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ASSESSMENT OF QUALITY ATTRIBUTES OF TUNA, MACKEREL AND COMMON CARP FISH AFTER CANNIG PROCESS

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Abstract

Due to the importance of fish for human nutrition, this study was focused on the beneficialness from the cheaper aquaculture fish kinds (common carp *Cyprinus carpio*) and improvement their quality attributes by canning process to get guarantee a good final product similarly with processed canned tuna and canned mackerel fish. Therefore, different kinds of fish (tuna, mackerel and carp) were used to canning process. Chemical composition, fatty acids, minerals, microbiological and sensory properties were evaluated after canning process. Fat content of canned fish samples were significantly affected ($p< 0.05$) by the canning process. Both canned mackerel and canned carp had higher fat level 20.29±0.43% and 19.69±0.64 % respectively compared with fat content (8.5±0.47%) in canned tuna.

The results showed that canned carp samples had high significant values ($P< 0.05$) in minerals content compared with canned tuna samples. Monounsaturated fatty acids (MUFAs) constitute the majority of the fatty acids pool in canned common carp samples followed by canned tuna and canned mackerel, while polyunsaturated fatty acids (PUFAs) pool were 24.40, 11.60 and 22.29% for canned tuna, canned mackerel and canned carp respectively. Total bacterial count (TBC) were ranged from 2.14 to 2.67 Log_{10} CFU/g for all canned samples, whereas coliform bacterial count (CC) and *Clostridium botulinum* were not detected for all canned samples. Organoleptic scores were usedas a quality index to assess the canned fish quality which appeared canned carp samples had quality attributes liken with quality of canned tuna.

INTRODUCTION

Consumption of fish is very popular amongst people all around the world because it has high protein content, low saturated fatty acids, and high Omega fatty acids content (Ikem and Egiber, 2005; Tuzen and Soylok, 2007)

Tunas are an important global commodity due to their high economic value and extensive international trade. They form one of the most preferred food sources across the continent, used mostly for canning (Chitradurga *et al.,* 2014).

Fish and canned fish are sources of protein rich in essential amino acids, micro and macro elements (calcium, phosphorus, fluorine, iodine), fats that are valuable sources of energy, fat-soluble vitamins, and unsaturated fatty acids that, among other benefits, have a hypocholesterolic effect (anti-arteriosclerosis). In comparison to the meat of slaughter animals, that of fish is rich in phosphorus, potassium and magnesium, and the calcium content of small-boned fish is also high (Ismail, 2005). Due to their nutritional value, fish and canned fish products are high quality foods that are beneficial to human health.

Khallaf *et al*. (1997) found that, canning process improved the organoleptic characteristics of silver canned fish. Both canned smoke and canned minced fish showed noticeable increase in an acceptance of flavor and color. Overall acceptability scores were decreased progressively in all canned fish groups.

Rodriguez *et al.* (2001) found that, the change in aroma during canning depends on compounds from lipid oxidation and from thermal degradation of carbohydrates as well as compounds from other types of reactions, e.g. the Striker degradation and the Millard reaction. The most important changes caused by sterilization during the canning process were the appearance of furans, nitrogen containing compounds and branched aldehydes and increased in the contents of aldehydes and sulphur containing compounds.

The white flesh fish muscle contains lipids less than the dark flesh fish muscle and usually possesses about 18–23% of protein, depending on the species and time of harvesting. The nutritional importance of fish consumption is in great extent associated with the content of omega-3 fatty acids (Manat *et al.,* 2010).

During the canning process, both enzymes and bacteria should be permanently inactivated by heat and, provided re-infection does not occur and no negative interaction with the container is produced, heat-processed fish keeps for a very long time. However, several detrimental effects have been encountered during canning (loss of essential nutrients, formation of undesirable compounds, browning development and lipid and protein damage) that can strongly influence the shelf life of canned fish products (Lukoshkina and Odoeva, 2003).

The objectives of the present study was improvement the quality attributes of common carp fish flesh by canning process and determine chemical composition, some minerals, fatty acids, bacteriological and organoleptic properties for canned tuna, mackerel and common carp fish. Also, this study was to report if canned carp products were in compatible with other canned fish and with Egyptian mode.

MATERIALS AND METHODS

Sample collection:

Raw tuna and mackerel fish were purchased from Elobour market and transport in icebox to the laboratory, while common carp fish (*Cyprinus carpio*) was immediately obtained after catching from Abbassa farm in Sharkia governorate, Egypt. The mean of individual weight of common carp fish was about 2.0 Kg. The fish samples were washed using tap water, then head, scales, fins using a sharp knife and viscera removed by hand. After that the fish were washed using tap water then cuts to medium sizes. All fish samples were transport in icebox to the factory in the second industrial zone of Ismailia (United food Products Company).

Preparation of packing solution:

A stock of salt solution was prepared from sodium chloride 2.0% (w/w), 3.5% vinegar (6% conc.) and 1.5% spices mixture consists of 22.5% coriander, 7.5% cubeb, 15.0% cumin, 32.0% black pepper, 9.0% red pepper, 10.0% cardamon and 40.0% cloves].

The samples were soaked in saturated salt solution with a little acetic acid (6%), after that washed the fish samples using tap water to remove the over salt. The fish samples were packed in the cans, each can was weighed 340.0gm. (310.0 gm. fish flesh, 10.0 ml sunflower oil and 20.0 ml packing solution).

Cooking:

All samples were set in cans and cooked for 30 min at 100°C and then sealed according Salah Selmi and Sadok (2007).

Sterilization of the cans:

Sterilization was performed at 121ºC for 40 min at pressure respectively. After sterilization the cans were cooled for 10 min using cold water. After that, the cans were carefully dried and incubated for 21 days at 37ºC and placed in room temperature to analyses.

Analytical methods

The rest of the sample of about 10-15 g was used for moisture measurements and dried until constant weight at 105ºC, total protein, lipids, ash and minerals (Ca, Mg, P, Fe and K) were also determined according to methods described in AOAC (2000). Fatty acids contents were estimated by gas-liquid chromatography after being liberated and esterified as recommended by AOAC (2000) modification. Total bacterial count (TBC) and the Coliform count (CC) were detected according to the methods described by Kato *et al.* (1985) and Hitchins *et al.* (1995) respectively. *Clostridium botulinum* counts were determined according to Anderson (1951). The bacterial counts were expressed as mean log $_{10}$ CFU/g sample. All analyses were performed in triplicate. Samples were organoleptically evaluated for taste, colour, odour, texture and overall acceptability after the incubated time as described by Teeny and Miyauchi (1972) according to the following scheme:

Description	Score	Description	Score
Fair	4	Ideal	10
Poorly fair	3	Excellent	9
Poor	2	Very good	8
Very poor	1	Good	7
Repulsive	0	Fairly good	6
		Acceptable	5

Statistical Analysis:

Three replications of each trial were analyzed using Analysis of Variance (ANOVA) and means were separated by Duncan at a probability level of $P < 0.05$ (SAS, 2000).

RESULTS AND DISCUSSION

The results given in Table (1) declared that the average of moisture contents of canned tuna, canned mackerel and canned common carp were 77.54±0.77, 73.25±0.66 and 74.35±0.59 % respectively. As for statistical analysis, there were significant differences ($P< 0.05$) in moisture content between canned tuna and both of canned mackerel and common carp. Also, there were significant differences in protein content between all canned fish samples. It could be observed that canned mackerel and canned common carp samples had high values of fat content compared of canned tuna, no significant differences in fat content between canned mackerel and canned common carp samples. In addition, ash content of canned common carp fish samples had high significant ($P< 0.05$). Finally carbohydrates content of canned tuna, canned mackerel and canned common carp were 1.56±0.35, 2.40±o.27and 2.80±0.19 %, respectively.

Table 1. Chemical composition of canned fish (tuna, mackereland common carp).

Items / Treatments	Moisture	Protein (d/w)	Fat (d/w)	Ash (d/w)	Carbohydrates (d/w)
Canned tuna	77.54± 0.77^{a}	83.81± 0.77^{a}	8.5± 0.47^{b}	6.12± 0.26^{b}	1.56± 0.35^{b}
Canned mackerel	73.25± 0.66^{b}	73.47± 0.72^{b}	19.69± 0.64^{a}	4.43± 0.45^{c}	2.40± 0.27^{b}
Canned carp	74.35± 0.59^{b}	65.25± 0.41^{c}	20.29± 0.43^{a}	11.64± 0.61^{a}	2.80± 0.19^{a}

$^{a-c}$ Values with different superscripts in a column are significantly different ($P< 0.05$).
d/w = on dry weight bases

Minerals contents:

Statistical analyses of the data in Table (2) showed that there were significant differences in minerals content ($P< 0.05$) among all canned samples.

Canned mackerel samples had higher values of minerals content (145.4±0.62, 141.3±0.62, 512.53±1.09 and 542.2±0.7 mg/100g) for Ca, Mg, K and P respectively. While, canned carp samples were 112.13±0.42, 111.4±0.56, 428.27±0.95 and 465.2±0.62 mg/100 g for Ca, Mg, K and P respectively. Furthermore, canned carp samples had high significant values ($P< 0.05$) compared with canned tuna samples for investigated minerals.

Table 2. Minerals composition (Mg/100g) of canned tuna, mackerel and common carp (On dry weight bases).

Items / Treatments	Ca	Mg	K	P	Fe
Canned tuna	101.53± 1.48^{c}	102.53± 0.47^{c}	403.3± 1.23^{c}	450.13± 0.65^{c}	0.51± 0.04^{b}
Canned mackerel	145.4± 0.62^{a}	141.3± 0.62^{a}	512.53± 1.09^{a}	542.2± 0.7^{a}	0.53± 0.07^{b}
Canned carp	112.13± 0.42^{b}	111.4± 0.56^{b}	428.27± 0.95^{b}	465.2± 0.62^{b}	0.73± 0.07^{a}

$^{a-c}$ Values with different superscripts in a column are significantly different ($P< 0.05$).

Fatty acids content:

The results are given in Tables (3) declared fatty acids content of canned tuna, canned mackerel, and canned common carp. In canned tuna samples monounsaturated fatty acids (MUFAs) constitute the majority of the fatty acids pool followed by saturated fatty acids (SFAs) and polyunsaturated fatty acids (PUFAs). Within these treatment, major fatty acids were (C18:1) (C16:0) and (C18:2). While, In canned mackerel samples constitute the majority of the fatty acids pool saturated fatty acids (SFAs) followed by monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs). Within these treatment, major fatty acids were (C16:0), (C18:1) and (C16:1). Also, in canned common carp samples monounsaturated fatty acids (MUFAs) constitute the majority of the fatty acids pool followed by saturated fatty acids (SFAs) and polyunsaturated fatty acids (PUFAs).The major fatty acids in these treatments, were (C18:1), (C16:0) and (C18:2). However, polyunsaturated fatty acids (PUFAs) contents were lower values compared with monounsaturated fatty acids (MUFAs) and saturated fatty acids (SFAs) for all canned samples. High

temperatures at canning process were caused PUFA damage and lead to the formation of significant quantities of primary and secondary lipid oxidation products. These results may be due to lipolysis (free fatty acid formation) during cooking process and agreement with reported by (Aubourg *et al*., 2002).

Table 3. Fatty acids composition % of canned fish (tuna, mackerel and common carp).

Variable	Canned tuna	Canned mackerel	Canned common carp
C6:0	0.100	0.260	---
C8:0	2.900	0.470	0.250
C10:0	---	0.110	0.213
C12:0	0.500	0.220	0.325
C14:0	3.100	5.810	1. 61
C16:0	24.20	24.37	26.29
C18:0	5.000	7.920	2.3
C20:0	---	10.02	0.68
C22:0	0.400	4.360	0.19
Σ SFA*	36.20	53.54	31.858
C10:1	2.200	1.010	0.500
C12:1	0.400	2.500	---
C14:1	---	---	1.12
C16:1	5.600	13.38	8.3
C18:1	30.70	16.40	34.89
C20:1	0.200	0.720	0.500
Σ MUFA**	39.10	34.10	45.31
C18:2	20.30	6.980	22.10
C18:3	4.100	4.620	0.89
Σ PUFA***	24.40	11.60	22.29

*SFA: Saturated fatty acids **MUFA: Mono unsaturated fatty acids ***PUFA: Poly unsaturated fatty acids.

Microbiological evaluation:

Total bacterial count (TBC), coliform bacterial count (CC) and *Clostridium botulinum* of canned samples were determined in Table (4). TBC were 2.67, 2.14 and 2.47 (Log $_{10}$ CFU/g) for canned tuna, mackerel and common carp respectively, these results agreement with (Leroi, 2010). On the other hand, CC and *Clostridium botulinum* were not detected in all canned

samples. These results are in agreement with (El-Dengawy *et al*., 2012). The gained results may be attributed to the initial microbial load of during fish handling. These results coincide with those given by Egyptian Standard (1991) and Gonzalez *et al*. (1999).

Table 4. Total bacterial count (TBC), Coliform bacterial count (CC) and *Clostridium botulinum* of canned fish (tuna, mackerel and common carp).

Parameter	TBC (Log $_{10}$ CFU/g.)	CC (Log $_{10}$ CFU/g.)	*Clostridium botulinum* (Log $_{10}$ CFU/g.)
Canned tuna space	2.67	ND	ND
Canned mackerel	2.14	ND	ND
Canned common carp	2.47	ND	ND

ND = Not detected

Organoleptic evaluation:

The canned products were presented to panelists for the quality evaluation (taste, colour, odour, texture and overall acceptability) and the results are recorded in Tables (5). The values were expressed as average scores of all judges. Maximum possible scores for each attribute were 10 and the minimum was zero. The overall impression of the canned product on the assessor was scored in overall acceptability.

Table 5. Organoleptic parameters of canned tuna, canned mackerel and canned common carp.

Items / Treatments	Taste	Colour	Odour	Texture	over all acceptability
Canned tuna	8.57± 0.59^{a}	9.27± 0.45^{a}	9.0± 0.43^{a}	8.63± 0.67^{a}	89.1± 1.06^{a}
Canned mackerel	7.0± 0.56^{b}	8.0± 0.74^{b}	8.0± 0.95^{b}	8.45± 1.06^{a}	78.8± 0.96^{b}
Canned carp	7.3± 0.5^{b}	7.52± 0.41^{c}	8.0± 0.82^{b}	8.2± 0.66^{b}	78.17± 1.07^{b}

$^{a-c}$ Values with different superscripts in a column are significantly different (P< 0.05).

It is proved that, canned tuna has highest significant (P< 0.05) scores of organoleptic properties followed by canned mackerel and canned common carp

respectively. The taste scores were good to very good for all canned samples. Also, odour and texture scores were very good to excellent for all canned samples, meanwhile canned carp samples had good colour after canning process. The organoleptic properties scores in this study may be due to levels of fat in fish flesh as reflect the diets and fish type, the results are in agreement with those given by Sage and Kenneth (2003) and Delwiche and Liggett (2004).

CONCLUSION

Final canned products were studied for quality characteristics. The difference between canned tuna, canned mackerel and canned common carpwas related to chemical composition, fatty acids and sensory properties and their affected by the canning process. All the canned fish samples appeared to be highly valuable products for human nutrition concerning the content of fatty acids. However, canned carp fish samples in sunflower oil are a good source of essential fatty acids (oleic and linoleic acids). The sensory results indicated that the canned carp had better acceptability. Further studies in canned carp with other additives are necessary to understand the nutritional changes and biochemical quality. So, increasing fish aquaculture and fisheries resource development could be recommended. From this study we noticed that canned productions with guarantee good quality, nutritive value and healthy for consumers are produce from common carp fish flesh which compete the imported fish. So, heedfulness of fish aquaculture and fisheries resource development could be increased.

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تقييم خواص الجودة لاسماك التونة والماكريل والمبروك العادى بعد عملية التعليب

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الملخص العربى

نظرا لأهمية الاسماك في تغذية الانسان فقد ركزت هذه الدراسة على الاستفادة من ارخص انواع الاسماك المستزرعة (سمك المبروك العادي) وتحسين خواص جودتها من خلال عملية التعليب للحصول على منتج نهائي مضمون الجودة ، لذا تم استخدام انواع مختلفة من الاسماك (تونه، ماكريل، مبروك) للتعليب. وتم تقييم التركيب الكيميائي والاحماض الدهنية والمعادن وكذلك الخواص الميكروبية والحسية بعد عملية التعليب لكل عينات الاسماك محل الدراسة. اوضحت النتائج ان هناك تأثير معنوي ($P<0.05$) لعملية التعليب على المحتوى الدهني لعينات الاسماك المعلبة حيث ارتفعت نسبة الدهن 20.29 ، % 19.69 في كل من عينات سمك المبروك العادى المعلبة وعينات سمك الماكريل المعلبة على التوالي مقارنة بنسبة الدهن (% 8.5) في عينات سمك التونة المعلبة.

كما أوضحت النتائج وجود اختلافات معنوية ($P<0.05$) في محتوى المعادن بين عينات سمك المبروك وعينات سمك التونة المعلبة. شكلت الاحماض الدهنية احادية عدم التشبع الاغلبية لإجمالي الاحماض الدهنية في عينات سمك المبروك المعلبة تليها عينات اسماك التونة ثم عينات اسماك الماكريل المعلبة، بينما كانت نسبة الاحماض الدهنية عديدة عدم التشبع 24.40، 11.60، 22.29% لعينات سمك التونة المعلبة، عينات الماكريل وعينات المبروك المعلبة على التوالي. وقد تراوح العدد الكلى للبكتريا من 2.14 الى2.67 (Log_{10} CFU/g.) لجميع عينات السمك المعلبة، في حين لم تظهر بكتريا *botulinum Clostridium* وبكتريا Coliform bacteria في كل العينات المعلبة. اظهرت درجات التقييم الحسى كدليل لتقييم جودة الاسماك المعلبة ان عينات اسماك المبروك المعلبة لها خواص جودة تقارب جودة اسماك التونة المعلبة، ومن خلال ذلك يمكن انتاج معلبات من لحم سمك المبروك العادي ذات جودة وقيمة غذائية وصحية للمستهلك تنافس الاسماك المستوردة، لذا يجب زيادة الاهتمام بالأسماك المستزرعة من خلال تنمية الثروة السمكية.