J. Food and Dairy Sci., Mansoura Univ., Vol. 2 (12): 667 - 681, 2011

EFFECT OF_PACKAGING AND STORAGE PERIOD ON SOME PHYSICAL, CHEMICAL CHARACTERISTICS ,FATTY ACID COMPOSITION ,STABILITY AND KEEPING QUALITY OF SUNFLOWER OIL .

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ABSTRACT

This investigation was carried out to study effect of packaging and storage period on the specific gravity at 25°C (Sp. Gr) , refractive index(R.I.),color intensity; acid value, peroxide value(P .V), thiobarbituric acid (TBA) ,iodine value (IV) ,fatty acid composition , and keeping quality of Sunflower oil . The obtained results revealed that the storage of sunflower oil at ambient temperature for nine months did not seem to have any appreciable effect on the specific gravity, while the refractive index was decreased gradually .In contrast the color intensity increased as the storage period increased. The rate of change(either increase or decrease) was depended on the storage period as well as type of container. The obtained results showed that the acid value, peroxide value and TBA increased gradually in all oil samples during storage. The highest increase in acid value was recorded in the colorless glass containers while the lowest increase was observed in plastic and brown glass containers. Also, the results showed that the I.V. decreased gradually in all oil samples. The extent of decrease was affected by storage period and type of container. The results revealed that the saponification value (S.V.) increased gradually in all oil samples as storage period increased. The highest increase in S.V. was recorded in oil samples stored in colorless glass containers,. In contrast, the lowest increase in the S.V. due to prolonged storage was observed in oil samples stored in brown glass containers . The unsaponifiable matter percentage decreased gradually in all oil samples during storage. The results obtained reveald that the values of fatty acids $C_{18:2}$, $C_{18:3}$, TPUFA, TUFA and ratio of TUFA: TSFA, $C_{18:2}$: $C_{18:1}$ as well as iodine value were decreased with increasing the storage period., while the values of fatty acids $C_{18:2}$, $C_{18:3}$, TPUFA, TUFA and ratio of TUFA: TSFA, $C_{18:2}$: $C_{18:1}$ as well as iodine value were decreased with increasing the storage period. The rate of change in the values of fatty acids was depended on the storage period and types container. The oil samples packed in colorless glass containers showed the highest value of changes in comparison with other oil samples packed in plastic and brown glass containers. It could be mention that the decrease in $C_{18:2}$ and $C_{18:3}$ was accompanied by the decreased in the I.V.

INTRODUCTION

In Egypt, there is a big gap (or great shortage) between the production and consumption of vegetable oils, where more than 90% of consumed quantities is imported from outside. In Egypt, cottonseed oil, soybean oil and sunflower oil are considered as the major sources of vegetable oils. Hence, they are used for several purposes, i.e. salad, cooking and frying oils. Sunflower is one of the important oilseeds cultivated on a large scale in the world. It is one of two or three most important oily crops in Egypt. Sunflower is considered the fourth major source of vegetable oil in the world beside it provides protein of good nutritional quality. Therefore it is a potential protein supplement for human diet. Sunflower oil is a high quality oil for cooking and salad oil uses. The oil is unusually good for frying foods, popping corn and for other culinary processes where a liquid oil with a high smoke point is desired. In addition, sunflower oil with higher levels of linoleic acid, i.e. highly polyunsaturated, is desired for the soft margarine and coating industries (Egan, *et al*., 1981 and Honda, *et al*., 2005). Vegetable oils such as sunflower oil which are relatively high in linoleic acid are susceptible for auto-oxidation. Extend the shelf-life and improving the quality of sunflower oil are of particular interest since this oil is one of the most healthy and widely consumed in the world. On the other hand, the increasing of the shelf-life of any food commodity and maintaining its quality at a high level are the main purposes for any procedure, in order to extent the product availability for consumption. Oils and fats are considered sensitive to deterioration during their packaging and handling. The acceptability of a fat or oil depends partly on the extent that deterioration has occurred. Common quality deteriorations that may occur to oils and fats are oxidation, hydrolysis, cross contamination between grades of products and contamination with foreign substances. Polyunsaturated fatty acids are most susceptible to oxidation and promote the formation of volatile compounds in the oil. These changes create economic loss in food industry. In addition, volatile compounds that are produced have been associated with increased risk of cancer and other degenerative diseases (Draper & Brid, 1984; Hemeda, 1994 and Abdul-Magied, 1994).This study was carried out to study the effect of packaging and storage period on some physical and chemical characteristics, fatty acid composition, stability and keeping quality of sunflower seed oil.

MATERIALS AND METHODS

Materials:

Oil samples:

Fresh refined, bleached and deodorized sunflower oil without any addition, used in this study was obtained from Oil Tec. Company El-Saddat city, Monufia Governorate. The oil produced as per intl. standards codex 210/1999 and license from Allseeds Trade Ltd. (The trade name for this type of oil is "Wasfa").

Containers:

Different types of containers were used in packing the sunflower oil, namely: plastic cans (250 gram capacity), colorless and brown glass containers (250 gram capacity).

Storage conditions of oil samples:

The oil samples were packed in the above mentioned containers exposed to diffused light at ambient temperature (30±2°C) for nine months. Three samples of each type of containers were taken every month for analysis. The physical properties and the chemical characteristics of sunflower oil presented in different containers were examined without delay. The results reported herein were the average of three containers.

Analytical methods:

Physical properties :

Specific gravity (Sp. Gr.):

The Sp. Gr. of oil samples was determined at 25/25°C according to the **AOCS official methods Cc10a-25 (1998).**

Refractive index (R.I):

The refractive index was measured according to the method cited in the AOCS Official Methods Cc-B-92 (1998).A refractometer NYRL-3- Poland was used and the results were standardized at 25°C.

Color:

The color of oil samples was measured by the color Wesson methods using Lovibond glasses and calibrated (Lovibond and Tintometer model F. Tintometer LTD., Wiles, England) According to Cocks and VanRede (1966) and AOCS Official Methods Cc-B-92 (1998).

Chemical characteristics:

Acid value (A.V.):

The acidity of the investigated samples was examined according to the method described in the AOCS Official Method Cd3a-63 (1998) and was calculated in terms of acid value as mg.KOH per g. of oil sample.

Peroxide value (P.V.):

P.V was tested according to the AOCS Official Methods Cd 8-53 (1998). The P.V. was reported as milliequivalents of peroxide per kg oil sample.

Iodine value (I.V.):

The iodine value was determined by the Hanus method as described in the AOCS Official Method Cd1-25 (1998).

Saponification value (S.V.):

The saponification value was investigated as outlined in the AOCS Official Method Cd 3-25 (1998). It was calculated as milligram of KOH required to saponify one gram of oil.

Thiobarbituric acid value (TBA):

The TBA value was determined in the oil samples as outlined in the AOCS Official Method Cd 19-90 (1998). The TBA value calculated as mg malonaldehyde/kg oil sample (Girgis, 1999).

Fatty acids compositions:

Preparation of fatty acid methyl esters:

Fatty acids of standard and samples were converted to methyl ester using etheral solution of diazomethane according to Vogel (1975) samples were dissolved in 0.5 ml of anhydrous diethyl either and methylated by drop wise addition of diazomethane solution until the yellow color. The mixture was left at ambient temperature for 15 min, the solvent was evaporated in a water bath and then mainained at 60°C. The methyl esters of fatty acids, were dissolved in pure chloroform and an aliquots of this solution were subjected to Gas Liquid Chromatography (GLC) analysis.

Identification of fatty acids:

The methyl esters of the fatty acids and standard samples were analyzed by using a GLC Rye-unicam Pro-GLC. The gas liquid chromatography equipped with a dual flam ionization detected (F.I.D.). The

nitrogen (N2), hydrogen (H2) and air flow rates were 30, 33 and 330 ml/min., respectively. The chart speed was 0.4 cm/min. The used column was Sp-2300-fatty acids which has dimensions 1.5 m x 4 mm packed with diatomate C (100-120 mesh) and coated with 10% polyethylene glycol adipate (PEGA). The operation was carried out by programming, the initial temperature 70°C, rate temperature 8°C/min., the final temperature 190°C, the final time 35 min., the injectior temperature 250°C and the detector temperature 300°C.
The presented fatty acids were identified according to an authentic sample of fatty acids chromatographed under the same conditions. Finally, fatty acids peaks were performed by comparing the relative retention time of each peak with those of standard samples.

Unsaponifable matters analysis:

Separation of the unsaponifiable matters:

The unsaponifiable matters were separated from the vegetable oil samples under investigation after saponification according to the method outlined in the AOCS (1998).

RESULTS AND DISCUSSION

Effect of storage conditions on some physical properties:

The obtained results in Table (1) showed the changes that took place in the specific gravity (Sp. Gr.) of the sunflower seed oil stored at ambient temperature for nine months in various containers. The Sp. Gr. of the oil was 0.9173 at zero time. This value became 0.9172,0.9170 and 0.9171 at the end period of storage in plastic, colorless and brown glass containers, respectively. The results presented in Table (1)also, revealed that storage of sunflower oil at ambient temperature for nine months did not seem to have valuable effect on the Sp. Gr. of the investigated oil samples. These results are in general accordance with Hashem (1969) who confirmed that the Sp. Gr. was not affected during storage either in dark or in light. In addition, Eskander (1974) and Mehany (2007) mentioned that the Sp. Gr. for sunflower and cottonseed oils packed in different containers had revealed slight changes during storage at ambient temperature.

Table (1): Effect of storage period at ambient temperature and container types on specific gravity* (Sp. Gr.) of sunflower seed oil.

Storage period (months)	Type of containers		
	Plastic	Glass	
		Colorless	Brown
Zero (control)	0.9173	0.9173	0.9173
1	0.9174	0.9172	0.9173
2	0.9172	0.9175	0.9174
3	0.9172	0.9175	0.9172
4	0.9173	0.9174	0.9172
5	0.9174	0.9173	0.9171
6	0.9175	0.9173	0.9173
7	0.9173	0.9172	0.9172
8	0.9170	0.9171	0.9172
9	0.9172	0.9170	0.9171

*** Specific gravity at 25/25°C.**

Concerning the refractive index (R.I.) of the stored oil samples storage period ,it could be noticed from data obtained in Table (2) that the refractive index of the investigated oil samples was decreased gradually as the storage period increased. The rate of decrease was depended on the storage period as well as the type of container. The decrease in the R.I. during storage could be explained on the basis of the double bonds saturation of the fatty acids during the production of hydroperoxides and intermediate compounds. These results are in coincide with those reported by Swern (1979); Gunstone and Norris (1983), Hui (1996); Mehanni (2006); Mehany (2007) and Iskander, *et al*. (2010).

Table (2): Effect of storage period at ambient temperature and container types on refractive index (R.I.) of sunflower seed oil.

Storage period (months)	Type of containers		
	Plastic	Glass	
		Colorless	Brown
Zero (control)	1.4735	1.4735	1.4735
1	1.4735	1.4735	1.4735
2	1.4734	1.4733	1.4733
3	1.4734	1.4734	1.4733
4	1.4733	1.4734	1.4733
5	1.4731	1.4732	1.4731
6	1.4732	1.4732	1.4732
7	1.4731	1.4730	1.4731
8	1.4730	1.4730	1.4731
9	1.4730	1.4739	1.4730

Refractive index at 25°C. *

On the basis of the color intensity change of the studied oil samples during storage at ambient temperature for nine months, the results presented in Table (3) revealed that the color intensity increased from 3.50 (red unit) at zero time of storage to 3.77, 4.15 and 3.86 due to storage for nine months in plastic, colorless and brown glass containers, respectively. The extent of increase in color intensity was affected by the storage period as well as container types. These results are in coincide with those obtained by Helen (1982); Raghav, *et al*. (1999); Mehany (2007) and Iskander, *et al*. (2010). The increase in the color intensity of the oil during storage could be attributed to the formation of fatty acid polymers which accumulate a result of triglycerides hydrolysis during storage (June, 1981). On the other hand, White (1991) and Saguy, *et al*. (1996) reported that the increase in color index is probable due to oxidation typically resulting in the generation of hydroperoxides, conjugated dienoic acids, epoxides, hydroxides and ketones. Oils and fats can also produce dimeric acids and form polymers of higher molecular weight, causing a darker color and a deposit of yellow or brown pigments (Blumenthal, 1991; Mehanni, 2006 and Iskander, *et al*., 2010).

Table (3): Effect of storage period at ambient temperature and container types on color* intensity (red units) of sunflower seed oil.

Storage period (months)	Type of containers		
	Plastic	Glass	
		Colorless	Brown
Zero (control)	3.50	3.50	3.50
1	3.50	3.54	3.58
2	3.52	3.63	3.65
3	3.55	3.70	3.70
4	3.58	3.75	3.72
5	3.62	3.86	3.74
6	3.66	4.00	3.78
7	3.70	4.08	3.81
8	3.72	4.12	3.83
9	3.77	4.15	3.86

Color was determined by the Lovibond Tintometer and yellow units was 35.00 *

Effect of storage conditions on some chemical characteristics:
Effect of storage conditions on lipolytic rancidity:

Results in Table (4) showed the effect storage of sunflower oil in different types of containers on its acidity. Generally, the acid value increased gradually in all oil samples during storage. However, the rate of increase was depended on the storage period and the type of package used. The acid value of sunflower seed oil increased from 0.05 (mg KOH/g. oil) to 0.13, 0.17 and 0.15 upon storage of the sunflower oil for nine months in plastic, colorless and brown glass containers, respectively. The slight gradual increase in the acidity could be attributed to the hydrolysis of some phosphatides and triglycerides to glycerol and free fatty acids.

Table(4): Effect of storage period at ambient temperature and container types on acid value* (A.V.) of sunflower seed oil.

Storage period (months)	Type of containers		
	Plastic	Glass	
		Colorless	Brown
Zero (control)	0.05	0.05	0.05
1	0.05	0.07	0.06
2	0.06	0.07	0.06
3	0.08	0.09	0.07
4	0.09	0.10	0.08
5	0.10	0.12	0.10
6	0.11	0.14	0.12
7	0.11	0.15	0.12
8	0.12	0.16	0.14
9	0.13	0.17	0.15

*** As mg. KOH/g oil.**

These results are in accordance with those reported by Swern (1979); June (1981); Moharram and Osman (1982); Iskander, *et al*. (1985); Mehany (2007) and Iskander, *et al*. (2010). The reason for the more pronounced effect in the colorless glass container could be explained on the accelerating effect of light on glycerides splitting and free fatty acids formation. Keeping the stored oil away from the light caused a less pronounced rate of gycerides splitting. Such findings and conclusions agree with those reported by Swern

(1979) and Hui (1996).In addition, Aziz (1982) reported that oils were considered to be unsuitable for edible purpose when their acid value increased to values greater than 2.0.

Effect of storage conditions on oxidative rancidity development:

Oxidative rancidity is the principal problem in fats and oils. Two determinations: peroxide value (as indicator of primary oxidation) and thiobarbituric acid (as indicator of secondary oxidation) are employed in this study to determine the extent of oxidation caused during storage at ambient temperature for nine months.

Data given in Table (5) illustrates the peroxide value of sunflower seed oil stored for nine months in the aforementioned containers at ambient temperature . The peroxide value of investigated oil samples before storage was 0.89 meq. Peroxide/kg sample. This value became 16.77, 19.35 and 15.86 after storage for nine months in plastic, colorless glass and brown glass containers, respectively. On the basis of the peroxide value levels, the studied containers can be arranged in the following descending order according to their efficiency in keeping quality of sunflower seed oil: brown glass, plastic and colorless glass containers. Generally, it was noticed that the P.V. was increased gradually in all oil samples during storage; the rate of increase depending on the storage period and the container types. The gradual increased in the P.V. could be attributed to the accelerating effect of storage temperature in the presence of oxygen on oxidation and peroxide formation. The presented findings are in the same line with those reported by June (1981) and Iskander, *et al*. (1986 and 2010). On the other hand, the spoilage of sunflower oil was considered to have occurred when the P.V. surpassed 25 meq. peroxide/kg sample according to EOSQC (2005).

Table (5): Effect of storage period at ambient temperature and container types on peroxide value* (P.V.) of sunflower seed oil.

Storage period (months)	Type of containers		
	Plastic	Glass	
		Colorless	Brown
Zero (control)	0.89	0.89	0.89
1	2.20	4.00	1.75
2	4.15	5.25	3.15
3	5.24	7.52	4.70
4	7.10	8.05	6.25
5	8.53	9.78	7.50
6	9.66	12.47	8.76
7	12.15	14.85	11.95
8	14.52	17.66	13.57
9	16.77	19.35	15.86

Reported as milliequivalents of peroxide per kilogram sample *

Concerning the aldehyde development as shown by the thiobarbituric acid (TBA) which is consider as a more reliable indicator of oxidative rancidity (Jacobson, 1967), the results presented in Table (6) showed that the TBA varied with the storage period as well as the type of containers. Generally, it was noticed that the TBA value increased gradually as storage period increased in all oil samples. The rate of increase was found to be highest in colorless glass container (0.60) after nine months of storage, followed by oil sample in plastic container (0.38). Where as the lowest TBA value was recorded in oil sample preserved in brown glass container (0.33). This difference could be due to the variation in the decomposition of the peroxides and hydroperoxides into aldehydes, ketones, and low molecular weight fatty acids, which are relatively volatile given a rise to the characteristic off flavours associated with oxidative rancidity. The increase in TBA value due to increasing in absorption at 532 nm could reflect increases in shorter chain dienals and malonaldehydes, which are not as pleasant in flavor. Such finidings are in the same trend with those reported by Jacobson (1967); Allen and Hamilton (1983) and Iskander, *et al*. (2010).

Table (6): Effect of storage period at ambient temperature and container types on thiobarbituric acid value* (T.B.A.) of sunflower seed oil.

Storage period (months)	Type of containers		
	Plastic	Glass	
		Colorless	Brown
Zero (control)	0.21	0.21	0.21
1	0.25	0.36	0.23
2	0.28	0.49	0.24
3	0.30	0.56	0.27
4	0.35	0.62	0.30
5	0.39	0.67	0.32
6	0.43	0.71	0.37
7	0.47	0.76	0.42
8	0.52	0.80	0.47
9	0.60	0.85	0.50

*** Calculated as mg. malonaldehyde/kg. sample.**

Effect of storage conditions on the iodine value of sunflower :

Data given in Table (7) illustrate the changes that took place in the degree of unsaturation, as shown by change in iodine value (I.V.) of sunflower oil during storage. It could be noticed that the I.V. decreased gradually in all oil samples. The extent of decrease in I.V. was affected by storage period and container types. The I.V. of oil samples at zero time of storage was 116.02. This value decreased to 113.42, 110.85 and 112.16 in oil samples stored in plastic, colorless glass and brown glass containers, respectively after nine months of storage. The decrease in I.V. of the oil samples during storage could be attributed to the formation of new fatty acids which differ in their degree of unsaturation or to the distribution of double bonds saturation of the fatty acids during the production of hydroperoxides and intermediate compounds. Such results are in reasonable agreement with those reported by Eskander (1974); Swern (1979); Gunston and Norris (1983); Frankel, *et al*. (1984); Iskander, *et al*. (1986); Mehany (2007) and Iskander, *et al*. (2010).Also, results presented in Table (7) showed that the decreased in the I.V. was accompanied by the decreas in linoleic acid content. The same trend was found for sunflower seed oil reported by Cummins *et al*. (1967), Eskander and Banu (1982), Iskander (1990) and Iskander *et al*. (2010).

Table (7): Effect of storage period at ambient temperature and container types on iodine value* (I.V.) of sunflower seed oil.

Storage period (months)	Type of containers		
	Plastic	Glass	
		Colorless	Brown
Zero (control)	116.02	116.02	116.02
1	115.90	115.25	115.66
2	115.65	114.50	115.05
3	115.40	113.86	114.75
4	115.24	113.45	114.38
5	114.93	112.88	113.90
6	114.66	112.34	113.66
7	114.07	111.67	113.07
8	113.85	111.23	112.63
9	113.42	110.85	112.16

*** Reported as numbers of grams of iodine required to saturate 100 grams of the sample.**

Effect of storage conditions on the saponification value:

The changes in the saponification value (S.V.) of sunflower seed oil during storage at ambient temperature for nine months are shown in Table (8).

Generally, it can be observed from the results that the S.V. increased gradually in all oil samples as storage period increased. The rate of increase in S.V. was affected by storage period and type of container. The highest increase in the S.V. was recorded in oil samples stored in colorless glass containers and stored for nine months (194.44). In contrast, the lowest increase in the S.V. was observed in oil sample stored in brown glass containers (193.20) at the end period of storage. These results are in general agreement with those reported by Williams (1966); Fahmy (1969); Eskandar (1974); Swern (1979); Ibrahim (2000); Mehanni (2006) and Iskander, *et al*. (2010). Who mentioned that the S.V. of oil increased during storage . The high saponification values indicate a lower molecular weight, usually due to presence of lower fatty acids (Swern, 1979 and Hui, 1996).

Effect of storage conditions on the unsaponifiable matters:

These compounds usually exert an effect on the stability of vegetable oils (Williams, 1966; Swern, 1979 and Hui, 1996). Data given in Table (8) illustrate the changes in unsaponifiable matter percentage of sunflower seed oil during storage for nine months in different containers. Generally, it can be observed that the unsaponifiable matter percentage decreased gradually in all oil samples during storage.The rate of decrease depends on the storage period and the container types. The unsaponfiable matter value at zero time of storage was 1.03%.

Table (8): Effect of storage period at ambient temperature and container type on saponification value* (S.V.) of sunflower seed oil.

Storage period (months)	Type of containers		
	Plastic	Glass	
		Colorless	Brown
Zero (control)	190.33	190.33	190.33
1	190.88	191.00	190.66
2	191.50	191.68	190.95
3	191.76	191.94	191.40
4	192.00	192.30	191.66
5	192.33	192.86	191.87
6	192.87	193.25	192.00
7	193.02	193.77	192.37
8	193.44	194.10	192.85
9	193.85	194.44	193.20

*** Calculated as milligrams of KOH required to saponify one gram of oil sample.**

Table (9): Effect of storage period at ambient temperature and container type on unsaponifiable matter (%) of sunflower seed oil.

Storage period (months)	Type of containers		
	Plastic	Glass	
		Colorless	Brown
Zero (control)	1.03	1.03	1.03
1	1.03	1.00	1.03
2	1.01	0.94	1.00
3	0.99	0.91	0.98
4	0.96	0.87	0.95
5	0.96	0.84	0.93
6	0.94	0.80	0.90
7	0.90	0.76	0.86
8	0.88	0.70	0.81
9	0.84	0.65	0.77

This value however decreased to 0.84%, 0.65% and 0.77% in oil samples stored in plastic, colorless glass and brown glass containers, respectively at the end period of the storage. The decrease in the unsaponfiable matter during storage may be due to the effect of oxidation (Swern, 1979 and Mehanni, 2006).

Effect of storage conditions on fatty acid composition of sunflower seed oil:

The data presented in Tables (10,11& 12)showed the changes that took place in fatty acid composition of sunflower seed oil due to storage at ambient temperature for nine months. In general, it can be observed from the results of GLC analysis in Tables 17, 18 and 19 that the values of C14:0, C16:0, C16:1, C18:0, C18:1, C20:0, C20:1, C22:0, TSFA and total MUFA were increased gradually with increasing the storage period in the investigated oil samples. In contrast, the values of C18:2, C18:3, TPUFA; TUFA and the ratio of TUFA: TSFA, C18:2 : C18:1 as well as I.V. were decreased with increasing the storage period. The rate of change (either increase or decrease) was depended on the storage period and container types.The decrease in unsaturated fatty acids (especially polyunsaturated fatty acids as C18:2 and C18:3) could be attributed to the oxidation and hence the change in the degree of unsaturation.

Table (10): Effect of storage period at ambient temperature on fatty acid composition of sunflower seed oil stored in plastic containers.

Fatty acids (wt.% of total fatty acids)		Storage period (months)					
		0	**1**	**3**	**5**	**7**	**9**
Saturated fatty acids (SFA)							
Myristic	$C_{14:0}$	0.40	0.44	0.47	0.50	0.50	0.52
Palmitic	$C_{16:0}$	10.45	10.55	10.59	10.66	10.67	10.69
Stearic	$C_{18:0}$	5.19	5.24	5.30	5.34	5.35	5.36
Arachidic	$C_{20:0}$	00.54	0.58	0.61	0.64	0.65	0.65
Behenic	$C_{22:0}$	00.52	0.55	0.57	0.61	0.62	0.68
Total saturated fatty acids (TSFA)		**17.10**	**17.36**	**17.54**	**17.75**	**17.79**	**17.84**
Unsaturated fatty acids (USFA)							
Monounsaturated fatty acids(MUFR)							
Palmitoleic	$C_{16:1}$	00.39	0.41	0.44	0.47	0.50	0.50
Oleic	$C_{18:1}$	30.19	30.20	30.42	30.80	31.50	32.15
Gadoleic	$C_{20:1}$	00.25	0.25	0.25	0.26	0.27	0.27
Total (MUFA)		**30.83**	**30.86**	**31.11**	**31.53**	**32.27**	**32.92**
Polyunsaturated fatty acids (PUFA)							
Linoleic	$C_{18:2}$	51.50	51.23	50.82	50.19	49.44	48.74
Linolenic	$C_{18:3}$	00.57	0.55	0.53	0.53	0.50	0.50
Total (PUFA)		**52.07**	**51.78**	**51.35**	**50.72**	**49.94**	**49.24**
Total unsaturated fatty acids(TUFA)		82.90	82.64	82.46	82.25	82.21	82.16
TUFA : TSFA		4.85	4.76	4.70	4.63	4.62	4.60
$C_{18:2}$: $C_{18:1}$		1.71	1.70	1.67	1.63	1.57	1.52
Iodine value (I.V.)		**116.02**	**115.90**	**115.40**	**114.93**	**114.07**	**113.42**

Table (11): Effect of storage period at ambient temperature on fatty acid composition of sunflower seed oil stored in colorless glass containers.

Fatty acids (wt.% of total fatty acids)		Storage period (months)					
		0	**1**	**3**	**5**	**7**	**9**
Saturated fatty acids (SFA)							
Myristic	$C_{14:0}$	0.40	0.47	0.50	0.52	0.55	0.55
Palmitic	$C_{16:0}$	10.45	10.56	10.65	10.68	10.70	10.73
Stearic	$C_{18:0}$	5.19	5.27	5.32	5.35	5.37	5.40
Arachidic	$C_{20:0}$	00.54	0.59	0.64	0.67	0.69	0.70
Behenic	$C_{22:0}$	00.52	0.56	0.60	0.62	0.64	0.64
Total saturated fatty acids (TSFA)		**17.10**	**17.45**	**17.71**	**17.84**	**17.95**	**18.02**
Unsaturated fatty acids (USFA)							
Monounsaturated fatty acids(MUFR)							
Palmitoleic	$C_{16:1}$	00.39	0.47	0.58	0.62	0.65	0.66
Oleic	$C_{18:1}$	30.19	30.87	31.67	32.41	33.30	34.22
Gadoleic	$C_{20:1}$	00.25	0.28	0.30	0.32	0.34	0.34
Total (MUFA)		**30.83**	**31.62**	**32.55**	**33.35**	**34.29**	**35.22**
Polyunsaturated fatty acids (PUFA)							
Linoleic	$C_{18:2}$	51.50	50.41	49.24	48.34	47.31	46.33
Linolenic	$C_{18:3}$	00.57	0.52	0.50	0.47	0.45	0.43
Total (PUFA)		**52.07**	**50.93**	**49.74**	**48.81**	**47.76**	**46.76**
Total unsaturated fatty acids (TUFA)		82.90	82.55	82.29	82.16	82.05	81.98
TUFA : TSFA		4.85	4.73	4.65	4.61	4.57	4.55
$C_{18:2}$: $C_{18:1}$		1.71	1.63	1.55	1.49	1.42	1.35
Iodine value (I.V.)		**116.02**	**115.25**	**113.86**	**112.88**	**111.67**	**110.85**

Also, it is noteworthy to mention that the decrease in linoleic and linolenic acid content (Tables 10, 11 and 12) was accompanied by the decrease in the iodine value. These results are in accordance with those reported by Swern (1979); Iskander, *et al*. (1986); Iskander (1990); Hui (1996); Mehanni (2006) and Iskander, *et al*. (2010).

Table (12): Effect of storage period at ambient temperature on fatty acid composition of sunflower seed oil stored in brown glass containers.

Fatty acids (wt.% of total fatty acids)		Storage period (months)					
		0	1	3	5	7	9
Saturated fatty acids (SFA)							
Myristic	$C_{14:0}$	0.40	0.46	0.49	0.51	0.53	0.54
Palmitic	$C_{16:0}$	10.45	10.55	10.59	10.66	10.69	10.71
Stearic	$C_{18:0}$	5.19	5.26	5.30	5.34	5.37	5.38
Arachidic	$C_{20:0}$	00.54	0.58	0.61	0.65	0.67	0.67
Behenic	$C_{22:0}$	00.52	0.55	0.59	0.61	0.62	0.62
Total saturated fatty acids (TSFA)		**17.10**	**17.40**	**17.58**	**17.77**	**17.88**	**17.92**
Unsaturated fatty acids (USFA)							
Monounsaturated fatty acids(MUFR)							
Palmitoleic	$C_{16:1}$	00.39	0.43	0.49	0.55	0.58	0.58
Oleic	$C_{18:1}$	30.19	30.59	31.10	31.61	32.13	33.18
Gadoleic	$C_{20:1}$	00.25	0.27	0.28	0.29	0.31	0.31
Total (MUFA)		**30.83**	**31.29**	**31.87**	**32.45**	**33.02**	**34.07**
Polyunsaturated fatty acids (PUFA)							
Linoleic	$C_{18:2}$	51.50	50.77	50.04	49.28	48.62	47.55
Linolenic	$C_{18:3}$	00.57	0.54	0.51	0.50	0.48	0.46
Total (PUFA)		**52.07**	**51.31**	**50.55**	**49.78**	**49.10**	**48.01**
Total unsaturated fatty acids (TUFA)		82.90	82.60	82.42	82.23	82.12	82.08
TUFA : TSFA		4.85	4.75	4.69	4.63	4.59	4.58
$C_{18:2}$: $C_{18:1}$		1.71	1.66	1.61	1.57	1.53	1.45
Iodine value (I.V.)		**116.02**	**115.66**	**114.75**	**113.90**	**113.07**	**112.16**

In addition, Aboziada (2002) mentioned that the fatty acid composition of sunflower seed oil was greatly affected by storage in light in which C18:2 sharply decreased while C18:1 was increased, indicating degradation of polyunsaturated fatty acids by the action of light. Also, all edible fats and oils rich in polyunsaturated fatty acids deteriorated under the effect of light exposure during storage. On the other hand Knothe and Dunn (2003) mentioned that oleic and linoleic acids decreased the oxidative stability of commercial vegetable oils during storage.

In the present work, it was noticeable that the decrease in C18:2, C18:3, TUFA, ratio of TUFA: TSFA; C18:2:C18:1 and I.V. was higher in sunflower seed oil samples packed in colorless glass containers and stored at ambient temperature for nine months compared with other oil samples packed in plastic and brown glass containers. These results could be help explaining the accelerating effect of light in photooxidation of fatty acids specially high unsaturated fatty acids as linoleic and linolenic (Abduo Sattar and Alexander, 1976; Iskander, *et al*., 1986 and Hui, 1996).

REFERENCES

Abdul-Magied, S.S. (1994). Effect of packaging materials and storage conditions on shelf-life of refined cottonseed oil; M.SC. THESIS FOOD Sci. & Technology, Fac. of Agric., Cairo University, Giza, Egypt.

Abdoziada, N.N. (2002). Studies on natural antioxidants effectiveness in oils;- Ph.D. Thesis, Fac. of Agric., Saba Bacha, Alexandria UNIV., Egypt

Abdou- Sattar, J.M. and Alexander, J.C. (1976). Stability of edible oils and fats to fluorescent light irradiation; J. AM. Oil Chemists Soc. 53(3): 473-477.

Allen, J.C. and Hamilton, R.J. (1983). Rancidity in foods. Applied Science Publication LTD. London-New York.

A.O.C.S. (1998). Official and Tentative Methods of the American Oil Chemists Society (5th ed.); AOCS 35 East Waker Drive, Chicago, Illinois, USA.

Aziz, Y. (1982). Studies on deep frying oils;- M.SC. Thesis, Fac. OF Agric. Cairo Univ., Egypt.

Blumenthal, M.M. (1991). A new look at the chemistry and physics of deep-fat frying;- Food Technol. 37(3): 49-56.

Cocks, L,V. and VanRede, C. (1966) Laboratory Handbook for Oil and Fats Analysis;-London: Academic Press.

Cummins, D.G.; Marion, J.E.; Graigmiles, J.P. and Burns, R.E. (1967). Oil content, fatty acid composition and other agronomic characteristics of sunflower introductions; The Journal of the American Oil Chemists Society 44(10): 581-582.

Draper, H.H. and Brid, R.P. (1984).Antioxidants and cancer; J. Agric. Food Chim., 32: 433.

Egan, H.; Kirk, R.S. and Sawyer, R. (1981). Pearson's Chemical Analysis of Foods (8TH ED.); Churchill livingstone, Longmon Group Limited. London, New York.

E.O.S.Q.C. (2005).Egyptian Organization for Standardization and Quality Control. Standard for vegetable edible oils E.S : 49 – 7 2005;-Published by EOSQC, Ministry OF Industry, Cairo, Egypt

Eskandar, M.H. (1974).Chemical and technological studies on the hydrogenated cottonseed oil; M.SC. Thesis, Dept., OF Food Sci. & Technol. Fac. OF Agric. Assiut Univ., Assiut, Egypt.

Eskandar, M.H. and Banu, C. (1982).Chemical composition of Roumanian sunflower seeds from different varieties and hybrids; La Rivista Italiana Delle Sostanze Grasse. Vol. LIX-April (1982): 195-198.

Fahmy, A.A. (1969).Studies on chemical and physicochemical changes of hydrogenated oils during storage; -M.Sc. Thesis, Dept. of Agric. Industries, Fac. of Agric. Ain Shams Univ. Egypt.

Frankel, E.N.; Smith, L.M.; Hamblin, C.L.; Creveling, R.K. and Clifford, A.J. (1984).Occurrence of cyclic fatty acid monomers in frying oils used for fast foods;-J. Am. Oil Chem. Soc. 61: 87-90.

Girgis, N.A.A. (1999).Physical and technological studies on Margarine and shortening; -M.Sc. Thesis, Faculty of Agriculture, Minia Univ., Minia, Egypt.
Gunstone, F.D. and Norris, F.A. (1983).Lipid in foods, chemistry, biochemistry and technology; Pergamon Press.
Hashem, H.A. (1969).A study on the efficiency of different bleaching agent and their effect on properties of cottonseed oil;-M.Sc. Thesis, Dept. of Agric. Industries, Fac. of Agric. Cairo Univ., Egypt.
Helen, C. (1982).Food Science (2nd Edition);-John Wiley & Sons Inc.
Hemeda, H.M. (1994).Isolation of natural antioxidants from vegetables waste by products; J. Agric. Sci. Mansoura Univ., 19(9): 2953-2960.
Honda, Y.; Mukasa, Y. and Suzuki, T. (2005).Traits of Nu sun TM varieties of sunflower in Hokkaido, Japan; Plant Production Science 8(4): 461-464.
Hui, Y.H. (1996).Bailey's industrial oil and fat products. (5th ed.) Vol. 2. Edible oil and fat products, oils and oilseeds; John Wiley & Sons Inc. New York.
Ibrahim, F.F. (2000).Chemical and technological studies on canola oil; M.SC. Thesis, Faculty of Agric. Assiut Univ. Assiut, Egypt.
Iskander, M.H. (1990).Effect of heating on some chemical characteristics, fatty acid composition and stability of corn and palm oils; Minia J. Agric. Res. & Dev. Vol. 12(4): 2461-2478.
Iskander, M.H.; EL-Morsi, A.E. and Hatour, F.S. (1985).Some physical and chemical changes in cottonseed oil properties during frying of some vegetables; Minia J. Agric. Res. & Dev. 7(4): 1575-1589.
Iskander, M.H.; Dawood, A.A. and Hatour, F.S. (1986).Effect of storage conditions on the stability and fatty acid composition of sunflower oil;-Minia J. Agric. Res. & Dev. 8(3): 879-892.
Iskander, M.H.; Hammam, A.M.; Sorour, M.A. AND Mehanni, A.E. (2010).Effect of storage period and antioxidants treatment on physio-chemical characteristics, keeping quality and stability of cottonseed and canola oils; Journal of Enviro. Studies 1(1): 55-64. Egypt.
Jacobson, G.A. (1967).Quality control of commercial deep fat frying; Food Technology 21(2): 43-48.
June, C.G. (1981).Basic Foods (2ed Edition); Holt Rinehart and Winston
Knothe, G. and Dunn, R.O. (2003).Dependence of oil stability index of fatty acid compounds on their structure and concentration and presence of metals; J. Am. Oil Chem. Soc. 80: 1021-1026.
Mehanni, A.E. (2006).Chemical and technological studies on some vegetable oils; M.Sc. Thesis, Food Sci. Dept. Fact of Agric. Minia University, Minia, Egypt.
Mehany, S.S. (2007).Chemical and Technological studies on sunflower oil;-M.Sc. Thesis, Food Sci. Dept. Fac. of Agric. Minia University, Minia, Egypt.
Moharram, Y.G. and Osman, H.O.A. (1982).Some changes in cottonseed oil during frying falafel and eggplant; Food Chemistry 9: 159-165.
Raghav, P.K.; Grover, P.C. and Thopar, V.K. (1999).Storage stability of sunflower (Helianthus annus) oil in different packaging materials ;Journal OF Food Science and Technology, India; 36(3): 253-255.

Swern, D. (1979).Bailey's industrial oils and fats (Vol. 1, 4 Ed.); John Wiley and Sons, Inc. London.

Saguy, I.S.; Shani, A.; Weinberg, P. and Grati, I. (1996).Utilization of jojoba oil for deep fat frying of foods;-Lebensm. - wiss. U-Technol. 9(3): 149-152. (C.F. Mehanni, 2006).

Vogel, A.J. (1975).A textbook of practical original chemistry (3ed ed.). PP. 969-971; English Language Book Society and London Group LTD, London

White, P.J. (1991).Methods for measuring changes in deep fat frying oils;-Food Technol. 45(2): 75-80.

Williams, K.A. (1966). Oils, Fats and Fatty Foods (4th ed.); J. and A. Churchill LTD, London.

تأثير مدة التخزين ونوع العبوات على بعض الخواص الطبيعية والكيماوية وتركيب الأحماض الدهنية على جوده ثبات زيت دوار الشمس

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يهدف هذا البحث دراسة تأثير التخزين فى الجو العادي ونوع العبوات على الوزن النوعي، معامل الانكسار، كثافة اللون ،رقم الحموضة ،رقم البيروكسيد وقيمة حامض الثيوباربتيوريكTBA وتركيب الأحماض الدهنية على جوده وثبات زيت دوار الشمس. تم تخزين الزيت فى عبوات من الزجاج عديم اللون ومن الزجاج البنى ومن البلاستيك لمدة ٩ أشهر على درجة حرارة الغرفة . أوضحت النتائج أن تخزين زيت دوار الشمس لمدة ٩ أشهر لم يظهر أي تغير واضح على الوزن النوعي للزيت، بينما انخفض معامل الانكسار تدريجياً وزادت كثافة اللون(الأحمر) بزيادة مدة التخزين ، ويتوقف معدل التغير(سواء بالزيادة أو النقص) على مدة التخزين ونوع العبوة.وقد أظهرت النتائج زيادة رقم الحموضة ورقم البيروكسيد وقيم حامض الثيوباربتيوريك (TBA)تدريجياً فى جميع العينات خلال مدة التخزين، وسجلت عينات الزيت المخزنة بالعبوات الزجاجية عديمة اللون أعلى معدل في الزيادة، بينما سجلت عينات الزيت المخزنة بالعبوات الزجاجية البنية أقل معدل زيادة. وأظهرت نتائج قياس درجة عدم التشبع انخفاضا تدريجياً فى جميع العينات ،بينما حدثت زيادة تدريجية فى قيم رقم التصبن في جميع العينات خلال مدة التخزين و يتأثر معدل الزيادة بمدة التخزين ونوع العبوات. هذا وقد سجلت أعلى قيم لرقم التصبن فى العينات التي حفظت فى الزجاج عديم اللون.، بينما سجلت أقل قيم لرقم التصبن فى العينات التى حفظت فى عبوات الزجاج البنى. و انخفضت نسبة المواد الغير قابلة للتصبن تدريجياً فى جميع العينات خلال مدة التخزين. أظهرت نتائج التحليل الكروماتوجرافى الغازى زيادة قيم الأحماض الدهنية المشبعة الكلية والأحماض الأحادية عديمة التشبع تدريجياً بزيادة فترة التخزين فى جميع العينات،بينما انخفضت قيم حامض اللينوليك، اللينولينك، الأحماض عديدة عدم التشبع الكلية والأحماض الغير مشبعة الكلية ونسبة الأحماض الدهنية الغير مشبعة الكلية إلى الأحماض الدهنية المشبعة الكلية ونسبة اللينوليك إلى الأوليك و الرقم اليودى بزيادة مدة التخزين،ويتوقف معدل التغير فى قيم الأحماض الدهنية (بالزيادة أو النقص) على مدة التخزين ونوع العبوات،وكما أظهرت العينات التي حفظت فى الزجاج عديم اللون أعلى قيم مقارنةً بالعينات الأخرى المحفوظة فى العبوات البلاستيكية أو الزجاج البني وهذا يوضح تأثير الضوء على الأكسدة الضوئية للأحماض الدهنية خاصةً الغير مشبعة (اللينوليك واللينولينك)، وأثبتت النتائج أيضاً أن انخفاض قيم حامض اللينوليك واللينولينك يكون مصحوباً بانخفاض قيم الرقم اليودي.

قام بتحكيم البحث

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