RESULTS AND DISCUSSION

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4.1. Degumming by-product.

Degumming process is aimed to removing certain fat-soluble impurities that may impart undesirable flavour, color or keeping quality i.e. phospholipids, free fatty acids (FFA), pigments, peroxides and their breakdown products.

4.1.1.Gums solubility in petroleum ether and acetone.

Data in Table (1) showed that the solubility of three gums under investigation in petroleum ether and acetone. It can be seen that, corn gum by-product characterized by higher solubility in petroleum ether (74.42) than soybean and sunflower gums (40.45, 55.35), respectively. Also the results declare a higher solubility percentage of corn gums in acetone (62.29) when compared with the other by-products sunflower and soy gums (53.32 %, and 35.00 %) under investigation. These results indicated that corn gum contain a higher non glyceride impurities i.e. free fatty acids, sterols, phospholipids and polymerized products.

Table (1) : **Gums Solubility in petroleum ether and acetone.**

Stage	Source of gum	Solubility %	
		Petroleum ether (60-80°C)	Acetone
Degumming	Corn	74.42 ± 0.80	62.29 ± 0.61
	Soybean	40.45 ± 0.94	35.00 ± 0.45
	Sunflower	55.35 ± 0.64	53.32 ± 0.70

4.1.2.Chemical composition of degumming by-product

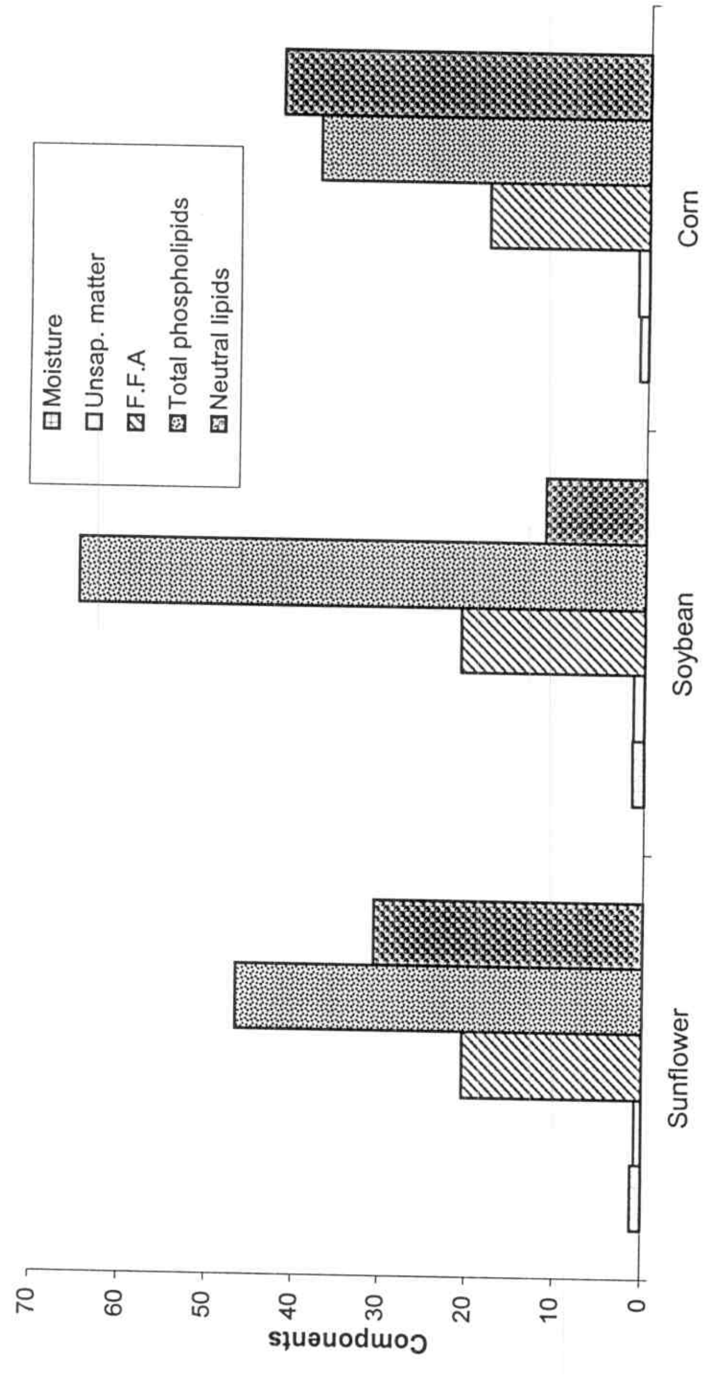
The chemical composition of corn, soybean and sunflower oils degumming by-products are given in Table (2) and Fig. (1). The results showed that, moisture content of the oils degumming by-products ranged from 0.90% to 1.34%. The moisture content of degumming by-product is usually determined for commercial considerations, because high content of moisture affect the keeping quality of gums. Quantitation of unsaponifiable matter of fats and oils is one of the more important analytical determination in lipid chemistry. A significant signment of fat and oil industry used the value obtained (in conjunction with moisture and free fatty acid values) as the basis for the buying and selling of fats, oils and greases, **Schwartz(1988)**. The results showed that, free fatty acid as oleic content is higher in soybean gum than in sunflower and corn gums since their ratio were 21.00%,20.50 and 18.20%, respectively.

The abovementioned results indicate that soybean gum by-product contain higher phospholipid content (65.00%) when compared with sunflower and corn gum by-products (46.66% and 37.70% respectively). On the other hand natural lipids was found to be in higher corn gum by-product (42.00%) than in sunflower and soybean gums (30.80% and 11.44%) these results are near to those of **Woerfel (1981).**

Table (2) Chemical composition of degumming by-product.

Components %	Degumming by-product		
	Corn	Soybean	Sunflower
Moisture	0.90	1.34	1.22
Unsap. matter	1.20	1.22	0.82
F.F.A as oleic acid	18.20	21.00	20.50
Total phospholipids	37.70	65.00	46.66
Neutral lipids	42.00	11.44	30.80

Fig. (1): Chemical composition of degumming by-product



4.1.3 Production of native powder of lecithin

Utilization of lecithin have expanded to the traditional application in paints, chocolate and margarine. Food technologists have used lecithin as functional ingredient in many modern systems. Its multy functional properties and its natural systems make commercial lecithin an ideal food ingredient. The major function properties include: emulsification, instantizing and particle wetting, release, viscosity modification and nutrition. The nutritional impact of lecithin is currently being assessed in the medical field as an important factor in improving neurochemical disorders. Other medical and health related activity areas include positive in choleserol, blood chemistry and circulatory factors. Lecithin is also used in numerous industrial and nonfood applications such as pigment dispersing, mold release and animal feeds. **(Szuhaj, 1983).**

Soybean, sunflower and corn lecithin are insoluble in acetone. From the above mentioned results, it can be deduced that, soybean gum have a higher content of native powder of lecithin followed by sunflower and corn gum. These results are in agreement with **NSPA (1987) and Lantz (1989).**

4.1.3.1. Phospholipid composition of native powder of lecithin:-

The phospholipid composition of corn,soybean and sunflower lecithin are showed in Table (3). Further separation of the phospholipids fraction into four fractions Phosphatidylserine (PS), Phosphatidylinosetol (PI), Phosphatidylcholine (PC), Phosphatidylethanolamine (PE), (PS, PI, PC and PE g/100g) was carried out by TLC in the presence of authentic standards. The original amounts of the four phospholipids fraction ranged from 15.37-32.35, 13.59-22.56, 15.54-42.21 and 28.83-33.99 g/100g for PS, PI, PC and PE respectively.

Native powder of sunflower lecithin was found to contain the highest contents of PS and PI (32.35 and 22.56) followed by soybean and corn lecithin. Corn lecithin was found to contain the higher percentage of PC when compared with soybean and sunflower. On the other hand corn lecithin contain the lowest percentage of PE when compared with the other two by-products under investigation.

Table (3): Phospholipid composition of native powder of lecithin obtained from degumming by-product.

Phospholipid	Native powder of lecithin		
	Corn	Soybean	Sunflower
PS (g/100g)	15.37	28.27	32.35
PI (g/100g)	13.59	17.16	22.56
PC (g/100g)	42.21	20.24	15.54
PE (g/100g)	28.83	33.99	29.41

PS = Phosphatidylserine

PI = Phosphatidylinosetol

PC = Phosphatidylcholine

PE = Phosphatidylethanolamine

4.1.3.2 Fatty acid composition of native powder lecithin of soybean, sunflower and corn

The total saturated fatty acids in corn lecithin, Table (4) represents 35.08%, while, unsaturated fatty acids were (64.94%). Among the saturated ones, palmitic acid constituents showed major percentage, (32.15%), followed by stearic 2.63%. On the other hand, five unsaturated fatty acids were identified, linoleic acid which was the major one reached a value of (40.54) followed by oleic acid (23.32%).

Soybean lecithin contain the highest level of saturated fatty acids than the other two by-products, reached to (54.63%). Among the saturated ones, palmitic acid constituent major percentage, being (44.50%) followed by stearic acid (10.13%). On the other hand four unsaturated fatty acids were identified, oleic acid which was the major one reached a value of (23.90%).

On the contrary, sunflower lecithin contain the highest level of unsaturated fatty acids reached to (78.16%) when compared by the other two by-products under investigation. The major unsaturated fatty acids were linoliec (39.71%) followed by oleic acid (37.14%). These results are in agreement with that stated by **Vijayalakshmi and Rao (1972)**.

Table (4): Levels and fatty acid composition of Phospholipids in soybean, sunflower and corn degumming by-product.

Fatty acid%	Relative content (%)		
	Corn	Soybean	Sunflower
$C_{16.0}$	32.15	44.50	14.58
$C_{16.1}$	0.15	0.66	0.64
$C_{18.0}$	2.63	10.13	6.35
$C_{18.1}$	23.32	23.90	37.14
$C_{18.2}$	40.54	20.00	39.71
$C_{18.3}$	0.34	0.38	0.67
$C_{22.0}$	0.3	-	-
$C_{22.2}$	0.59	0.32	-
Total saturated	35.08	54.63	20.93
Total unsaturated	64.94	45.26	78.16

4.1.4. Hydrocarbons and sterols composition of the unsaponifiable matter of degumming by-product of some edible oils:

From the data listed in Table (5), it can be seen that the unsaponifiable matter of degumming by-product of corn oil consisted mainly of hydrocarbons (35.15%) and sterols (64.82%). Ten hydrocarbons were identified in corn gum, the main hydrocarbons were squalene and C28 which represents as 10.96% and 12.51% from the total unsaponifiable matter respectively.

The sterol composition of unsaponifiable matter corn gum consisted mainly of two compounds being campesterol and β-sitosterol. β-sitosterol was detected in corn gum by-product as the major sterol content (43.49%).

From the data presented in Table (5), it could be observed that, the sterols of the soybean gum constituted the major part of the unsaponifiable which contained 3 different components amounted 70.57% of the total unsaponifiable matter of the soybean gum under investigation, it contain β-sitosterol as a major constituent amounted 39.13% while stigmasterol and campesterol were present in moderate amounts 16.46 and 14.98% respectively.

Also, the data tabulated in Table (5), showed that, the hydrocarbon of the sunflower gum constituted the minor part of the unsaponifiable which contained 8 different components amounted 46.08% of the total unsaponifiable matter of sunflower gum under investigation. It contained C24 and C28 as a major constituents amounted 17.90% while C20, C22 and C26 were present in moderate amounts. Moreover, other hydrocarbons C19, C25 and squalene were found in relatively small amounts. β-sitosterol, campesterol and stigmasterol were detected in sunflower gum, their total amount was 53.92%, β-sitosterol was the main sterol comprised as 36.90%.

Table (5): Hydrocarbons and sterols of the unsaponifiable matter of degumming by-product of some edible oils.

Degumming by-product	Hydrocarbon %										Sterol %			Total hydro. %	Total sterols %
	C_{18}	C_{19}	C_{20}	C_{22}	C_{24}	C_{25}	C_{26}	C_{28}	C_{30}	Squalene	Campesterol	Stigmasterol	β-sitosterol		
Corn	1.92	1.96	1.67	1.23	0.36	0.07	1.62	12.51	2.85	10.96	21.33	-	43.49	35.15	64.82
Soybean	0.72	6.45	15.20	0.21	0.79	0.27	4.95	-	-	0.84	14.98	16.46	39.13	29.43	70.57
Sunflower	-	3.45	6.71	6.52	9.78	2.05	6.26	8.12	-	3.19	12.33	4.69	36.90	46.08	53.92

4.1.5. Antioxidant activity of native powder of lecithin:

Antioxidants are used to preserve foods by retarding rancidity, discoloratoion or deterioration due to autoxidation. Hence, the addition of antioxidants to food has become increasingly common as a means of increasing the shelf life and improving the stability of lipids and lipid containing foods. Synthetic antioxidants are widely used because they are effective and cheaper than natural types. However, the savfety and toxicity of synthetic antioxidants have been important concerns, Natural alternatives for synthetic antioxidants have been studied over the last few decades . Antioxidative substances obtained from natural sources ,such as oil seeds, grains, beans, fruits, leaf waxes and see weeds have been elucidated. **Yen and Duh(1993) and Duh et al (1997).**

4.1.5.1. Effect of addition of lecithin powder on the rate of oxidation of heated sunflower oil:

The classical antioxidant butylated hydroxy toluene (BHT) and native powder of lecithin produced from corn, soybean and sunflower gums by-product were separately added to refined sunflower oil in order to evaluate their effect as antioxidant on the rate of autoxidation and deterioration during deep fat frying (at 180 ± 10C). The obtained results are shown in Table (6) and Fig. (2). From these results, it could be noticed that the acid value of all samples increased gradually with heating time. Acid value of fresh sunflower oil was 0.14 and reached 2.48 after 48 hr of frying. The results showed that acid value increased to reach to 2.62, 2.54, 2.42, 2.42 in sunflower oil plus soybean, corn, sunflower lecithin and BHT respectively.

The increase in the acid value of oil may be attributed to slight random hydrolysis of triglycerols to produce free fatty acids and diacylglycerols **(Yoshida *et al.*, 1992).** And also the increase of acid value of sunflower oil and sunflower oil with additives is mainly due to the formation of acidic compounds and free fatty acid as result of secondary products cleavage formed during oxidation and frying. **Abdel-Wahed (1986) and El-Said (1995).**

The iodine value is used as a measure of degree of unsaturation of an oil. Therefore, the iodine value of fresh and heated sunflower oil were determined and the results are shown in Table (6) and Fig. (3).

It is clear that the iodine values decreased rapidly from 134.43 for fresh sunflower oil to 78.91 after 24 hr heating. Whereas the sunflower oil containing added corn, soybean and sunflower native powder of lecithin and butylated hydroxytoluene (BHT) decreased slowly from 134.43 to 115.3, 107.7, 98.14 and 93.78 after 24 hr of heating, respectively. Such little decrease in the iodine values was coincident with the rapid increase in benzidine number from 92.24 for fresh oil to 268.35 after 24 hr heating. Whereas the sunflower oil containing added lecithin powder of corn, soybean, sunflower and BHT its benzidine number increased slowly from 92.24 at zero time to 184.7, 215.42, 212.14 and 216.36 after 24 hr of heating, respectively. The noticed rapid increase in benzidine number after 24 hr in case of BHT might be attributed to its volatility during prolonged heating as mentioned by **DeMan (1976).** These results are in parallel with that reported by **Pel-Fen and Nawar (1986), Abdel-Rahman (1984) and Ahmed (1997).** The high decrease in iodine values corresponds fairly well with the decrease in the dienoic acid, owing to the saturation and mostly oxidation that change in iodine values could be used as a means of the dienoic acids change during oil frying at high temperature, **Waltking and Smachinski (1970).**

The decrease occurred in iodine value due to heating may be attributed to the decrease in the relative percentage of total unsaturated fatty acids, since, oxidation caused a decrease in the relative percentage of total unsaturated fatty acids and an increase in the relative percentage of total saturated fatty acids after heating **(Yoshida *et al.*, 1990).**

The peroxide values mostly increased up to a certain point after 24 hr then decreased gradually after 32 hr of heating due to the breakdown of peroxides to secondary oxidation products.

The peroxide value of sunflower oil, sunflower oil plus different lecithin powder and BHT are shown in Table (6) and Fig. (4). The results showed that the peroxide value (m.eq./kg oil) increased gradually during frying process from 0.49 in sunflower oil to 58.93 in 24 hrs of heating, then decreased to 8.23 after 48 hr of heating.

The results showed that the peroxide value (m.eq. of O_2/ kg oil) in sunflower oil plus sunflower lecithin powder and soybean lecithin powder increased gradually during frying up to 33.88, 42.13, respectively after 24 hr of heating, while in sunflower oil plus corn lecithin powder and BHT increased to 48.49 and 50.66 respectively after 24 hr of heating. Then it began to decrease reaching to 12.23, 19.17, 15.42, 15.01 in sunflower oil plus sunflower lecithin powder, soybean lecithin powder, corn lecithin powder and BHT respectively. 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).** And also, decrease in peroxide value is mainly caused by destruction of peroxide compounds and formation of high molecular weight products.

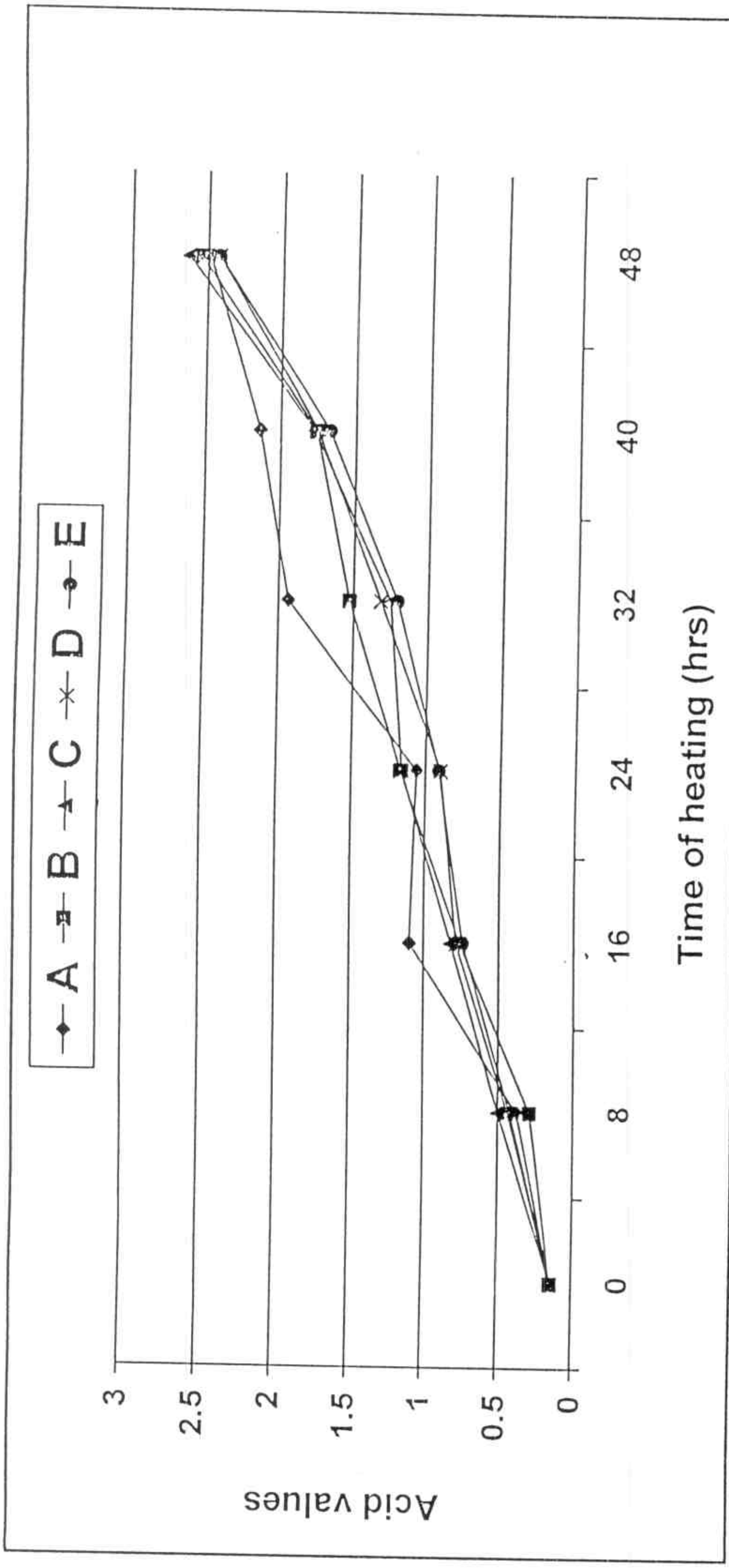
As a result of frying process **Arellano and Esteves (1992) and Cuesta *et al.* (1993).**

These results are in agreement with those reported by **Hudson and Mahgoub (1981)** who found that phosphatidylcholine and phosphatidylethanolamine, acts as powerful synergists in conjunction with representatives of at least two classes of naturally occurring antioxidants, the tocopherols and the flavonols. In addition the results showed that corn lecithin powder contained high level of (phosphatidylcholine and phosphatidylethanolamine (42.21, 28.83) comparing with sunflower lecithin powder and soybean lecithin powder.

It could be noticed that, the addition of native powder of lecithin which produced from corn, soybean and sunflower gums caused a pronounced increase in the induction period of sunflower oil.

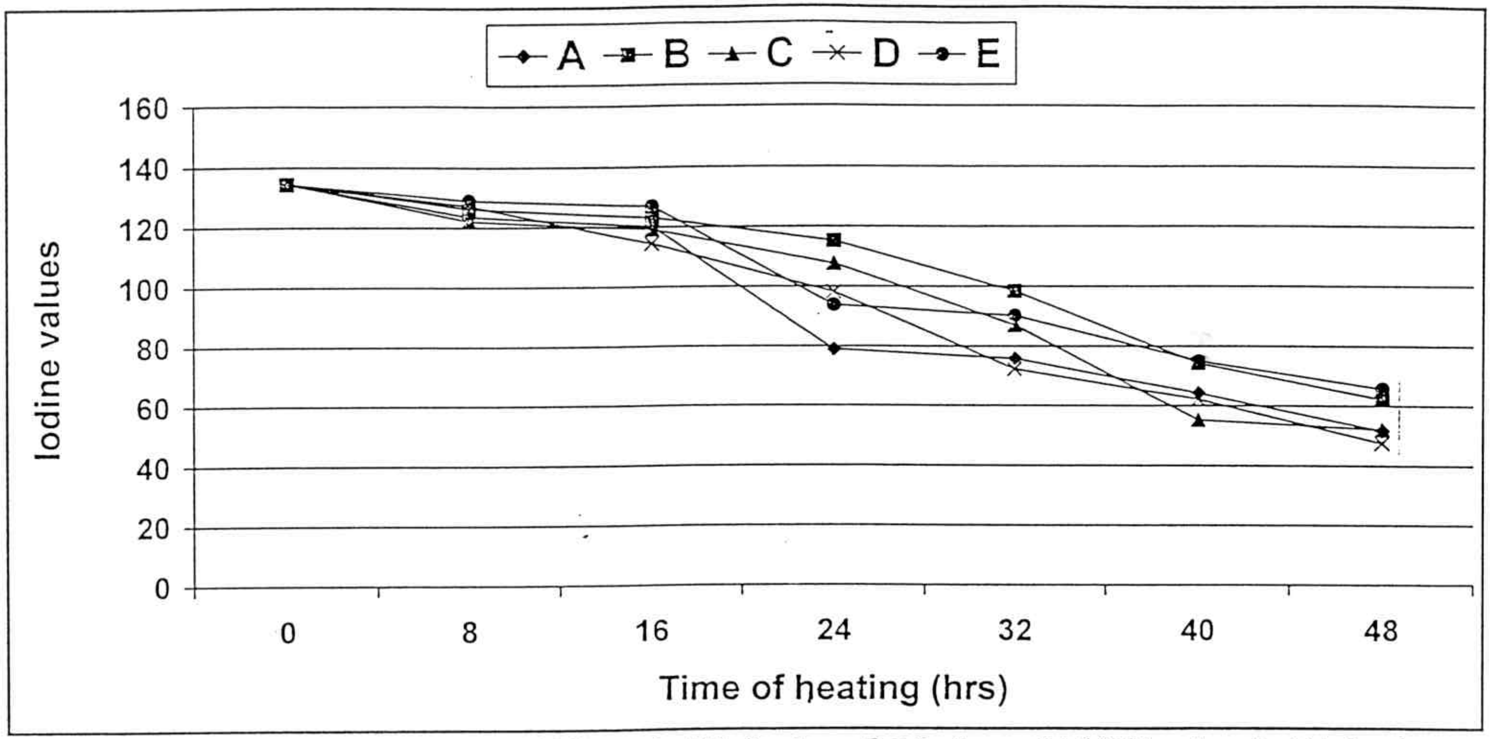
Table (6): Effect of addition of lecithin powder on the rate of oxidation of heated sunflower oil at 180 ± 10°C

Source	Independent variable	Acid value Means ± Standard Error	Iodine value Means ± Standard Error	Peroxide value Means ± Standard Error	Benzidine Number Means ± Standard Error
Sunflower oil	Zero time	0.14 ± 0.00	134.43 ± 0.32	0.49±0.01	92.24±0.12
	8 hrs	0.37 ± 0.00	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	17.9±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 Lecithin Powder	Zero time	0.14 ± 0.00	134.43±0.32	0.49±0.01	92.24±0.12
	8 hrs	0.29 ± 0.01	126.26±1.05	15.47±0.46	140.89±0.77
	16 hrs	0.76 ± 0	123.21±0.01	24.44±0.33	164.16±1.07
	24 hrs	1.17 ± 0.04	115.3±0.06	48.49±0.24	184.7±2.39
	32 hrs	1.52 ± 0.00	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 ± 2.04	62.22±0.99	15.42±0.16	529.15±1.43
Sunflower oil + 0.05 % soybean Lecithin Powder	Zero time	0.14 ± 0.00	134.43±0.32	0.49±0.01	92.42±0.12
	8 hrs	0.5 ± 0.03	122.17±0.99	10.09±0.12	146.33±1.88
	16 hrs	0.82 ± 0.01	119.22±0.04	30.6±0.35	198.13±0.21
	24 hrs	1.16 ± 0.31	107.7±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 ± 0.01	55.21±0	37.08±0.26	511.73±10.24
	48 hrs	2.62 ± 0.04	52.17±0.01	19.17±0.25	589.12±2
Sunflower oil + 0.05 % sunflower Lecithin Powder	Zero time	0.14 ± 0.00	134.43±0.32	0.495±0.015	92.24±0.12
	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	0.9 ± 0.02	98.14±1.03	33.88±0.02	212.14±12.77
	32 hrs	1.31 ± 0.105	72.24±0.96	15.73±0.59	313.84±1.83
	40 hrs	1.75 ± 0.04	62.19±0.01	14±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	Zero time	0.14 ± 0.00	134.43±0.32	0.49±0.01	92.24±0.12
	8 hrs	0.42 ± 0.02	129.02±0.8	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±0.00	216.36±1.34
	32 hrs	1.20 ± 0.00	90.21 ±1	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 ± 0.3	65.74 ± 2.46	15.01±0.40	481.79±15.17



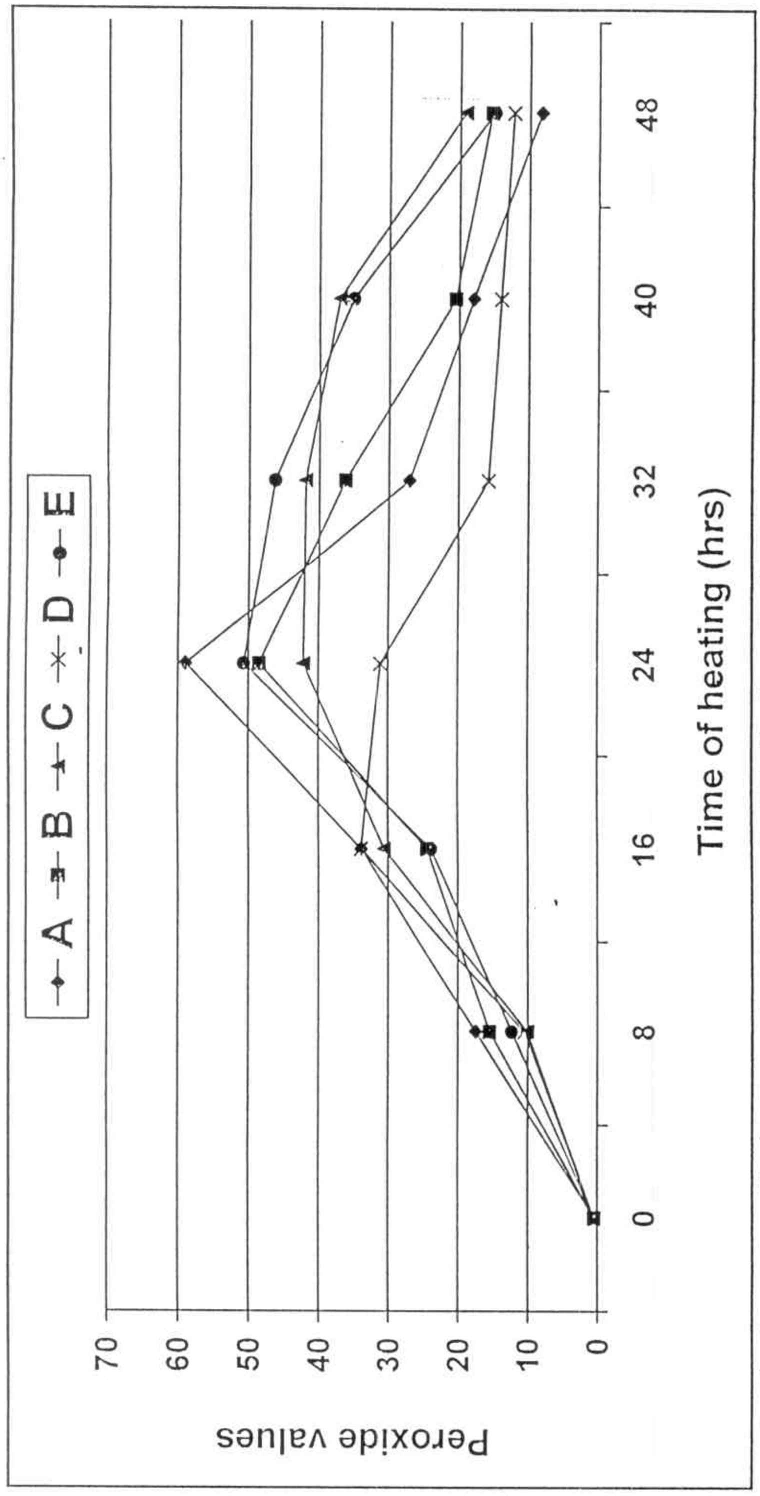
A = Sunflower oil, **B** = Sunflower oil + 0.05 % corn Lecithin Powder, **C** = Sunflower oil + 0.05 % soybean Lecithin Powder.
D = Sunflower oil + 0.05 % sunflower Lecithin Powder, **E** = Sunflower oil + 0.05 % BHT

Fig. (2): Effect of heating on acid values of treated sunflower oil.



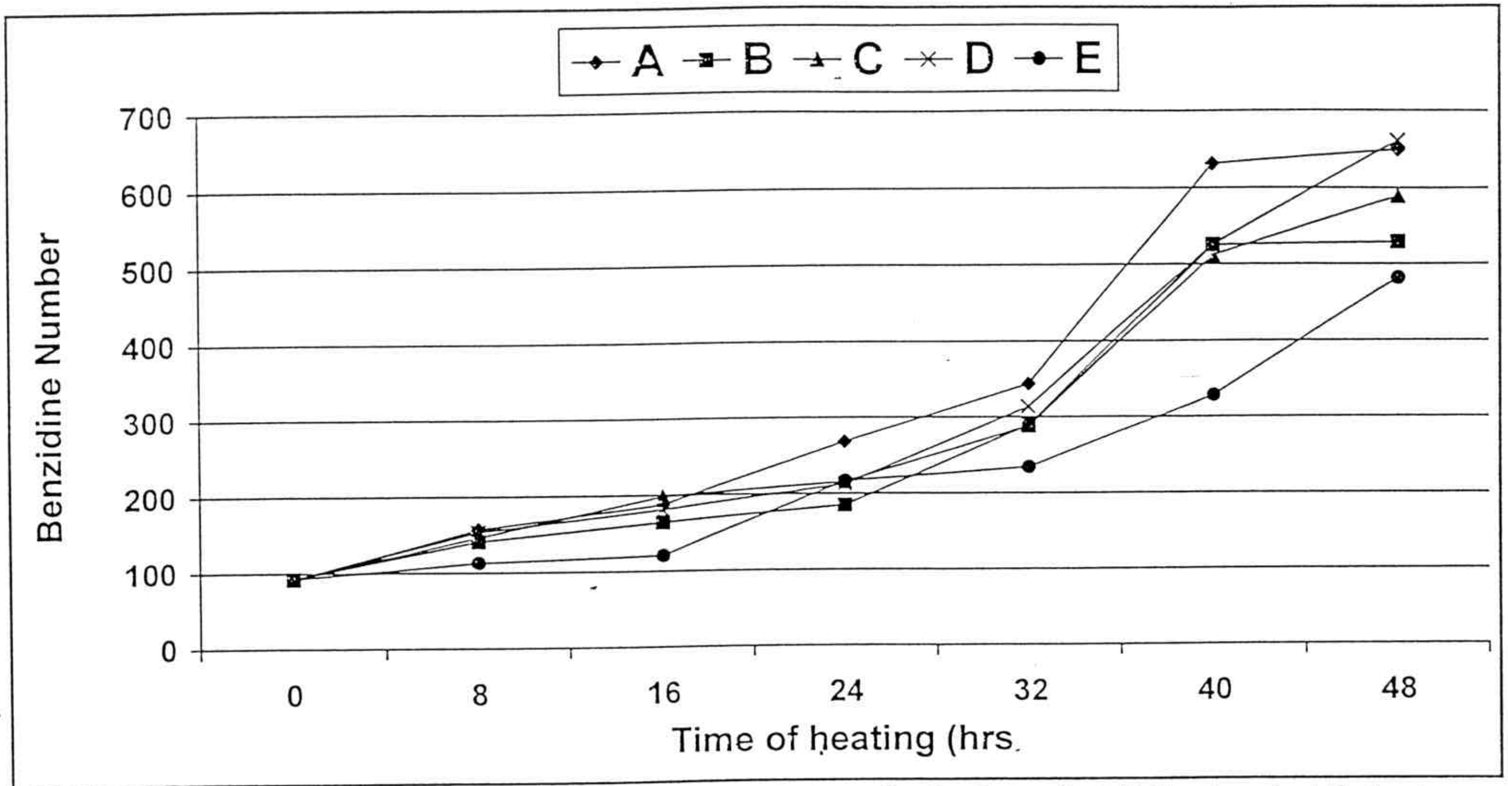
A = Sunflower oil, **B** = Sunflower oil + 0.05 % corn Lecithin Powder, **C** = Sunflower oil + 0.05 % soybean Lecithin Powder. **D** = Sunflower oil + 0.05 % sunflower Lecithin Powder, **E** = Sunflower oil + 0.05 % BHT

Fig. (3): Effect of heating on iodine values of treated sunflower oil.



A = Sunflower oil, **B** = Sunflower oil + 0.05 % corn Lecithin Powder, **C** = Sunflower oil + 0.05 % soybean Lecithin Powder,
D = Sunflower oil + 0.05 % sunflower Lecithin Powder, **E** = Sunflower oil + 0.05 % BHT

Fig. (4): Effect of heating on peroxide values of treated sunflower oil.



A = Sunflower oil. **B** = Sunflower oil + 0.05 % corn Lecithin Powder, **C** = Sunflower oil + 0.05 % soybean Lecithin Powder, **D** = Sunflower oil + 0.05 % sunflower Lecithin Powder, **E** = Sunflower oil + 0.05 % BHT

Fig. (5): Effect of heating on Benzidine number of treated sunflower oil.

4.1.5.2. Effect of addition of lecithin powder on fatty acid composition of heated sunflower oil:

Oxidation of oils can easily occur in the presence of oxygen. Oils become rancid as a result of oxidation, this oxidative rancidity is mainly due to the reaction of oxygen with unsaturated fatty acids to form oxidized products. The changes of fatty acid composition during heating at 180°C ± 10 °C of sunflower oil without or with addition of native powder of lecithin are shown in Table (7). The obtained results show that, the content of polyunsaturated fatty acid in fresh sunflower oil was around 60%. During heating of oil at 180 °C ± 10 °C, the decrease in linoleic and linolenic acid contents for sunflower oil (control) and sunflower plus native powder of lecithin of corn, sunflower and soybean were observed.

Meanwhile oleic (C18:1) increased from 30.93 to 39.26, 32.80, 33.85, 30.35 and 33.12 for sunflower oil, sunflower oil plus corn, soybean, sunflower lecithin powder and BHT respectively after frying for 48 hours.

The decrease in linoleic indicates that this acid is actually oxidized and polymerized to high molecular weight fraction (polymeric materials) which could not identified by gas liquid chromatography the results were in agreement with **El-Hadidi (1994) and El-Said (1995).**

Conversely, an increase occurred in relative percentage of total saturated fatty acids as well as in 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 relative percentage of total unsaturated fatty acids after heating **(Yoshida *et al.*, 1990).**

Results revealed that palmitic acid (16:0) increased from 6.40% to 16.38% in sunflower oil, while it increase to 14.12, 13.21, 15.43 and 12.50 in sunflower oil treated with corn, soybean, sunflower lecithin powder and BHT respectively after heating for 48 hours.

Changes in the $C_{18:3} + C_{18:2} / C_{16:0}$ ratio may provide a reliable measure of oil deterioration. As shown in Table (7), it is clear that, the percentage of linoleic + linolenic to palmitic acid in fresh sunflower oil was 9.35, this value decreased rapidly to 5.34 after 16 hr heating. Furthermore, the higher ratios for treatments with the native powder of lecithin than for the control implied the sunflower oil with the native powder of lecithin possessed a high resistance to oil oxidation.

Table (7): Effect of addition of lecithin powder on the fatty acid composition of heated sunflower oil.

Time of heating (hr)	Fatty acids %										$C_{18:3}$ + $C_{18:2}$ / $C_{16:0}$
	C_{12}	C_{14}	$C_{16:0}$	$C_{16:1}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$	TS	TUS	
Control											
Zero	0.22	0.18	6.40	-	2.33	30.93	47.47	12.36	9.13	90.36	9.35
16	0.28	0.45	9.86	2.31	2.88	30.35	43.08	9.60	14.47	85.34	5.34
32	0.86	0.78	13.36	3.42	6.41	33.31	36.55	4.33	21.41	77.61	3.06
48	2.01	2.51	16.38	-	6.82	39.26	31.07	-	29.62	70.33	1.90
Sunflower oil + 0.05% corn native powder of lecithin											
16	0.34	0.70	7.37	0.4	3.96	30.83	46.06	10.11	12.37	87.4	7.62
32	0.14	0.63	11.22	2.01	3.45	31.76	41.35	9.21	15.44	84.33	4.51
48	0.51	0.83	14.12	4.07	7.07	32.80	35.41	5.61	22.53	77.89	2.91
Sunflower oil + 0.05% soybean native powder of lecithin											
16	0.26	0.52	7.55	0.66	4.30	30.90	44.35	11.32	12.63	87.23	7.37
32	0.51	0.61	11.98	2.34	4.48	31.13	39.48	9.91	17.58	82.86	4.12
48	0.62	0.84	13.21	3.81	6.26	33.85	36.42	4.99	20.93	79.07	3.14
Sunflower oil + 0.05% sunflower native powder of lecithin											
16	0.23	0.33	7.86	0.50	3.77	30.91	45.82	10.23	12.19	87.46	7.13
32	0.43	0.76	12.56	2.30	3.59	29.18	40.18	10.18	17.34	81.84	4.01
48	0.40	0.287	15.43	3.67	6.32	30.35	36.11	6.84	23.02	76.96	2.78
Sunflower oil + 0.05% BHT											
16	0.43	0.36	8.10	0.56	3.40	30.83	46.04	10.15	12.29	87.58	6.94
32	0.50	0.45	11.01	2.32	4.72	31.74	40.12	9.18	16.68	83.36	4.48
48	0.72	0.89	12.50	3.70	6.33	33.12	37.12	5.56	20.44	79.50	3.41

4.2. Bleaching by-product:

The primary function of the bleaching process is to remove the oxidative breakdown products and it should be noted that color reduction is coincidentally achieved **(Wiedermann, 1981).**

4.2.1. Solubility of bleaching by-product in petroleum ether:

Petroleum ether extraction of bleaching by-product undoubtedly includes minor components present adsorbed in bleaching clay such as phospholipids, fatty acids and sterols as well as other oxidized, hydrolyzed, and polymerized products.

From the data presented in Table (8) it is clear that corn bleaching by-product contain the highest level of solubility adsorbed matter (20.21%), while it was (11.04%) and (8.71%) in sunflower and soybean bleaching by-product respectively.

Table (8): Solubility of bleaching by-product in petroleum ether.

Source of bleaching by-product	Solubility %
	Petroleum ether (60-80°C)
Corn	20.21 ± 0.71
Soybean	8.71 ± 0.10
Sunflower	11.04 ± 0.12

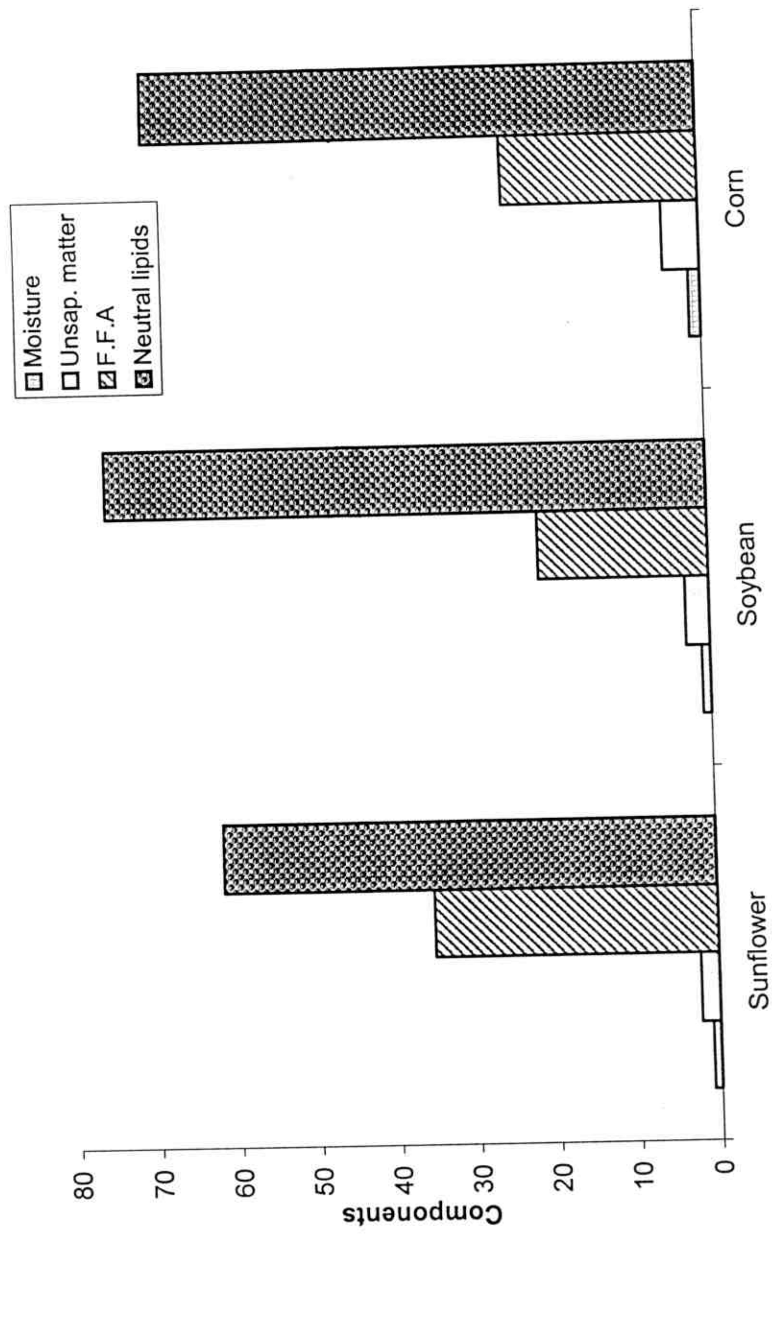
4.2.2. Chemical composition of petroleum ether extract of bleaching by-product.

The chemical composition of sunflower, soybean and corn oils bleaching by-product extract are shown in Table (9) and Fig. (6). The results showed that the moisture content of the bleaching by-product was 1.45%, 1.05% and 0.92% for corn, soybean and sunflower bleaching by-product respectively. The unsaponifiable matter was 4.61%, 2.97% and 2.32% for corn, soybean and sunflower bleaching by-product respectively. While free fatty acid as oleic content is higher in sunflower bleaching by-product 35.22% than corn and soybean bleaching by-product (24.50 and 21.12%) respectively. Neutral lipid was higher in soybean bleaching by-product (75.12) followed by corn and sunflower bleaching by-product 69.50 and 61.54 respectively.

Table (9) Chemical composition of bleaching by-product extract.

Components %	Corn	Soybean	Sunflower
Moisture	1.45	1.05	0.92
Unsap. matter	4.61	2.97	2.32
F.F.A	24.50	21.12	35.22
Neutral lipids	69.50	75.12	61.54

Fig. (6): Chemical composition of bleaching by-product



4.2.3. Hydrocarbon and sterols composition of unsaponifiable matter of bleaching by-products:

From the results shown in Table (10), it can be noticed that the unsaponifiable matter of bleaching by-product of corn oil consisted mainly of hydrocarbons (64.11%). The main hydrocarbons were squalene and C30 which represents as 9.76 and 9.49% respectively. The sterol composition of unsaponifiable matter of bleaching by-product of corn consisted of ß-sitosterol which represents as 25.54%.

The data represented in Table (10) showed that sterols constituted the major part of the unsaponifiable matter of soybean bleaching by-product, their amount were (54.79%), the main component was ß-sitosterol (30.23%) while stigmasterol was 13.00%.

From the data represented in the same Table it could be seen that hydrocarbons were the major component of unsaponifiable matter of sunflower bleaching by-product their total amount was 69.75%. The main hydrocarbons were C26, C20 and C19 which represents as 22.37, 12.32% and 9.44% respectively.

Table (10): Hydrocarbons and sterols composition of unsaponifiable matter of bleaching by-products:

Bleaching by-product	Hydrocarbon %										Sterol %			Total hydrocarbon.%	Total sterols%
	C_{18}	C_{19}	C_{20}	C_{22}	C_{24}	C_{25}	C_{26}	C_{28}	C_{30}	Squalene	Campesterol	Stigmasterol	β-sitosterol		
Corn	3.25	4.09	5.79	4.13	6.52	6.61	8.4	6.07	9.49	9.76	10.38	-	25.54	64.11	35.92
Soybean	2.86	5.05	7.40	2.47	4.25	3.69	10.30	2.61	4.63	2.04	11.56	13.00	30.23	45.30	54.79
Sunflower	5.52	9.44	12.32	5.91	3.25	4.58	22.37	1.89	1.44	3.03	10.10	5.57	14.56	69.75	30.23

4.3. Deodorization by-product

Deodorization is the last major processing step in refining of edible oils. It is responsible for removing the undesirable volatile compounds occurring in natural fats and oils. Deodorizer distillate contains the volatile organic materials which is steam distillated in the deodorization process. This distillate contain tocopherols, sterols, hydrocarbons which are considered as valuable raw materials.

4.3.1. Solubility of deodorizer distillate in petroleum ether:

From the data presented in Table (11) it can be noticed that high solubility of all deodorizer distillate obtained from corn, soybean and sunflower ranged from (94.25 to 96.88%).

Table (11): Solubility of deodorizer distillate in petroleum ether.

Source	Solubility %
	Petroleum ether (60-80°C)
Corn	94.25 ± 0.13
Soybean	95.6 ± 0.52
Sunflower	96.88 ± 0.17

Means ± Standard Error

4.3.2. Chemical composition of petroleum ether extract of deodorizer distillate:

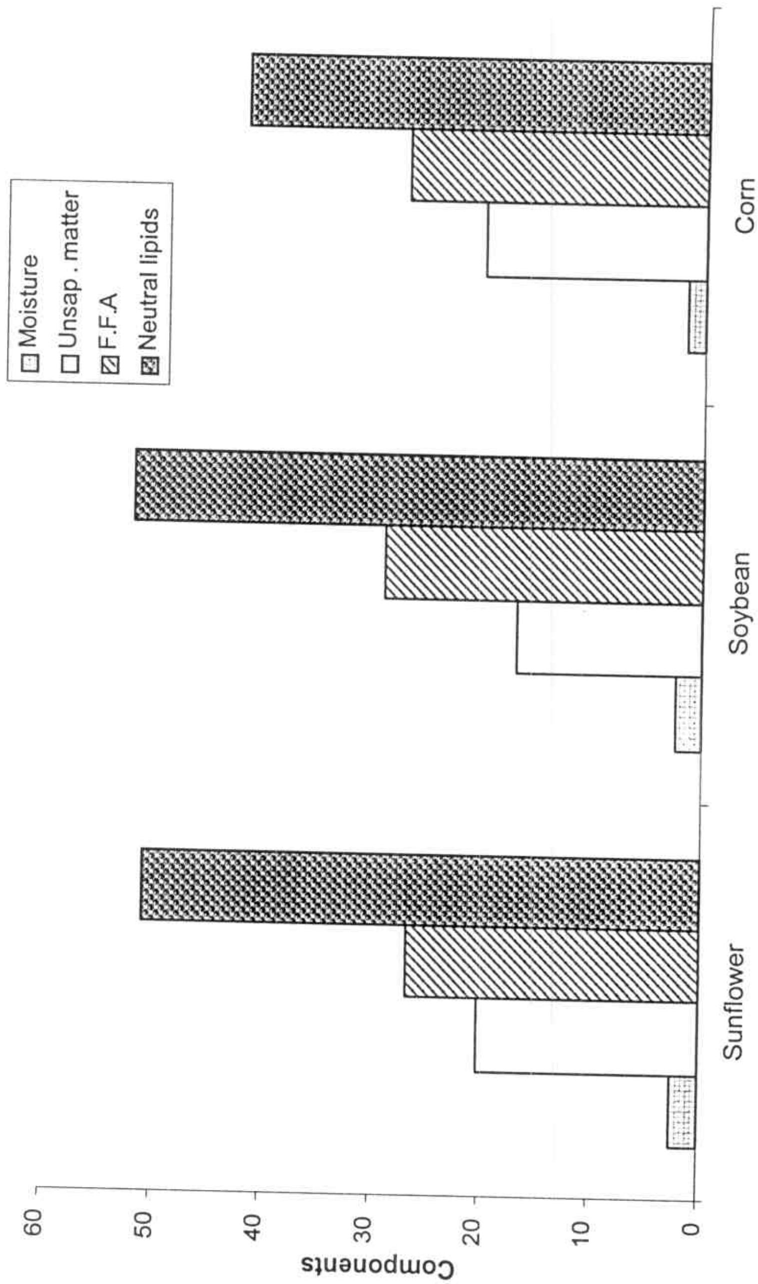
From the Table (12) and Fig. (7) it can be noticed that moisture content ranged from 1.79 to 2.21% in the three extraction of deodorizer distillate under investigation. Unsaponifiable matter was 22.08, 16.86 and 20.07 for corn, soybean and sunflower deodorizer distillate extraction respectively. Those results are in agreement with **Suresh and Alan (1993)**.

Free fatty acid as oleic content is higher in corn deodorizer distillate extract (29.91) than soybean and sunflower (29.00 and 26.72). On the other hand, neutral lipid was higher in soybean (52%) deodorizer distillate extract than sunflower and corn (51.00 and 46.22), respectively.

Table (12) Chemical composition of petroleum ether extract of deodorizer distillate.

Components %	Deodorizer distillate of		
	Corn	Soybean	Sunflower
Moisture	1.79	2.14	2.21
Unsap. matter	22.08	16.86	20.07
F.F.A	29.91	29.00	26.72
Neutral lipids	46.22	52.00	51.00

Fig. (7): Chemical composition of deodorizer distillate



4.3.3. Fatty acid composition of deodorizer distillate of soybean, sunflower and corn oil.

Gas liquid chromatography technique (GLC) was used to study the fatty acid composition of soybean, sunflower and corn oil deodorizer distillate. The results are shown in Table (13). From these results it could be noticed that, the major constituents of unsaturated fatty acids from the three oils by-product under investigation were oleic (33.55, 35.10 and 29.39%) and linoleic acids (37.23, 46.23 and 36.36%) for deodorizer distillate of soybean, sunflower and corn oils, respectively. While the major saturated fatty acids was palmitic acid. While the other fatty acids constituted represented as a minor components.

These results are in agreement with **Suresh and Alan (1993)** who reported that palmitic, oleic and linoleic acid is the major component in fatty acid of deodorizer distillate of soybean oil.

Table (13): Fatty acid composition of deodorizer distillate of soybean, sunflower and corn oils.

Source	C_{14}	$C_{16;0}$	$C_{18.0}$	$C_{18.1}$	$C_{18.2}$
Soybean	0.99 ± 0.77	24.56 ± 0.07	3.72 ± 0.31	33.55 ± 1.23	37.23 ± 3.27
Sunflower	1.01 ± 0.06	14.73 ± 1.7	2.93 ± 0.335	35.10 ± 0	46.23 ± 7.20
Corn	0.55 ± 0.22	27.63 ± 2.46	6.05 ± 1.44	29.39 ± 0.80	36.36 ± 3.33

4.3.4. Hydrocarbons and sterols composition of the unsaponifiable matter of deodorizer distillate, of some edible oil:

From the data represented in Table (14) it could be noticed that the unsaponifiable matter of deodorizer distillate of corn oil consisted mainly of hydrocarbons (49.49%) and sterols (49.90%). The main hydrocarbons were squalene and C28 (13.99% and 21.85%) respectively. The sterols composition of unsaponifiable matter of deodorizer distillate of corn oil consists mainly of ß-sitosterol (34.46%).

From the data represented in Table (14) it could be noticed that, the unsaponifiable matter of soybean deodorizer distillate consisted of hydrocarbons (56.15) and sterols (53.86). The main hydrocarbons were C22 and C26 (8.76% and 9.42%). The sterols composition consisted mainly of two compounds ß-sitosterol and stigma sterol. ß-sitosterol was detected as the major sterol (34.77%). These results are in agreement with **Ghosh and Bhattacharyya (1996).**

The same data showed that, the sterols of sunflower deodorizer distillate consisted of three components ß-sitosterol, stigmasterol and campsterol which amounted (45.11%, 6.69% and 12.65%) respectively, the total amount of sterols was 65.45% of unsaponifiable matter of sunflower deodorizer distillate, these results are in agreement with **Suresh and Alan (1993).**

Table (14): Hydrocarbons and sterols composition of the unsaponifiable matter of deodorizer distillate, of some edible oil:

Deodorizer distillate	Hydrocarbon %										Sterol %			Total hydrocarbon.%	Total sterols%
	C_{18}	C_{19}	C_{20}	C_{22}	C_{24}	C_{25}	C_{26}	C_{28}	C_{30}	Squalene	Campesterol	Stigmasterol	β-sitosterol		
Corn	3.01	0.13	1.74	0.59	0.20	0.71	2.19	21.85	5.08	13.99	15.44	-	34.46	49.49	49.9
Soybean	2.45	5.84	1.52	8.76	6.95	4.36	9.42	0.70	0.27	5.88	9.09	10.00	34.77	56.15	53.86
Sunflower	2.52	3.55	5.06	14.64	2.77	0.71	1.69	1.71	0.69	1.25	12.65	6.69	45.11	34.59	65.45

4.3.5. Determination of total tocopherols in deodorizer distillate of some edible oils:

Tocopherol, which is physiologically active as vitamin E is major natural antioxidant and is used for protection of fats and oils from atmospheric oxidation. **Ghosh and Bhattacharyya (1996).**

From the results shown in Table (15) it could be noticed that total tocopherol were higher in soybean and corn deodorizer distillate than sunflower deodorizer distillate, these results are in good agreement with **Suresh and Alan (1993).**

From the same Table it could be noticed that the total detected tocopherol in sunflower deodorizer distillate were (4.19%), these results are in agreement with **Ghosh and Bhattacharyya (1996)** in sunflower deodorizer distillate percentage.

Table (15): Total tocopherols percentage of deodorizer distillate of corn, soybean and sunflower oil:

Determined sample	Total percentage of tocopherol
Corn	10.41
Soybean	10.70
Sunflower	4.19

Conclusion :

This study was carried out to investigate the suitability of utilization of by-products produced through corn, soybean, and sunflower refining. These by-products were degumming by-product, bleaching by-product and deodorizer distillate. Chemical composition of these by-products were identified. The obtained results indicated that degumming by-product characterized by high level of phospholipids, which used as a good source for producing of native powder of lecithin. Addition of native powder of lecithin which separated from degumming by-product led to increase the stability of heated sunflower oil.

The obtained results indicate that the deodorizer distillate contained a high level of sterols and tocopherol reached to 10.70%.