloride and few drops were placed between sodium chloride pellets technique. A light pressure was applied to obtain a thin film and the spectrum was recorded over the range 4000-200 Cm<sup>-1</sup>. This method was described by Farag *et al.* (1977).

**UV:-**

UV spectra of frying oil in C<sub>2</sub>H<sub>5</sub>OH were carried out using Unicam UV2-100 UV/Visible spectrometer V 3.32 in spectra Analysis Unit above too, for identification of saturated and unsaturated double bonds of deep frying oil samples.

## RESULTS AND DISCUSSION

**Effect of heat treatment:-**

For frying oil at 170°C for 15, 45 and 90 min. without any type of foods as control. IR spectra (Figs. 2, 3 and 4) revealed that there is no any trans ethylenic double bonds compared with control fresh oil as shown by IR spectra in Fig. 1 and UV (Fig. 1a) for unsaturated cis-ethylenic double bonds ( $\Pi \rightarrow \Pi^*$ ). While IR spectra in Figs. 5, 6 and 7 frying oil at 200°C for 15, 45 and 90 min. showed that trans ethylenic double bonds appeared at 200°C for 90 min. only at 974 Cm<sup>-1</sup> such absorption bands agreed with (Bellamy, 1975). It is worthy to state that trans-ethylenic double bonds lies at 975 Cm<sup>-1</sup> according to (Bellamy, 1975). While, Rabie, and Hassan (1996) indicated that bands at 970 Cm<sup>-1</sup> corresponding to trans ethylenic double bond in frying palm oil. Also, Szonyi *et al.* (1962) indicated that the concentration of isolated-trans fatty acid isomers may be determined by measurement of the infra-red absorption at about 10<sup>-3</sup> nm (970 Cm<sup>-1</sup>) due to deformation of the C-H bonds adjacent to the isolated-trans double bond in triglycerides.

**Effect of frying:-**

Table (1) show effect of heat processing on stability of cottonseed oil during potato frying, data indicated that during deep frying of Potatoes at 170°C for 15, 45 and 90 min., slight increase in refractive index, acidity, acid value, peroxide value, red and yellow color was noticed, while iodine value decreased

Data of the same table show to an increase in refractive index, acidity, acid value, peroxide value, red and yellow color at 200°C for 15, 45 and 90 min., more than 170°C at the same time. Also, data shows decrease in iodine value at 200°C for 15, 45 and 90 min. than at 170°C for the same time where, the higher the iodine value the greater the degree of unsaturation in the oil. This variation may be due to the effect of heat processing on the chemical composition of oil. These results were similar to that obtained by Perkins, (1967) who found during deep frying and under conditions (high temperature, moisture and atmospheric oxygen) oxidation, polymerization and degradation occur. Also, our data are in agreement with that obtained by Pamela, (1991) and Owon (1999).

**Table 1: Effect of heat processing at different periods, on stability of cottonseed oil during potato frying.**

Properties of deep frying for	Heat processing and time with minutes						
	at 170°C				at 200°C		
Cottonseed oil	Control	15 min.	45 min.	90 min.	15 min.	45 min.	90 min.
Refractive index (40°C)	1.4648	1.4648	1.4650	1.4654	1.4646	1.4650	1.4655
Acidity	0.11	0.06	0.06	0.19	0.17	0.13	0.20
Acid value	0.22	0.12	0.11	0.37	0.33	0.26	0.41
Iodine value	92.92	62.00	91.00	78.00	92.80	91.00	78.80
Peroxidee value	0.37	8.42	8.76	5.57	6.14	7.96	5.65
<b>Color Iovibond:</b>							
Red	1.20	1.80	2.30	3.30	2.30	2.30	4.70
Blue	-	-	-	-	-	-	-
Yellow	20.00	25.00	25.00	30.00	21.00	25.00	35.00

(-) Not-present.

The spectra IR (Fig. 8) showed that the mentioned samples gave absorption bands at wave numbers 722 - 790, 1105 - 1163, 1458, 1745, 2857, 2926 and 3007  $\text{Cm}^{-1}$  for Cis-ethylenic double bond, C-O ester, -COO, C = O (ester, Keton and aldehyde), C-H (aldehyde), O-H (COOH) and C-H (aromatic ring) respectively for processing at 170°C for 90 min. Such absorption bands agreed with obtained by Bellamy (1975) of any edible oil. UV absorption spectra those were similar, indicating related structures of frying oil as shown in Fig. (8a) where (nm 235, 248, 277 and 293)  $\Pi \rightarrow \Pi^*$  for conjugated double bond, ( $>\text{C} = \text{C}<$ ,  $>\text{C} = \text{N}$ ,  $>\text{C} = \text{O}$  as unsaturated double bond.

While, the spectra IR (Fig. 9) showed that the above samples gave absorption bands at wave numbers 721, 977, 1164, 1457, 1745, 3005 and 3473  $\text{Cm}^{-1}$  for Cis-ethylenic double bond, trans-ethylenic double bonds, C-O ester, -COO, C = O ester, C-H aromatic ring and -OH hydrogen bond respectively, at 200°C for 90 min. It is worthy to state that Cis-ethylenic

double bonds give rise to a strong band at 748 - 690  $\text{Cm}^{-1}$  and trans-ethylenic double bonds lies at 970  $\text{Cm}^{-1}$  (Bellamy, 1975). Our-data are in agreement with those obtained by Rabie and Hassan (1996) and Szonyi *et al.*, (1962). UV absorption spectra show similar structures of deep frying oil at 200°C for 90 min. as shown in Fig. (9a) where  $\text{nm } 236, 247, 288 \text{ } \Pi \rightarrow \Pi^*$  but (nm 375, 400)  $n \rightarrow \Pi^*$  for uncharged pair electron, ( $>\text{C} = \ddot{\text{O}}$  or  $>\text{CH}\ddot{\text{O}}$ ,  $>\text{C} = \ddot{\text{O}}\text{R}$ ) or function group.

Results in Table (2) show the effect of heat processing at 170°C and 200°C for 15, 45 and 90 min. for fish samples, where the refractive index increase from 1.4646 to 1.4682, 1.4644 to 1.4649 at 170°C for 15 and 90 min., and 200°C for 15 to 90 min. respectively. This may be due to the effect of heat processing, chemical composition of fish and polymer of components of frying oil. Also, data in Table (2) revealed that the increase in acidity at 170°C for different times were higher than at 200°C for the same times, this may be due to the increase of fish fat during frying by increasing the heat processing and its effect on the chemical components and condition of deep frying as moisture, heat, atmospheric oxygen according to Perkins, (1967). These results were in agreement with data obtained by Chang *et al.*, (1978), Pamela, (1991) and Owon (1999). Also, acid value took the same trend at 170°C and 200°C for 15, 45 and 90 min., where the term acid value refers to a measure of free fatty acids present in oil as a result of heat effect on oil stability.

**Table 2:Effect of heat processing at different periods on the stability of cottonseed oil during fish frying.**

Properties of deep frying for	Heat processing and time with minutes						
	at 170°C				at 200°C		
cottonseed oil	Control	15 min.	45 min.	90 min.	15 min.	45 min.	90 min.
Refractive index (40°C)	1.4648	1.4646	1.4654	1.4682	1.4644	1.4646	1.4649
Acidity	0.110	0.140	1.300	8.130	0.178	0.140	0.128
Acid value	0.22	0.27	2.26	16.18	0.350	0.250	0.255
Iodine value	92.92	75.50	78.90	61.81	110.20	112.10	113.50
Peroxidee value	0.37	6.18	5.66	0.47	1.52	5.20	5.68
<b>Color lovibond:</b>							
Red	1.20	2.50	16.00	=*	=	=	=
Blue	-	-	4.00	=	=	=	=
Yellow	20.00	30.00	60.00	=	=	=	=

\* (=) Darkening  
 (-) Not-present.

Also, data in Table (2) show that peroxidee value and color increased with increasing heat from 170°C to 200°C for 15, 45 and 90 min. while iodine value decreased with increased heat treatment from 170°C at 15, 45 and 90 min., but at 200°C iodine value slightly increased by prolonged time. This may be due to the effect of heat treatment at the first time at 170°C, but with increase heat treatment to 200°C, fat of fish appear with the increase heat treatment and effect on the chemical components of frying oil. It worth that users want frying fats with maximum stability, but also with low melting points to minimize greasiness in the mouth.

The spectra IR (Fig. 10) showed that the mentioned samples gave absorption bands at wave numbers 722, 1163, 1370, 1456, 1745, 2857, 3005

and 3473  $\text{Cm}^{-1}$  for Cis-ethylenic double bond, C-O ester, C-H deformation, -COO, C=O (ester, Keton, aldehyde), C-H aromatic ring and -OH hydrogen bond respectively according to the results obtained by (Bellamy, 1975) and Rabie and Hassan (1996). Also, UV absorption spectra were similar indicating related structures of frying oil of fish samples as shown in (Fig. 10a) where nm 225, 269 and 280)  $\Pi \rightarrow \Pi^x$  for conjugated double bonds or unsaturated double bonds. While, fish samples frying at 200°C for 90 min. IR spectra in (Fig. 11) showed that absorption bands at wave numbers 724, 971, 1163, 1370, 1456, 1744, 2859 and 2931  $\text{Cm}^{-1}$  for Cis-ethylenic double bond, trans-ethylenic double bond, C-H deformation, -COO, C=O ester, C-H aldehyde and O-H (COOH) respectively according to results obtained by Bellamy (1975) and Rabie and Hassan (1996). Also, UV (Univisible region) absorption spectra indicating related above function group as shown in (Fig. 11a) where (nm 225, 238, 268, 408 and 426) as  $\Pi \rightarrow \Pi^x$  (225 to 268),  $n \rightarrow \Pi^x$  (408 to 426), as unsaturated double bond and function group respectively. Also, UV (Visible region) absorption spectra as shown in (Fig. 11b) where (nm 550, 651, 705, 766, 797, 829, 524 and 434)  $n \rightarrow \Pi^x$  for uncharged pair electron.

As illustrated in Table (3) the effect of heat treatment at 170°C and 200°C for 15, 45 and 90 min., during Taamia frying, data show slight increase in refractive index, acidity, acid value, peroxide value are among the oxidation products formed, these commonly include such compounds as aldehydes, Ketones and short fatty acids (Potter, 1986), and color at 170°C and 200°C for the same time during frying Taamia. While, iodine value decrease at 170°C for 15, 45 and 90 min., but data show increase in iodine value at 200°C for 15, 45 and 90 min., with Taamia frying from 109.40, 110.20 and 114.60 respectively. This may be due to the effect of chemical components of Taamia and additive components which used as antioxidant of mixture during deep frying, and protect oil and late oil oxidation. These results were in agreement with that obtained by Aurand *et al.*, (1987), Pamela, (1991) and Owon (1999) for effect of heat treatment on oil stability during frying.

**Table 3:Effect of heat processing at different periods on the stability of cottonseed oil during Taamia frying.**

Properties of deep frying for	Heat processing and time with minutes						
	at 170°C				at 200°C		
cottonseed oil	Control	15 min.	45 min.	90 min.	15 min.	45 min.	90 min.
Refractive index (40°C)	1.4648	1.4652	1.4652	1.4652	1.4644	1.4652	1.4652
Acidity	0.11	0.31	0.28	0.42	0.163	0.290	0.327
Acid value	0.22	0.63	0.56	0.79	0.325	0.590	0.650
Iodine value	92.92	79.00	79.42	78.50	109.40	110.20	114.60
Peroxidee value (m.Eq/Kg)	0.37	12.87	13.25	12.00	6.72	7.30	6.48
<b>Color lovibond:</b>							
Red	1.20	4.60	5.30	11.00	=*	=	=
Blue	-**	-	-	-	-	-	-
Yellow	20.00	35.00	30.00	60.00	=	=	=

\*(-) Darkening

\*\*(-) Not-present.

























The spectra (Fig. 12) showed that the mentioned samples at 170°C for 90 min. gave similar absorption bands at wave numbers, 721, 1163, 1450, 1745, 2858 and 3005  $\text{Cm}^{-1}$  for Cis-ethylenic double bond, C-O ester, -COO, C=O ester, C-H (aldehyde) and C-H (aromatic ring) respectively according to obtained results by Bellamy, (1975) and Rabie and Hassan (1996).

Also, UV absorption spectra were similar, indicating related structures of deep frying oil of the above mentioned samples as shown in (Fig. 12a) where nm 225, 247, 272, 286 ( $\Pi \rightarrow \Pi^*$ ) unsaturated double bond, while, 383 ( $n \rightarrow \Pi^*$ ) for uncharged pair electrons or function group. Also, Fig. (12b) where nm 478 in visible region for uncharged pair electrons.

On the other hand, frying at 200°C for 90 min. the spectra (Fig. 13) showed that absorption bands at wave numbers, 721, 976, 1163, 1367, 1453, 1744 and 3003  $\text{Cm}^{-1}$  for Cis-ethylenic double bonds, trans - ethylenic double bonds, C-O ester, C-H deformation, -COO, C=O (ester, Keton, aldehyde) and C-H aromatic ring these results are in agreement with those obtained by Bellamy, (1975) and Rabie and Hassan (1996).

Also, UV absorption spectra were similar, indicating related structures of frying oil of the above mentioned samples as shown in (Fig. 13a) where nm 226, 270 and 284 unvisible region indicated  $\Pi \rightarrow \Pi^*$  or unsaturated double bond, while spectra visible region nm 428, 766, 472 and 450 indicated that ( $n \rightarrow \Pi^*$ ) uncharged pair electron or function group, as shown in (Fig. 13b).

It can be concluded that using the oil at 200°C for 45 min, the oil chemical properties and fatty acids quality remain with high quality and had not been effected with such heating degree and period. Also, it can be concluded that there was slight effect on the chemical properties and fatty acids quality according to the kind of fried different raw materials. The most effect had been due to heat degree and frying periods for trans formation.

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### تأثير المعاملات الحرارية ونوع المادة الغذائية على ثبات خواص زيت بذرة القطن وتكوين مكونات الترانس أثناء عملية التحمير (المقلي)

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أجرى هذا البحث لدراسة تأثير المعاملات الحرارية على درجات حرارة 170 °م، 200 °م لمدة 15، 45 و 90 دقيقة على ثبات بعض خواص زيت بذرة القطن والتعرف على مركبات الترانس الضارة باستخدام أنواع مختلفة من الأغذية الشائعة الإستعمال في التحمير مثل البطاطس والأسماك والطعمية وتم إستخدام جهاز UV, IR للتعرف على مركبات في وضع الترانس الضارة وأشارت النتائج إلى الآتي:-  
1. يزداد معامل الإنكسار للزيت المقلي لعينة السمك عن باقي العينات خاصة عند 170 °م لمدة 90 دقيقة يليها زيت البطاطس ثم زيت الطعمية 0 بينما عند التحمير على درجة 200 °م لمدة 90 دقيقة كان معامل الإنكسار أعلى في زيت البطاطس ثم الطعمية يليه زيت السمك 0  
2. تزداد حموضة الزيت المقلي لعينة السمك عن باقي العينات عند 170 °م لمدة 90 دقيقة يليها زيت الطعمية ثم زيت البطاطس ولكن عند 200 °م لمدة 90 دقيقة زادت حموضة زيت الطعمية يليها البطاطس ثم زيت عينة السمك وكذلك بالنسبة لرقم الحموضة 0

3. إنخفض الرقم اليودي لزيت عينة السمك عن زيت البطاطس والطعمية عند 170<sup>5</sup>م لمدة 90 دقيقة، بينما إزداد الرقم اليودي لزيت عينة الطعمية ثم زيت عينة السمك، بينما إنخفض الرقم اليودي لزيت عينة البطاطس عند 200<sup>5</sup>م لمدة 90 دقيقة وهذا يرجع إلى طبيعة التركيب الكيماوى لهما
4. إزداد رقم البيروكسيد لزيت عينة الطعمية والبطاطس بينما إنخفض رقم البيروكسيد لزيت عينة السمك عند 170<sup>5</sup>م لمدة 90 دقيقة، بينما زاد رقم البيروكسيد فى عينة الطعمية عن كل من زيت عينة البطاطس والسمك عند التسخين لدرجة 200<sup>5</sup>م لمدة 90 دقيقة
5. زادت درجة اللون الأحمر والأصفر لزيت عينة الطعمية عند 170<sup>5</sup>م لمدة 90 دقيقة يليها زيت عينة البطاطس، بينما لزيت عينة السمك كانت درجة اللون قاتمة جدا 0 بينما عند درجة 200<sup>5</sup>م لمدة 90 دقيقة كانت درجة اللون الأحمر والأصفر لزيت عينة البطاطس (4,75ر، 35 على التوالى ولكن زيت عينة السمك وزيت عينة الطعمية درجة اللون فى كلاهما معتمة وقاتمة جدا مما يصعب قياسها
6. باستخدام جهاز IR (الأشعة الحمراء) وكذلك جهاز UV (الأشعة فوق البنفسجية) ظهرت الأحماض الدهنية فى الوضع ترانس عند التسخين لزيت كل العينات على 200<sup>5</sup>م لمدة 90 دقيقة وكانت نسبتها أعلى فى زيت عينة السمك عن الطعمية والبطاطس على التوالى وهنا ممكن الخطورة على صحة المستهلك فى تواجد هذه الأحماض الدهنية فى الوضع الترانس ضمن مكونات العينات وأثرها فى مسببات الأمراض السرطانية<sup>0</sup> ولذا ينصح باستخدام زيت التحمير لأى عينات فيما لايزيد عن 90 دقيقة على 170<sup>5</sup>م أو أكثر قليلا، بينما لاينصح باستخدام زيت التحمير لأى عينات غذائية على 200<sup>5</sup>م لمدة 90 دقيقة ليكون فى حدود الأمان حيث أن التأثير يرجع إلى درجة الحرارة ووقت التحمير لتكوين مركبات الترانس الضارة<sup>0</sup>