Journal of Food and Dairy Sciences

Journal homepage & Available online at: www.jfds.journals.ekb.eg

Improvement of Red Tuna Luncheon Quality Attributes

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ABSTRACT

The main goal of such research was to produce a high quality fishery product such as luncheon from low value fish species like red tuna fish, low demand fish in Egypt, using various amount of chickpea flour and beef fat in the recipe to improve its consuming and protective properties and produce special organoleptic characteristics. Studied red tuna fish luncheon blends were 10% fat, 20% fat, 10% sham chickpea, 10% Tasali chickpea and 5% sham +5% Tasali. These samples were evaluated in terms of approximate chemical composition, physiochemical attributes (TVN, TBA and pH), texture profile, color measurement and sensory properties. The blends with beef fat obtained high content of crude fat and low content of crude protein and moisture. Total carbohydrates of chickpea replacement were ranged from 11.32 to 12.4%. The total volatile nitrogen of all luncheon samples was in acceptable limit, which ranged from 14.84 to 22.12 mg N/100g sample. Also, pH values were fluctuated between 5.76 and 5.82. Treatments containing sham chickpea flour had the highest value of TBA. Firmness, gumminess and chewiness, while fat replacements had the least values, but cohesiveness of all treatments had no significant differences. The lightness L^* of fat treatments were higher than others. Redness a^* value of red tuna fish luncheon ranged from 2.39 to 2.94. The blend of 20% beef fat obtained the highest score of sensory evaluation as taste, color, odor, texture and overall acceptability.

Keywords: Red Tuna fish, luncheon, chickpea, animal fat, physio-chemical attributes

INTRODUCTION

One of the most important fish species is Bluefin tuna (*Thunnus thynnus*), which has high economic values as a result of its increasing demand in global fish markets. Normally, fresh, frozen or canned products of tuna are consumed. In Japan, fresh and uncooked tuna is consistently consumed for sushi and sashimi dishes. Generally, fish and their derivatives products included high nutritional values as proteins and polyunsaturated fatty acids omega-3 (PUFA) such as Ecosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA). The approximate chemical composition of tuna flesh was 63.28% moisture, 20.96% proteins, and 11.40% lipids (Topic Popovic *et al.*, 2012).

Tuna is usually consumed raw as popular seafood. Consequently, indices of freshness, such as redness, odor, microbiological content, and texture, furthermore other factors, are critical quality properties. Tuna turns red meat brown when oxidized as a result its myoglobin content (Brands and van Boekel, 2002).

Lunch meat is a kind of filling pressed minced meat, which increased during World War II. Lunch meat was displayed as a source of military food supply. Today, lunch meat which is either pre-cooked or cured remains a very popular canned food. Generally, pork, beef, or chicken are the main raw materials for canned lunch meat (Agarwal *et al.*, 2015).

Luncheon meat is a common and favorite food product for most of consumers whether adults or children and it is considered an important industrial product. It is a comminuted product treated with curing salts and beef fats, which may contain variable amounts of non-meat binders (Hsu and Sun, 2006).

Most Egyptians frequently consumed well-liked meat products called luncheon as a fast food. It is containing of ground meat and animal fat with or without the addition of cereals, cured with nitrite and salt using heat processing (Abu-Salem *et al.*, 2011). In Egypt, there were two kinds of this product, which may be consumed semi-dry or canned. These kinds of luncheon are ready-to-eat without need to be cooked before consumption (ESS, 2005).

Non-meat proteins are added to enhance water binding, stabilize fat and control costs; however, their functionality can greatly differ (Hsu and Sun, 2006). FAO selected 2016 as the International Year of Pulses, which will highlight the health and environmental benefits. Legumes contain valuable compounds such as oligosaccharides, phenol compounds, tocopherols, fiber and phytoestrogens (Kouris Blazos and Bleski, 2016).

Pulses are excellent for a human dietary in terms of their nutritional characteristics, which have high content of protein, carbohydrates, dietary fiber and contain some minerals and vitamins and they are also weak in fat. A part from being nutritious, pulse proteins are highly functional and observable attributes like solubility, gelation and water binding playing an essential role in structural formation and mouth feel of the final products (Abdelrahman, 2014).

For nutrient content, chickpeas are considered the leader. It is uniquely natural plant source of biogenic nutrients as proteins and amino acids, simple carbohydrates, indigestible polysaccharides (including dietary fiber), lipids and vitamins. The chemical composition of chickpea flour were 14% moisture content, 22% protein, 6% lipid, 1% minerals and 57% Total carbohydrates (Dzhaboeva *et al.*, 2021).

Consumers of chickpeas and/or hummus have been shown to have greater nutrient intakes of polyunsaturated fatty

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DOI:10.21608/jfds.2023.186148.1094

acids, dietary fiber, vitamin C, folate, vitamin A, vitamin E, potassium, magnesium, and iron as compared to non-consumers. Hummus consumers have also been shown to have higher Healthy Eating Index 2005 (HEI-2005) scores (Taylor *et al.,* 2016). The same author found that the percentage of moisture, protein, fat and total carbohydrates in Hummus were 10.54, 20.47, 6.04 and 62.95%, respectively.

The main goal of such study was directly to demonstrate that it possible to produce a fishery product such as luncheon from low value fish species like red tuna fish, low demand fish using various amount of chickpea flour and beef fat in the recipe to improve its consuming and protective properties and produce special organoleptic characteristics. To achieve this goal; chemical, physical and sensory evaluation of the studied fish luncheon treatments were carried out.

MATERIALS AND METHODS

Materials:

Fresh Red Tuna fish (*Thunnus thunnus*) were purchased from local market in Damietta Governorate, Egypt. Fish were transported in an ice-box to Food Industries Department, Faculty of Agriculture, Damietta University. After being weighed, the red tuna were gutted, skinned, beheaded, and washed in water. In iced conditions, the skinned red tuna was manually filleted, then grounded. Fresh buffalo fat, chickpea and other ingredients were obtained from local market in Damietta Governorate, Egypt.

Methods:

Preparation of red tuna fish luncheon:

The ground red tuna fish has been added in proportion 75 g, 2 g salt, (ground garlic, onion and sugar) 0.5 g for each, spices 1.7 g, corn starch 5 g, sodium tri-polyphosphate 0.3 g and chilled water 14.5 g) for 100 g luncheon. All components were manually combined and twice ground through a 4 mm plate. To make the red tuna luncheon treatments, the ground red tuna fish in the formulation was replaced with 10, 20 % of buffalo fat, 10 % chickpea (Sham), 10% chickpea (Tasali) and (5% Sham + 5% Tasali). After being mixed by hand, each treatment finally ground (4 mm plate). The emulsion was filled in stretch roll as 4 cm diameter and 10 cm in height to a weight of 100 g. The rolls were steamed for 30 min at 95°C.The luncheon rolls were refrigerated by water and then stored at (2±1ºC) until analysis.

Proximate chemical composition:

The contents of red tuna fish luncheon samples were determined for moisture, crude fat, crude protein and total ash according to AOAC (2012) and total carbohydrates were estimated by difference.

Physiochemical analysis of luncheon samples:

Determination of thiobarbituric acid (TBA):

The thiobarbituric acid (TBA) was determined using spectrophotometer at 538 nm according to the method described by Vyncke (1970). The TBA values were expressed as mg malonaldehyde (MDA)/kg fish sample.

Determination of total volatile nitrogen (TVN):

Total volatile nitrogen (TVN) of red tuna fish luncheon was determined using the method described by EOS (2006).

Determination of pH value:

pH value of red tuna fish luncheon samples was determined using 5 g of sample, which homogenized with 50 ml distilled water at 25ºC for 30 min. pH value was measured using a pH meter (Model JENWAY pH/ mv meter Model 3510 instruction Manual) according to Egan *et al.*(1981).

Texture profile analysis (TPA):

Using software Bourne (2003) a universal testing machine (Cometech, B type, Taiwan) was used to determine the texture of red tuna fish luncheon samples. In a ''Texture Profile Analysis'' (TPA) double compression test, a cylindrical aluminum probe with 25 mm diameter was utilized to penetrate to 30% depth, at 1 mm/s speed test. Gumminess (N), firmness (N), chewiness (N), cohesiveness, springiness and resilience were calculated from the TPA graphic. Both, springiness and resilience, reveal information about the after stress recovery capacity. However, the former refers to retarded recovery, the latter concerns instantaneous recovery (immediately after the first compression, while the probe goes up). The determination of texture was done on samples that were of the same size (10 mm height).

Color measurements:

The interior surface color of red tuna luncheon samples was examined using a spectrophotometer CM-3600A, KONICA MINOLTA, Osaka, Japan utilizing the color profile system of lightness (*L**), redness (*a**) and yellowness (*b**) (CIE, 2004).

Sensory evaluation:

Ten trained panelists who represented graduate students and staff members at Food Industries Department, Faculty of Agriculture, Damietta University, Egypt, evaluated the sensory quality of red tuna fish luncheon treatments. Individual panelists received randomly coded samples (Ali *et al.,* 2017).

Taste, odor, color, texture and overall acceptability were evaluated using a nine-point hedonic scale, where 9 = extremely like, 8 = very much like, 7 = moderately like, 6 = slightly like, 5 = neither like nor dislike, 4 = slightly dislike, 3 = moderately dislike, 2 = very much dislike and 1 = extremely dislike.

Statistical analysis

Using SPSS (2008) version 17 program for windows, the obtained results were analyzed using analysis of variance (one way ANOVA) and comparisons were done by Duncan's test at $P<0.05$ level of significance.

RESULTS AND DISCUSSION

Fresh red tuna fish composition was moisture 71.74%, protein 23.68 %, fat 3.72%, ash 0.44% AOAC (2012) and 0.41% total carbohydrates as calculated by difference.

The chemical composition of red tuna luncheon treatments were tabulated in Table (1), the higher moisture content ($p<0.05$) was in control red tuna luncheon. The replacement with beef fat concentration resulted in decreasing moisture and protein content compared to control sample. Crude protein in 10% and 20% animal fat treatments were 18.89% and 20.13%, respectively compared to 22.93% in control. These results were in the same trend with Ali *et al.* (2017), who reported that by raising the proportion of beef fat addition, the crude protein of canned tilapia fish luncheon decreased. Chickpea replacing affected on moisture content (59.15-59.6) % and total carbohydrates content (11.32-12.40) % in fish blends ($p<0.05$) compared to control luncheon sample, which were 66.64 % and 4.03%, respectively. Ash content of all treatments had a slight difference, which ranged between 3.13 % and 3.50 %, this is may be due to salt concentration stability of all blends and the decrease of ash content in fresh tuna fish (0.44%) and other additives.

Table 1. Approximate chemical composition of red tuna fish luncheon (% on wet weight basis) as affected by different replacements.

Components (%) Treatments	Moisture	Crude Protein	Crude Fat	Ash	Total Carbohydrates
Control	66.64[a]±0.25	22.93[a]±0.10	3.12[cd]±0.025	3.28[bc]±0.12	4.03[d]±0.17
10% Animal Fat	61.06[b]±0.03	18.89[d]±0.22	10.70[b]±0.09	3.35[ab]±0.03	6.00[c]±0.20
20% Animal Fat	54.10[d]±0.34	20.13[c]±0.16	20.09[a]±0.10	3.13[c]±0.04	2.60[e]±0.10
10% Sham	59.55[c]±0.26	21.83[b]±0.14	2.92[d]±0.11	3.29[bc]±0.09	12.40[a]±0.14
10 % Tasali	59.60[c]±0.27	21.95[b]±0.08	3.46[c]±0.02	3.48[ab]±0.01	11.51[b]±0.07
5% sham+ 5% Tasali	59.15[c]±0.22	23.05[a]±0.14	2.97[d]±0.27	3.50[a]±0.01	11.32[b]±0.17

Mean values ± standard error (n=3). Mean values in the same column with the same letter are not significantly different at *P* < 0.05.

The most important physiochemical quality in fish products were total volatile nitrogen (TVN), thiobarbituric acid (TBA) and pH value of luncheon treatments. The obtained results recorded in Table (2) and Figure (1). Total volatile nitrogen reflects quality change in fish protein. As shown, total volatile nitrogen values were 19.04, 14.84, 22.40, 20.72 and 22.12 mg N/100g sample, in 10% animal fat, 20% animal fat, 10% sham, 10% Tasali and 5% Sham+5%Tasali, respectively compared with 20.44 mg N/100g sample in control. These results is line with Echeverría *et al.* (2018), who reported that total volatile nitrogen in Bluefin tuna slices was acceptable (<20 mg/100g sample). In any case, total volatile nitrogen values of all fish luncheon treatments did not reach the maximum acceptability limit Saloko *et al.* (2014).

pH value of all luncheon treatments is presented in Table (2). There were no significant differences between 10% sham, 10% Tasali and 5% Sham+5% Tasali treatments, and there were significant differences between control, 20% animal fat, 10% Sham, 10% Tasali and 5% Sham + 5% Tasali.

From tabulated data, pH value of all treatments fluctuated between 5.76 and 5.82., A decrease in pH is generally correlated with the release of inorganic phosphate from the breakdown of adenosine triphosphate (ATP) and the production of lactic acid from anaerobic respiration in fish muscle. These results were agree with Torrieri *et al.* (2011), who stated that pH of Bluefin tuna fillets reached a value of 5.60 after 11 days of refrigerated storage.

Table 2. Physiochemical attributes of red tuna fish luncheon as affected by different replacements.

Attributes Treatments	TVN (mg N/100g)	TBA (mg MAD/Kg)	pH
Control	20.44[b]±0.28	1.64[c]±0.01	5.76[c]±0.003
10% Animal Fat	19.04[c]±0.56	0.77[f]±0.01	5.76[c]±0.005
20% Animal Fat	14.84[d]±0.28	1.25[d]±0.02	5.81[b]±0.003
10% Sham	22.40[a]±0.56	3.00[a]±0.01	5.82[a]±0.003
10 % Tasali	20.72[b]±0.56	1.05[e]±0.03	5.82[ab]±0.006
5% sham+ 5% Tasali	22.12[a]±0.28	1.97[b]±0.01	5.81[ab]±0.003

Mean values ± standard error (n=3). Mean values in the same column with the same letter are not significantly different at *P* < 0.05.

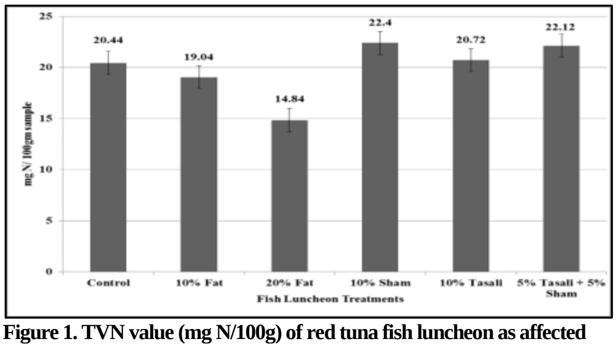

Figure 1. TVN value (mg N/100g) of red tuna fish luncheon as affected by different replacements.

Lipid oxidation is shown by the TBA value. It has frequently used to measure the production of the secondary products of lipid oxidation, especially aldehydes. Data shown in Table (2) and Figure (2) obtained that there were significant difference between all luncheon treatments and TBA value of treatments containing chickpea (Sham) had the highest value. These results may be due to the oxidation and improper storage of chickpea (Sham).

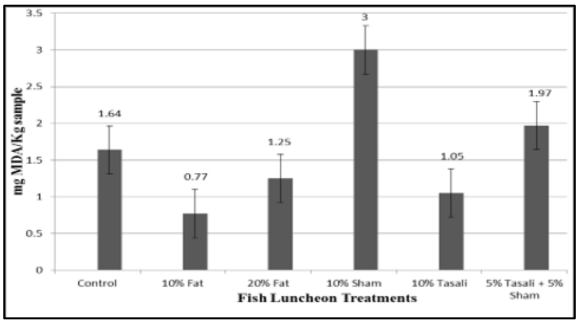

Figure 2. TBA value (mg MDA/Kg sample) of red tuna fish luncheon as affected by different replacements.

Texture is an important quality parameter for fish products. Texture profile results of red tuna luncheon treatments were determined as firmness, cohesiveness, gumminess, chewiness, springiness and resilience values are obtained in Table (3) and Figure (3). The tabulated data obtained that firmness recorded the highest value in (5% Sham + 5% Tasali), 10% Tasali and 10% Sham samples, which were 20.50, 19.32 and 18.70 N, respectively. There were significant differences between all fish luncheon treatments. Cohesiveness of fish luncheon treatments reduced in all different replacement compared with control and there were significant differences between all fish luncheon treatments except the sample containing 20% animal fat compared to control. Gumminess recorded the highest value in 10% Sham treatment, while the sample containing animal fat had the least value, which recorded 9.60 and 9.04 in 10% and 20% animal fat, respectively. Sham and Tasali treatments had the highest value of Firmness, gumminess and chewiness. These results may be due to decreases of fat content with chickpea flour addition. Chickpea flour has higher carbohydrates which could effect on the texture attributes of the red tuna fish luncheon and raise the firmness value (Taylor *et al.*, 2016). On the other hand, fat containing treatments had the least value of firmness, gumminess and chewiness compared to control. This may be due to the high fat content. These results were in line with Ali *et al.* (2017), who stated that cohesiveness and springiness of fish luncheon were unaffected by beef fat concentration but the hardness of tilapia luncheon reduced (p<0.05). It is known that fat content has a relationship with tenderness and smoothness of red tuna luncheon treatments. From tabulated data, significant differences (p<0.05) were noticed between all fish luncheon treatments for resilience parameter.

Table 3. Texture profile of red tuna fish luncheon as affected by different replacements.

Properties Treatments	Firmness (N)	Cohesiveness	Gumminess(N)	Chewiness(N)	Springiness	Resilience
Control	15.11^{d}±0.02	0.81^{a}±0.01	12.23^{b}±0.01	10.15^{b}±0.01	0.83^{a}±0.01	0.71^{a}±0.01
10% Animal Fat	12.80^{e}±0.01	0.75^{b}±0.01	9.60^{e}±0.02	7.86^{e}±0.02	0.81^{a}±0.01	0.61^{c}±0.01
20% Animal Fat	11.28^{f}±0.01	0.80^{a}±0.01	9.04^{f}±0.01	7.50^{f}±0.01	0.83^{a}±0.01	0.67^{b}±0.01
10% Sham	18.70^{c}±0.01	0.75^{b}±0.01	14.01^{a}±0.02	11.35^{a}±0.01	0.81^{a}±0.01	0.61^{c}±0.01
10 % Tasali	19.32^{b}±0.02	0.58^{c}±0.01	11.20^{c}±0.02	8.41^{c}±0.02	0.75^{b}±0.01	0.44^{d}±0.01
5% sham+ 5% Tasali	20.50^{a}±0.01	0.53^{d}±0.01	11.09^{d}±0.01	7.97^{d}±0.01	0.73^{b}±0.01	0.41^{d}±0.01

Mean values ± standard error (n=3). Mean values in the same column with the same letter are not significantly different at *P* < 0.05.

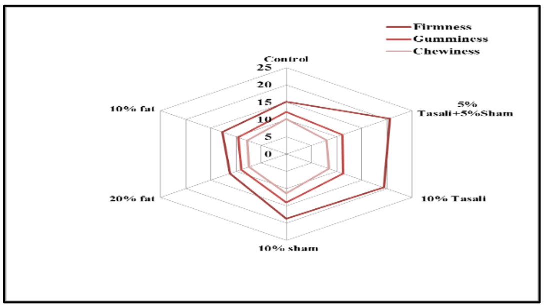

Figure 3. Firmness, gumminess and chewiness of red tuna fish luncheon as affected by different replacements.

Color measurements results of red Tuna fish luncheon as affected by different replacements were shown in Table (4).

The lightness (L* value) of red tuna fish luncheon treatments containing fat were significantly (p<0.05) higher than other treatments, which they were 37.37 and 37.97 in 10% and 20% animal fat replacements, respectively. On the other hand, chickpea treatments had the least L* value, which were 31.67, 33.41 and 32.76 in 10% Tasali, 10% Sham and (5% Sham +5% Tasali), respectively. The color of samples becomes lighter because of replacement of red tuna fish containing high myoglobin with beef fat. These results agree with data from Ali *et al.* (2017), who obtained that L* value of tilapia fish luncheon with different concentration of beef fat ranged from 38.42 to 53.05.

For redness (a* value) results of red tuna luncheon treatments, Table (4) obtained that a* value ranged from 2.39-2.94. The treatments of fat addition had no significant difference (p<0.05), but other treatments obtained high significant difference (p<0.05). The control red tuna fish luncheon's redness value was similar to fish luncheon formulated with 10% Sham addition (p <0.05). The myoglobin content of red tuna fish and chickpea addition may be the cause of the highest value of 10% Tasali and 5% Sham+5% Tasali.

From obtained results, the b* value of red tuna fish luncheon contained 10% Sham and 5% Sham+5% Tasali was similar to the b* value of control red tuna luncheon (p<0.05). However, at 10% and 20% fat addition, b* value was higher (p<0.05) than control red tuna fish luncheon. The b* value of fish luncheon ranged from 7.67 to 9.00 which were lower than the ones (14.07–18.32) for tilapia fish luncheon reported by Ali *et al.* (2017).

Table 4. Color measurement of red tuna fish luncheon as affected by different replacements.

Attributes Treatments	L*	a*	b*
Control	36.38^{b}±0.10	2.41^{d}±0.01	8.01^{b}±0.05
10% Animal Fat	37.37^{a}±0.27	2.55^{c}±0.01	8.65^{a}±0.03
20% Animal Fat	37.97^{a}±0.21	2.59^{bc}±0.06	9.00^{a}±0.09
10% Sham	33.41^{c}±0.51	2.39^{d}±0.01	8.06^{b}±0.20
10 % Tasali	31.67^{d}±0.27	2.94^{a}±0.03	7.67^{b}±0.20
5% sham+ 5% Tasali	32.76^{c}±0.14	2.65^{b}±0.03	8.08^{b}±0.07

Mean values ± standard error (n=3). Mean values in the same column with the same letter are not significantly different at *P* < 0.05.

Sensory attributes of red tuna fish luncheon samples obtained in Table (5) and Figure (4).

Table 5. Sensory properties of red tuna fish luncheon as affected by different replacements.

Properties Treatments	Taste(9)	Color(9)	Odor(9)	Texture(9)	Overall acceptability(9)
Control	4.8^{c}±0.20	6.85^{bc}±0.26	5.00^{d}±0.30	7.65^{ab}±0.38	5.40^{c}±0.22
10% Animal Fat	6.6^{b}±0.56	7.50^{ab}±0.17	6.75^{bc}±0.51	8.00^{ab}±0.37	6.95^{b}±0.38
20% Animal Fat	8.1^{a}±0.31	8.30^{a}±0.26	8.20^{a}±0.17	8.35^{a}±0.26	8.40^{a}±0.21
10% Sham	6.45^{b}±0.38	6.65^{bc}±0.28	7.15^{ab}±0.35	7.55^{ab}±0.41	7.20^{b}±0.32
10 % Tasali	6.90^{b}±0.27	6.55^{c}±0.35	6.95^{bc}±0.37	7.60^{ab}±0.33	7.10^{b}±0.28
5% sham+ 5% Tasali	5.50^{bc}±0.46	6.40^{c}±0.36	5.85^{cd}±0.43	7.10^{b}±0.39	6.40^{b}±0.31

Mean values ± standard error (n=10). Mean values in the same column with the same letter are not significantly different at 0.05 levels.

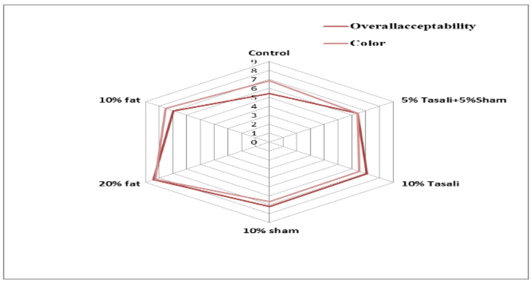

Figure 4. Color and overall acceptability of red tuna fish luncheon as affected by different replacements.

From tabulated data, the blend with 20% animal fat replacement had the highest score of taste, color, odor, texture and overall acceptability, which was 8.1, 8.3, 8.2, 8.35 and 8.40, respectively. These results were agreement with Ali *et al.* (2017)**,** who reported that sensory properties of tilapia fish luncheon were improved with fat addition and tilapia luncheon formulated with 25% beef fat had higher (p<0.05) sensory attributes score compared to control fish luncheon. The control red tuna fish luncheon had the lowest score of taste, odor and overall acceptability, which were 4.8, 5.00 and 5.40, respectively. The replacement of chickpea had the lowest texture score, which were 7.55, 7.60 and 7.10 for 10% sham, 10% Tasali and 5% sham+5% Tasali, respectively.

CONCLUSION

From previous results, it could be concluded that 10% and 20% fat treatments had the lowest protein content and the highest fat content. TVN of studied red tuna fish luncheon were in the safe limit and pH value had a slight difference between all blends. Chickpea treatments especially (10% Sham) had the highest indicator of TBA content. Red tuna luncheon treatments with chickpea obtained inversely relationship with indicators of juiciness and moisture content. According to this indicator, the chickpea treatments had lower parameters of springiness, resilience and moisture content and the highest value of firmness, gumminess and chewiness.

Finally, it could be stated that red tuna fish were high nutritive value and could be processed into high quality minced products such as luncheon.

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تحسين صفات جودة لانشون سمكة التونة الحمراء

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الملخص

الهدف الرئيسي من هذا البحث هو إنتاج منتج سمكي شبيه باللانشون من نوع من الأسماك منخفضة القيمة في مصر مثل سمكة التونة الحمراء باستخدام كميات مختلفة من دقيق الحمص والدهن الحيواني وذلك بالإستبدال لتحسين قابليتها للإستهلاك وخواص حفظها وإنتاج صفات حسية مميزة. وكانت خلطات لانشون التونة الحمراء عبارة عن ١٠٪ دهن، ٢٠٪ دهن, ١٠٪ حمص شام, ١٠٪ حمص تسالي و ٥٪ حمص شام+ ٥٪ حمص تسالي. تم تقييم العينات من حيث التركيب الكيميائي, الخصائص الفيزيوكيميائية مثل (تقدير النيتروجين الكلي المتطاير، رقم حمض الثيوباربتيوريك و رقم الأس الأيدروجيني), تحليل القوام، قياس اللون والصفات الحسية. أوضحت الخلطات المحتوية علي الدهن إرتفاع محتواها من الدهن الخام وانخفاض محتواها من البروتين الخام والرطوبة. تراوحت نسبة الكربوهيدرات الكلية في عينات الحمص بين ١١,٣٢ إلي ١٢,٤ %. وكان النيتروجين الكلي المتطاير لعينات اللانشون في الحد المقبول والذي تراوح بين ١٤,٨٤ إلي ٢٢,١٢ ملجم نيتروجين/ ١٠٠ جم عينة. أيضا تراوحت قيم رقم الأس الأيدروجيني بين ٥,٧٦ و ٥,٨٢. احتوت معاملات دقيق حمص الشام علي أعلي قيم لرقم حمض الثيوباربتيوريك. بالنسبة للعينات المحتوية علي الدهن أظهرت أقل قيم لكل من الخشونة، المطاطية والقابلية للمضغ, بينما لم توجد فروق معنوية في خاصية التماسك بين جميع المعاملات. وكانت قيم L^* أعلي في معاملات الدهن مقارنة بغيرها، وتراوحت قيم a^* في عينات لانشون التونة الحمراء بين ٢,٣٩-٢,٩٤. أوضحت الخلطة المحتوية علي ٢٠٪ دهن أعلي درجات التقييم الحسي من حيث الطعم، اللون، الرائحة والقبول العام.

الكلمات الدالة: سمكة التونة الحمراء, اللانشون, الحمص, الدهن الحيواني, الخصائص الفيزيوكيميائية