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Quality evaluation and safety of little tuna fish shawarma

Mohamed M. M. Khallaf [1], Mamdouh H. O. El-Kalyoubi [1], Abdelrahman Said Talab [2*], Abdel-Fattah, A. A. [1] and Shimaa M. Abou-Taleb [1]

[1] Food Science Department, Faculty of Agriculture, Ain Shams University.
[2] Fish Processing and Technology Laboratory, National Institute of Oceanography and Fisheries, Cairo, Egypt.

[*]Corresponding Author: e-mail Abdelrahman_saidh@yahoo.com

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ABSTRACT

The quality and effect of using two different recipes with and without fat (T1, T2, T3 and T4) of fish shawarma processed from little tuna fish *(Euthynnus alletteratus)* were determined during frozen storage at -18ºC for three months. The analysis was carried out at an interval of 15 days. A significant decrease ($P \leq 0.05$) in the values of moisture, protein, lipid, and pH was correlated with increasing the duration of the frozen storage period. While ash and carbohydrate were significantly increased ($P \leq 0.05$) with an increasing storage period. The values of cooking loss, TVB-N, TMA-N and TBA were significantly increased ($P \leq 0.05$) after 3 months of the frozen period. However, significant decreases ($p \leq 0.05$) of fish shawarma in the water holding capacity (WHC), cooking yield and microbial parameters occurred periodically during the frozen storage till its end. Sensory examination indicated that the cooked fish shawarma samples kept their integrity well. Panelists rated the color and taste of shawarma in the next ranking T1> T2> T3> T4, although shawarma samples were desirable, their color intensity was intense. In conclusion, the first recipe (T1) without adding fat was the best one, however, more researches on processing and improving the quality of fish shawarma are essential to provide an insight into the consumer's purchasing patterns.

INTRODUCTION

The consumption of fish and ready to eat fish products is considered a healthy source of protein, and is rich in polyunsaturated fatty acids, which are associated with several health benefits **(Weichselbaum *et al*., 2013)**. However, some epidemiological studies have recently reported the link between excessive consumption of processed meat with various diseases. This link was particularly associated with consumption of takeaway and fast food, mainly because of their fat content and fatty acid composition **(McAfee *et al*., 2010; Jaworowska *et al*., 2013)**. Shawerma is one of the most popular consumed fast-food, and is considered a traditional Middle East meat product. Shawerma is sometimes known as Döner kebab, gyro, donair, dona kebab and chawarma **(Kilic, 2003)**. Shawerma is a Levantine Arab dish consisting of meat cut into thin slices seasoned with salt, pepper, onions, cumin, allspice and thyme, stacked in a cone-like shape, and roasted on a slowly-turning vertical rotisserie or spit. Originally, it is made with lamb, mutton and chicken, today's shawarma may also use chicken, turkey, beef or veal, however, there is a lack of information in literature about possible usage of fish in the manufacture of shawerma **(Simsek & Kilic, 2016)**. Kebab is a traditional Middle East meat product, which is consumed widely in many areas of the world **(Kilic, 2003, Kilic, 2009)**. It is a meat product with fat content ranging between 20-40% (**Kilic & Richards, 2003; Kilic, 2009)**. A variety of kebab meat products (KMP) is available in the market, such as doner or shawarma, shish, kofte and mixed doners. For example, doner kebab is reportedly a Turkish national dish (Döner kebab, literally "turning roast") **(LACORS, 2009)**, slowly roasted on a rotating spit made mostly from intact muscle or ground lamb, beef and chicken meat and is seasoned with onion, tomato, and spices **(Kayisoglu *et al.*, 2003; Kilic, 2009)**. It is also known by other names such as shawarma or chawarma, donna-kebab and gyro **(Kayisoglu *et al.*, 2003)**. Kebab meat products are popular in restaurants and fast-food outlets in the Middle Eastern countries, Turkey, Europe, Canada and the USA **(Kilic, 2009)**. The kebab industry has gained popularity since it was first introduced to the UK in the 1960's **(LACORS, 2009).**

According to the 5th British Kebab Awards 2017, there are over 20,000 Kebab outlets in the UK, selling around 2,500 tonnes of lamb and chicken doner a week, with an estimated production of 1.3 million kebabs sold every day. The British kebab industry contributes over £2.8 billion annually to the British economy, providing around 200,000 jobs across restaurants, suppliers and into the wider food industry in the UK **(British Kebab, 2017)**. The KMP are widely consumed in the UK and some other parts of Europe, and are considered one of the fastest growing sectors in the fast food market **(Meldrum *et al*., 2009)**. These growing patterns are due to lifestyle changes taken place in the last few decades. Moreover, there is an increasing frequency of meals consumed outside of the home; even meals consumed at home are often from fast food outlets **(Jaworowska *et al*., 2013)**. Little tunny or *Euthynnus alletteratus* is a pelagic species; one of the members of the Scombridae, which has a wide distribution in the world and is predominant in the Mediterranean Sea and the Black Sea **(Belloc, 1955; Valeiras & Abad, 2007)**. It occurres in the Mediterranean catch all over the year but in more abundance during summer months **(Sylva & Rathjen, 1961)**. The Egyptian Mediterranean catch of *E. alletteratus* fluctuated between 1302 and 1003 tonnes during the period extending from 2010 to 2018 **(GAFRD, 2019)**.

The aim of the present study was to investigate the use of little tuna (*Euthynnus alletteratus*) for producing ready-to-eat fish shawarma and evaluate the effect of using two different recipes (with and without fat) on the physicochemical, microbiological and the sensory qualities of the produced fish shawarma during a frozen storage at -18°C.

MATERIALS AND METHODS

Fish samples

Little tuna (*Euthynnus alletteratus*) fish samples were purchased from Alexandria city fish market, Egypt, and were immediately transferred in an ice box in 3 hours' time to Fish Processing and Technology Laboratory, El-Kanater El-khairia, Fish Research Station, National Institute of Oceanography and Fisheries. Fish samples were carefully washed with tap water, beheaded, gutted, filleted, rewashed carefully and drained.

Little tuna fish shawarma manufacturing

Fish fillet were cut into 5 mm thick, 12 cm long and 6 cm wide rectangular shaped slices. The meat blocks (2 kg each) were prepared from randomly chosen little tuna fillets. Fish shawarma were processed according to two different formulas, the first was reported in **Simsek and Kilic (2016)** as follows: shawarma was formulated with yogurt 10 %, salt 2%, whey powder 1%, black pepper 0.2 %, ginger powder 0.15 %, white pepper 0.2 %, cumin 0.15 %and onion powder 0.2 %. While, the second formula was reported in the study of **Abd-El Aziz (2013)** with some modifications as follows: little tuna slices were well mixed with 6.7% chopped onions, 1% spices blend, 1% salt, 3.3% vinegar, 7% water, 0.5% garlic and 6.6% UHT skimmed milk in bowl then stored at 4°C for 24 hrs. The spices blend was consisted of 42% black pepper, 23% cumin, 18% all spices, 5% ginger, 5% cardamom, 2% cubeb, 2% clove, 2% coriander and 1% red pepper. Raw shawarma (uncooked samples) slices were stored at -18 °C.

Four different formulations of little tuna fish shawarma were processed as follows: 1st trial (T_1) was performed according to the first formula without fat adding; the 2nd trial (T_2) was achieved according to the first formula but with the addition of fat ; the 3rd trial (T_3) was done according to the second formula but without adding fat and the 4th trail (T_4) was done according to the second formula with fat adding.

Analytical methods

Moisture, crude protein, fat and ash contents of little tuna fish shawarma were determined as described in the **A.O.A.C. (2012)**. The pH value was determined as described in the study of **Egbert *et al*. (1992)**. The determination of expressible water and WHC were determined following the method of **Hennigar *et al.* (1988)**. Total volatile basic nitrogen (TVB-N) was determined according to the method of **Pearson (1976)**. Trimethylamine-nitrogen (TMA-N) was assessed as described in **A.O.A.C. (2012)**. Thiobarbituric acid (TBA) was fixed spectrophotometrically according to the procedure of **Tarladgis *et al.* (1960)**. Fish shawarma was cooked properly at 425°F (218 °C) for 6 min after being spread on a surface of hot clean moved grill **(Abd-El Aziz, 2013)**. The total viable bacterial count (TVBC) and the total spore forming bacterial count were determined by using nutrient agar medium following the description of **Oxoid (2006)**. The counts of yeasts and molds were determined according to **ISO 21527-2 (2008)**. Data were expressed as the mean values of three replicates, and the standard deviations were statistically analyzed by performing analysis of variance technique

(ANOVA) using the statistical analysis system according to **SAS (2008)**. Differences among means were compared using Duncan's multiple range test (1955) at a significant level of 95% ($P \leq 0.05$).

RESULTS AND DISCUSSION

The moisture, protein, lipid, ash and carbohydrates of fresh little tuna (*Euthynnus alletteratus*) fish samples were recorded as follows: 70.38, 22.07, 6.15, 1.43 and 0.56, respectively (Table 1). In general, the chemical composition of fish differs from one to the other depending on some factors, including environment, season, sex and age. The obtained results are in accordance with those of **Muraleedharan *et al.* (1996)**, **Murthy *et al*. (2019)** and **Badran *et al*. (2020)**.

Table 1. Proximate composition of fresh little tuna fish (on wet weight basis)

Item%	mean values
Moisture	70.38±0.73
Protein	22.07±0.56
Fat	6.15±0.84
Ash	1.43±0.78
Carbohydrate	0.56±0.19

Means ± Standard error

Table (2) shows that the TVB-N and TMA-N were 16.84 mg N/100g and 2.02 mg N/100g, respectively. These obtained results are lower than the permissible limits of TVB-N and TMA-N for the investigated fish. **Connell (1995)** reported that the limit of acceptability of fish is 20 to 30 mg N/100 g, while **Kirk and Sawyer (1991)** suggested values of 30 to 40 mg N/100 g with respect to the upper limit. **Ghaly *et al.*, (2010)** also suggested a level below 25 mg/100mg as a border line for the TVB-N content for various fish and fish products chemical characteristics as well as TVB-N and TMA-N values that have been widely used to detect for protein degradation in fish.

From data presented in Table (2), the pH value was 6.35 of fresh little tuna fish. This result is in accordance with that of **Genina (2017)** who found that the pH of fresh kapreeta (like tuna) fish flesh was 6.4.

Table 2. Physicochemical and chemical quality characteristics of fresh little tuna fish

Item	mean values
TVB–N (mg/100g samples)	16. 84±0.89
TMA-N(mg/100g samples)	2.02±0.57
TBA (mg malonadehyde/kg)	0.58±0.47
pH	6.35±0.66
Water holding capacity %	47.86±0.98

Means ± Standard error

Table 3. Change in proximate composition of little tuna fish shawarma samples as affected by different treatments during storage period for 90 day at -18±1

Storage Period (days)	Moisture content (%)			
	T_1	T_2	T_3	T_4
Zero	65.43^{aB} ±0.59	58.16^{aC} ±0.28	65.63^{aA} ±0.76	57.87^{aD} ±0.44
15	65.16^{bA} ±0.73	57.77^{bB} ±0.88	65.18^{bA} ±0.93	57.42^{bC} ±0.66
30	64.72^{cA} ±0.54	57.32^{cC} ±0.75	64.56^{cB} ±0.48	56.05^{cD} ±1.18
45	64.15^{dB} ±0.85	56.78^{dC} ±0.81	64.38^{dA} ±0.56	55.94^{dD} ±0.77
60	63.28^{eB} ±0.89	56.49^{eC} ±0.45	63.97^{eA} ±0.42	55.41^{eD} ±1.22
75	63.14^{fB} ±1.05	55.95^{fC} ±0.93	63.89^{fA} ±1.70	55.03^{fD} ±0.45
90	63.03^{gB} ±1.82	54.91^{gC} ±0.73	63.17^{gA} ±0.87	54.82^{gC} ±1.33
Protein content (%)				
Zero	23.23^{aB} ±0.89	20.12^{aC} ±0.59	23.43^{aA} ±1.03	20.01^{aC} ±0.87
15	22.92^{bB} ±0.45	19.62^{bD} ±0.87	23.13^{bA} ±0.32	19.89^{aC} ±0.96
30	22.76^{cA} ±0.94	19.31^{cD} ±0.66	22.56^{cB} ±0.98	19.65^{bC} ±0.56
45	22.43^{dA} ±0.34	18.96^{dD} ±0.93	21.42^{dB} ±0.38	19.43^{bC} ±44
60	21.88^{eA} ±0.65	18.79^{eD} ±0.87	21.33^{eB} ±0.87	19.19^{cC} ±0.92
75	21.44^{fA} ±0.45	18.46^{fD} ±0.77	20.99^{fB} ±0.93	18.93^{dC} ±2.03
90	21.16^{gA} ±0.76	18.29^{gD} ±0.96	20.75^{gB} ±0.55	18.72^{eC} ±1.11
Fat content (%)				
Zero	8.10^{aC} ±0.23	18.75^{aA} ±0.59	7.78^{aD} ±0.87	18.23^{aB} ±0.66
15	7.83^{bC} ±0.87	18.50^{bA} ±0.83	7.58^{bD} ±0.74	18.15^{aB} ±0.73
30	7.58^{cB} ±0.66	17.80^{cA} ±0.47	7.39^{cC} ±0.93	17.75^{bA} ±0.36
45	7.37^{dB} ±0.89	17.77^{cA} ±0.98	7.24^{dC} ±0.27	17.68^{bA} ±0.42
60	7.28^{dC} ±0.74	17.68^{cA} ±0.37	7.19^{edC} ±1.09	16.63^{cB} ±1.34
75	7.19^{eB} ±1.04	16.59^{dA} ±0.54	7.10^{eB} ±0.30	16.52^{cA} ±0.65
90	7.02^{fC} ±0.39	16.15^{eB} ±0.89	7.00^{eC} ±0.84	16.37^{dA} ±1.34
Ash content (%)				
Zero	2.58^{gAB} ±0.23	2.13^{gC} ±0.89	2.48^{fB} ±1.26	2.98^{gA} ±0.16
15	3.30^{fB} ±0.76	3.15^{fC} ±0.36	3.36^{eB} ±0.23	3.56^{fA} ±0.76
30	4.06^{eC} ±1.66	4.46^{cB} ±0.68	4.54^{dB} ±0.23	5.48^{eA} ±0.59
45	4.98^{dD} ±1.33	5.25^{dC} ±0.99	5.80^{cA} ±0.23	5.60^{dB} ±0.87
60	6.33^{cB} ±0.28	5.48^{cD} ±0.58	6.13^{bC} ±0.96	6.81^{cA} ±0.64
75	6.16^{bB} ±0.89	6.83^{bA} ±0.97	6.18^{bB} ±1.23	6.99^{bA} ±0.43
90	6.33^{aD} ±0.44	7.80^{aA} ±0.76	6.96^{aC} ±0.29	7.17^{aB} ±0.25
Carbohydrate content (%)				
Zero	0.66^{fB} ±0.57	0.84^{gA} ±0.99	0.68^{fB} ±0.87	0.91^{fA} ±0.45
15	0.79^{eB} ±0.88	0.96^{fA} ±0.34	0.75^{fB} ±1.59	0.98^{fA} ±0.79
30	0.88^{eB} ±0.59	1.11^{eA} ±0.54	0.95^{eB} ±0.88	1.07^{eA} ±0.83
45	1.07^{dC} ±0.77	1.24^{dB} ±0.67	1.16^{dB} ±0.46	1.35^{dA} ±0.75
60	1.23^{cD} ±1.98	1.56^{cB} ±0.34	1.38^{cc} ±0.79	1.96^{cA} ±0.87
75	2.07^{bC} ±0.44	2.17^{bB} ±0.87	1.84^{bD} ±0.65	2.53^{bA} ±1.05
90	2.46^{aB} ±0.87	2.85^{aA} ±0.65	2.12^{aC} ±0.48	2.92^{aA} ±0.75

Where: T1: Prepared with Formula (1) sample without fat; T2: Prepared with Formula (1) sample without fat Formula (1) sample with fat; T3: Prepared with Formula (2) sample without fat; T4: Prepared with Formula (2) sample with fat.

- Means of triplicate ± Standard Deviation (SD).

- Means followed by different small letters in the same column (effect of storage period) are significantly by Duncan´s multiple tests ($p \leq 0.05$).
- Means followed by different capital letters in the same raw (effect of samples) are significantly by Duncan´s multiple tests ($p \leq 0.05$).

The WHC mean value in little tuna fish was 47.86%. Whereas, water holding ability was inversely proportional with percentage of calculated WHC according to free water loss when the determination was carried out. The free water of little tuna fish was 24.50%. The variation in % WHC could also be discussed based on the fat content of species of fish. As shown in Table (٣), the moisture content of fish shawarma samples decreased periodically from 65.43, 58.16, 65.63 and 57.87% on zero time to 63.03, 54.91, 63.17 and 54.82% after 90 days of T1 ,T2, T3 and T4, respectively. The changes in the moisture content are one of the problems in the technology of fish products. The decrease in moisture content could be related to the denaturation and aggregation of protein and loss of water by evaporation, besides the sublimation of ice in frozen storage and the loss of drip during thawing . Similar findings were reported in the studies of **Gomma (2005)**, **Ibrahim and El-Sherif (2008)** and **Gandotra *et al*. (2012)**. Moreover, these results agree with the findings in works conducted on fish products processed from other types of fish. **Orban *et al.* (2002)** and **Benjakul *et al.* (2005)** reported a decrease in total moisture content in sea bass (*Dicentrarchus labrax*) fillets during frozen storage.

Significant decreases ($p \leq 0.05$) were noticed in the protein content of all samples during the storage period, recording a decline from ٢٠.01-23.43, while values reached 18.29-21.16 at the end of the frozen storage, respectively. These decreases might be attributed to the continuous hydrolysis of protein as affected by proteolystis enzyme, which lead to the formation of simple nitrogenous compounds and protein denaturation. These results coincide with those of **Sudip *et al.* (1985)** and **El mossalami and Emara (1999)**.

The results in table (3) showed that, sample in T2 was dusting wished by the highest fat contact being 18.75% followed by T4 (18.23%) at zero time, While samples inT1 and T3 were marked by the lowest fat content being 7.83 and 7.85% respectively. These values were step by step dominated, reaching 7.02, 16.15, 7.00 and 16.37 for T1, T2, T3 and T4, respectively, at the end of storage period which reflects significant differences ($p \leq 0.05$) between all samples. The decrease in fat content may be due to the oxidation and hydrolysis of lipids, which resulted in the formation of some volatile compounds as aldehydes and ketones. This finding concurs with those of **Gandotra *et al.* (2012)** and **Simsek and Kilic (2016)**.

Furthermore, table (3) shows that an increasing trend was generally noticed in the ash content of the different samples during storage period. Significant differences ($p \leq 0.05$) were detected in the ash content of all samples. Treatment4 recorded the highest value in ash content at both the inception and the end of the storage period. Similar observation was found during frozen storage of some fish products **(Ibrahim & El-Sherif, 2008)**.

The remaining percentage of the chemical composition of a given food product is likely to be that of the carbohydrate. The carbohydrate content of little tuna fish products during frozen storage was calculated using difference methods, and data obtained are presented in Table (3). It gradually and significantly increased ($p \leq 0.05$) during frozen storage showing a significant difference ($p \leq 0.05$) in its content of all the samples. The effect of frozen storage on pH values, WHC, cooking loss and cooking yield of little tuna fish shawarma are shown in Table (4).

Table 4. Physicochemical and cooking quality of little tuna fish shawarma samples during frozen storage at -18 ºC

Storage period (days)	pH values			
	T_1	T_2	T_3	S_4
4Zero	6.12^{aA}	6.12^{aA}	5.83^{aB}	5.82^{aB}
15	5.42^{bA}	5.41^{bA}	5.33^{bAB}	5.23^{bB}
30	5.18^{cA}	5.16^{cA}	5.06^{cB}	5.01^{cB}
45	4.92^{dA}	4.94^{dA}	4.81^{dB}	4.77^{dB}
60	4.77^{eA}	4.79^{eA}	4.66^{eB}	4.62^{eB}
75	4.56^{fA}	4.52^{fA}	4.43^{fB}	4.41^{fB}
90	4.33^{gA}	4.29^{gA}	4.15^{gB}	4.12^{gB}
Water holding capacity (%)				
Zero	54.84^{aA}	50.74^{aC}	54.44^{aB}	50.66^{aC}
15	54.15^{bA}	49.19^{bC}	53.55^{bB}	49.54^{bC}
30	52.92^{cA}	48.56^{cC}	52.48^{cB}	47.15^{cD}
45	50.95^{dA}	46.52^{dC}	49.76^{dB}	45.64^{dD}
60	49.58^{eA}	44.27^{eC}	47.52^{eB}	42.08^{eD}
75	46.29^{fA}	40.49^{fC}	44.65^{fB}	39.77^{fD}
90	40.65^{gA}	38.65^{gC}	40.22^{gB}	37.19^{gD}
Cooking yield (%)				
Zero	86.43^{aA}	85.31^{aB}	86.34^{aA}	85.32^{aB}
15	85.37^{bA}	84.33^{bC}	84.48^{bC}	85.18^{bB}
30	83.11^{cD}	84.17^{cB}	84.06^{cC}	84.31^{cA}
45	83.03^{dC}	83.11^{dC}	83.44^{dB}	83.65^{dA}
60	82.25^{eA}	81.75^{eC}	82.01^{eB}	81.27^{eD}
75	81.63^{fA}	80.83^{fB}	81.52^{fA}	80.45^{fC}
90	81.45^{gA}	77.11^{gC}	80.27^{gB}	76.65^{gD}
Cooking loss (%)				
Zero	13.57^{gB}	14.69^{gA}	13.66^{gB}	14.68^{gA}
15	14.63^{fC}	15.67^{fA}	15.52^{fB}	14.82^{fC}
30	16.89^{eA}	15.83^{eC}	15.94^{eB}	15.69^{eD}
45	16.97^{dA}	16.89^{dA}	16.56^{dB}	16.35^{dC}
60	17.75^{cD}	18.25^{cB}	17.99^{cC}	18.73^{cA}
75	18.37^{cD}	19.17^{bB}	18.48^{bC}	19.55^{bA}
90	18.55^{aD}	22.89^{aB}	19.73^{aC}	23.35^{aA}

Where**:** T1: Prepared with Formula (1) sample without fat; T2: Prepared with Formula (1) sample without fat Formula (1) sample with fat; T3: Prepared with Formula (2) sample without fat; T4: Prepared with Formula (2) sample with fat.

- Means of triplicate
- Means followed by different small letters in the same column (effect of storage period) are significantly by Duncan´s multiple tests ($p \leq 0.05$).
- Means followed by different capital letters in the same raw (effect of samples) are significantly by Duncan´s multiple tests ($p \leq 0.05$).

It could be observed that, frozen storage temperature (-18°C) had a significant effect on these parameters. The pH values of T1, T2, T3 and T4 of little tuna fish shawarma were 6.12, 6.12, 5.83 and 5.82 at zero time, then they were reduced to show values of 4.33, 4.29, 4.15 and 4.12, respectively at the end of frozen storage. Additionally, the WHC values of T1, T2, T3 and T4 of samples were 54.84, 50.74, 54.44 and 50.66% at zero time, then reduced showing the following values: 40.65, 38.65, 40.22 and 37.19%, respectively at the end of frozen storage. On the other hand, the cooking loss showed a significant increase during the frozen storage of T1, T2, T3 and T4 of little tuna fish shawarma which recorded 13.57, 14.69, 13.66 and 14.68% at zero time, then it gradually increased to 18.55, 22.89, 19.73 and 23.35%, respectively at the end of frozen storage. Accordingly, the cooking yield values of T1, T2, T3 and T4 of little tuna fish shawarma decreased from 86.43, 85.31, 86.34 and 85.32 % at zero time to 81.45, 77.11, 80.27 and 76.65%, respectively at the end of frozen storage.

Table 5. Chemical quality criteria of little tuna fish shawarma samples during frozen storage at -18 ºC

Storage period (days)	Total volatile basic nitrogen (TVB-N)			
	T_1	T_2	T_3	T_4
Zero	18.53^{gC}	18.8^{gA}	18.65^{gB}	18.38^{gD}
15	19.74^{fA}	19.42^{fB}	19.83^{fA}	19.57^{fB}
30	20.19^{eA}	19.68^{eA}	20.21^{eA}	19.82^{eB}
45	20.63^{dC}	20.38^{dD}	20.94^{dA}	20.82^{dB}
60	21.26^{cC}	21.90^{cA}	21.66^{cB}	21.42^{cD}
75	24.70^{bC}	23.15^{bD}	25.11^{bA}	24.88^{bB}
90	26.57^{eB}	25.68^{eD}	27.19^{aA}	26.11^{aC}
Trimethylamine nitrogen (TMA-N)				
Zero	3.65^{fC}	3.75^{eB}	3.75^{fB}	3.86^{fA}
15	3.88^{eA}	3.83^{dA}	3.88^{eA}	3.93^{fa}
30	4.15^{dB}	4.42^{cA}	4.18^{dB}	4.52^{eA}
45	4.38^{cB}	5.54^{bB}	4.46^{cB}	4.70^{dA}
60	5.42^{cC}	5.60^{bB}	5.53^{cB}	5.83^{cA}
75	5.76^{bB}	5.96^{aA}	5.78^{bB}	6.05^{bA}
90	5.80^{aB}	6.15^{aA}	5.93^{aB}	6.20^{aA}
TBA as (mg malonadehyed /kg samples)				
Zero	0.66^{gB}	0.84^{fA}	0.68^{eB}	0.91^{fA}
15	0.79^{fB}	0.96^{eA}	0.75^{eB}	0.98^{eA}
30	0.88^{eB}	$1. 01^{eA}$	0.95^{dA}	1.07^{eA}
45	1.07^{dC}	1.24^{dB}	1.16^{cCB}	1.35^{dA}
60	1.23^{cC}	1.56^{cA}	1.38^{bB}	1.66^{cA}
75	1.86^{bC}	2.17^{bA}	1.93^{aBC}	2.01^{bB}
90	2.46^{aB}	2.85^{aA}	2.03^{aC}	2.92^{aA}

Where: T1: Prepared with Formula (1) sample without fat; T2: Prepared with Formula (1) sample without fat Formula (1) sample with fat; T3: Prepared with Formula (2) sample without fat; T4: Prepared with Formula (2) sample with fat

- Means followed by different small letters in the same column (effect of storage period) are significantly by Duncan´s multiple tests ($p \leq 0.05$).
- Means followed by different capital letters in the same raw (effect of samples) are significantly by Duncan´s multiple tests ($p \leq 0.05$).

Chemical properties of little tuna fish shawarma, affected by different treatments and storage period for 3 months at -18±1ºC, are illustrated in Table (5). It could be clearly noticed that, TVB-N, TMA and TBA were significantly increased being affected by freezing conditions. TVB-N values of T1, T2, T3 and T4 of little tuna fish shawarma were 18.53, 18.80, 18.65 and 18.38 mg/100g at zero time, then increased to 26.57, 25.68, 27.19 and 26.11 mg/100g, respectively at the end of frozen storage. In addition, TMA values of T1, T2, T3 and T4 of little tuna fish shawarma were 3.65, 3.75, 3.75 and 3.86 mg/100g at zero time, then increased to 5.80, 6.15, 5.93 and 6.20 mg/100g, respectively at the end of frozen storage. Similarly, the TBA values of T1, T2, T3 and T4 of little tuna fish shawarma were 0.66, 0.84, 0.68 and 0.91 mg MDA/kg at zero time, then they increased to 2.46, 2.85, 2.03 and 2.92, mg MDA/kg, respectively at the end of frozen storage.

The increases in TVBN content of fish shawarma samples, with increased frozen storage time, could be related to the increased protein degradation by muscle enzymic activity. In this regard, muscle proteins are decomposed into ammonia, hydrogen sulfide and ethyl mercaptan etc. which together make up TVBN **(Huang, *et al*., 2014)**. Regarding to TMA, **Sotelo *et al*. (1995)** suggested that some residual bacterial activity could still be found at temperatures slightly below zero. However, the TMA increase observed at -10 °C and -18 °C was probably related to enzymatic degradation. According to the formation of TMA during the frozen storage of crustaceans can also be attributed to the biochemical breakdown of proteins and non-protein nitrogen (NPN) compounds.

Microbiological quality of fish shawarma

It could be clearly noticed from Table (6) that, the total bacterial count, yeast & molds, spore forming bacteria and total coliform were significantly decreasedbeing affected by freezing conditions.

Table 6. Microbiological analysis of little tuna fish shawarma during frozen storage at -18 ºC

Storage period (days)	Total plate counts (log cfu/g)			
	T_1	T_2	T_3	T_4
Zero	4.38	4.10	4.36	4.13
15	4.20	4.00	4.18	4.06
30	3.95	3.86	3.96	3.88
45	3.82	3.68	3.80	3.74
60	3.51	3.30	3.55	3.18
75	3.34	3.15	3.36	3. 00
90	3.06	2.96	3.01	2.98
Yeast and mold counts (log cfu/g)				
Zero	2.88	2.60	2.74	2.54
15	2.82	2.59	2.60	2.49
30	2.71	2.48	2.53	2.43
45	2.66	2.40	2.46	2.40
60	2.53	2.26	2.38	2.34
75	2.28	2.01	2.30	2.18
90	2.15	1.98	2.24	2.10

Spore forming bacterial counts (log cfu/g)				
Zero	2.30	2.15	2.36	2.19
15	2.08	2.00	2.10	1.98
30	1.94	1.89	2.00	1.86
45	1.80	1.66	1.89	1.47
60	1.74	1.40	1.69	1.36
75	1.48	1.22	1.40	1.18
90	1.22	1.02	1.28	1.06
Total coliform count (log cfu/g)				
Zero	2.15	2.08	2.06	2.00
15	2.02	1.98	2.01	1.88
30	1.89	1.70	1.86	1.75
45	1.70	1.62	1.74	1.69
60	1.55	1.42	1.60	1.47
75	1.48	1.28	1.40	1.29
90	1.35	1.16	1.34	1.13

Where: T1: Prepared with Formula (1) sample without fat; T2: Prepared with Formula (1) sample without fat Formula (1) sample with fat; T3: Prepared with Formula (2) sample without fat; T4: Prepared with Formula (2) sample with fat.

Total bacterial count values of T1, T2, T3 and T4 of little tuna fish shawarma were 4.38, 4.10, 4.36 and 4.13 log cfu/g at zero time, then gradually decreased to 3.06, 2.96, 3.01 and 2.98 mg/100g, respectively at the end of frozen storage. Yeast & molds counts of T1, T2, T3 and T4 samples were 2.88, 2.60, 2.74 and 2.54 log cfu/g at zero time, then gradually decreased to 2.15, 1.98, 2.24 and 2.10 log cfu/g, respectively at the end of frozen storage. In the same way, spore forming bacteria counts of T1, T2, T3 and T4 of samples accounted 2.30, 2.15, 2.36 and 2.19 log cfu/g at zero time, then generally decreased to 1.22, 1.02, 1.28 and 1.06, log cfu/g, respectively at the end of frozen storage. The total coliform counts of T1, T2, T3 and T4 of little tuna fish shawarma were 2.15, 2.08, 2.06 and 2.00 log cfu/g at zero time, then decreased to 1.35, 1.16, 1.34 and 1.13, log cfu/g; respectively at the end of frozen storage. It could be noticed that the values of TVBC are considerably lower than the maximum limit (7 log cfu/g) of the microbiological criteria of fresh fish given by the International Commission Microbiological Specification for Food **(ICMSF, 1978)**. The obtained data indicate that, after 3 months of frozen storage, the total viable bacterial counts in little tuna fish shawarma samples did not exceed the limit recommended by **ICMSF (1978)**. Similar findings were reported by **Tokur *et al.* (2006)** and **Izci, *et al.* (2011)**. Furthermore, **Simsek and Kilic (2016)** found a significant reduction in total coliform bacteria count and total mesophilic aerobic bacteria accomplished with the cooking process ($P \leq 0.05$). Additionally, **Al-Bulushi *et al.* (2005)** reported a significant reduction of coliform bacteria in fish burgers during storage at −20°C.

Sensorial properties of little tuna fish shawarma

Fig. (1) clarifies the sensorial properties of little tuna fish shawarma affected by different treatments and storage period for 3 months at -18±1ºC. The results generally indicate that, the sensorial quality properties (color, tenderness, juiciness, taste, flavor and overall acceptability) of little tuna fish shawarma affected by different treatments and storage period for 3 months at -18±1 ºC were significantly and gradually increased in relation to the prolonged period of shelf-life.

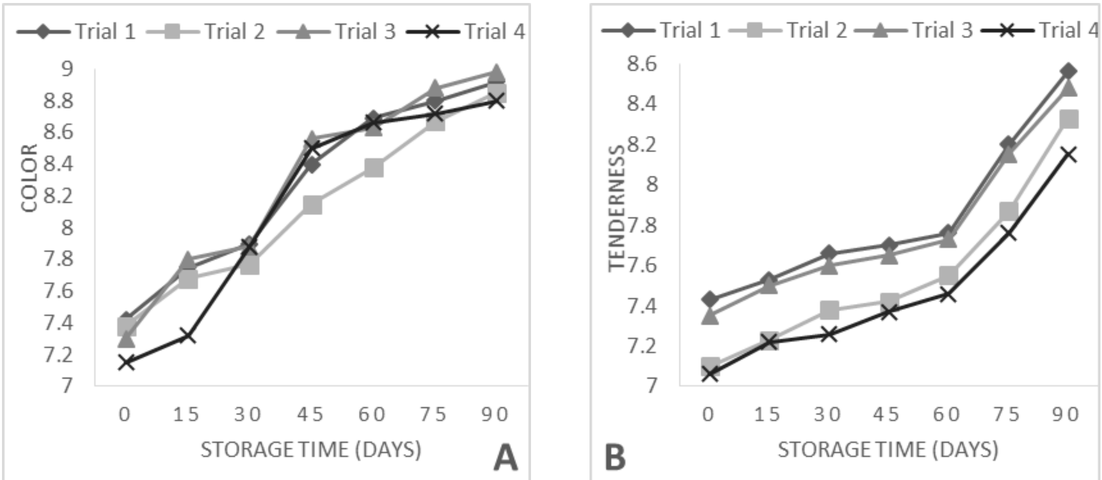

Fig. 1. Sensorial properties of little tuna fish shawarma as affected by different treatments and storage period for 3 months at -18±1ºC

CONCLUSION

Our results suggest the possibility of little tuna (*Euthynnus alletteratus)* to be used in ready-to-eat fish shawarma production within the scope of a healthy food source for consumers. Because of various health concerns, the fast-food industry has been searching for healthier fast-food products to satisfy consumer demands. In this essence, it was determined that fish shawarma has the advantage of possessing high amounts of protein and low fat content. In addition, a high sensory quality in fish shawarma is also satisfactory. The first recipe was the best one according to its sensory evaluation, however more researches on processing and improving the quality of fish shawarma are essential to provide a deep insight into the consumer's purchasing patterns.

REFERENCES

A.O.A.C. (2012). Official Methods of Analysis of the Association ofOfficial Analytical Chemistry. International, 19th ed.,Gaithersburg, Maryland, USA.

Abd-El Aziz, N.A. (2013) .Effect of Fat Content on Quality and Storage Stability of Beef Shawarma. Alexandria Science Exchange Journal. 3:283-289.

Al-Bulushi, I. M.; Kasapis, S.; Al-Oufi, H. and Al-Mamari, S.(2005). Evaluating the quality and storage stability of fish burgers during frozen storage. Fisheries Sci. 71: 648–654.

Badran M.; Sulaeman S. and Ghanem B. (2020). Comparison of some biochemical properties of two marine fish species *Euthynnus alletteratus* and *Siganus rivulatus* in

Syrian marine waters. Tishreen University Journal for Research and Scientific Studies - Biological Sciences Series, 42 (5): 257-268.

Belloc, G. (1955). Les thons de la Méditerranée. Deuxième note: Thonine et Bonite. FAO Proc. Gen. Fish. Counc. Medit., 3(52): 471-486.

Benjakul, S.; Visessanguan, W.; Thongkaew, C. and Tanaka, M. (2005): Effect of frozen storage on chemical and gel forming properties of fish commonly used for surimi production in Thailand. Food hydrocolloids, 19: 197-207.

British K. (2017). Kebab. https://britishkebabawards.co.uk/british-kebab-awards-.

Connell, J.J. (1995). Control of fish quality, (4th Ed). Oxford: Fishing News Books, Ltd. Surrey, England, Pp: 31-35.

Duncan, D.B. (1955) Multiple range and F test. Biometrics, 11: 1-42.

Egbert, W. R.; Huffman, D. L.; Chen, C. M. and Jones, W. R. (1992). Microbial and oxidative changes in low-fat ground beef during simulated retail distribution. J. Food Sci., 57: 1269-1269.

El-mossalami, M.K. and Emara M.T. (1999). Safety and quality of fresh water crayfish Procambarus clarkii in the river Nile. Nahrung, 43 (2): 126-128.

GAFRD Genera Authority for Fisheries Resource Development (2019). Annual fishery statistics report., Ministry of agriculture, Cairo, Egypt.

Gandotra, R.; Koul, M.; Gupta, S. and Sharma, S. (2012): change in proximate composition and microbial count by low temperature preservation in fish muscle of labeo rohita (Ham-Buch). IOSR Journal of Pharmacy and Biological Sciences (IOSRJPBS). 2(1): 13-17

Genina E. M., (2017). Lipid quality and stability of some processed marine fish products. Ph.D. of Agric.Sci. Alexandria Univ.

George, J.F.; Richard T.L.; Leopoldo G.E. and Genaro C.A. (2007). Changes in nitrogenous compounds in freshwater crayfish (*Procambarus clarkii*) tail meat stored in ice. Journal of Muscle Foods, 5 (2): 105-118.

Ghaly, A.E.; Dave, D.; Budge, S. and Brooks, M.S. (2010). Fish spoilage mechanisms and preservation techniques: Review. Am. J. Applied Sci., 7: 859-877.

Gomma, R. A. M. (2005): Studies on producing sausage from some fish types. M.Sc. Thesis, Fac.of Agric. Al-Azher Uni., Egypt.

Hennigar, C. J.; Buc, E.M.; Hultin, H. O.; Peleg, H.M and Vareltzis, K. (1988). Effect washing and sodium chloride on mechanical properties of fish muscle gels. J. Food Sci., 53: 963-964.

Huang L.; Zhao J.; Chen Q. and Zhang Y. (2014). Nondestructive measurement of total volatile basic nitrogen (TVB-N) in pork meat by integrating near infrared spectroscopy, computer vision and electronic nose techniques. Food Chem. 145: 228-36.

Ibrahim, S. M. and El-Sherif, S.A. (2008). Effect of some plant extracts on quality aspects of frozen Tilapia (*Oreachromis niloticus* L.). Global Veterinaria 2 (2):62-66.

ICMSF The International Commission on Microbiological Specifications for Foods.(1978): Microorganisms in foods. Vol. 1, Toronto, Canada.

ISO 21527, 2008. Microbiology of food and animal feeding stuffs - Horizontal method for the enumeration of yeasts and moulds - Part 2: Colony count technique in products with water activity less than or equal to 0, 95.

Izci, L.; Sengu, B. and Ali, G. (2011): Production of fish finger from sand smelt (Atherina boyeri, RISSO 1810) and determination of quality changes. African Journal of Biotechnology, 10 (21): 4464-4469.

Jaworowska, A.; Blackham, T.; Davies, I. G. and Stevenson, L. (2013). Nutritional challenges and health implications of takeaway and fast food. Nutrition Reviews, 71, 310-318.

Kayisoglu, S., Yilmaz, I.; Demirci, M. and Yetim, H. (2003). Chemical composition and microbiological quality of the doner kebabs sold in Tekirdag market. Food Control, 14: 469-474.

Kilic, B. (2009). Current trends in traditional Turkish meat products and cuisine. LWT-Food Science and Technology, 42: 1581-1589.

Kilic, B. and Richards, M. (2003). Lipid Oxidation in Poultry Döner Kebab: Prooxidative and Anti-oxidative Factors. Journal of Food Science, 68: 686-689.

Kilic, B.(2003). Effect of microbial transglutaminase and sodium caseinate on quality of chicken döner kebab. Meat Sci. 63:417–421.

Kirk, R.S. and Sawyer, R. (1991). Pearson's Composition and Analysis of Foods (9th Edn). Longman Scientific and Technical, London, pp. 510 -511.

LACORS.ALACORS coordinated food standards survey (2009). The composition and labelling of doner kebabs: A LACORS coordinated food standards survey Number 9. London: Local Authorities Coordinators of Regulatory Services.

McAfee, A. J.; McSorley; E. M., Cuskelly; G. J., Moss; B. W., Wallace; J. M., Bonham; M. P. and Fearon, A. M. (2010). Red meat consumption: An overview of the risks and benefits. Meat Science, 84: 1-13.

Meldrum, R. J.; Little, C. L.; Sagoo, S.; Mithani, V.; McLauchlin J. and De Pinna, E. (2009). Assessment of the microbiological safety of salad vegetables and sauces from kebab take-away restaurants in the United Kingdom. Food Microbiol, 26: 573-577.

Muraleedharan, V.; Antony, K. P.; Perigreen, P. A. and Gopakumar, K,(1996). Utilization of unconventional fish resources for surimi preparation. Proceedings of the second workshop on scientific results of FORV SAGAR, New Delhi: Department of Ocean development, pp.539-543.

Murthy L.; Narasimha, A.; Jeyakumari,G. Phadke,U.;Parvathy,S.; Visnuvinayagam and C.N. Ravishankar (2019). Quality Assessment and Comparison of Three Different Types of Fish Retail Outlets of Navi Mumbai, Maharashtra, India. Int.J.Curr.Microbiol.App.Sci 8(8): 248-259

Orban, E.; Di Lena G.T.; Nevigato; I.; Casini; G.Santaroni; Marzetti A.; and Caproni R. (2002). Quality characteristics of sea bass intensively reared and from lagoon as affected by growth conditions and the aquatic environment. J. Food Sci., 67: 542-546.

Oxoid, 2006. The Oxoid Manual of Culture, Media and Other Laboratory Services. 9^{th} Edition, Compiled by E.Y. Bridson, Published by Oxoid Limited, Wade Road, Basingstoke, Hampshire RG24 8PW, England.

Pearson, D., (1976) The Chemical Analysis of Food .Chem. Pub. Comp. Inc., New York.

SAS Program (2008). SAS System for Windows (Statistical Analysis System). Version 9.2. Cary, USA: SAS Institute Inc.

Simsek, A.and Kilic, B. (2016) Physicochemical and Microbiological Assessment of Ready-to-Eat Tuna Döner Kebab During Marination, Cooking, and Different Storage Conditions, Journal of Aquatic Food Product Technology, 25(3): 423-433.

Sotelo, C.G.; Gallardo, J.M.; Pineiro, C.and Pérez-Martin, R. (1995) Trimethylamine oxide and derived compounds'changes during frozen storage of hake (Merluccius merluccius). Food Chem.53: 61–65.

Sudip, N.J.;Pavlos,K.A.; Soliman,S. K. Y. and Spiros,C.M. (1985). Chemical composition and shelf life study of crayfish. Journal of Food Science, 50 (3): 719-722.

Sylva, D. and Rathjen, W. (1961). Life History Notes on the Little Tuna, Euthynnus alletteratus, from The Southeastern United States. Bull. Mar. Scie. Gulf and Caribbean, volume II.

Tarladgis, B.G.; Watts, B.M.; Younathan, M.T. and Dugan, Jr. L. (1960). A distillation method for the quantitative determination of malonaldehyde in rancid foods. J. Am. Oil Chem. Soc., 37: 44-48.

Valeiras, J. and Abad, E. (2007). ICCAT Field Manual. Chapter 2. Description of Species. 2.1 Species Directly Covered by the Convention. 2.2.11. Small tuna

Weichselbaum, E.; Coe, S.; Buttriss, J.and Stanner, S. (2013). Fish in the diet: A review. Nutrition Bulletin, 38: 128-177.

تقييم جودة وسلامة شاورما أسماك الكبريت

محمد مجدى مصطفى خلاف[١] ، ممدوح القليوبي[١] ، عبد الرحمن سعيد تعلب[٢]، عبدالفتاح عبدالكريم عبدالفتاح[١] و شيماء محمد أبو طالب[١]

[1]قسم علوم الأغذية ، كلية الزراعة ، جامعة عين شمس.

[2]معمل تكنولوجيا وتصنيع الأسماك ، شعبة المصايد ، المعهد القومي لعلوم البحار والمصايد ، القاهرة ، مصر

الملخص

يهدف البحث الي الاستفادة من اسماك الكبريت منخفضة الجودة والتي لا يقبل عليها المستهلك في تصنيع بعض المنتجات السمكية مثل شاورما السمك حيث تم مقارنة تأثير استخدام وصفتين مختلفتين على خصائص الطهي ، الصفات الفيزيائية والكيميائية والميكروبيولوجية والحسية للمنتج أثناء التخزين المجمد علي -١٨ درجة مئوية لمدة ثلاثة أشهر .أظهرت النتائج المتحصل عليها حدوث أنخفاض معنوى فى محتوى كلا من الرطوبة و البروتين والدهن وقيمة الأس الهيدروجيني وفاقد الطهي. وكما حدث زيادة معنوية فى كلا من محتوى الرماد و الكربوهيدات خلال التخزين. دلت النتائج على أن هناك زيادة معنوية فى قيم ال TBA , TMA-N , TVB-N, pH خلال التخزين بالتجميد، كما لوحظ حدوث إنحفاض معنوى فى قيم القدرة على الأرتباط بالماء (WHC) وريع الطهي والدلائل الميكروبية أثناء التخزين المجمد. تم تسجيل العدد الكلي للبكتيريا ، وعدد الخمائر والفطريات ، وعدد البكتريا المكونة للجراثيم ، والعدد الكلي للبكتيريا القولونية في شاورما أسماك الكبريت للمعاملات الأربعة (T1, T2, T3, T4). أظهرت نتائج التقييم الحسي ان عينات الشاورما كانت مرغوبة بالنسبة للقبول العام واللون والطعم وحصلت العينة (T1) علي أعلي الدرجات في التقيم الحسي . كما إشارت النتائج إلى أن عينات شاورما سمك الكبريت حافظت على سلامتها الميكروبيولوجية حتي نهاية فترة التخزين. و يمكن القول بان كانت الخلطة الاولي غير المضاف اليها الدهن (T1) هي الافضل حسيا ويجب إجراء المزيد من الأبحاث لتحسين جودة شاورما الاسماك لزيادة درجة قبول المستهلك لها.