RESULTS AND DISCUSSION

A) Sardine fish:

It is well known that season of fishing affects the weight, size and composition of fish. Also the weight of viscera and gutted fish increases by increasing the whole fish weight. Sardine caught in March were less in weight, consequently less of viscera and gutted fish while those of October were higher in weight, viscera and gutted ones. Such differences may be due to season effect where sardine fish of March are considered lean fish, while those of October are fatty ones. When sardine fish are dressed the yield of October showed less value than that of March which may be due to high percentage of fat in viscera of fish caught in October.

Smoking of whole, gutted and dressed sardine fish decreased their weight, however smoked whole fish decreased their weight followed by gutted and dressed ones.

1. Nutritional evaluation of smoked Sardine products:

1.1. Chemical composition of frozen and smoked Sardine fish products:

The chemical composition of frozen sardine, smoked whole, gutted and dressed fish is shown in Table (1).

Frozen sardine fish had 72.40, 17.62, 7.91, 2.07, 357.55 and 41.95%. Smoked whole fish were of 56.55, 25.01, 13.09, 5.35, 251.95 and 59.55%. Smoked gutted fish revealed 56.07, 24.78, 11.58, 7.57, 254.24 and 59.00%, while smoked dressed fish showed 55.43, 26.90, 11.47, 6.20, 5.62, 234.20 and 64.05%;

Table (1): Chemical composition of frozen and smoked-Sardine fish products (*Sardina pilcharides*).

Constituents	Frozen Sardine fish	Smoked-sardine products		
		Whole	Gutted	Dressed
Moisture %	72.40	56.55	56.07	55.43
Crude protein % (N x 6.25)	17.62	25.01	24.78	26.90
Ether extract %	7.91	13.09	11.58	11.47
Ash %	2.07	5.35	7.57	6.20
G.D.R for protein (g)	357.55	251.95	254.24	234.20
PS/150 gm for protein %	41.95	59.55	59.00	64.05

moisture, crude protein, ether extract, ash, G.D.R. for protein (g) and PS/150 g for protein percentage, respectively.

Data presented in Table (1) show the effect of cold-smoking on proximate chemical composition of imported frozen Sardine fish (*Sardina pilcharides*). Moisture content decreased by smoking for all smoked products. This may be due to penetration of smoke compounds which lowered the pH values and consequently decreased the W.H.C. The water loss may be also explained by simple evaporation during smoking. Thus, smoked product which had the lowest pH and W.H.C. values showed the highest decrease of moisture content. Also, it could be observed that the decrement was lower for whole smoked product which had higher ether extract content. This may be due to high fat acted as a protective barrier during smoking and reduced moisture evaporation and loss. These results were approved by the findings of Bhuiyan *et al.* (1986) and Dessouki & Hassanin (1995).

With respect to the effect of smoking on crude protein content, it showed apparent increase which may be due to the loss of moisture content. The percent increase were: 41.94%, 40.64% and 52.68% for whole, gutted and dressed smoked Sardine, respectively.

From the results in Table (1), it could be observed that all smoked-Sardine products showed apparent increase in ether extract compared to frozen fish. This might be due to the loss of moisture content. These results coincided with the findings of Hoffman *et al.* (1977) and Dessouki & Hassanin (1995). Smoking method increased evidently the ash content of smoked products. This may be due to increase of NaCl during brining and smoking process (Shiau and Chai, 1985 and Bhuiyan *et al.*, 1986a). Thus it may be expected that ash and NaCl contents of smoked products will be related to the condition of brining process (concentration of brine and the form of fish product). In this connection, products brined in higher concentration of NaCl solution had higher ash content than those brined in solution of lower concentration being, 7.57% for gutted and 6.20% for dressed. But for products brined in the same NaCl solution the ash content in smoked products was related to the form of fish, where gutted fish had higher ash content than whole fish. This may be due to the increased exposed area that was in contact with brine, and increased rate of NaCl penetration into fish tissue during brining process; also the rate of moisture evaporation during smoking process might show some effect.

GDR; grams of smoked Sardine fish products are consumed to cover the daily requirements of protein for adult man (25-50 years old) and Ps/150 g; per cent satisfaction when 150 g of such products for the daily requirements of adult. These values of GDR and Ps/150 g are affected by protein content.

Therefore cold-smoked Sardine products could be arranged descendingly as follows; dressed, whole and gutted Sardine. Results of GDR and Ps/150 g fore protein revealed that cold-smoked dressed Sardine fish were the best among the other three prepared smoked Sardine products. When the adult man (25-50 years) consumes 150 g of such product, the RDA (recommended dietary allowances) for protein will be satisfied at 64.05%.

1.2. Physico-chemical evaluation of smoked-Sardine fish products:

Results in Table (2) show the effect of cold-smoking on the physico-chemical properties of frozen and smoked Sardine fish. The total phenols and carbonyls compounds (as mg/100 g) for smoked whole, gutted and dressed Sardine products were 13.00, 28.62, 16.03, 32.11, 16.90 and 32.60, respectively. These values revealed that smoked whole and gutted fish had the lowest contents of phenols and carbonyl compounds while smoked dressed product had the highest levels. This may be due to fish form, in other words the larger exposed area of dressed fish to smoke compounds. Thus, the penetration of these compounds into dressed fish (eviscerated, scaled and headed) was higher than into gutted (eviscerated) and whole fish.

The pH value of frozen Sardine was 6.38 and decreased by smoking for all products as it reached 5.85, 5.71 and 5.62 for whole, gutted and dressed fish, respectively. This may be probably due to the penetration of organic acids and indirectly the absorption of smoke compounds (phenols and carbonyls) into fish muscles. It is well known that, there was a reverse relation between pH value and such compounds. Therefore, the product which had high concentration of phenols and carbonyls, had lower pH value. The three smoked products could be arranged descendingly according to phenols and carbonyls contents as follows; dressed, gutted and whole Sardine but according to pH values reverse arrangement could be noticed.

Table (2): Physico-chemical properties of frozen and smoked-Sardine products.

Indices	Frozen Sardine fish	Smoked-Sardine products		
		Whole	Gutted	Dressed
Phenols (mg/100 g)	-	13.00	16.03	16.90
Carbonyls (mg/100 g)	-	28.62	32.11	32.60
pH value	6.38	5.85	5.71	5.62
WHC: as (cm^2/0.3 g sample)	4.82	5.12	5.52	5.76
WHC: as (bound water) %	81.36	74.65	72.43	70.90
Plasticity: as (cm^2/0.3 g sample)	3.25	3.11	2.83	2.65
Plasticity: as (cm^2/g TN)	384.27	259.10	238.94	205.24
Water phase salt (WPS) %	-	7.58	10.29	9.15
TBA (mg malonaldehyde/kg)	1.978	1.23	0.794	0.532
TVN (mg/100 g)	16.58	11.32	8.80	7.45

The values of WHC as (0.3 cm^2/g sample) are inversely to the high water holding capacity (% bound water). The better WHC indicates directly the good quality of the product. From Table (2), it could be observed that frozen Sardine had high water holding capacity being 81.36% (as bound water) and decreased by smoking to 74.65, 72.43 and 70.90 for whole, gutted and dressed fish, respectively, where there is a positive relation between pH and WHC values (% bound water). Thus, the smoked products could be arranged according to WHC values as the same order of pH values. Therefore, the product which had the highest pH value had the highest WHC value (bound water). Also, results of moisture level contents went parallel to that of WHC values (Table, 2), indicating the effect of the latter property on the former one.

Plasticity values (as cm^2/0.3 g sample or as cm^2/g TN) were directly related to good quality of animal foods. Results obtained in Table (2) revealed that smoking decreased the plasticity of smoked Sardine products as the same for WHC and PH values where, it was noticed that there was a positive correlation between the three parameters and also phenols & carbonyls compounds. These results coincided with that of Dessouki and Hassanin (1995). Thus the three smoked-Sardine products could be arranged descendingly according to pH values, WHC and plasticity as follows; whole, gutted and dressed fish.

The water phase salt (WPS) of smoked-Sardine products followed the same trend as mentioned before for ash. Also, the three smoked products had higher WPS contents than recommended by FDA (1970) for cold-smoked fish products due to high salt concentration in tissues from the brine (Chai and Shiah, 1985). Also, data in Table (2) pointed out that frozen Sardine contained 1.978 mg malonaldehyde/kg. This value of TBA was low, being in the range of acceptability where Greene and Cumuze (1982) reported 10 mg/kg fish as a higher level for acceptance. The TBA level evidently decreased by smoking. This may be attributed to evaporation and loss of some malonaldehyde or reaction with smoke components. The results of TBA values were inversely related to the phenols compounds levels. This because TBA value indicates lipids oxidation while the phenols are potent antioxidants. The results of TBA value agree with the findings of Dessuki and Hassanin (1995).

The TVN values of smoked Sardine products followed the same trend recorded for TBA values. Such results may indicate that the smoke compounds were possibly acting as antimicrobial agents during preparation of the smoked Sardine (Horner, 1992 and Hassanin, 1995). The decrease and loss of TVN may be also affected by the exposed area during smoking.

1.3. Effect of smoking on protein quality of Sardine fish:

Data in Table (3) show the effect of cold-smoking on the amino acids composition (g/100 g protein). It could be observed that by smoking the concentration of all amino acids contents (essential and non-essential with exception of alanine + glutamic and glycine + asparatic) decreased. This probably was due to Maillard reaction or some destruction of amino acids (Hoffman *et al.*, 1977 and Dessouki and Hassanin 1995). Lysine recorded the highest losses among the essential amino acids.

Table (3): Amino acids composition (g/16g N.) g/100g protein of frozen and smoked-Sardine products (g/16g N)

Amino acids	Frozen Sardine fish	Smoked Sardine products		
		Whole	Gutted	Dressed
Isoleucine	4.32	4.24	4.12	4.28
Leucine	8.18	8.08	7.99	8.14
Lysine	9.36	5.44	5.13	5.76
Methionine + cystine	3.85	3.80	3.67	3.68
Phenylalanine +tyrosine	8.40	8.35	8.11	8.36
Threonine	4.54	4.40	4.24	4.46
Valine	4.82	4.73	4.64	4.80
Histidine	2.55	2.84	2.26	2.53
Arginine	6.13	5.92	5.93	5.95
Alanine + glutamic	21.83	22.18	22.28	23.08
Glycine + aspartic	15.15	15.25	16.15	16.30
Proline	5.24	5.18	5.14	5.20
Serine	4.88	4.23	4.73	4.65

To evaluate the nutritional value, grams consumed to cover the daily requirements of adult man of the EAA were considered. GDR values were calculated and results obtained are presented in Table (5). Also, per cent satisfaction of daily requirements of adult man in EAR when consuming 150 g of smoked Sardine products (Ps/150%) were calculated and the obtained values were presented in Table (6), considering that GDR values are inversely related while Ps/150 values are proportionally related to amino acids content. Thus, lower GDR values and higher Ps/150 values pointed out the better nutritive value. It could be observed that the nutritive value of smoked products were lower than frozen Sardine. This is due to the observed loss of amino acids concentration as (g/100 g sample) by smoking. But when restricting amino acids (RAA) which had the highest GDR and lower Ps/150 values were considered, the nutritional value of different products could be evaluated. Both values indicated that nutritive value of fish decreased by smoking. These results agree with the findings of Dessouki and Hassanin (1995).

Results revealed that smoked-dressed Sardine had the highest nutritive value among the other smoked-Sardine products. When the adult man (25-50 years old) consumes 150 g of this product, the daily requirements of restricting essential amino acids will cover at 101.19% level corresponding to 92.26%

Table (4): Essential amino acids composition (g/100 g protein) and amino acid score (A.S.) of frozen and smoked-Sardine products.

Amino acids	FAO reference pattern (g/16 g N)	Frozen Sardine fish		Smoked Sardine products					
				Whole		Gutted		Dressed	
		g/16 g N	A.S.	g/16 g N	A.S.	g/16 g N	A.S.	g/16 g N	A.S.
Isoleucine	1.3	4.32	3.32	4.24	3.26	4.12	3.17	4.28	3.29
Leucine	1.9	8.18	4.31	8.08	4.25	7.99	4.21	8.14	4.28
Lysine	1.6	9.36	5.85	5.44	3.40	5.13	3.21	5.76	3.60
Methionine + cystine	1.7	3.85	2.26	3.80	2.24	3.67	2.16	3.68	2.16
Phenylalanine + tyrosine	1.9	8.40	4.42	8.35	4.39	8.11	4.27	8.36	4.40
Threonine	0.9	4.54	5.04	4.40	4.89	4.24	4.71	4.46	4.96
Valine	1.3	4.82	3.71	4.73	3.64	4.64	3.57	4.80	3.69
Histidine	1.6	2.55	1.59	2.48	1.55	2.26	1.41	2.53	1.58

Table (5): Essential amino acids composition (g/100 g sample) and (GDR) of frozen and smoked-Sardine products.

Amino acids	Daily requirements of adult man (25-50 years) (g)	Frozen Sardine fish		Smoked Sardine products					
				Whole		Gutted		Dressed	
		g/100 g sample	GDR (g)	g/100 g sample	GDR (g)	g/100 g sample	GDR (g)	g/100 g sample	GDR (g)
Isoleucine	0.819	0.76	107.76	1.06	77.26	1.02	80.29	1.15	71.22
Leucine	1.197	1.44	83.13	2.02	59.23	1.98	60.45	2.19	54.66
Lysine	1.008	1.65	61.09	1.36	74.12	1.27	79.37	1.55	65.03
Methionine + cystine	1.071	0.68	157.50	0.95	112.74	0.91	117.69	0.99	108.18
Phenylalanine + tyrosine	1.197	1.48	80.88	2.09	57.27	2.01	59.55	2.25	53.20
Threonine	0.567	0.80	70.88	1.10	51.55	1.05	54.00	1.20	47.25
Valine	0.819	0.85	96.35	1.18	69.41	1.15	71.22	1.29	63.49
Histidine	1.008	0.45	224.00*	0.62	162.58	0.56	180.00	0.68	148.24
R.A.A.*			224.00		162.58		180.36		148.24

*: Restricting E.A.A.

Table (6): Essential amino acids composition (g/100 g protein) and (PS/150%) of frozen and smoked-Sardine products.

Amino acids	Daily requirements of adult man (25-50 years) (g)	Frozen Sardine fish		Smoked Sardine products					
				Whole		Gutted		Dressed	
		g/100 g sample	PS/150%	g/100 g sample	PS/150%	g/100 g sample	PS/150%	g/100 g sample	PS/150%
Isoleucine	0.819	0.76	193.20	1.06	194.15	1.02	186.82	1.15	201.61
Leucine	1.197	1.44	180.44	2.02	253.25	1.98	248.14	2.19	274.42
Lysine	1.008	1.65	245.54	1.36	202.37	1.27	188.99	1.55	230.66
Methionine + cystine	1.071	0.68	95.24	0.95	133.05	0.91	127.45	0.99	138.66
Phenylalanine + tyrosine	1.197	1.48	185.46	2.09	261.92	2.01	251.89	2.25	281.95
Threonine	0.567	0.80	211.63	1.10	290.98	1.05	277.78	1.20	317.46
Valine	0.819	0.85	155.68	1.18	216.11	1.15	210.61	1.29	236.26
Histidine	1.008	0.45	66.96	0.62	92.26	0.56	83.33	0.68	101.19
PS/150 forR.A.A.			66.96		92.26		83.33		101.19

and 83.33% when consuming the same quantity from smoked-whole and smoked gutted Sardine, respectively. Thus, the three technological procedures; of smoked whole, gutted and dressed fish could be recommended to produce Sardine products on a commercial scale.

2. Organoleptic evaluation of smoked Sardine products:

The average scores of sensory characteristics for processed Sardine products immediately after smoking are presented in Table (7). It could be observed that dressed Sardine had the highest score of color, while whole Sardine had the lowest one. Such results may be in accordance with those of carbonyl compounds as mentioned before in, based on that color formation of smoked products is the reaction between carbonyl compounds and free amino groups of skin protein (Maillard reaction). The absorption of smoke components by dressed fish tissues was higher (due to larger exposed area) than for whole and gutted fish. However, no significant differences were recorded for color scores between the three products at 5% level.

With respect to the flavor, average flavor score of smoked Sardine products followed the same trends for color. This because the flavor of smoked products was attributed to smoke compounds (principally phenols in addition of some carbonyls and acids).

Dressed fish had the lowest texture score while whole fish had the highest one. This was in accordance with results of WHC and plasticity values as mentioned before, where product of higher smoke compounds due to more exposed area had lower WHC and plasticity, and acquired relatively less tender texture

Table (7): Organoleptic evaluation of smoked-Sardine products.

Quality characteristics	Smoked-Sardine products		
	Whole fish	Gutted fish	Dressed fish
Color	8.6	8.8	9.0
Flavor	8.3^{ab}	8.8^{b}	9.0^{a}
Texture	8.5^{a}	8.2	8.0^{a}
Overal acceptability	9.0	9.0	9.0
Composite score*	34.4	34.8	35.0
Average	8.6	8.7	8.75

* ∑ (color + flavor + texture + overall acceptability)
a and b = Significance at 5% level.

as mentioned by Dessouki and Hassanin (1995) and Hassanin (1995) came to the same conclusion. This less tender texture accompanied by more absorption of phenols, carbonyls and organic acids (dressed fish) may favor the storage stability of such a product.

With regard to the overall acceptability, all Sardine products recorded the same overall acceptability score. But when composite scores were calculated, dressed product had the highest score among the other three smoked Sardine products.

According to the organoleptic evaluation (Table, 7), the three smoked Sardine products could be arranged descendingly (based on color, flavor, composite score and average total score) as follows: dressed, gutted then whole fish. Nevertheless, the differences between such products may be negligible based on the overall acceptability score. At the same time the three products ranked "very good" and could be recommended for production on a commercial scale which may add to assortment of smoked fish in the Egyptian market.

B) Silver carp fish:

1. Chemical composition of fresh and canned Silver carp fish products:

Dressed Silver carp fish were preserved by canning in free sunflower seed oil and the same oil flavored by extracts from peppermint, rosemary, thyme and marjoram herbs. As shown in Table (8) fresh Silver carp fish obtained 78.99, 17.78, 1.97, 1.17 and 0.17% moisture, crude protein, ether extract, ash and sodium chloride respectively besides energy of 98.85 (cal/100 g).

Canned fish in all oils showed less decrease in moisture content as it reached 65.25 to 65.55% which might be due to the effect of pre-cooking on evaporation of water from fish flesh. These results agree with those mentioned by Salem (1999). Protein content took the same trend where it decreased to 15.19 to 15.24% which could be attributed to loss of some volatile compounds generated during pre-cooking. Lee *et al.* (1973) and Shiau and Shue (1989) confirmed the same result.

On the contrary fat increased as it reached 15.69-15.95% which might be due to reflection of moisture and protein decrease. These results agree with those mentioned by Mustafa and Medeiros (1985) and Garica-Arias *et al.* (1994). Ash took the same trend and increased to 3.57-3.58% which might be due to absorption of mineral salt from sodium chloride solution during brining, besides decrease of moisture and protein. Sodium chloride increased also to 2.60% due to same reasons in ash.

Table (8): Chemical composition of fresh and canned silver carp fish.

Fish	Moisture %	Crude protein (N x 6.25) %	Ether extract %	Ash %	NaCl %	Energy (cal/100 g)
Fresh	78.99	17.78	1.97	1.17	0.17	98.85
Canned in sunflower oil	65.55	15.19	15.69	3.57	2.60	201.97
Canned in oil flavored with:						
Peppermint	65.27	15.24	15.91	3.58	2.60	204.15
Rosemary	65.31	15.22	15.89	3.58	2.60	203.89
Thyme	65.25	15.23	15.95	3.57	2.60	204.47
Marjoram	65.26	15.23	15.94	3.57	2.60	204.38

The energy value increased to 201.97-204.47 (cal/g) due to decrease of moisture and addition of sunflower seed oil

In concern to canning, the changes were affected by the loss of moisture and the addition of sunflower seed oil during canning treatment which raised the energy value because the tested canned sample include parts of dressed fish and media.

Results in Table (9) for the G.D.R. values, represented the weight of canned fish product that should be consumed to meat the daily requirements of individual energy for adult man as recommended by USRDA (1989). These results indicate that there was a noticeable decrease in the G.D.R. values of all canned fish products as a reflection of increasing the energy value content of canned Silver carp fish.

Concerning the percentage satisfaction of the daily requirements of adult man in the individual energy and protein when consuming 150 grams of canned fish as recorded in Tables (9 and 10), it could be clear that the consumption of 150 grams from canned products provide the adult man with 10.5% and 36.2% of energy and protein respectively, above 5.1% of energy and 42.3% of protein in raw. The differences was due to the increasing of energy value of canned products and decreasing in protein above the raw because of the tested samples of products included the parts of fish and the media.

Table (9): The G.D.R.@ and PS*/150 values of raw and canned silver carp fish for energy.

Fish	G.D.R.	PS/150
Fresh	**2933.74**	**5.11**
Canned fish in sunflower oil (control)	**1435.86**	**10.45**
Canned fish in oil flavored with:		
Peppermint	**1420.52**	**10.56**
Rosemary	**1422.34**	**10.55**
Thyme	**1418.30**	**10.58**
Marjoram	**1418.93**	**10.57**

G.D.R.@: Grams consumed of raw or canned product to cover the daily requirement of adult man in energy (2900 cal.) according to Nat. Acad. Sci.

PS*/150: Percent satisfaction of the daily requirement of man in energy when consuming 150 gm of product.

Table (10): The G.D.R.@ and PS*/150 values of raw and canned silver carp fish for protein.

Fish	G.D.R.	PS/150
Fresh	**354.33**	**42.33**
Canned fish in sunflower oil (control)	**414.75**	**36.17**
Canned fish in oil flavored with:		
Peppermint	**413.39**	**36.29**
Rosemary	**413.93**	**36.24**
Thyme	**413.66**	**36.26**
Marjoram	**413.66**	**36.26**

G.D.R.@: Grams consumed of raw or canned product to cover the daily requirement of adult man in protein (63 g).

PS*/150: Percent satisfaction of the daily requirement of man in protein when consuming 150 gm of raw or canned silver carp fish.

2. Physico-chemical evaluation of fresh and canned Silver carp fish:

Physico-chemical properties of fresh and processed fish such as water holding capacity (WHC), plasticity, pH value, T.B.A., T.V.N., T.M.A. and ammonia should be considered as important quality attributes which assess somewhat the consumer acceptance degree of fishery product (Tables, 11 and 12).

2.1. Water holding capacity (W.H.C.) and plasticity:

Water holding capacity (W.H.C.) and plasticity are important properties, considered as a good index of tenderness and texture of fish and canned fish products (Paul and Palmer, 1972; Etman, 1985 and Wahdan, 1992). Fresh Silver carp fish obtained 4.8 value for W.H.C.

The obtained results of Table (11) illustrate that canning caused decrease in W.H.C. of all canned Silver carp fish and these canned in sunflower seed oil had a higher value (3.9 $cm^2/0.3$ g) than those canned in flavored sunflower oils. The values of W.H.C. as (0.3 cm^2/g sample) are inversely to the high water holding capacity but as (% bound water). The reduction in WHC of canned fish products could be attributed to denaturation of fish protein and increase in sodium concentration as a result of thermal commercial sterilization, resulting a compacting of fish tissues leading to a disappearance of some free chemical groups able to bind water. The thermal treatment during canning caused a destruction of fibers and collagen turning the later to gelatine which had a higher property to bind the water.

Table (11): water holding capacity (W.H.C.) and Plasticity for fresh and canned silver carp fish.

Sample	W.H.C.		Plasticity	
	Cm^2/0.3 g sample	% bound water	Cm^2/0.3 g sample	Cm^2/g TN
Raw	4.8	82.99	3.7	433
Canned fish in sunflower oil (control)	3.9	83.34	4.0	549
Canned fish in flavored oil with:				
Peppermint	3.4	85.41	4.3	587
Rosemary	3.5	85.00	4.2	574
Thyme	3.5	84.98	4.2	574
Marjoram	3.6	84.55	4.1	560

Plasticity of all tested fish products improved after canning. The improvement extent was higher for canned products with flavored oil than those with oil only. This improvement may be due to destruction and hydrolysis of fish protein through out the thermal canning treatment, which was confirmed by increasing in free amino nitrogen and some volatile basic nitrogen compounds as previously discussed. These findings were in agreement with those found by Vaskrisenski (1966), Wahdan (1992) and Salem (1999) and, also the thermal treatment caused emulsifying for the oil and increasing of intermascular fat which aids to improve the tenderness and the elasticity of the products.

All canned products in flavored oils had better results than those in oil only as a filling media in canning because canning with herbs extracts had a higher percentage of fat able to make a higher quantity of emulsifier.

2.2. pH value:

As shown in Table (12) the pH value was 5.99 and reached 6.07 after canning using only sunflower oil as a filling media due to the thermal sterilizing effect on fish protein breakdown resulting a formation of free some dibasic amino acids as well as the accumulation of some volatile compounds such as NH_3-N, as previously reported. These results agree with Hafiz (1982) who reported that canning caused an increase in the pH value of dolfin flesh. Similar results had been reported by Shehata (1980), Abo-Taleb (1997) and Salem (1999).

However canned fresh in different extracts of herbs in oil showed no significant difference in pH value.

Table (12): Effect of canning process on pH value.

Fish	pH	T.B.A. (mg/kg)	T.V.N. (mg/100 g)	T.M.A. (mg/100 g)	Ammonia (mg/100 g)
Fresh	5.99	0.00	11.23	2.43	3.24
Canned fish in sunflower oil (control)	6.07	1.22	17.16	2.31	4.53
Canned fish in oil flavored with:					
Peppermint	6.31	0.74	15.49	2.22	4.22
Rosemary	6.30	0.80	15.81	2.25	4.35
Thyme	6.32	0.82	16.13	2.23	4.46
Marjoram	6.32	1.18	16.31	2.26	4.39

This alteration in the pH value may be due to breakdown and degradation of some basic compounds such as volatile basic nitrogen compounds, amines and hydrogen sulphide, leading to increase the pH value. These findings are in agreement with those showed by Paredes (1987), Arafa (1994), Abo-Taleb (1997) and Salem (1999) who reported that pH value of canned fish was increased gradually through out storage at ambient temperature.

2.3. Thiobarbituric acid (TBA) value:

Thiobarbituric acid (TBA, as mg malonaldhyde/kg sample) was used as an important indicator for testing the oxidative rancidity of Silver carp fish products.

From Table (12), it could be noticed that canned Silver carp fish in oil contained 1.22 mg malonaldhyde/kg. This value of TBA was low, being in the range of acceptability where Green and Cumuze (1982) reported 10 mg/kg fish as a higher level for acceptance. The TBA level was evidently increased by canning. The increase in TBA value of the canned fish sample could be attributed to the oxidation of lipids, either in fish flesh or in oil used as a filling medium, by the effect of thermal treatments used for commercial sterilization on the unsaturated fatty acids. These results agree with those obtained by Hafiz (1982) for canned dolphin meat, Seet *et al.* (1983) for canned tuna and Salem (1999) for canned Tilapia who reported that there was increase in the TBA value after thermal sterilization which associated with oxidation of lipids, either in fish flesh or oil used as a filling media, that did not occur during sterilization only, but also may happen during the exhausting of the jars prior to the covering. The increment rate of TBA value was varied in all canned fish products depending on the different herbs extract used as antioxidants in canning process.

Products canned in flavored sunflower oils had a lower TBA value than those canned in oil only which might be due to antioxidants of herbs extracts which reduced the oxidation of lipid and TBA value.

2.4. Total volatile basic nitrogen (TVB-N):

Total volatile basic nitrogen is an index of degree of putrefaction, decomposition and degree of proteins constituents breakdown in fish tissues. TVB-N is a mixture of many volatile nitrogen compounds, trimethylamine nitrogen, ammonia nitrogen and other lower simple monoamins as mentioned by Meinke *et al.* (1983) and Khallaf (1990). Therefore the effect of canning process on the TVBN content of Silver carp fish was investigated and results obtained are tabulated in Table (12).

Fresh Silver carp fish showed 11.23 value and increased by canning as it reached 15.49 to 17.16 mg/100 g in all other products.. This increase was due to the effect of thermal sterilization on breakdown of fish protein and conversion of some non-volatile compounds to the volatile form. These results are in agreement with those obtained by Sallam (1973), Cantoni *et al.* (1979), Abo-Taleb (1997) and Salem (1999). It is worth to mention that the critical value of TVB-N in fish products was 30 mg/100 g fresh flesh, above which the decomposition takes place in fish tissues and being organoleptically unaccepted (Cobb and Vanderzant, 1975 and Shalaby, 1990).

2.5. Trimethylamine nitrogen (TMA-N):

Trimethylamine nitrogen value is considered among the essential measurements which indicate the acceptability of fish and fish products (Tonogi *et al.*, 1984 ad Kallaf, 1990). A wide range of TMA level (from 5 to > 26 mg/100 g) has been reported for various spoiled fish species (Krzymien and Elias, 1990 and Reddy *et al.*, 1996 and 1997). The effect of canning on T.M.A. content in canned Silver carp fish was investigated and results obtained are recorded in Table (12).

Fresh Silver carp fish showed 2.43 value which decreased to 2.31, 2.22, 2.25, 2.25, 2.23 and 2.26 mg/100 g in all products after canning, respectively. The reduction of the TMA content in canned products may be due to the volatilization of TMA during thermal treatment used in canning. These results are in agreement with those found by Chia *et al.* (1983) and Abo-Taleb (1997).

2.6. Ammonia nitrogen (NH_3-N):

Ammonia nitrogen of fish and fish products is considered an important indicator for detection of spoilage and determination of shelf life for fish and fish products. So, the effect of canning process on the NH_3-N content of canned sliver carp fish was investigated and obtained data are tabulated in Table (12).

Fresh products of Silver carp fish had 3.24 value and increased in all canned products from 4.22 to 4.53 mg/100 g as a result of thermal sterilization on breakdown of protein, amino acid and other nitrogenous fraction such as nucleic acid and amines resulting in origination of ammonia nitrogen. These results agree with those reported by Vynck (1970), Chia *et al.* (1983) and Salem (1999).

3. Fat quality of fresh and canned Silver carp fish:

A good fat quality is characterize by a moderate content and better balance of indispensable fatty acids (I.F.A.) in fat of the final fish canned product.

3.1. Fatty acids profile of Silver carp fish as affected by canning in oil and different aromatic oil:

G.L.C. analysis was carried out to show the fatty acids composition of total lipids extracted from fresh and canned Silver carp fish as shown in Table (13).

The low molecular fatty acids (< $C_{10:0}$) were not found in any product.

$C_{16:1}$ F.A. showed a moderate level (13.31%) for fresh, while for canned fish levels were low (0.72-1.20%). This could be due to the effect of added oil during canning (as the control had 1.20%), the effect which seems to increase by effect of herbs extraction (0.72-0.90%). Similarly $C_{14:0}$ was higher (5.29%) in fresh fish and decreased in control (1.15%) and decreased more in canned fish with extract of herbs (0.50-1.00%). On the contrary $C_{18:2}$ was low in fresh carp fish (6.61%), increased in control (27.32%) and increased more in the canned with herbs extraction (30.59-41.24%).

The major fatty acids in raw fish lipids were $C_{18:1}$ (38.51%) and $C_{16:0}$ (26.25%), followed by $C_{16:1}$ (13.31%). When vegetable oil was added during canning the major F.A. were $C_{18:1}$ (51.11%), followed by $C_{18:2}$ (27.32%). The latter was a low F.A. in fresh fish, 6.61%, then cane the $C_{16:0}$ F.A. (15.10%). This was also noticed for canned with the herbs extraction where

Table (13): Fatty acids composition of fresh and canned silver carp fish.

Fatty acids	Fresh fish	Canned in sunflower oil (control)	Canned fish in oil flavored with			
			Peppermint	Rosemary	Thyme	Marjoram
$C_{10:0}$	0.26	1.33	0.27	0.72	0.14	0.74
$C_{12:0}$	0.20	0.75	0.63	0.48	0.26	0.61
$C_{14:0}$	5.29	1.15	0.50	0.96	1.00	0.82
$C_{15:0}$	1.48	0.61	0.10	0.20	0.29	0.17
$C_{15:1}$	2.11	1.52	0.60	1.13	0.40	1.43
$C_{16:0}$	26.25	15.10	9.95	12.88	14.27	14.50
$C_{16:1}$	13.31	1.20	0.83	0.90	0.72	0.79
$C_{17:0}$	2.93	0.07	0.05	0.05	0.00	0.04
$C_{18:0}$	3.05	0.09	0.09	0.06	0.09	0.07
$C_{18:1}$	38.51	51.11	45.65	50.40	42.87	50.26
$C_{18:2}$	6.61	27.32	41.24	32.15	40.27	30.59

major FA was $C_{18:1}$ (42.87-50.40%), followed by $C_{18:2}$ (30.59-41.24%) then came the $C_{16:0}$ (9.95-14.50%).

Regardless of raw fish, canned fish with herbs extraction had lower $C_{18:1}$ FA (42.87-50.40% vs. 51.11%) and higher $C_{18:2}$ (30.59-41.24% vs. 27.32), and lower $C_{16:0}$ (9.95-14.50% vs. 15.10%).

Towards canned fish with herbs extraction higher $C_{18:1}$ was found for rosemary, higher $C_{18:2}$ FA in peppermint (41.24%) and higher $C_{16:0}$ F.A. in marjoram (14.50%) products.

The results of Table (14) show levels of F.A. lipids fractions as well as evaluation of F.A. profile, values for fresh fish was also calculated.

Total saturated fatty acids were the higher in fresh Silver carp fish as it reached 39.46% while those unsaturated revealed the value of 60.54%. Canned fish obtained the higher values of unsaturated fatty acids due to addition of sunflower oil. Therefore Ks and Du values were lower in fresh Silver carp fish compared to canned ones as they were 1.53 and 0.67 among 4.25, 7.62 and 1.09, 1.30, respectively. This may be possibly in favour of mans health. In this concern the best product of (higher Ks and Du value) may be the canned fish with peppermint followed by rosemary or thyme, while marjoram product came next canned fish in sunflower oil only were of the best value of Ks and Du.

Data presented in Table (15) show the evaluation of nutritional value based on the omega-6 F.A. level. Unfortunately, G.L.C. analysis of fatty acids did not reveal other essential fatty acids such as $C_{20:4}$ (omega-6 F.A.) and $C_{18:3}$, $C_{20:5}$ and $C_{22:6}$ fatty

Table (14): Evaluation of fatty acids composition of fresh and canned silver carp fish.

Fatty acids fraction	Fresh fish	Canned in sunflower oil (control)	Canned fish in oil flavored with			
			Peppermint	Rosemary	Thyme	Marjoram
Total saturated	39.46	19.10	11.59	15.35	16.05	16.95
Total unsaturated	60.54	81.15	88.32	84.58	84.26	83.07
Ks value	1.53	4.25	7.62	5.51	5.25	4.90
Du value	0.67	1.09	1.30	1.17	1.25	1.14
$\frac{C_{16:0}}{\text{Total } C_{18}}$	0.55	0.19	0.11	0.16	0.17	0.18
$\frac{\text{Total } C_{16}}{\text{Total } C_{18}}$	0.82	0.21	0.12	0.17	0.18	0.19
$\frac{C_{16:0}}{C_{18:2}}$	3.97	0.55	0.24	0.40	0.35	0.47

$$Ks = \frac{\text{Total (unsaturated fatty acids)}}{\text{Total saturated fatty acids}}$$

$$Du = \left[\frac{\text{monounsaturated fatty acids}}{100}\right] + 2\left[\frac{\text{Diunsaturated fatty acids}}{100}\right]$$

Table (15): PS/150 (%) for omega-6 fatty acids.

Indices	Fresh	Canned fish in oil flavored with:				
		Sunflower	Peppermint	Rosemary	Thyme	Marjoram
Omega-6 F.A./100 g sample	0.13	4.29	6.56	5.11	6.42	4.88
Omega-6 F.A./150 g sample	0.20	6.44	9.84	7.67	9.63	7.32
PS/150 %	2.00	66.60	101.76	79.32	99.59	75.70

acids (omega-3 F.A.). Nevertheless based on available information fresh carp fish showed lowest nutritional value of only 2%, which increased to 66.60% for fish canned in vegetable oil. P.S./150 values increased more (75.70-101.76%) for canned fish in flavored oils with herbs extracts. Higher P.S./150 value recorded for peppermint extract (101.76%), followed by thyme (99.59%) and rosemary (79.32%), while marjoram was the latter (75.70%).

It should be noted that Ks value and Du value may be used as indication for lipids oxidation. The lower the Ks and Du values the more the oxidation of lipids. Oxidation of lipids may occur, though at low rate during canning by effect of head space air. This was proved by determination of TBA value. Same arrangement of products according to TBA could be observed also for Ks and Du values, indicating that quality of lipids was best for peppermint, followed by Rosemary and thyme samples, then came the marjoram product.

Bracco *et al.* (1981) and Shai *et al.* (1985) studied the effect of rosemary as natural antioxidant.

Hassanin *et al.* (1989) and Shams El-Din (1990) used the ether extract of peppermint as a natural antioxidant.

4. Organoleptic evaluation of canned Silver carp fish in jar:

The organoleptic quality of fishery products are correlated significantly with the chemical (Freshness indices) and physical attributes of fishery products quality. Sensory evaluation, together with estimation of the former attributes have been used extensively to assess the quality of canned fish products. Therefore, the organoleptic properties (taste, odor, tenderness, appearance and overall acceptability) of canned Silver carp fish products as affected by canning were investigated and obtained results are shown in Table (16).

All canned fish in flavored oil had very good organoleptic quality properties compared to canned fish in oil only (good) immediately after canning.

Concerning the flavor properties, it could be observed that flavor properties (taste and odor) of canned fish in flavored oils were higher than those canned in oil only as they were 9.1, 9.1; 8.2, 7.3; 7.8, 6.9; 8.0, 8.8 and 7.2, 6.1, respectively.

With respect to tenderness, it could be observed that canned products took the same trend.

With regard to appearance properties, no significant difference could be pronounced as all Silver carp fish either fresh or canned showed nearly the same degree of appearance. Overall acceptability scores of products canned in flavored oils were better than those canned in oil only.

Finally it could be concluded that canned Silver carp fish products in flavored oils had very good and pleasant organolyptic quality and better acceptability.

Table (16): Organoleptic evaluation of canned silver carp fish in jar.

Properties	Canned fish in sunflower oil (control)	Canned fish in flavored oil with:			
		Peppermint	Rosemary	Thyme	Marjoram
Taste (10)	7.2	9.1	8.2	7.8	8.0
Odour (10)	6.1	9.1	7.3	6.9	8.8
Tenderness (10)	7.1	8.1	7.2	7.9	8.0
Appearance (10)	8.2	8.4	8.2	8.2	8.2
Overall acceptability (10)	7.0	9.0	8.0	8.3	8.0
Total score (50)	35.4	43.7	38.9	39.1	41.0
Average (10)	7.08	8.74	7.78	7.82	8.20