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# CHEMICAL STUDIES ON BY-PRODUCTS OF SOME VEGETABLE OILS

BY

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## ABSTRACT

Chemical studies were conducted on by-product compounds of refining stages of corn, soybean and sunflower oils (degumming, bleaching and deodorizer distillate). Crude lecithin was separated from the degumming by-product compounds and its effect as an antioxidant on frying process was investigated.

There were significant differences ($P<0.01$) in the unsaponifiable matter percent among the different studied vegetable oils besides of the by-products of the three refining stages. Phospholipids (PL) were the major components in the studied gums. The individual phospholipids subclasses were found to be phosphatidylserine (PS), phosphatidylinosetol (PI), phosphatidylcholine (PC) and phosphatidylethanolamine (PE). The predominant PL-bound fatty acids were palmitic, oleic and linoleic acids.

Frying the sunflower oil caused significant increases ($P<0.01$) in acid value, peroxide value and benzidine number. On the other hand, it caused significant decrease ($P<0.01$) in the percentage of total unsaturated fatty acids. Conversely, a significant increase ($P<0.01$) occurred in the percentage of total saturated fatty acids. The addition of lecithin powder which was separated from corn, soybean and sunflower gums caused a pronounced increase in the induction period of sunflower oil.

## INTRODUCTION

The technological processes of fat and oil manufactures result in accumulation of large quantities of by-products. Proper utilization of these by-products might reduce waste disposal problems and provide a new potential source for improving oil properties. Crude oils are subjected to a number of commercial refining processes, both physical and chemical (namely degumming,, neutralization, bleaching and deodoriztion), to remove substances that may cause undesirable flavor, color and odor (Nawar, 1985). For example, degumming remove phospholipids and mucilaginous; alkaline refining removes free fatty acids, phospholipids, metals and chlorophyll. The process of bleaching reduces chlorophyll, carotenoids, and residual fatty acids. Deodorization removes volatile compounds, free fatty acids and tocopherol (Jung *et al.*, 1989). Thus, the by-products of these stages of industrial processing i.e gum, soapstock and deodorizer distillate are rich in phospholipids, sterols and tocopherols.

Hollo *et al.* (1993) determined the components of sunflower commercial lecithin. The distribution of phosphatides were phosphatidyl-choline 41%, phosphatidylethanolamine 17%, phosphatidylinositol 23% and phosphatidic acid 3%. The main fatty acid in phospholipids was linoleic 66.9%. The other fatty acids were palmitic 16.9%, stearic 5.4% and oleic acid 8.6%. Ghyczy (1995) reported that, the three basic constituent groups of lecithin are phospholipids 57%, oil or triglycerides 33% and secondary lipids 10%. Van Nieuwenhuyzen (1999) reported that the crude lecithin derived from soybean oil contained a mixture of vartious phospholipids 55% carbohydrates 10% and triglycerides oil 35%. However, Vandana *et al.* (2001) reported that, soybean lecithin is a complex consists of phospholipids, triglycerids and minor amounts of other constituents like phytoglycolipids, phytosterols, tocopherols and fatty acids.

Antioxidants play an important role in manufacture, package and storage of fats and fatty foods (Shabana *et al.*, 1991; Shimada *et al.*, 1992 and Yen and Duh 1993). However, the most widely used antioxidants i.e. butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) are suspected to cause liver damge (Abd El-Rahman and El-Deeb 1999). Hildebrand (1984), Ishkawa *et al.* (1984), Hayase *et al.* (1989) and Hui (1997) reported that, the addition of phosphatidylethanolamine, phosphatidylcholine, phosphatidylinosital and tocopherol increased oil stability. Antioxidants have been detected in a number of food and agricultural products, including cereal grains, vegetables, fruits, and oil seeds (Yu *et al.*, 2002 b). Antioxidants are well recognized for their potential health promotion and prevention of aging - related diseases, including cancer and heart disease (Yu *et al.*, 2002 a).

The current investigation was conducted to illustrate the main differences that might be found among the refining by-product compounds of three different oils namely corn, soybean and sunflower oils. Moreover, the effect of frying sunflower oil and its chemical characteristies and its fatty acids composition was investigated. Effect of crude lecithin additive as a natural antioxidant during the frying process was also tried.

## MATERIALS AND METHODS

Oil by-product samples used in this work were obtained directly from refineries specialized in production of the oil. Sunflower gum, bleaching by-product and deodorizer distillate of sunflower oil were obtained from Misr Gulf Oil Company, Attakah-Suez. Corn gum, bleaching by-product and dodrizer distillate of corn oil were obtained from Savola Sime Egypt Company 10$^{th}$ of Ramadan. Soy gum, bleaching by-product and deodorizer distillate of soybean were obtained from Tanta Oil Soap Company, Banha. Authentic fatty acids, and phospholipids were obtained from Sigma Chemical Company (USA).

Moisture content, acid value, peroxide value, iodine value and unsaponifiable matter were determined according to A.O.A.C (1990). The benzidine number was determined according to Scharmulter (1969). Commercial phospholipids were obtained according to the method of Popov *et al.* (1971). The amount of phospholipids and their fractions were determined according to Kates (1972). The fatty acids methyl esters obtained from different samples were analyzed using a Pye Unicum Series 304 Gas Chromatograph, with flame ionization detector.

All results were expressed as mean values. Analysis of variance for the recorded data was performed according to the method described by Gomez and Gomez (1984).

## RESULTS AND DISCUSSION

The chemical composition of corn, soybean and sunflower oils degumming, bleaching and deodorizer distillate by-products are given in Table (1). The moisture content is usually determined for commercial considerations, because high content of moisture affects the induction period. Quantity of unsaponifiable matter of fats and oils is one of the most important analytical determinations in lipid chemistry (Schwartz, 1988). The abovementioned results indicate that, gum by-product can be considered as a rich source for phospholipids. Soybean gum had significantly higher ($P < 0.01$) phospholipids percentage (65.00%) than corn and sunflower gums. On the other hand, bleaching and deodorizer distillate were considered as rich sources for both neutral lipids and free fatty acids. These results are within the ranges obtained by Woerfel (1981) and Suresh and Alan (1993).

The compositions of corn, soybean and sunflower phospholipids are shown in Table (2) The phospholipids were separated into four fractions, i.e. phosphatidylserine (PS), phosphatidylinosetol (PE), phosphatidylcholine (PC) and phosphatidylethanolamine (PE). Phospholipids of sunflower were found to contain a significant higher ($P < 0.01$) percentage of PS and PI followed by soybean and corn. Corn phospholipids was found to contain a significant ($P < 0.01$) higher percentage of PC when compared with soybean and sunflower. On the other hand, corn phospholipids contain the lowest percentage of PE when compared with the other two by-products under investigation. These results are in agreement with those of Carelli *et al.* (1997) and Ramadan and Morsel (2003).

The fatty acids contents in corn, soybean and sunflower phospholipids are shown in Table (3). Soybean phospholipids contain the highest level of saturated fatty acids as compared with the other two by-products. Among the saturated ones, palmitic acid constituent showed the highest percentage followed by stearic acid. On the other hand, sunflower phospholipids contain the highest level of unsaturated fatty acids as compared with the other two by-products under investigation. The unsaturated fatty acids were dominated by linoleic acid which was the major one followed by oleic acid. These results are in agreement with those of Vijayalakshmi and Roa (1972)

**Table (1) Chemical composition of degumming, bleaching and deodorizer distillate by-products of corn, soybean and sunflower oils.**

| Components % | Degumming by-product | | | Bleaching by-product | | | Deodorizer distillate | | | L.S.D. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Corn | Soybean | Sunflower | Corn | Soybean | Sunflower | Corn | Soybean | Sunflower | 0.05 | 0.01 |
| Moisture | 0.90 ±0.03 | 1.34 ±0.05 | 1.22 0.04 | 1.45 ±0.05 | 1.05 ±0.04 | 0.92 ±0.03 | 1.79 ±0.03 | 2.14 ±0.04 | 2.21 ±0.05 | 0.07 | 0.10 |
| Unsap. matter | 1.20 ±0.04 | 1.22 ±0.03 | 0.82 ±0.02 | 4.61 ±0.06 | 2.97 ±0.02 | 2.32 ±0.03 | 22.08 ±1.04 | 16.86 ±0.81 | 20.07 ±0.92 | 0.92 | 1.26 |
| Free fatty acids (as oleic acid) | 18.20 ±1.01 | 21.00 ±1.04 | 20.50 ±1.06 | 24.50 ±1.11 | 21.12 ±1.12 | 35.22 ±2.13 | 29.91 ±2.01 | 29.00 ±1.98 | 26.72 ±1.15 | 2.55 | 3.49 |
| Neutral lipids | 42.00 ±2.13 | 11.44 ±1.15 | 30.80 ±2.08 | 69.50 ±2.98 | 75.12 ±2.60 | 61.54 ±2.18 | 46.22 ±2.11 | 52.00 ±3.17 | 51.00 ±1.18 | 3.90 | 5.34 |
| Total phospholipids | 37.70 ±1.98 | 65.00 ±2.16 | 46.66 ±1.56 | - | - | - | - | - | - | 3.83 | 5.80 |

Each value is a mean of three replicates±SD.

**Table (2): Phospholipids composition of native lecithin powder obtained from degumming by-products.**

| Phospholipids | Native lecithin powder % | | | L.S.D. | |
|---|---|---|---|---|---|
| | Corn | Soybean | Sunflower | 0.05 | 0.01 |
| PS (g/100g) | 15.37 ±1.12 | 28.27 ±1.98 | 32.35 ±1.48 | 3.13 | 4.74 |
| PI (g/100g) | 13.59 ±1.38 | 17.16 ±1.12 | 22.56 ±1.52 | 2.70 | 4.09 |
| PC (g/100g) | 42.21 ±2.24 | 20.24 ±1.64 | 15.54 ±1.74 | 3.78 | 5.73 |
| PE (g/100g) | 28.83 ±1.51 | 33.99 ±1.72 | 29.41 ±1.98 | 2.77 | 4.20 |

Each value is a mean of three replicates±SD.
PS = Phosphatidylserine PI = Phosphatidylinosetol
PC = Phosphatidylcholine PE = Phosphatidylethanolamine

**Table (3): Fatty acids composition of phospholipids in degumming by-products.**

| Fatty acids | Relative content (%) | | | L.S.D. | |
|---|---|---|---|---|---|
| | Corn | Soybean | Sunflower | 0.05 | 0.01 |
| $C_{16:0}$ | 32.15 ±1.25 | 44.50 ±2.05 | 14.58 ±1.18 | 3.09 | 4.68 |
| $C_{16:1}$ | 0.15 ±0.01 | 0.66 ±0.01 | 0.64 ±0.02 | 0.01 | 0.02 |
| $C_{18:0}$ | 2.63 ±0.02 | 10.13 ±0.54 | 6.35 ±0.25 | 0.70 | 1.07 |
| $C_{18:1}$ | 23.32 ±1.13 | 23.90 ±1.98 | 37.14 ±1.44 | 3.11 | 4.71 |
| $C_{18:2}$ | 40.54 ±2.24 | 20.00 ±1.15 | 39.71 ±1.58 | 3.27 | 4.95 |
| $C_{18:3}$ | 0.34 ±0.04 | 0.38 ±0.02 | 0.67 ±0.07 | 0.09 | 0.14 |
| $C_{22:0}$ | 0.30 ±0.01 | - | - | - | - |
| $C_{22:2}$ | 0.59 ±0.01 | 0.32 ±0.01 | - | - | - |
| Total saturated | 35.08 ±1.28 | 54.63 ±2.59 | 20.93 ±1.43 | 3.72 | 5.63 |
| Total unsaturated | 64.94 ±3.44 | 45.26 ±3.16 | 78.16 ±3.12 | 5.48 | 9.82 |

Each value is a mean of three replicates±SD.

The classical antioxidant butylated hydroxyl toluene (BHT) and native lecithin powder produced from corn, soybean, and sunflower gums by-product were separately added to the refined sunflower oil in order to evaluate their effect as antioxidants on the rate of oil autoxidation and deterioration during deep fat frying at 180±10°C. The obtained results (Table, 4) show a significant (($P < 0.01$) gradual increase in acid value with heating time. The increase in the acid value of oil may be attributed to slight random hydrolysis of triglycerides that results in free fatty acids and diacylglycerides (Yoshida *et al.*, 1992). The increase may be also due to the formation of acidic compounds and free fatty acids as a result of secondary products cleavage formed during oxidation and frying (El-Said, 1995).

It is clear that (Table 4) the iodine value rapidly and significantly (($P < 0.01$) decreased in sunflower oil with heating time. However, the iodine value of the sunflower oil that received corn, soybean, sunflower native lecithin powder or butylated hydroxytoluene (BHT) decreased slowely. Such slow decrease in the iodine values was coincident with the rapid increase in benzdine number. The decrease occurred in iodine value due to heating may be attributed to the decrease in the relative percentage of total unsaturated fatty acids due to oxidation (Yoshida *et al.* 1990).

The results in Table (4) show that, the peroxide value in sunflower oil that received the corn, soybean, sunflower lecithin powder or BHT gradually and significantly increased during frying for 24 hr, then, gradually and significantly decreased after 32 hr of heating due to the breakdown of peroxides to secondary oxidized products. The increase in peroxide value may be attributed to the oxidation of unsaturated fatty acids due to heating of the oil (Yoshida *et al.* 1990). It could be noticed that the addition of native lecithin powder produced from corn, soybean or sunflower gums caused a pronounced prolongation in the induction period of sunflower oil.

The changes in fatty acids content during heating at 180±10°C of sunflower oil without or with addition of native lecithine powder are shown in Table (5). Generally, a significant decrease ($P < 0.01$) was observed in percentage of total unsaturated fatty acids. Also, a significant decrease ($P < 0.01$) was detected in linoleic and linolenic acids due to heating. Conversely, a significant increase ($P < 0.01$) occurred in percentage of total saturated fatty acids e.g. palmitic and stearic acids after heating periods. These results are in good agreement with those reported by Yoshida and Takagi (1997), who stated that heating affected the composition and positional distribution of fatty acids. Also, oxidation caused a decrease in the percentage of total unsaturated fatty acids after heating (Yoshida *et al.* 1990). Changes in the ratio ($C_{18:2}$ +$C_{18:3}$/$C_{16:0}$) i.e. linoleic % + linolenic % / palmitic acids may provide a reliable measure for oil deterioration. This ratio in fresh sunflower oil was 9.35, decreased rapidly to 5.34 after 16 hr of heating. Application of native lecithin powder of corn, soybean sunflower or BHT maintained the $C_{18:2}$+$C_{18:3}$ / $C_{16:0}$ ratio at higher values at all the heating times as comared with the control treatment. This means that these additives elongated the induction period of the sunflower oil.

**Table (4): Effect of lecithin powder on chemical characteristics of heated sunflower oil.**

| Time of heating (hr) | | Acid value | Iodine value | Peroxide value | Benzidine Number |
|---|---|---|---|---|---|
| **Sunflower oil (control)** | | | | | |
| **Zero time** | | 0.14 ± 0.01 | 134.43 ± 0.32 | 0.49±0.01 | 92.24±0.12 |
| **8 hrs** | | 0.37±0.01 | 123.62±0.96 | 17.47±0.22 | 156.73±1.35 |
| **16 hrs** | | 1.09 ± 0.02 | 120.31±1.06 | 33.87±0.30 | 187.27±0.21 |
| **24 hrs** | | 1.06±0.01 | 78.91±0.70 | 58.93±0.41 | 268.35±0.66 |
| **32 hrs** | | 1.93 ± 0.11 | 75.80±1.48 | 27.04±0.12 | 343.69±0.55 |
| **40 hrs** | | 2.13±0.08 | 64.21±2.00 | 17.90±0.22 | 631.17±1.01 |
| **48 hrs** | | 2.48 ± 0.01 | 51.72±0.49 | 8.23±0.95 | 649.41±1.49 |
| **Sunflower oil + 0.05% corn native lecithin powder** | | | | | |
| **8 hrs** | | 0.29±0.01 | 126.26±1.05 | 15.47±0.46 | 140.89±0.77 |
| **16 hrs** | | 0.76 ± 0.06 | 123.21±1.01 | 24.44±0.33 | 164.16±1.07 |
| **24 hrs** | | 1.17±0.04 | 115.30±0.06 | 48.49±0.24 | 184.70±2.3 |
| **32 hrs** | | 1.52 ± 0.09 | 98.36±0.45 | 36.22±0.99 | 289.26±0.25 |
| **40 hrs** | | 2.76±0.22 | 74.23±1.97 | 20.49±1.60 | 525.35±1.55 |
| **48 hrs** | | 2.54 ± 0.04 | 62.22±0.99 | 15.42±0.16 | 529.15±1.43 |
| **Sunflower oil + 0.05% soybean native lecithin powder** | | | | | |
| **8 hrs** | | 0.50±0.03 | 122.17±0.99 | 10.09±0.12 | 146.33±1.88 |
| **16 hrs** | | 0.82 ± 0.01 | 119.22±1.04 | 30.6±0.35 | 198.13±0.21 |
| **24 hrs** | | 1.16±0.31 | 107.70±1.55 | 42.13±0.14 | 215.42±0.32 |
| **32 hrs** | | 1.25 ± 0.02 | 86.99±0.72 | 41.96±0.70 | 288.25±0.91 |
| **40 hrs** | | 1.77±0.0 | 55.21±0.32 | 37.08±0.26 | 511.73±1.24 |
| **48 hrs** | | 2.62 ± 0.04 | 52.17±0.01 | 19.17±0.25 | 589.12±2.11 |
| **Sunflower oil + 0.05% sunflower native lecithin powder** | | | | | |
| **8 hrs** | | 0.43±0.01 | 127.26±1.94 | 10.49±0.19 | 153.32±2.88 |
| **16 hrs** | | 0.78 ± 0.02 | 114.47±2.24 | 31.11±0.18 | 180.66±0.94 |
| **24 hrs** | | 0.90±0.02 | 98.14±1.03 | 33.88±0.02 | 212.14±2.77 |
| **32 hrs** | | 1.31 ± 0.05 | 72.24±0.96 | 15.73±0.59 | 313.84±1.83 |
| **40 hrs** | | 1.75±0.04 | 62.19±0.01 | 14.11±0.18 | 525.95±3.72 |
| **48 hrs** | | 2.42 ± 0.03 | 47.56±0.35 | 12.23±0.11 | 660.72±0.38 |
| **Sunflower oil + 0.05% BHT** | | | | | |
| **8 hrs** | | 0.42±0.02 | 129.02±0.80 | 12.29±0.05 | 112.89±1.67 |
| **16 hrs** | | 0.74 ± 0.02 | 127.03±0.75 | 23.89±0.18 | 120.46±1.54 |
| **24 hrs** | | 0.91±0.04 | 93.78±1.56 | 50.66±0.02 | 216.36±1.34 |
| **32 hrs** | | 1.20 ± 0.06 | 90.21 ±1.13 | 46.29±0.32 | 233.87±0.75 |
| **40 hrs** | | 1.67±0.05 | 75.01±2.20 | 35.08±0.19 | 328.25±6.09 |
| **48 hrs** | | 2.42 ± 0.03 | 65.74 ± 2.46 | 15.01±0.40 | 481.79±5.17 |
| L.S.D. | 0.05 | 0.07 | 1.99 | 2.40 | 2.89 |
| | 0.01 | 0.10 | 2.68 | 3.23 | 3.90 |

Each value is a mean of three replicates±SD.

**Table (5): Effect of lecithin powder on fatty acids composition of heated sunflower oil.**

| Time of heating (hr) | Fatty acids % | | | | | | | | | | $(C_{18:2} + C_{18:3}) / C_{16:0}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $C_{12}$ | $C_{14}$ | $C_{16:0}$ | $C_{16:1}$ | $C_{18:0}$ | $C_{18:1}$ | $C_{18:2}$ | $C_{18:3}$ | TS | TUS | |
| **Sunflower oil (control)** | | | | | | | | | | | |
| Zero | 0.22 ±0.01 | 0.18 ±0.01 | 6.40 ±0.15 | - | 2.33 ±0.09 | 30.93 ±0.13 | 47.47 ±0.76 | 12.36 ±0.58 | 9.13 ±0.26 | 90.36 ±1.47 | 9.35±0.30 |
| 16 | 0.28 ±0.02 | 0.45 ±0.02 | 9.86 ±0.58 | 2.31 ±0.15 | 2.88 ±0.04 | 30.35 ±0.65 | 43.08 ±0.78 | 9.60 ±0.28 | 14.47 ±0.66 | 85.34 ±1.86 | 5.34±0.24 |
| 32 | 0.86 ±0.03 | 0.78 ±0.03 | 13.36 ±0.78 | 3.42 ±0.19 | 6.41 ±0.03 | 33.31 ±0.98 | 36.55 ±0.98 | 4.33 ±0.41 | 21.41 ±0.87 | 77.61 ±2.56 | 3.06±0.16 |
| 48 | 2.01 ±0.03 | 2.51 ±0.09 | 16.38 ±0.98 | - | 6.82 ±0.12 | 39.26 ±0.56 | 31.07 ±0.71 | - | 29.62 ±1.13 | 70.33 ±1.27 | 1.90±0.09 |
| **Sunflower oil + 0.05% corn native lecithin powder** | | | | | | | | | | | |
| 16 | 0.34 ±0.02 | 0.70 ±0.02 | 7.37 ±0.48 | 0.40 ±0.01 | 3.96 ±0.26 | 30.83 ±0.98 | 46.06 ±0.62 | 10.11 ±0.35 | 12.37 ±0.78 | 87.4 ±1.96 | 7.62±0.21 |
| 32 | 0.14 ±0.01 | 0.63 ±0.03 | 11.22 ±0.36 | 2.01 ±0.12 | 3.45 ±0.15 | 31.76 ±0.77 | 41.35 ±0.74 | 9.21 ±0.71 | 15.44 ±0.55 | 84.33 ±2.34 | 4.51±0.18 |
| 48 | 0.51 ±0.01 | 0.83 ±0.01 | 14.12 ±0.57 | 4.07 ±0.12 | 7.07 ±0.37 | 32.80 ±0.61 | 35.41 ±0.61 | 5.61 ±0.18 | 22.53 ±0.96 | 77.89 ±1.52 | 2.91±0.16 |
| **Sunflower oil + 0.05% soybean native lecithin powder** | | | | | | | | | | | |
| 16 | 0.26 ±0.01 | 0.52 ±0.02 | 7.55 ±0.19 | 0.66 ±0.11 | 4.30 ±0.38 | 30.90 ±0.71 | 44.35 ±0.82 | 11.32 ±0.41 | 12.63 ±0.60 | 87.23 ±2.05 | 7.37±0.19 |
| 32 | 0.51 ±0.02 | 0.61 ±0.02 | 11.98 ±0.68 | 2.34 ±0.14 | 4.48 ±0.22 | 31.13 ±0.85 | 39.48 ±0.91 | 9.91 ±0.12 | 17.58 ±0.94 | 82.86 ±2.02 | 4.12±0.17 |
| 48 | 0.62 ±0.02 | 0.84 ±0.04 | 13.21 ±0.48 | 3.81 ±0.21 | 6.26 ±0.16 | 33.85 ±0.96 | 36.42 ±0.97 | 4.99 ±0.14 | 20.93 ±0.70 | 79.07 ±2.28 | 3.14±0.13 |
| **Sunflower oil + 0.05% sunflower native lecithin powder** | | | | | | | | | | | |
| 16 | 0.23 ±0.01 | 0.33 ±0.01 | 7.86 ±0.52 | 0.50 ±0.05 | 3.77 ±0.27 | 30.91 ±0.18 | 45.82 ±0.79 | 10.23 ±0.17 | 12.19 0.81 | 87.46 ±1.19 | 7.43±0.18 |
| 32 | 0.43 ±0.02 | 0.76 ±0.01 | 12.56 ±0.44 | 2.30 ±0.14 | 3.59 ±0.15 | 29.18 ±0.66 | 40.18 ±0.75 | 10.18 ±0.18 | 17.34 ±0.62 | 81.84 ±1.73 | 4.01±0.15 |
| 48 | 0.40 ±0.01 | 0.87 ±0.91 | 15.43 ±0.26 | 3.67 ±0.17 | 6.32 ±0.18 | 30.35 ±0.98 | 36.11 ±0.70 | 6.84 ±0.26 | 23.02 ±0.46 | 76.96 ±2.11 | 2.78±0.11 |
| **Sunflower oil + 0.05% BHT** | | | | | | | | | | | |
| 16 | 0.43 ±0.02 | 0.36 ±0.01 | 8.10 ±0.18 | 0.56 ±0.01 | 3.40 ±0.16 | 30.83 ±0.91 | 46.04 ±0.68 | 10.15 ±0.21 | 12.29 ±0.37 | 87.58 ±1.81 | 6.94±0.19 |
| 32 | 0.50 ±0.02 | 0.45 ±0.02 | 11.01 ±0.28 | 2.32 ±0.03 | 4.72 ±0.12 | 31.74 ±0.71 | 40.12 ±0.54 | 9.18 ±0.12 | 16.68 ±0.44 | 83.36 ±1.40 | 4.48±0.12 |
| 48 | 0.72 ±0.03 | 0.89 ±0.02 | 12.50 ±0.58 | 3.70 ±0.10 | 6.33 ±0.25 | 33.12 ±0.48 | 37.12 ±0.65 | 5.56 ±0.18 | 20.44 ±0.88 | 79.50 ±1.41 | 3.41±0.11 |
| L.S.D. 0.05 | 0.01 | 0.02 | 0.89 | 0.21 | 0.36 | 1.23 | 1.27 | 0.50 | 1.25 | 3.15 | 0.27 |
| L.S.D. 0.01 | 0.02 | 0.03 | 1.20 | 0.28 | 0.49 | 1.65 | 1.71 | 0.67 | 1.68 | 4.23 | 0.37 |

Each value is a mean of three replicates±SD.

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# دراسات كيميائية علي مخلفات بعض الزيوت النباتية

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يهدف هذا البحث إلي الاستفادة من مخلفات تكرير الزيوت النباتية والتي تنتج أثناء عمليات إزالة الصموغ والتبييض وإزالة الرائحة للزيت. وقد تم تقدير التركيب الكيميائي لمخلفات المراحل الثلاث لتكرير زيت الصويا وعباد الشمس وزيت الذرة. وقد تم فصل الفوسفولبيدات (الليسيثين التجاري) من مخلف مرحلة إزالة الصموغ كما تم التعرف علي التركيب الكيميائي للفوسفوليبيدات باستخدام التحليل الكروماتوجرافي ذو الطبقة الرقيقة حيث وجد أنها تتكون من نسب مختلفة من الفوسفاتيديل كولين والفوسفاتيديل إيثانول أمين والفوسفاتيديل أنيوسيتول والفوسفاتيديل سيرين بنسب مختلفة. كما تم تقدير الأحماض الدهنية للفوسفوليبيدات المفصولة من مخلف مرحلة إزالة الصموغ باستخدام التحليل الكروماتوجرافي الغازي حيث وجد أن الأحماض الدهنية السائدة هي البالميتيك والأوليك واللينوليك .

كم تم تقييم الليسيثين التجاري (المستخلص من مخلف إزالة الصموغ) كمضاد أكسدة أثناء عملية تسخين الزيت وذلك بالمقارنة بمضاد أكسدة تخلقي (BHT) وهو مضاد أكسدة مستخدم علي نطاق تجاري . حيث تم إضافة الليسيثين التجاري إلي زيت عباد الشمس والتسخين علي درجة حرارة ١٨٠±١٠°م لفترات زمنية مختلفة. وقد أوضحت النتائج أن هناك زيادة معنوية في رقم الحموضة ورقم البيروكسيد ورقم البنزيدين وعلي الجانب الأخر كان هناك انخفاض معنوي في الرقم اليودي . كما أن هناك ارتفاع معنوي في نسبة الأحماض الدهنية المشبعة وعلي العكس فهناك انخفاض معنوي في نسبة الأحماض الدهنية الغير مشبعة في زيت عباد الشمس نتيجة لتسخين الزيت دون إضافة مضادات الأكسدة . وقد أدت إضافة الليسيثين التجاري المستخلص من مخلف إزالة الصموغ لزيت الصويا وعباد الشمس وزيت الذرة إلي زيادة فترة الثبات للزيت أثناء التسخين بالمقارنة بالكنترول (زيت بدون إضافات).