Chemical profile of salted and canned fish products

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Abstract

Hundred random samples of salted fish products (fesiekh, sardine, moluoha and herring); canned smoked (mackerel and tuna); canned fish (mackerel, anchovy, sardine and tuna) 10 of each were collected from different super markets in El-Sharkia Governorates, Egypt. The pH values in examined salted fish products were 6.39 ± 0.03, 6.28 ± 0.05, 6.44 ± 0.06 , 6.17± 0.07, 6.23 ± 0.04, 6.11± 0.03, 6.59 ± 0.05, 6.46 ± 0.06, 6.41± 0.04 and 6.52 ± 0.05 in examined fesiekh, sardine, moluoha and salted smoked herring, canned smoked mackerel, canned smoked tuna, canned mackerel, canned anchovy canned sardine and canned tuna, respectively. The total volatile basic nitrogen TVB-N values in examined salted fish products were 27.91 ± 0.79, 23.16 ± 0.84, 29.53 ± 1.03 and 19.87± 0.82 31.35 ± 0.98, 16.39± 0.72, 38.25 ± 0.78, 33.31 ± 1.13,34.78± 1.06 and 22.06 ± 0.84 mg/100g in examined fesiekh, sardine, moluoha , salted smoked herring, canned smoked mackerel, canned smoked tuna, canned mackerel, canned anchovy canned sardine and canned tuna, respectively. The TMA values in examined salted fish products were 7.08 ± 0.32, 5.73 ± 0.28, 7.35 ± 0.48, 4.62± 0.24, 5.40 ± 0.34, 4.06± 0.23, 7.18 ± 0.37, 5.86 ± 0.28, 6.27± 0.41 and 5.14 ± 0.31mg/100g in examined fesiekh, sardine, moluoha and salted smoked herring, canned smoked mackerel, canned smoked tuna, canned mackerel, canned anchovy canned sardine and canned tuna, respectively. The TBA values in examined salted fish products were 3.47 ± 0.34, 2.9 ± 0.36, 3.84 ± 0.36 and 2.76± 0.32 3.1 ± 0.32, 2.57± 0.31, 3.36 ± 0.32, 2.93 ± 0.34, 3.12± 0.35 and 2.74 ± 0.32 mg malondialdehyde /kg in examined fesiekh, sardine, moluoha and salted smoked herring, canned smoked mackerel, canned smoked tuna, canned mackerel, canned anchovy canned sardine and canned tuna, respectively.

Keywords: Canned fish, Salted fish, Smoked fish, Total volatile basic nitrogen, Thiobarbituric acid, Trimethylamine.

1. Introduction:

Fish is known to have an excellent amino acid composition, also unsaturated fatty acids that are why it is recommended for a balanced, healthy diet. Fresh fish is considered as the most perishable food product due to its composition, and improvement of fish quality is the main aim of fish industry.

Salting is the preservation of fish with dry edible salt (fesiekh and moluoha) or it is related to pickling (sardine), and is one of the oldest methods of preserving food. Salt inhibits the growth of microorganisms by drawing water out of microbial cells through osmosis. Concentrations of salt up to 20% are required to kill most species of unwanted bacteria. Smoking, often used in the process of salted fish (smoked salted herring). Salting is used because most bacteria, fungi and other potentially pathogenic organisms cannot survive in a highly salty environment, due to the hypertonic nature of salt. Any living cell in such an environment will become dehydrated through osmosis and die or become temporarily inactivated. Both of slated and smoked fish products are traditionally consumed, in different occasion in Egypt.

Canning provides a typical shelf life ranging from 1 to 5 years, making fish available for the inhabitants of very remote non-fishing areas. During canning heat treatment should be sufficient to destroy all heat sensitive bacteria and spores (116°C for 30 min), inactivate the enzymes and cook the fish so that the products remain acceptable to the consumers after prolonged storage. If the heat treatment is properly carried out, canned fish may remain in storage for several years without refrigeration **(Oranusi *et al.*, 2012)**.

Spoilage of fish products is a complex process involving both chemical and microbiological processes. Microorganisms and autolytic enzyme act chemically converting the tissue components, protein, carbohydrate and fat into simpler metabolites (TMA, TVB, lactic acid, Dimethyleamine (DMA), Thiobarbituric acid (TBA). The increase in concentration of these metabolites in tissue leads to the changes in sensory characters and chemical properties of tissues **(Mexis et al., 2009)**. So they can be used as an index of quality of fish.

Oxidative rancidity of fish lipids (lipids oxidation) during processing and storage is one of the major factors that limits the quality, acceptability of lipid-containing foods and storage period (shelf-life) and thereby affects marketing and distribution of fish products **(Rao et al., 2008)**. The fish oxidative changes is induced by the oxygen radical and tissue enzymes and deteriorate sensory characteristics and quality causes (off-flavor, rancid taste, loss of muscle color due to oxidation of oxymyoglobin and drip accumulation (liquid oozing out of stored muscle) leading to deterioration in appearance **(Antionewski et al., 2007)** and development of various substances which may have adverse effects on human health **(Ames et al.1993)**.

Therefore, the aims of this study were to determine some chemical parameters in salted fish products (fesiekh, sardine, moluoha and herring); canned smoked (mackerel and tuna) and canned fish (mackerel, anchovy, sardine and tuna) marketed is Zagazig city, Sharkia province, Egypt.

2. Materials and Methods:

2.1. Collection of samples:

Hundred random samples of salted fish products (fesiekh, sardine, moluoha and herring); canned smoked (mackerel and tuna); canned fish (mackerel, anchovy, sardine and tuna) 10 of each were collected from different super markets in El-Sharkia Governorates, Egypt. Collected samples were transported without undue delay in an ice box, to the laboratory of meat hygiene faculty of

Veterinary Medicine, Zagazig University, Egypt. The samples were subjected to chemical and bacteriological examinations.

2.2. Physicochemical examination of fish:

2.2.1. Measurement of pH:

Five grams of each fish sample was homogenized in 50 mL distilled water in a ratio of 1:10 (w/v) using laboratory warring blender. The pH was measured using a digital pH meter by inserting the electrodes into the homogenates. The pH meter was calibrated using pH 4 and 7 buffer **(Abelti, 2013).**

2.2.2. Determination of Total Volatile Basic-Nitrogen (TVB-N) values:

Fish extracts for determination of Total Volatile Basic Nitrogen (TVB-N) values were prepared by homogenizing 100 gm of each frozen fish sample with 200 mL of 7.5% (w/v) aqueous trichloroacetic acid (TCA) solution in a laboratory homogenizer for 1 min at a high speed. The homogenate was centrifuged at 3000 rpm for 5 min and the supernatant liquid was then filtered through Whatman No. 1 filter paper. TVB-N was measured by steam-distillation of the TCA-fish extract, using the method of **Malle and Tao (1987)**. Twenty five ml of the filtrate was added to a Kjeldahl-type distillation tube, followed by 5 mL of 10% (w/v) aqueous NaOH solution. Steam-distillation was performed using a vertical steam distillation unit and the distillate was received into a beaker containing 25 mL of 4% (w/v) aqueous boric acid and 0.04 mL of methyl red and bromo-cresol green indicator solution up to a final volume of 100 ml. The boric acid solution turned green when alkalinized by the distilled TVB-N. The titration was allowed to run against aqueous 0.025 N sulfuric acid solutions to the endpoint indicated by a green to pink color change. Complete neutralization was obtained when the color turned pink on the addition of a further drop of sulfuric acid.

The TVB-N content was calculated by the following formula:

TVB-N (mg N per 100 gm) = (14mg/mol×a×b×300) ÷ 25ml

Where, a = mL of sulfuric acid

b = Normality of sulfuric acid

2.2.3. Determination of TMA:

A Tri-chloro-acetic acid (TCA) extract was steam distilled by the modified method of **Malle and Poumeyrol (1989)**. Briefly, 20 ml of formaldehyde was added to the distillation flask to block the primary and secondary amines. Steam distillation was then performed as for the determination of TVB-N in TCA extract. When the required amount of formaldehyde was added, only the TMA was distilled. The TMA content was calculated from the volume of 0.025N H_2SO_4 used for titration as follows:

TMA (mg N per 100 gm) = (14mg/mol×a×b×300) ÷ 25ml

Where, a = mL of sulfuric acid

b = Normality of sulfuric acid

2.2.4. Determination of Thiobarbituric acid number (TBA):

2.2.4.1. Principle:

Thiobarbituric acid (TBA) reacts with malondialdehyde (MD) in acidic medium at temperature of 95°C for 30 min to form thiobarbituric acid reactive product the absorbance of the resultant pink product can be measured at 534 nm **(Satoh, 1978** and **Ohkawa *et al*., 1979).**

2.2.4.2. Procedure:

1-Prior to dissection, perfuse tissue with a PBS (phosphate buffered saline) solution, pH 7.4. Containing 0.16 mg / ml heparin to remove any red blood cells and clots.

2-Homogenize the tissue in 5–10 ml cold buffer (i, e, 50 mM potassium phosphate, pH 7.5.) per gram tissue.

3- Centrifuge at 4000 r.p.m for 15 minutes.

4- Remove the supernatant for assay and store on ice. If not as saying on the same day, freeze the sample at - 80°C. The sample will be stable for at least one month.

5- Mix well, cover the test tube with glass bead, heat in boiling water bath for 30 min, COOL , then add 0.2ml of the blank reagent in the blank tube.

6- Mix and read the absorbance of sample (A Sample) against blank and standard against d. water at 534 nm.

2.2.4.3. Calculation:

Malondialdehyde in sample:

$$\frac{A\ sample}{Standard} \times \frac{10}{gm.tissue\ used}$$

TBA No. = D × 7.8 mg malondialdehyde/ kg of sample.

D: the read of sample against blank.

2.3. Statistical analyses:

The experimental data were evaluated using mixed model's procedure, *post hoc* comparisons were applied, whenever appropriate, using Duncan's test. All statistical procedures were performed using PASW statistics 18 (SPSS Inc., USA). Statisticalsignificance was considered at $P \leq 0.05$.

3. Results and discussion:

Preservation techniques are needed to prevent fish spoilage and lengthen shelf life. They are designed to inhibit the activity of spoilage bacteria and the metabolic changes that result in the loss of fish quality. Spoilage bacteria are the specific bacteria that produce the unpleasant odours and flavours associated with spoiled fish (**Huss, 1988**). Spoilage bacteria need the right temperature, sufficient water and oxygen, and surroundings that are not too acidic. Preservation techniques work by interrupting one or more of these needs **(FAO, 2005)**. There are a number of techniques that have been or are used to tie up the available water or remove it by reducing the a_w. Traditionally, techniques such as drying, salting and smoking have been used, and have been used for thousands of years. Moreover, canning, developed during the 19th century has also had a significant impact on fishing by allowing seasonal catches of fish that are possibly far from large centers of population to be exploited.

Potency of hydrogen ion (pH):

Fresh fish is close to neutral pH and gradually rising during storage with pH values above 7.1 is sign of decomposition. The pH as an index, which is important in determining the quality of fish, and it could be used as a guide (**Özyurt, et al., 2009)**. The data in table 1 and figure 1 showed that the pH values in examined salted fish products were 6.39 ± 0.03, 6.28 ± 0.05, 6.44 ± 0.06 and 6.17± 0.07 in examined fesiekh, sardine, moluoha and salted smoked herring, respectively.Nearly similar pH values for salted fish obtained by **Edris et al. (2014)** who recorded 6.39 ± 0.01, 6.24 ± 0.02 and 6.58 ±0.01 in examined fesiekh, sardine and moluoha, respectively and **Mohamed (2016)** who found pH values were 6.37± 0.04, 6.27± 0.19 and 6.33± 0.08 in examined fesikh, smoked herring and salted sardine respectively. Higher pH values obtained for fesikh and sardine samples 6.90 ± 0.05 and 6.70 ± 0.01 (**El–Sheshnagui, 2006)**.

The salted fish samples were accepted according to the established limit 6.5 of **EOS (2005)**.

The results in table 1 and figure 1 showed that the pH values in examined canned fish products were 6.23 ± 0.04, 6.11± 0.03, 6.59 ± 0.05, 6.46 ± 0.06, 6.41± 0.04 and 6.52 ± 0.05 in examined canned smoked mackerel, canned smoked tuna, canned mackerel, canned anchovy canned sardine and canned tuna, respectively. Comparable pH values obtained by **Bilgin and Gençcelep (2015)** they found mean values of pH were 6.12±0.11, 5.90±0.42, 3.38±0.12, and 5.61±0.09 for canned sardines, canned mackerel, marinated anchovies, and canned tuna, respectively. The examined canned fish samples within the established limits for pH in canned fish are 5.90 - 6.20 (**CFSAN, 2008)**.

Table (1). Potency of hydrogen ion (pH) of examined fish products (n= 10 of each).

product		Minimum	Maximum	Mean ± SE
Salted	Fesiekh	6.31	6.44	6.39 ± 0.03^{ab}
	Sardine	6.25	6.32	6.28 ± 0.05^{b}
	Moluoha	6.38	6.49	6.44 ± 0.06^{ab}
	Smoked herring	6.12	6.23	6.17 ± 0.07^{c}
Canned smoked	Mackerel	6.18	6.27	6.23 ± 0.04^{c}
	Tuna	6.06	6.14	6.11 ± 0.03^{c}
Canned	Mackerel	6.55	6.64	6.59 ± 0.05^{a}
	Anchovy	6.42	6.49	6.46 ± 0.06^{a}
	Sardine	6.38	6.45	6.41 ± 0.04^{ab}

	Tuna	6.48	6.54	6.52 ± 0.05[a]

- (a, b,c) Means on the same column carrying different superscript letters are significantly different (P< 0.05).

The differences in pH values attributed to the storage periods of fish before canning which lead to increase in volatile bases such as ammonia produced by either microbial or muscular enzymes **(Li *et al.*, 2012).** Moreover, the pH decrease in fish flesh by the addition of salt is explained by the increase of the ionic strength of the solution inside of the cells **(Goulas and Kontominas, 2005)**.

Total volatile basic nitrogen (TVB-N):

The TVBN may be considered as a quality index for fish. Its increase is related to the activity of spoilage bacteria and endogenous enzymes **(Özoğul et al., 2004 and Ruiz-Capillas& Moral, 2005)**, the function of such enzymes results in the formation of ammonia, monoethylamine, and dimethylamine, as well as trimethylamine, imparting characteristics of off-odor to fish. When reach level between 35 to 40 mg of TVB-N per 100 g of fish muscle is usually regarded as an indication that the product is spoiled as reported by (**Lakshmanan, 2000**).

Table (2). Total volatile basic nitrogen (TVB-N) mg/100g of examined fish products (n= 10 of each).

product		Minimum	Maximum	Mean ± SE
Salted	Fesiekh	25.34	29.63	27.91 ± 0.79[ab]
	Sardine	19.83	26.44	23.16 ± 0.84[b]
	Moluoha	25.64	33.65	29.53 ± 1.03[ab]
	Smoked herring	16.11	24.56	19.87± 0.82[c]
Canned smoked	Mackerel	19.42	25.68	22.06 ± 0.84[c]
	Tuna	12.67	18.98	16.39± 0.72[c]
Canned	Mackerel	36.24	41.25	38.25 ± 0.78[a]
	Anchovy	31.24	36.45	33.31 ± 1.13[a]
	Sardine	31.24	39.54	34.78± 1.06[a]
	Tuna	28.34	43.25	31.35 ± 0.98[ab]

- (a, b,c) Means on the same column carrying different superscript letters are significantly different (P< 0.05).

The achieved results in table 2 and figure 2 showed that the TVB-N values in examined salted fish products were 27.91 ± 0.79, 23.16 ± 0.84, 29.53 ± 1.03 and 19.87± 0.82 mg/100g in examined fesiekh, sardine, moluoha and salted smoked herring, respectively. Nearly similar values obtained by **Mohamed (2016)** who found TVB-N values of fesikh, smoked herring and salted sardine were 29.47± 0.71, 23.8 ± 0.23 and 29.48 ± 0.72 mg/100g, respectively. Lower values showed by **Yanar *et al*., (2006)** and **Osheba (2013)** while **Bahir Batir *et al*., (2006)** (55.4 mg/100g) and **Saritha *et al*., (2012)** reported the higher values. Smoked herring significantly lower in TVB-N content than other examined salted fish (p< 0.05) which attributed to the high marketability of this type and withstand only little days in the market, so that the deterioration not take place.

The data in table 2 and figure 2 showed that the TVB-N values in examined canned fish products were 31.35 ± 0.98, 16.39± 0.72, 38.25 ± 0.78, 33.31 ± 1.13,34.78± 1.06 and 22.06 ± 0.84 in examined canned smoked mackerel, canned smoked tuna, canned mackerel, canned anchovy canned sardine and canned tuna, respectively. Nearly similar TVB-N values 37.16± 11.11, 20.91±2.26, 8.37±2.30 and 25.80 ± 3.67 mg/100g in examined canned sardines, canned mackerel, marinated anchovies, and canned tuna, respectively (**Bilgin and Gençcelep, 2015)**. In general canned fish significantly higher in TVB-N content (p< 0.05) than canned smoked fish, which may be due to using of high quality fish in canned smoked fish or due to the effect of smoking which delay the bacterial and enzymatic deterioration of protein. All examined fish products were within the acceptable limit of TVB-N levels (30–45 mg per 100 g) that are commonly found in good-quality fish products **(EC, 1995)**.

Trimethyl amine (TMA):

TMA-N is an important spoilage index, particularly in marine fishes. TMA-N is derived from Trimethyl amine oxide (TMAO) which is critical for osmoregulation in marine fish. During spoilage, TMAO is reduced by enzymes to TMA **Kilnic *et al.* (2008).** TMA-N is considered as a valuable tool in the evaluation of fish quality because of its rapid accumulation in muscle under refrigerated conditions **(Gökodlu et al., 1998).**

The data in table 3 and figure 3 showed that the TMA values in examined salted fish products were 7.08 ± 0.32, 5.73 ± 0.28, 7.35 ± 0.48and 4.62± 0.24 mg/100g in examined fesiekh, sardine, moluoha and salted smoked herring, respectively. Slightly higher values obtained by **Mohamed (2016)** who found TVB-N values of fesikh, smoked herring and salted sardine were 9.76 ± 0.21, 8.61± 0.22 and 9.79 ± 0.20mg/100g, respectively.

The results in table 3 and figure 3 showed that TMA values in examined canned fish products were 5.40 ± 0.34, 4.06± 0.23, 7.18 ± 0.37, 5.86 ± 0.28, 6.27± 0.41 and 5.14 ± 0.31 mg/100g in examined canned smoked mackerel, canned smoked tuna, canned mackerel, canned anchovy canned sardine and canned tuna, respectively.

Table (3).Trimethyl amine (TMA) mg/100g of examined fish products (n= 10 of each).

product		Minimum	Maximum	Mean ± SE
Salted	Fesiekh	4.98	9.36	7.08 ± 0.32[a]
	Sardine	4.17	8.91	5.73 ± 0.28[b]
	Moluoha	5.67	9.19	7.35 ± 0.48[a]
	Smoked herring	2.23	24.56	4.62± 0.24[c]
Canned smoked	Mackerel	3.12	7.35	5.14 ± 0.31[bc]
	Tuna	2.35	5.27	4.06± 0.23[c]
Canned	Mackerel	5.36	9.25	7.18 ± 0.37[a]
	Anchovy	3.21	7.98	5.86 ± 0.28[b]
	Sardine	4.69	8.25	6.27± 0.41[ab]
	Tuna	4.21	6.24	5.40 ± 0.34[b]

- (a, b,c) Means on the same column carrying different superscript letters are significantly different (P< 0.05).

TMA contents in all examined products remained below the critical values (10mg per 100 g) established as indicator of spoilage in fish products **(European Commission,1995).**

Fesiekh, moluoha and canned mackerel significantly higher in TMA content than other examined products (p<0.05) which attributed to the using of low quality fish during processing or elapsing of long time in the market.

Thiobarbituric acid (TBA):

Lipid in fish muscle typically consist of high percentage of polyunsaturated fatty acids and is consequently prone to oxidative reaction which is the major cause of a shortened shelf-life of fish. The TBA index is a measure of malonaldehyde (MDA) content, one of the degradation products of lipid hydroperoxides, formed during the oxidation process of polyunsaturated fatty acids **(Gomes et al., 2003). Bensid et al., (2014)** declared that MDA, a secondary product of lipid oxidation, and considered as a suitable indicator of fish meat freshness. TBA also is considered as spoilage indicator with microbiological and organoleptic examination in fish during storage period.

The data in table 4 and figure 4 declared that the TBA values in examined salted fish products were 3.47 ± 0.34, 2.9 ± 0.36, 3.84 ± 0.36 and 2.76± 0.32mg malondialdehyde /kg in examined fesiekh, sardine, moluoha and salted smoked herring, respectively. Lower values obtained by **Mohamed (2016)** who found TBA values of fesikh, smoked herring and salted sardine were 0.29± 0.02, 0.38±0.02 and and 0.49±0.03 32mg malondialdehyde /kg, respectively.

Table (4). Thiobarbituric acid (TBA) mg malondialdehyde /kg of examined fish products (n= 10 of each).

product		Minimum	Maximum	Mean ± SE
Salted	Fesiekh	2.59	4.56	3.47 ± 0.34[a]
	Sardine	1.99	3.95	2.9 ± 0.36[ab]
	Moluoha	2.16	4.51	3.84 ± 0.36[a]
	Smoked herring	1.84	3.68	2.76± 0.32[ab]
Canned smoked	Mackerel	2.14	4.03	3.1 ± 0.32[a]
	Tuna	1.82	3.67	2.57± 0.31[b]
Canned	Mackerel	2.26	4.36	3.36 ± 0.32[a]
	Anchovy	1.95	3.65	2.93 ± 0.34[ab]
	Sardine	2.11	4.18	3.12± 0.35[a]
	Tuna	1.98	3.89	2.74 ± 0.32[b]

- (a, b,c) Means on the same column carrying different superscript letters are significantly different ($P< 0.05$).

The data in table 4 and figure 4 that the TBA values in examined canned fish products were 3.1 ± 0.32, 2.57± 0.31, 3.36 ± 0.32, 2.93 ± 0.34, 3.12± 0.35 and 2.74 ± 0.32 mg.malondialdehyde /kg in examined canned smoked mackerel, canned smoked tuna, canned mackerel, canned anchovy canned sardine and canned tuna, respectively. Nearly similar TBA values 2.07±1.51, 0.95±0.15, 3.46±1.26 and 0.52±0.29 mg. malondialdehyde /kg in examined canned sardines, canned mackerel, marinated anchovies, and canned tuna, respectively (**Bilgin and Gençcelep, 2015)**. According to the permissible limit of TBA value in fish and fish products (4.5 mg MDA/kg) recommended by **ES (2005)** all examined samples were accepted. Smoked canned tuna and canned tuna significantly lower in TBA content than other examined fish products ($p < 0.05$) which related to the fact of tuna chemical composition low fat fish. Moreover, all the other examined products produced from medium and high fat containing fish.

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المخلص العربى

السمات الكيميائية لمنتجات الأسماك المملحة والمعلبة

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تعتبرالأسماك من أهم مصادر البروتين الحيوانى ويفضلها المصريين لأنها عالية القيمة الغذائية واسعارها مناسبة اضافة الى أنها سهلة الهضم بجانب أحتوائها على نسبة عالية من البروتين الحيوانى والفيتامينات والأملاح المعدنية كالفوسفورعلاوة على انخفاض نسبة الكوليسيترول بها. كانت قيم الأس الهيدروجيني في المنتجات السمكية المملحة التي تم فحصها هي ٦.٣٩ ± ٠.٠٣ و ٦.٢٨ ± ٠.٠٥ و ٦.٤٤ ± ٠.٠٦ و ٦.١٧ ± ٠.٠٧ في الفسيخ ، السردين ، الملوحة والرنجة المدخنة على التوالي. وكانت هذة القيم منتجات الأسماك المعلبة التي تم فحصها هي ٦.٢٣ ± ٠.٠٤ و ٦.١١ ± ٠.٠٣ و ٦.٥٩ ± ٠.٠٥ و ٦.٤٦ ± ٠.٠٦ و ٦.٤١ ± ٠.٠٤ و ٦.٥٢ ± ٠.٠٥ في الماكريل المدخن ، التونة المدخنة، الماكريل، الأنشوجة، السردين والتونة على التوالي.وتبين أن متوسط قيم المواد النيتروجينية المتطايرة في المنتجات السمكية المملحة كانت ٢٧.٩١ ± ٠.٧٩ و ٢٣.١٦ ± ٠.٨٤ و ٢٩.٥٣ ± ١.٠٣ و ١٩.٨٧ ± ٠.٨٢ مجم / ١٠٠ جم في الفسيخ ، السردين ، الملوحة والرنجة المدخنة على التوالي. وكانت هذة القيم فى منتجات الأسماك المعلبة التي تم فحصها هي ٣١.٣٥ ± ٠.٩٨ و ١٦.٣٩ ± ٠.٧٢ و ٣٨.٢٥ ± ٠.٧٨ و ٣٣.٣١ ± ١.١٣،٣٤.٧٨ ± ١.٠٦ و ٢٢.٠٦ ± ٠.٨٤ مجم / ١٠٠ جم في الماكريل المدخن ، التونة المدخنة، الماكريل، الأنشوجة، السردين والتونة على التوالي.ووجد أن قيم الميثيل أمين الثلاثى المنتجات السمكية المملحة التي تم فحصها هي ٧.٠٨ ± ٠.٣٢ و ٥.٧٣ ± ٠.٢٨ و ٧.٣٥ ± ٠.٤٨ و ٤.٦٢ ± ٠.٢٤ مجم/ ١٠٠ جم مجم / ١٠٠ جم في الفسيخ ، السردين ، الملوحة والرنجة المدخنة على التوالي. وكانت هذة القيم فى منتجات الأسماك المعلبة التي تم فحصها هي ٥.٤٠ ± ٠.٣٤ و ٤.٠٦ ± ٠.٢٣ و ٧.١٨ ± ٠.٣٧ و ٥.٨٦ ± ٠.٢٨ و ٦.٢٧ ± ٠.٤١ و ٥.١٤ ± ٠.٣١ مجم/١٠٠جم في الماكريل المدخن ، التونة المدخنة، الماكريل، الأنشوجة، السردين والتونة على التوالي.وكانت متوسطات حمض الثيوباربتيرك فى المنتجات السمكية المملحة التي تم فحصها هي ٣.٤٧ ± ٠.٣٤ ، ٢.٩ ± ٠.٣٦ ، ٣.٨٤ ± ٠.٣٦ و ٢.٧٦ ± ٠.٣٢مجم مالون داى ألدهايد/كجم في الفسيخ ، السردين ، الملوحة والرنجة المدخنة على التوالي. وكانت هذة القيم فى منتجات الأسماك المعلبة التي تم فحصها هي٣.١ ± ٠.٣٢ و ٢.٥٧ ± ٠.٣١ و ٣.٣٦ ± ٠.٣٢ و ٢.٩٣ ± ٠.٣٤ و ٣.١٢ ± ٠.٣٥ و ٢.٧٤ ± ٠.٣٢ مجم مالون داى ألدهايد/كجم في في الماكريل المدخن ، التونة المدخنة، الماكريل، الأنشوجة، السردين والتونة على التوالي.