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PHYSICAL AND CHEMICAL COMPOSITION OF FRESH, IMPORTED FROZEN AND CANNED TUNA

BY

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ABSTRACT

Fresh Libyan tuna contained significantly higher concentrations from Zn, Cu, Mn and Hg. Frozen tuna imported from India contained significantly higher amounts from total volatile nitrogen (TVN), K and Cd. Imported frozen tuna after canning (Subrata) contained significantly higher amounts from crude protein, ether extract, total ash, water soluble ash, total carbohydrates, Na and Pb.

The net weight percentage in all samples of canned tuna was lower than the limit reported by Libyan Standards. The oil percentage used of packaging in Alwafa (Al), Mawadda (Ma) and Subrata (Su) samples was within the limits of Libyan Standards. It could be noticed that the percentage of salt solution in all samples except Subrata (Su) sample was higher than the maximum limit of Libyan Standards. The percentage of drained weight ranged from 57.61 to 82.27%. It is evident that the percentage of drained weight in Alwafa (Al) and Subrata (Su) samples (canned in Libya) was higher than the limit of Libyan Standards.

In canned tuna moisture content, total solids, crude protein, ether extract, total ash, water insoluble ash, water soluble ash, alkalinity of water soluble ash and total carbohydrates ranged from 58.87 to 69.24, 30.76 to 41.13, 18.33 to 25.78, 4.54 to 7.57, 1.23 to 1.94, 0.13 to 0.28, 1.04 to 1.69, 0.30 to 0.51 and 3.84 to 9.38% on wet weight basis, respectively. Tuna canned in Libya (Al and Su samples) contained significantly higher content from total volatile nitrogen (T.V.N) 14.36 and 16.87 mg/100g on wet weight basis, respectively than those of other samples. The T.V.N. in all samples was lower than the maximum limit indicated by Libyan Standards.

The obtained data indicated that Subrata (Su) sample contained significantly higher concentrations from Na, K, Pb, Hg and As. The significantly higher concentrations from Al and Mn were found in Alwafa (Al) sample. Razo (Ra) sample contained significantly higher concentration from Cu. Statistical analysis did not appear any significant differences in Ca, P and Fe concentrations between all investigated samples. Hg in Libyan canned tuna (Al and Su samples), and As in (Su) sample were higher than the maximum limit of Libyan Standards.

The olive oil used in packaging of tuna contained significantly higher acid value and total free fatty acids. The oil separated from (Al) sample contained significantly higher peroxide value (15.58 meq./kg). The significantly higher iodine value were found in oil separated from (Ma) and (In) samples.

INTRODUCTION

The physical composition of fresh tuna was meat 42.62, skin 7.84, head 15.51, viscera 15.48, tail and fins 2.27 and bones 7.48% of whole fish (Ghazal *et al.*, 2005). The weight composition of canned tuna was as follows: net weight ranged from 78.28 to 83.48%, packaging solution to net weight ranged from 10.81 to 35.06%. The percentage of drained weight to net weight ranged from 64.94 to 89.19%.

Lean fish contains less than 1% fat and about 10% protein, with energy values ranging from 50 to 80 Kcal/100g. Fish proteins have a high biological value similar to the land animals protein (Davidson *et al* 1975).

The fresh tuna flesh contained 72.53, 1.253, 0.129, 1.124, 24.24, 1.47 and 0.51% of moisture, total ash, water insoluble ash, water soluble ash, crude protein, ether extract and total carbohydrates on wet weight basis, respectively (Ghazal *et al.*, 2005). The chemical composition of canned tuna was: moisture content ranged from 58.55 to 69.72%, crude protein ranged from 19.73 to 28.77%, total lipids ranged from 3.50 to 6.30%, total ash ranged from 1.35 to 1.62%, water insoluble ash ranged from 0.224 to .616% and water soluble ash ranged from 0.874 to 1.263% on wet weight basis, respectively. The alkalinity of water soluble ash ranged from 5.20 to 7.9 mlliequivalent acid per ash produced from 100g sample.

The value of any food product including fish is a function of its taste and nutritional properties. The nutritive value of a product depends mainly on the quantity of organic substances, protein, fat, carbohydrate, vitamins and mineral substances present (Novikov, 1983).

The concentrations of Cd and Hg in several samples of fresh tuna were higher than the limits of this elements (0.5 and 0.4 ppm of Cd and Hg, respectively). While the concentrations of Pb and Hg in liver were within the limits of WHO. The concentration of Cd in liver was higher than the same limits (Pruzina *et al.*, 1991). The concentration of Hg in fresh tuna ranged from 0.24 to 2.91 ppm on wet weight basis (Ntow and Khwaja, 1989; Landi *et al.*, 1992; Gawlik *et al.*, 1997 and Storelli and Marcotrigiano, 2000). The fresh tuna flesh contained 307.87, 2434.88, 19.51, 510.54 and 3586.46 ppm of Na, K, Ca, Mg and P on wet weight basis, respectively, while it contained 21.18, 18.52, 14.44, 23.13 and 6.64 ppm heavy metals, which comprised Fe, Cu, Zn, Mn and Pb on wet weight basis (Ghazal *et al.*, 2005).

The canned tuna contained 0.32 ug/g of Pb and 0.02 ug/g of Cd (Capar, 1990). Ohlin, (1993) reported that the concentration of Hg in canned tuna ranged from 0.04 to 0.21 ppm, respectively in 1993 comparing with 0.02 to 0.37 ppm in 1985.

Gajewska *et al.* (1995) showed that the concentration of Hg in canned tuna ranged from 0.04 to 0.578 ppm on wet weight basis. The concentrations of different elements in canned tuna were: Na ranged from 1794 to 5510; K ranged from 1677 to 2836; Mg ranged from 55 to 726; Ca ranged from 38 to 100; P ranged from 3600 to 5166, Fe ranged from 182 to 1010; Cu ranged from 2.48 to 10.11, Mn ranged from 0.77 to 14.73; Zn ranged from 0.4 to 1.75 and Pb ranged from 18.99 to 108.10 ppm on wet weight basis, respectively.

So this work was aimed to study the weight composition and chemical composition of fresh, imported frozen and canned tuna. Minerals content and some physical and chemical properties of separated oils from canned tuna were also determined.

MATERIALS AND METHODS

Materials:

Fresh tuna samples were obtained randomly from Fishing Circlet in Tripoli, frozen tuna imported from India before canning and its canned (Su) were obtained from Historical Coupling Manufacture for Canning Fish in Subrata City. Four species of canned tuna samples which comprise Alwafa (Al), Razo (Ra), Mawadda (Ma) and Insupebile (In) were obtained from Consumer Goods Collector in Sabha City.

The investigated samples were transferred to the Food Analysis Laboratory of Food Indust. Dept. Fac. of Science Engineering and Technology and Analytical Chemistry Lab., Fac. of Science, Sabha Univ.

Analytical methods:

Physical analysis:

Gross weight, can free weight, net weight, salt solution weight, oil weight and drained weight of canned tuna were determined according to the methods mentioned by A.O.A.C. (1990).

The flesh of fresh, imported frozen and canned tuna (after separation of packaging solution) samples were minced and mixed with a laboratory electric mincer before carrying out the chemical analysis.

Chemical analysis:

Moisture, crude protein, total ash, water insoluble ash, water soluble ash, soluble ash alkalinity and ether extract contents were determined according to the methods described in A.O.A.C. (1990). Total carbohydrates was calculated by difference.

pH value of tuna slurry was determined according to the method described by Woye Woda *et al.*, (1986).

Total volatile nitrogen (T.V.N.) was determined according to the method mentioned by Winton and Winton (1958).

Minerals content, Na and K were determined according to the method described in A.O.A.C. (1990) using Flame photometer 410; Ca, Mg, Fe, Zn, Cu, Mn, Pb, Hg and As were determined according to the method described by Willard *et al.*, (1981) using Atomic Spectroscopy at Central Laboratory in Libyan Petroleum Oil Guardianship.

Oil constants: acid value, peroxide value, iodine value were determined according to the method reported by A.O.C.S. (1974).The thiobarbituric acid (T.B.A.) value was determined according to the method described by Vyncke (1970).

Statistical analysis was calculated as described by Gomez and Gomez (1984).

RESULTS AND DISCCUSION

Chemical composition of fresh, imported and canned tuna:

The chemical composition of fresh Libyan tuna and frozen imported from India before and after canning is shown in Table (1). Statistical analysis did not appear any significant differences in moisture, crude protein, ether extract, total ash, water insoluble ash, total carbohydrates, Na, Ca, Mg, Fe and As between Libyan fresh tuna and imported frozen tuna before canning. The imported tuna after canning contained significantly higher amounts from crude protein, ether extract, total ash, water soluble ash, total carbohydrates, Na and Pb than those of Libyan and imported tuna before canning, while it contained significantly lower amounts from moisture, TVN, Ca, Mg and Mn than those of two other samples.

Imported frozen tuna before canning contained significantly higher amounts from TVN, K and Cd. Fresh Libyan tuna contained significantly higher concentrations from Zn, Cu, Mn and Hg than those of two other samples.

Weight composition of canned tuna:

As shown in Table (2) the net weight ranged from 111.85 to 171.13 g. The percentage of net weight to gross weight ranged from 76.88 to 81.4%, which was significantly higher in Razo (Ra) sample, while it was lower in Subrata (Su) sample. Statistical analysis did not appear any significant differences in net weight percentage between Alwafa (Al), (Ra) and Mawadda (Ma) samples. In general, the results of net weight percentage in all samples were lower than the limit of Libyan Standards (1994), which reported that the net weight must not decrease than 95% from the gross weight.

The percentage of oil used in packaging ranged from 15.84 to 26.86%, which was significantly higher in (Ra) sample, while it was significantly lower in (Ma) sample. It could be noticed that the percentage of oil in (Al), (Ma), and (Su) samples was within the limits of Libyan Standards (1994), which reported that the percentage of oil must not decrease than 15% and not increase than 25% from the net weight.

Table (1): Chemical composition of Libyan fresh tuna and imported frozen tuna before and after canning (on wet weight basis).

Components	Samples			L.S.D
	Libyan fresh	Imported frozen		
		Before canning	After canning	
Moisture (%)	72.73[a]	73.47[a]	58.87[b]	4.18
Crude protein (%)	23.85[b]	22.25[b]	25.78[a]	2.39
Ether extract (%)	1.96[b]	1.98[b]	4.54[a]	0.66
Total carbohydrates	0.17[b]	1.11[b]	9.38[a]	6.95
Total ash (%)	1.29[b]	1.19[b]	1.43[a]	0.13
• Water insoluble ash (%)	0.13	0.22	0.13	N.S.
• Water soluble ash (%)	1.16[b]	0.97[c]	1.30[a]	0.12
T.V.N. (mg/100g)	21.52[b]	24.26[a]	16.87[c]	1.32
Minerals (ppm)				
Na	347.36[b]	155.85[b]	2270.02[a]	195.35
K	1150.72[c]	2731.03[a]	2415.87[b]	94.34
Ca	274.97[a]	367.01[a]	89.64[b]	106.64
Mg	461.04[a]	493.42[a]	381.67[b]	38.78
Fe	30.99	18.87	29.92	N.S.
Zn	23.13[a]	2.15[b]	0.97[b]	9.47
Cu	14.54[a]	2.13[b]	2.91[b]	6.21
Mn	12.34[a]	7.61[b]	3.05[c]	1.82
Pb	1.89[c]	2.84[b]	3.89[a]	0.89
Hg	4.36[a]	1.42[b]	1.94[b]	0.73
As	0.91[b]	1.42[ab]	1.94[a]	0.55
Cd	0.36[c]	0.59[a]	0.48[b]	0.09

Data calculated from triplicates.

[a-c] There is no significant differences between any two means have the same letter within certain property.

The percentage of salt solution to packaging solution (oil & salt solution) ranged from 19.14 to 56.48%, which was significantly higher in (Ma), while it was significantly lower in (Ra) sample. It could be noticed that the percentage of salt solution in all samples except (Su) sample was higher than the maximum limit of Libyan standards (1994), which reported that the percentage of salt solution must not increase than 5% from the packaging solution.

The percentage of drained weight ranged from 57.60 to 82.27%, which was significantly higher in (Su) sample, while it was significantly lower in Insupebile (In) sample. It is evident that the percentage of drained weight of (Al) and (Su) samples, which produced in Libya was higher than the limit of Libyan Standards (1994), which reported that the drained weight must not decrease than 70% to the net weight. The drained weight percentage of (In), (Ma) and (Ra) samples was lower than the same Standards. The decrease of drained weight percentage may be due to increase of the oil or salt solution used in tuna packaging.

Table (2): weight composition of canned tuna.

Components	Samples					L.S.D
	Al	Ra	Ma	In	Su	
Gross weight (g)	207.35^{a}	195.13^{b}	212.28^{a}	200.38^{b}	145.49^{c}	5.46
Can free weight (g)	39.13^{b}	36.27^{c}	41.15^{a}	41.26^{a}	33.64^{d}	1.94
Net weight (g)	168.22^{a}	158.86^{b}	171.13^{a}	159.12^{b}	111.85^{c}	4.94
%	81.13^{a}	81.41^{a}	80.62^{a}	79.41^{b}	76.88^{c}	1.05
Oil weight (g)	31.91^{b}	42.67^{a}	27.10^{c}	41.99^{a}	19.83^{d}	4.30
%	18.97^{b}	26.86^{a}	15.84^{c}	26.38^{a}	17.73^{bc}	2.74
Salt sol. weight (g)	15.13^{b}	10.10^{b}	35.17^{a}	25.47^{a}	-	10.31
%	32.16^{b}	19.14^{c}	56.48^{a}	37.76^{b}	-	6.15
Drained weight (g)	121.18^{a}	106.09^{b}	108.86^{b}	91.66^{c}	92.02^{c}	10.15
%	72.14^{b}	66.78^{bc}	63.61^{c}	57.60^{d}	82.27^{a}	5.88

Data calculated from triplicates.

$^{a-d}$ There is no significant differences between any two means have the same letter within certain property.

Chemical composition of canned tuna:

From the results in Table (3) it could be noticed that the moisture content of canned tuna ranged from 58.87 to 69.24%, which was significantly higher in (Ma) sample, while it was lower in (Su) sample. Statistical analysis did not appear any significant differences in moisture content between (In) and (Ma) samples, also between (Ra) and (In) samples and finally between (Su) and (Al) samples. The decreasing in moisture content in (Su) sample may be due to addition of salt in dry form.

Total solids of canned tuna ranged from 30.76 to 41.13%, which were significantly higher in (Su) sample, while it were lower in (Ma) sample. Statistical analysis did not appear any significant differences in total solids between (Su) and (Al) samples, also between (Ra) and (In) samples and finally between (In) and (Ma) samples

Crude protein ranged from 18.33 to 25.78%, which was significantly higher in (Su) sample, while it was lower in (In) sample. Statistical analysis did not appear any significant differences in crude protein between (Al) and (Su) samples, also between (Ra) and (Al) samples and finally between (In), (Ma) and (Ra) samples.

Ether extract ranged from 4.54 to 7.57%, which was significantly higher in (Al) sample, while it was lower in (Su) sample. Statistical analysis did not appear any significant differences in ether extract between (Ma) and (Ra) samples and also between (Su) and (In) samples.

Total carbohydrates ranged from 3.84 to 9.38%, which were significantly higher in (Su) sample, while it were significantly lower in (Ma) sample. Statistical analysis did not appear any significant differences in total carbohydrates between (Ra), (In) and (Su) samples and also between (Ma), (Al), (Ra) and (In) samples.

Total ash content ranged from 1.23 to 1.94%, which was significantly higher in (Al) sample, while it was lower in (Ma) sample. Statistical analysis did not appear any significant differences in total ash between (Al) and (In) samples, also between (Su), (Ra) and (In) samples and finally between (Ma) and (Su) samples. Water insoluble ash ranged from 0.13 to 0.28%. The percentage of water insoluble ash to total ash ranged from 8.61 to 17.72%. Statistical analysis did not appear any significant differences in water insoluble ash between all samples of canned tuna. Water soluble ash ranged from 1.04 to 1.69%, which was significantly higher in (Al) sample, while it was lower in (Ma) sample. The percentage of water soluble ash to total ash ranged from 82.28 to 91.39%. Statistical analysis did not appear any significant differences in water soluble ash percentage between all investigated samples. This differences may be due to the difference of tuna variety, which used in the canning.

Table (3): Proximate chemical composition of canned tuna (on wet weight basis).

Components	Samples					L.S.D
	Al	Ra	Ma	In	Su	
Moisture(%)	60.65^{c}	64.46^{b}	69.24^{a}	67.35^{ab}	58.87^{c}	3.04
Total solids (%)	39.35^{a}	35.54^{b}	30.76^{c}	32.65^{bc}	41.13^{a}	3.05
Crude protein (%)	25.49^{ab}	20.69^{bc}	19.60^{c}	18.33^{c}	25.78^{a}	5.06
Ether extract (%)	7.57^{a}	6.28^{b}	6.09^{b}	5.02^{c}	4.54^{c}	0.78
Total carbohydrates (%)	4.35^{b}	7.06^{ab}	3.84^{b}	7.72^{ab}	9.38^{a}	4.18
Total ash (%)	1.94^{a}	1.51^{b}	1.23^{c}	1.58^{ab}	1.43^{bc}	0.37
Water insoluble ash (%)	0.25	0.13	0.19	0.28	0.13	N.S.
% from total ash	12.89	8.61	15.45	17.72	9.09	N.S.
Water soluble ash (%)	1.69^{a}	1.38^{ab}	1.04^{b}	1.30^{ab}	1.30^{ab}	0.42
% from total ash	87.11	91.39	84.55	82.28	90.91	N.S.
Alkalinity of soluble ash	0.49^{a}	0.51^{a}	0.46^{a}	0.30^{b}	0.31^{b}	0.13

Data calculated from triplicates.

[a-c] There is no significant differences between any two means have the same letter within certain property.

The alkalinity of water soluble ash calculated as Na_2CO_3 used to neutralize 100 g sample ranged from 0.30 to 0.51, which was significantly higher in (Ra) sample, while it was lower in (In) sample. Statistical analysis did not appear any significant differences in alkalinity between (Ma), (Al), and (Ra) samples and also between (In) and (Su) samples.

pH value and total volatile nitrogen (T.V.N) of canned tuna:

Total volatile nitrogen (T.V.N.) is an index to degree of protein and non protein decomposition by the effect of microorganisms as not by Shaheen (1958). As shown in Table (4) T.V.N. ranged from 1.82 to 16.87 mg/100gm on wet weight basis, which was significantly higher in Su sample, while it was lower in (Ma) sample. Statistical analysis did not appear any significant differences in T.V.N. between (Su) and (Al) samples and also between (In) and (Ma) samples.

From these results, it could be noticed that the Libyan canned tuna exhibited higher amount from T.V.N. than those of other samples.

In general, the amount of T.V.N. in all investigated samples was lower than the maximum limit indicated by Libyan Standards (1994), which reported that T.V.N. must not increase than 30 mg/100g on wet weight basis.

Table (4): pH value and total volatile nitrogen (mg / 100g on weight wet basis) of canned tuna.

Components	Samples					L.S.D
	Al	Ra	Ma	In	Su	
Total volatile nitrogen	14.36^{a}	8.96^{b}	1.82^{e}	4.13^{c}	16.87^{a}	2.67
pH value	5.68^{b}	5.55^{c}	5.39^{d}	5.45^{cd}	5.91^{a}	0.11

Data calculated from triplicates.

$^{a-d}$ There is no significant differences between any two means have the same letter within certain property.

pH value ranged from 5.39 to 5.91, which was significantly higher in (Su) sample, while it was lower in (Ma) sample. Statistical analysis did not appear any significant differences in pH value between (Ra) and (In) samples and also between (In) and (Ma) samples.

Minerals content of canned tuna:

Data in Table (5) show fourteen of minerals content of canned tuna. The minerals can be ranked in the following descending order: Phosphorous (P), Potassium (K), Sodium (Na), Aluminum (Al), Magnesium (Mg), Calcium (Ca), Iron (Fe), Zinc (Zn), Lead (Pb), Manganese (Mn), Copper (Cu), Arsenic (As), Mercury (Hg) and Cadmium (Cd). It could be noticed that there was a large variation in minerals content of the canned tuna.

Subrata (Su) sample (canned in Libya) contained significantly higher concentrations from Na, K, Pb, Hg and As. The significantly higher concentrations from Al and Mn were found in Alwafa (Al) sample (canned in Libya). While the significantly higher concentrations from Mg were found in (Su) and (Al) samples. Mawadda (Ma) sample contained significantly higher concentration from Zn. The significantly higher concentrations from Cu were found in Razo (Ra) and (Su) samples. Statistical analysis must not appear any significant differences in Ca, P and Fe concentrations between all investigated samples.

The obtained results of Zn, Cu, Mn and Pb concentrations are lower than the maximum limit, which reported by Libyan Standards (1994). It could be noticed that (Al), (Ra) and (Ma) samples contained on concentrations of As were lower than the maximum limit indicated by Libyan Standards (1994). In contrast, Subrata (Su) sample contained on concentration of As was higher than the maximum limit reported by the same Standards.

Table (5): Minerals content of canned tuna (ppm on wet weight basis).

Minerals	Samples					L.S.D
	Al	Ra	Ma	In	Su	
Sodium (Na)	925.59^{b}	667.12^{c}	452.05^{d}	879.15^{b}	2270.02^{a}	168.33
Potassium (K)	789.96^{c}	1155.18^{b}	579.46^{d}	600.45^{d}	2415.87^{a}	137.06
Calcium (Ca)	76.32	49.54	45.89	52.17	89.64	N.S.
Magnesium (Mg)	346.34^{a}	209.12^{b}	115.23^{c}	164.59^{bc}	381.67^{a}	92.82
Phosphorous (P)	2210.60	1917.39	2464.45	2016.32	2125.75	N.S.
Aluminum (Al)	1081.65^{a}	263.62^{c}	290.47^{c}	619.49^{b}	481.64^{bc}	310.41
Iron (Fe)	29.27	70.84	54.84	28.93	29.92	N.S.
Copper (Cu)	1.30^{bc}	4.67^{a}	0.73^{c}	1.87^{b}	2.91^{ab}	1.97
Zinc (Zn)	6.76^{b}	9.81^{ab}	12.37^{a}	8.53^{ab}	0.97^{c}	4.87
Manganese (Mn)	4.21^{a}	1.09^{d}	2.17^{c}	1.82^{c}	3.05^{b}	0.61
Lead (Pb)	2.70^{c}	2.95^{bc}	2.92^{bc}	3.41^{ab}	3.89^{a}	0.53
Mercury (Hg)	1.04^{b}	0.51^{c}	0.68^{c}	0.40^{c}	1.94^{a}	0.38
Arsenic (As)	0.92^{bc}	0.96^{bc}	0.73^{c}	1.17^{b}	1.94^{a}	0.65
Cadmium (Cd)	0.45^{a}	0.25^{b}	0.32^{b}	0.29^{b}	0.48^{a}	0.09

Data calculated from triplicates.

$^{a-c}$ There is no significant differences between any two means have the same letter within certain element.

Anyhow, it could be observed that the Hg content in Alwafa (Al) and Subrata (Su) samples was higher than the maximum limit reported by Libyan Standards (1994). These results are in agreement with the results obtained by Gajewska *et al,*. (1995), while were higher than the results obtained by Ohlin, (1993).

Libyan canned tuna (Al and Su samples) contained significantly higher concentrations from Cd than the other samples. In general, the concentration of Cd in all samples were higher than the limits of Capar (1990).

It was clear that canned tuna contained appreciable amounts of P, Mg, Zn and Cu compared to many other food sources. Canned tuna is rich source of P (average content 214.69 mg/100g on wet weight basis) is approaches ½ that present in meat and meat products and comparable to that found in whole dry milk (250 mg/100g) (Pellet and Shadarevian, 1970). The average content of Mg in canned tuna (24.34 mg/100g) is quite higher than those found in human milk or Cow's milk (4 and 12 mg/100ml, respectively) (NAS, 1974). The average content of Zn in canned tuna 0.77 mg/100g on wet basis and these result was closed to those found in milk (0.3 – 0.5 mg/100g) (FAO, 1974). The amount of Cu present in canned tuna (average value 2.3 ppm on wet basis) is considered a good source for Cu compared to the human milk (0.6 – 1.05 mg/liter) as reported by FAO (1974).

Chemical constants of oils separated from canned tuna:

It is shown from Table (6) that fresh olive oil (F.O.O.) contained significantly higher values from acid value and total free fatty acids. Generally it could be noticed that the acidity in all samples was below the permissible limits of 2%

(E.O.S., 1971) and Libyan Standards (1983). These results are in agreement with the findings by Colakoghi (1972), Abd El-Malek *et al.* (1989) and El-Agaimy *et al.* (1989).

Table (6): Some chemical constants of oil separated from canned tuna compared with fresh olive oil (F.O.O).

Properties	Samples						L.S.D
	Al	Ra	Ma	In	Su	F.O.O	
Acid value (mg/gm)	0.87^{b}	0.61^{b}	0.24^{c}	0.27^{c}	0.74^{c}	1.95^{a}	0.056
Free fatty acids (%)	0.44^{b}	0.31^{d}	0.12^{c}	0.14^{c}	0.37^{c}	0.98^{a}	0.033
Peroxide value (meq/kg)	15.58^{a}	11.73^{c}	8.90^{de}	8.09^{e}	10.10^{d}	13.25^{b}	1.25
Iodine value (%)	76.61^{ba}	74.37^{c}	116.07^{a}	114.74^{a}	79.24^{b}	78.16^{b}	3.73
Thiobarbituric acid mg/kg	2.72^{ab}	1.67^{c}	0.39^{c}	0.76^{d}	2.99^{a}	2.54^{b}	0.306

Data calculated from triplicates.

$^{a-c}$ There is no significant differences between any two means have the same letter within certain property.

The oil separated from Alwafa (Al) sample contained significantly higher peroxide value than other samples. Anyhow, it could be considered that the peroxide value in oil separated from all samples of canned tuna and fresh olive oil was within the limits reported by E.O.S. (1971) and Libyan Standards (1972) and (1983). These results are in agreement with those mentioned by Abd El-Malek *et al.* (1989).

Iodine value of separated oil from (Ma) and (In) samples was significantly higher than other samples. This increase may be due to using sunflower oil in the canning, while decreasing the iodine value in oil separated from other samples may be due to addition of olive oil during the canning of tuna.

The separated oil from (Al) and (Su) samples (Libyan canned tuna) and Libyan fresh olive oil contained significantly higher amounts from T.B.A. than other samples. This increase may be due to virgin olive oil without refining.

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التركيب الطبيعى والكيميائى للتونة الطازجة، المجمدة المستوردة والمعلبة

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إستهدف هذا البحث دراسة التركيب الكيميائى للتونة الليبية الطازجه والتونة المجمده المستورده من الهند والتى يتم تعليبها فى ليبيا وكذلك التونه المعلبة الناتجة منها. كما إشتملت الدراسه على تقدير الخواص الطبيعية (التركيب الوزنى)، التركيب الكيميائى، المواد النيتروجينية المتطايرة الكلية والعناصر المعدنية فى خمسة أنواع من التونة المعلبة داخل الجماهيرية الليبية (الوفاء وصبراته) والمستوردة (مودة، رازو وانسيوبيبل) وكذلك بعض الخواص الكيميائية للزيت المفصول من التونة المعلبة وقد أظهرت النتائج:-

- إحتوت التونة الطازجة الليبية على تركيزات عالية معنويا من عناصر الزنك، النحاس، المنجنيز والزئبق عن التونة المجمدة المستوردة من الهند والتى يتم تعليبها فى الجماهيرية الليبية.احتوت التونة المجمدة المستوردة قبل تعليبها على محتويات عالية معنويا من المواد النيتروجينية المتطايرة الكلية وعنصرى البوتاسيوم والكادميوم فى حين إحتوت التونة المستوردة بعد تعليبها على محتويات عالية معنويا من البروتين الخام، المستخلص الإثيرى، الرماد الكلى، الرماد الذائب فى الماء، الكربوهيدرات الكلية وعنصرى الصوديوم والرصاص.
- كان الوزن الصافى للتونة المعلبة (٧٦,٩٠-٨١,٤١%) فى كل العينات التى تم تحليلها أقل من الحدود الذكورة بالمواصفات الليبية (لا يقل عن ٩٥%) وعلى العكس من ذلك كانت النسبة المئوية للمحلول الملحى المستخدم فى تعبئة كل عينات التونة بإستثناء عينة صبراته (١٩,١٤-٥٦,٤٨%) أعلى من حدود المواصفات الليبية (لا يزيد عن ٥,٠% من محلول التعبئة). كانت النسبه المئوية للزيت المستخدم

فى تعبئة عينات الوفاء، مودة وصبراته (١٨,٩٧، ١٥,٨ و١٧,٧٣%) داخل حدود المواصفات الليبية (لا يقل عن ١٥% ولا يزيد عن ٢٥%). كانت النسبة المئوية للوزن المصفى فى التونة المعلبة داخل الجماهيرية الليبية (مودة وصبراته) (٧٢,٠٢، ٨٢,٢٧%) أعلى من المواصفات الليبية (لا يقل عن ٧٠%).

- فى التونة المعلبة تراوحت الرطوبة من ٥٨,٨٧ – ٦٩,٢٤، البروتين الخام من ١٨,٣٣ – ٢٥,٧٨، المستخلص الإثيرى من ٤,٥٤ – ٧,٥٧، الرماد الكلى من ١,٢٣ – ١,٩٤، الرماد غير الذائب فى الماء من ٠,١٣ – ٠,٢٨، الرماد الذائب فى الماء من ١,٠٤ – ١,٦٩، قلوية الرماد الذائب فى الماء من ٠,٣ – ٠,٥١% على أساس الوزن الرطب على الترتيب. احتوت التونة المعلبة داخل الجماهيرية الليبية (الوفاء وصبراته) على محتوي عالي معنويا من المواد النيتروجينية المتطايرة الكلية (١٤,٣٦ و١٦,٨٧ مللجم/١٠٠جم على التوالى) ولكن فى نفس الوقت كانت المواد النيتروجينية المتطايرة الكلية فى كل العينات أقل من الحد الأقصى المسموح بالمواصفات الليبية (لا تزيد عن ٣٠ مللجم/١٠٠جم).
- احتوت عينة صبراته على تركيزات عالية معنويا من عناصر الصوديوم، البوتاسيوم، الرصاص، الزئبق والزرنيخ عن العينات الأخرى فى حين إتضح أن التركيزات العالية معنويا من عنصرى الألومنيوم والمنجنيز وجدت فى عينة الوفاء. إحترت العينة وصبراته رازو على تركيز عالى معنويا من عنصر النحاس. لم تظهر نتائج التحليل الإحصائى عن وجود فروق معنوية فى تركيز كل من الكالسيوم، الفوسفور والحديد في كل العينات. إتضح أن عنصر الزئبق فى التونة المعلبة داخل الجماهيرية الليبية (الوفاء وصبراته) وكذلك عنصر الزرنيخ فى عينة صبراته أعلى من الحد الأقصى المسموح به فى الواصفات الليبية (١ جزء فى المليون).
- إختلفت الثوابت الكيميائية للزيوت المفصولة من التونة المعلبة حيث إحتوى الزيت المفصول من عينة الوفاء على قيمة عالية معنويا لرقم البيروكسيد، فى حين إحتوى الزيت المفصول من عينة مودة وعينة انسيوبيل على قيم عالية معنويا للرقم اليودى. كانت القيم العالية معنويا لرقم TBA موجودة فى الزيت المفصول من التونة المعلبة داخل الجماهيرية الليبية (الوفاء ومودة).