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PROCESSING OF CUSTOMARY SMOKED AND LIQUID SMOKED CANNED CRABMEAT

EL-DASHLOUTY, AMANI A., MOHAMED A. ABD EL-SALAM, THANAA M. HASSANEIN, WAFAA Z. MOHAMED AND MOHAMED H. GHALY

Meat and Fish Tech. Res. Dept., Food Tech. Res. Inst. Agric. Res. Centre, Giza

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Abstract

Because of the need for food products intended for export to support national economy and the promising exportation potential of less expensive processed crabmeat products for the markets of developed countries as well as to benefit from low cost labor, who practice the tedious separation of crabmeat from shells, this work was conducted to prepare a good quality smoked canned crabmeat which was previously customary smoked or canned with aromatized oil (diluted smoke concentrate added to filling oil), or with aromatized brine (diluted smoke concentrate was added filling NaCl solution). Unsmoked canned product was also prepared for comparison. Filling media were either sunflower oil, olive oil, or brine (NaCl solution). Canning was carried out in glass jars of local production. Boiling of whole crabs in water, cooking of separated crabmeat in salt solution and smoking (customary) caused the loss of moisture and accordingly the increase of other constituents. Organoleptic evaluation of the 9 prepared canned crabmeat revealed the choice of liquid smoked canned crabmeat than the customary smoked ones, then came the unsmoked canned products. Differences between canned crabmeat in aromatized brine and in aromatized sunflower oil were very slight, while that canned in aromatized olive oil rated less. This was associated with the milder flavor due to less phenols concentration in tissues, relatively heavy smoking seems not to fit the canned crabmeat, unsmoking also negatively affected the canned crabmeat quality. Analysis of some indices as the T.V.N., A.V and T.B.A, however, revealed the high quality of all samples. Canned crabmeat oil, in aromatized brine, in aromatized sunflower oil and in aromatized olive oil which ranked best and were recommended for commercial production showed 21-22% protein, 2 - 10% fat, 3.6-4.0% ash, 0.1-0.2% carbohydrates and 2.1-2.2% salt; energy value was 108 - 172 kcal/100g. The consumption of 100g of such products (crabmeat of whole glass jar contents; 130g capacity) will cover 33 - 35% of the RDA for protein (for man 25 - 50 years old) indicating high nutritive value. During 6 months storage maturation of canned crabmeat occurred, this was indicated by the improvement of overall, acceptability, particularly for the smoked products. The present work confirmed the previous findings about the relation between maturation of canned fish and migration of some nitrogen during storage. It seems that lipids hydrolysis is involved in the maturation of canned crabmeat as indicated by A.V determination.

INTRODUCTION

For economy improvement, developing countries should find out the means for raising their exportation. Good quality preserved fish and other marine products may be one solution for costal countries (El-Shafie, Sahar 1997). Processed crabmeat is a high priced product in the United Kingdom, USA and Canada (Marter, 1985; Ghazala Trenholm, 1996 and kuntz, 1997). This is referred to high costs involved in meat extraction and wage scale. Therefore, it was thought to use surimi, which is relatively inexpensive to simulate crab; addition of flavours and spices, marination and smoking were also practised to increase consumer interest and adding value to processed crab (Kuntz, 1997). Also, technological schemes were developed for processing crabmeat at sea to ensure maximum use of raw material including the residues to reduce production cost (Meita, 1975). Moreover, because removal of crabmeat from shell is tedious, time consuming unpleasant and costly, machines were designed to separate meat from the crab (Anon, 1971; Early and stroud, 1978; Britton, 1981 and Anon, 1984). According to Marter (1985), canned crabmeat of developing countries production will find easily good market in the United Kingdom. The Dutch manufactures already export a tasty crab salad to the UK market (Anon, 1982). However, processed crabmeat is promising for exportation by developing countries. In this concern, the crabmeat products preserved by canning seems to come in the first place to avoid possible contamination. Russians, Indians and Japanese are already involved in canning crabmeat commercially (Bykov, 1971; Govindan, 1972; Anon, 1984 and Osada *et al.,* 1988).

As for the nutritional value of crabmeat, protein content average is 17-20%; all essential amino acids were found in appreciable amounts indicating a well-balanced protein source (Salem *et al.,* 1970). Moreover, among shellfish, crabmeat showed extremely low levels of cholesterol; being 50mg/100g. Shrimp meat for example had 144 mg/100g. (Gordon, 1982).

This work was conducted to obtain good quality canned, smoked crabmeat as a new promising product for export. Canning was carried out in glass jars (of local manufacture) instead of tin cans to avoid H_2S blackening and the addition of chemicals such as monosodium fumarate, Osada *et al.*, 1988). used for this reason.

MATERIALS AND METHODS

Baladi crabs (*Lupa pelaica*) were purchased as fresh as possible from Alexandria city and rapidly transported with ice to the laboratory in Cairo. Crabs were cooked for 5

minutes in boiling water. After water strained, crabs were shelled and separated meat freed of blood residues to avoid blue discoloration. The washed meat was then boiled for 5 minutes in 3.5% NaCl solution, strained then rapidly cooled (immersed in cold NaCl solution for 5 minutes). After excess NaCl drained, crabmeat was soaked in 0.5% citric acid solution for 2 minutes to safeguard against blackening, any residual blood clots were removed before crabmeat was canned in glass jars (130g capacity). All canning media (salt solution 2.5%, sunflower oil or olive oil) were hot to (85°C) when filling (Zaitsev *et al.* 1969).

For customary smoking, beech wood sawdust was used to obtain the smoke. Smoking lasted for 4 hours at 40 °C until light golden brownish colour, and acceptable mild smoking flavour. The time of smoking was established experimentally.

Aromatized oil used in liquid smoked canned products was a diluted smoke concentrate (as the ratio 1: 3, smoke concentrate: water v/v) prepared by destructive distillation of wood sawdust according to (Dessouki 1976). Diluted smoke concentrate was directly added to the filling oil in the jars. The added diluted smoking concentrate was at the ratio 1: 30 v/v (concentrate: oil) (Shehata, 1980). To obtain the aromatized brine (salt solution with the smoke concentrate used for canned smoked crabmeat in brine), 1 ml of diluted smoke concentrate were added to 30 ml of 2.5% NaCl solution directly in the jar. This mixture was also established experimentally, filling medium was always about one quarter of the jar volume, while crabmeat was about three quarters of the jar (leaving the needed small headspace).

After filling, glass jars were heated open in water (99°C) for 10 minutes, sealed, then sterilized at 120 °C for 20 minutes, followed by cooling and storage at room temperature for 6 months. Analysis was carried out at zero time and after 6 months. The moisture, protein (NX 6.25, Micro Kjeldahl method), fat (Soxhelt apparatus, hexane as extraction solvent) ash, acid value (A.V.) thiobarbituric acid value (TBA), total volatile nitrogen (T.V.N) and salt were determined using the common methods of the A.O.A.C (1980). Phenol content on dry weight basis was determined according to (Moghazy 1994).

Organoleptic evaluation was carried out by aid of 10 panelists according to (self *et al.*, 1990), judging scale is shown in table 1.

Table 1. Palatability scores and corresponding description term.

Palatability attributes						
Scores	Tenderness	Flavour intensity	Colour intensity	Juiciness	Foreign flavour intensity	overall acceptability
1	Extremely tough	Extremely weak	Rejected	Dry	No foreign flavour	Extremely unacceptable
2	Very tough	Very weak	Extremely undesirable	Slightly Juicy	Slightly foreign flavour	Very unacceptable
3	Moderately tough	Moderately weak	Moderately undesirable	Moderately Juicy	Moderately foreign flavour	Moderately unacceptable
4	Slightly tough	Slightly weak	Slightly undesirable	Very Juicy	Pronouncedly foreign flavour	Slightly unacceptable
5	Slightly tender	Slightly strong	Slightly desirable	Extremely Juicy	--------	Slightly acceptable
6	Moderately tender	Moderately strong	Moderately desirable	--------	--------	Moderately acceptable
7	Very tender	Very strong	Very desirable	--------	--------	Very acceptable
8	Extremely tender	Extremely strong	Extremely desirable	--------	--------	Extremely acceptable

The ranking method and critical values were used to find out the best product and testing the significant according to the method of Basker (1988)

RESULTS AND DISCUSSION

1. Proximate composition:

Data of table 2 show the proximate composition of canned crabmeat

Table 2. Proximate composition of zero time canned crabmeat (%).

Components / Samples of Crabmeat	Boiled	Boiled in NaCl solution and soaked in citric acid	Customary smoked	Canned Crabmeat								
				Unsmoked			Customary smoked			Liquid smoked (Aromatized)		
				Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine
Moisture	79.59	76.70	72.43	66.46	66.20	72.18	63.15	63.00	68.74	65.64	65.37	71.80
Protein	16.75	18.64	22.23	20.65	20.16	21.60	23.49	22.12	32.95	21.26	20.56	21.89
Fat	1.42	1.85	2.20	9.17	9.83	2.18	9.52	10.40	2.52	9.29	9.87	2.21
Ash	1.95	2.47	2.84	3.56	3.59	3.84	3.60	4.20	4.50	3.57	3.95	3.99
NaCl	0.17	1.40	1.55	2.00	2.02	2.18	2.07	2.09	2.20	2.05	2.08	2.20

It could be observed that raw crabmeat had 79.59% moisture, 16.75% protein, 1.42% fat and 1.95% ash. These values were in the range reported by Zaitsev *et al.*, (1969) for crabmeat i.e. 77-79%, 17-20% and 1.3-1.9% for moisture, protein and ash respectively. Boiling of whole crabs decreased the moisture content, while raised the other components including salt. After reboiling the separated crabmeat (from boiled whole crabs) in salt solution, soaking in citric acid solution and drainage of excess solution, more loss of water occurred is possibly due to more protein denaturation (and loss of water binding ability) with more increase of fat, ash and salt. This is simply due to more increase of dry matter on account of more loss of water during reheating. Melnikova and Piotrov (1976), however found that the total lipids of crabmeat were decreased from 2.60 to 2.23% due to boiling. Other changes took place in present work; which means that the moisture decreased, with parallel increase of dry matter, protein and ash. Also, from the results presented in table 2, it can be seen that protein, fat and minerals were increased.

Customary smoking of crabmeat was associated by more decrease of moisture content; accordingly protein, fat and ash increased indicating more increase of nutritive value, when 100g of unsmoked and smoked crabmeat were considered. This was also found by El-Hidik and Yousef, (1970) working on smoking of horse mackerel. It is worth mentioning that crabmeat boiled in Na Cl solution (followed by citric acid dip) was used for processing unsmoked and liquid smoked canned crabmeat, while the customary smoked meat, was used for customary smoked canned crabmeat.

It is evident that for both treatments, boiled in canning, decreased the moisture content, while protein, fat and ash accordingly increased (Table 1). These changes were ascribed to the more loss of water binding ability by protein denaturation during the thermal treatment (sterilization). Nevertheless, the absorption of oil filling media may also contribute to the water loss during canning. This may be confirmed by the less water and higher fat contents of canned crabmeat in oil compared to that canned in brine. The high absorption of oil (and accordingly greater loss in moisture) for customary smoked crabmeat canned in olive oil resulted in a slight decrease of protein from 22.23 to 22.12%, while in all other cases the protein increased due to canning.

Unsmoked and liquid smoked canned crabmeat samples showed approximately similar composition (the raw material for canning was the same, which is the brine boiled followed by dipping in citric acid solution) provided that the moisture content tended to be slightly lower and other constituents slightly higher in the latter case than the former one. This may indicate that the nutritional value was very slightly higher for

liquid smoked than the unsmoked canned crabmeat as shown in table (3).

Table 3. Percent satisfaction of the daily requirements of adult man 25-50 years old (% of RDA)[1] in protein (63g daily) and energy (2900k cal. Daily) when consuming 100g of crabmeat[2].

Indices \ Samples of Crabmeat	Boiled	Boiled in NaCl solution and soaked in citric acid	Customary smoked	Canned Crabmeat								
				Unsmoked			Customary smoked			Liquid smoked (Aromatized)		
				Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine
Carbohydrates %	0.29	0.34	0.30	0.16	0.25	0.20	0.24	0.28	0.29	0.24	0.25	0.11
Kcalories/100g	80.94	92.57	109.92	165.77	170.11	0.20	106.82	183.20	119.62	169.61	172.07	107.89
% of RDA 100 g crabmeat protein	26.59	29.59	35.29	32.78	32.00	34.29	37.29	35.11	38.02	33.75	32.64	34.75
% of RDA 100 g crabmeat Energy	2.79	3.19	3.79	5.72	5.87	3.68	6.23	6.32	4.13	5.85	5.93	3.72

1. RDA (1989).
2. 100 g of canned crabmeat means the whole in each can, since the glass jar capacity 130g and crabmeat represented about 75% (100g) of this capacity. It is worth mentioning that analysis was carried out for crabmeat, not for meat/filling media mixture.

From the results of table 3, it could be also noticed that highest nutritive value may be found for customary smoked canned crabmeat because of more pronounced loss of moisture (table 2) and accordingly increase of dry matter and nutrients compared to other samples. This is obvious,when % of RDA values for protein were considered. Nevertheless liquid smoked canned crabmeat fulfills 33-35% of RDA values, which is quite enough (in one meal) nutritionally because only one third (33 %) of the RDA has to be covered in one of the three daily meals. Moreover, the consumption of 100g crabmeat, actually is not the only food eaten in the meal.

All canned crabmeat samples were not good source for energy (100g of canned crabmeat covered only about 4% of RDA for calories). Nevertheless many people like

to eat the filling media with the canned fish product. In this concern the consumption of filling vegetable oil may add 270 k calories when consuming a can contents. In this concern, the canned crabmeat product in aromatized brine remains a relatively low calorie food because no oil was added during processing.

The effect of the vegetable oil kind (tables 2 and 3), on the nutritive value of canned crabmeat was negligible. As compared with canned crabmeat in oil, samples processed with brine had pronouncedly less fat and some what, higher moisture and possibly protein and ash contents.

According to Indian standard - 1973 (Price, 1974) canned crabmeat should contain no more than 2% of Na Cl in brine. Unfortunately determination of salt in brine was not carried out in present study, nevertheless the canned crabmeat showed about 2% salt, and this was found in all samples (2.0 - 2.2%), revealing negligible differences which might fell in the range of experimental error.

2. Some quality attributes of canned crabmeat products after zero time storage:

The Total volatile nitrogen (T.V.N.), thiobarbituric acid value(T.B.A.),acid value (A.V.) and phenols content results are shown in table 4.

Table 4. Some quality attributes of canned crabmeat at zero time storage

Samples of Crabmeat / Indices		Boiled	Boiled in NaCl solution and soaked in citric acid	Customary smoked	Canned Crabmeat								
					Unsmoked			Customary smoked			Liquid smoked (Aromatized)		
					Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine
T.V.N	mg/100g	31.50	29.75	37.10	45.84	42.16	34.35	58.16	49.84	44.13	42.25	39.56	32.99
	% of T.N	1.18	1.00	1.04	1.39	1.31	0.99	1.55	1.41	1.15	1.24	1.20	0.94
T.B.A mg/kg malonaldehyde		0.1	0.2	0.5	0.6	0.4	0.8	0.8	0.6	1.0	0.4	0.3	0.6
A.V. mg Koll 1 g fat		0.04	0.05	0.08	0.18	0.16	0.20	0.35	0.28	0.44	0.15	0.12	0.18
Penols mg/100g		-	-	1.90	-	-	-	0.58	0.60	0.45	0.35	0.36	0.28

The results of table 4, revealed that with smoking the T.V.N. of crabmeat showed a small increase which may be due to slight nitrogen compounds changes during the smoking process. Canning was associated with some breakdown of nitrogen compounds with increase of T.V.N. It is known that due to meat and fish canning, ammonia (which is apart of T.V.N) may increase, possibly due to some deamination of certain amino acids; in this connection H_2S may increase (Zaitsev *et al.* 1969 and El-Dashlouty, Amani 1978), unsmoked and liquid smoked canned crabmeat had less T.V.N. than the customary smoked then canned meat probably because the raw material used had initially lower T.V.N. in the first case (29.75 mg/100g) compared to (37.1 mg/100g) in the later. Moreover, the lowest T.V.N. was recorded for the crabmeat canned in aromatized oil or aromatized brine. Also, the canned crabmeat in brine showed lower T.V.N. than in case of using vegetable oil as a filling media, this is possibly due to escape of more T.V.N. from meat to brine than to oil. This lowest T.V.N. was found in crabmeat canned in aromatized brine. Differences in the T.V.N. due to kind of vegetable oil were negligible.

T.B.A. and A.V. increased due to boiling in salt solution, then increased more during smoking indicating small rate of lipids oxidation and hydrolysis.

Canning increased both T.B.A. and A.V. of canned crabmeat. Being less when using unsmoked raw material compared to customary smoked raw crabmeat, because of initial higher T.B.A. and A.V. in the former cases. Differences due to filling media or kind of vegetable oil were actually slight. Although T.B.A. and A.V. of canned crabmeat showed proximate values, samples canned in aromatized oil or aromatized brine had lowest T.B.A. and A.V., possibly due to antioxidant effect of smoke concentrate (Shehata, 1980). however all, T.B.A and A.V. were very low for all samples, indicating good quality canned products.

The phenols contents decreased by canning (from 1.90 to 0.45-0.60mg/100g) possibly because of escape in filling media from the customary smoked crabmeat. Canned crabmeat in aromatized oil or aromatized brine had less phenols contents (0.28-0.36 mg/100g) compared to customary smoked canned samples (0.45-0.60). Lowest phenols levels, were in the canned crabmeat in brine, compared to vegetable oil. As the phenols contributes to the flavour of smoked fish, it is expected that the customary smoked canned crabmeat may have a stronger flavour than that of canned crabmeat in aromatized filling media; being lowest for canning in brine. In this concern the influence of vegetable oil kind may be negligible (table 4).

3. Organoleptic evaluation:

Data of table 5 show the average organoleptic scores for tenderness, flavour, colour, juiciness, foreign flavour and overall acceptability of unstored canned crabmeat samples.

Table 5. Average organoleptic scores of canned crabmeat at zero time storage.

Samples of Crabmeat / Organoleptic Properties	Canned Crabmeat								
	Unsmoked			Customary smoked			Liquid smoked (Aromatized)		
	Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine
Tenderness	6.25	5.75	6.50	6.00	5.75	6.75	6.75	6.25	7.00
Flavour	6.25	6.00	6.25	6.50	6.25	7.00	6.75	6.50	7.50
Colour	6.50	6.25	6.50	6.50	6.50	7.00	7.00	6.50	7.00
Juiciness	4.50	3.50	4.75	4.50	4.50	5.00	4.75	4.50	5.00
Foreign flavour	1.33	2.50	1.00	1.00	1.33	1.00	1.00	1.00	1.00
Overall acceptability	6.50	5.50	6.50	7.00	6.75	7.25	7.00	7.00	7.25

It is evident (table 5) that smoked canned crabmeat ranked better than the unsmoked canned product. Liquid smoked samples were better than the customary smoked ones and canned products in brine rated best, followed by sunflower samples then the crabmeat canned in olive oil. The advantage of smoked than unsmoked canned crabmeat is actually due to the presence of phenol (besides some other smoke components) in the product. Nevertheless, the lower phenols content the higher preference of sample. From tables (4 and 5) it is clear that overall acceptability and flavour scores were higher and phenol contents less for liquid smoked, than for customary smoked products, for canned crabmeat in brine than in oil and for samples canned in sunflower oil than in olive oil. Therefore mild smoking is more suitable for crabmeat compared to relatively heavy smoking.

From results of table 5, it may be noticed that differences between samples canned in brine and that canned in sunflower were negligible, while crabmeat canned in

olive oil showed sometimes less average scores. Due to slight differences recorded between treatments of liquid smoked samples, any of the three products i.e. that prepared in aromatized brine, aromatized sunflower oil or in aromatized olive oil may be recommended for commercial production. Preference of liquid smoked samples over customary smoked products was evident, based on organoleptic test (table 5). It is worthy mentioning that liquid smoking is easier to practise than the customary smoking, it requires a lower number of workers, reduces greatly the loss of wood sawdust and minimizes the possible physiological side effects (harm of health) via purifying the smoke concentrate (Shehata, 1980).

Table 6 show the results of ranking method to find out the best sample of canned crabmeat. Also, the critical difference was used for testing the significance among the products. From the results, it could be observed that the smoked canned products ranked better (lower sum of ranks) than the unsmoked products. As well as, liquid smoked samples were preferred than the customary smoked ones. On the other hand, crabmeat products canned in brine recorded the best followed by the products canned in sunflower oil and olive oil respectively.

Moreover, the best product among all was recorded for liquid-smoked crabmeat canned in brine, which had the lowest sum of ranks. These results were confirmed by the finding of table 5. According to the critical differences used, for testing the significance among all products either at level of 0.05 or 0.01, there are mainly significant differences between the liquid smoked and unsmoked product. At level of 0.05, there were significant differences among the smoked products, while there were no significant differences among the smoked products at level of 0.01. Finally, the best product recorded for liquid smoked crabmeat canned in brine followed by customary smoked crabmeat canned in brine, liquid smoked product canned in sunflower oil, liquid smoked product canned in olive oil, customary smoked products canned in sunflower oil and in olive oil then the unsmoked canned products respectively.

4. Some analyses of canned crabmeat after 6 month storage at room temperatures

a. Moisture and protein:

Data presented in table 7 show the moisture and protein contents of canned crabmeat after 6 months storage at room temperature, percent decrease (compared to zero time) was also calculated.

Table 6. Results of ranking method and critical difference of canned crabmeat at zero time storage.

Samples of Crabmeat / Indices		Unsmoked			Customary smoked			Liquid smoked (Aromatized)		
		A	B	C	D	E	F	G	H	I
Sum of ranks		78	90	72	52	55	23	25	43	12
Difference Vs.	A	-	12	6	26	23	55	53	35	66
	B	-	--	18	38	35	67	65	47	78
	C	-	--	--	20	17	49	47	29	60
	D	-	--	--	--	3	29	27	9	40
	E	-	--	--	--	--	32	30	12	43
	F	-	--	--	--	--	--	2	20	11
	G	-	--	--	--	--	--	--	18	13
	H	-	--	--	--	--	--	--	--	31
Significance Level		0.05			0.01					
Critical difference		38			44					
Preferable samples (descendingly)										
	I	a			a					
	F	ac			a					
	G	ac			a					
	H	ab			ab					
	D	bc			abc					
	E	bcd			abc					
	C	bd			bc					
	A	bd			bc					
	B	d			c					

- The lowest sum of ranks means the best product.
- The preferred samples differs singificantly (different letters in the same column) when the ranks sum difference between the products are greater than are equal to the critical difference.
- (A) (D) (G), (B) (E) (H) and (C) (F) (I) are crabmeat canned in sunflower oil, in olive oil and brine respectively.

Table 7. The moisture, protein and fat contents canned crabmeat, stored for 6 months at room temperature.

Samples of Crabmeat / Indices	Canned Crabmeat								
	Unsmoked			Customary smoked			Liquid smoked (Aromatized)		
	Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine
Moisture: g/100g	66.37	66.04	72.14	63.08	62.89	68.71	65.39	65.03	71.59
% decrease 1	0.14	0.24	0.06	0.11	0.18	0.04	0.38	0.52	0.29
Protein; g/100g	20.37	19.90	21.29	32.22	21.89	23.65	20.99	20.33	21.59
% decrease 1	1.36	1.29	1.44	1.15	1.04	1.25	1.27	1.12	1.37
% of RDA 2	32.33	31.59	33.79	36.86	34.75	37.54	33.32	32.27	34.27
% decrease 1	1.37	1.28	1.46	1.15	1.03	1.26	1.27	1.13	1.38
Fat; g/100g	9.06	9.38	2.58	9.48	10.00	3.05	9.26	9.61	2.78
% change*	-1.2	-4.58	+18.35	-0.42	-3.85	+21.03	-0.32	-2.63	+25.79

1 = Relative to values at zero time storage.

2 = Percent satisfaction of the daily requirements of adult man (25-50 years old) in protein (63.g) when consuming 100g of crabmeat, equivalent to the whole meat in each can.

* - % decrease : + % increase.

It could be observed that after 6 months of processing and storage at room temperature, the crabmeat of the canned products showed slight decrease of moisture and small decrease of protein (table 2 and 7). This may be related to the maturation or ripening of the canned tissues. According to Dominova and Pronishkina (1977), Hussein *et al.*, (1980) and Kolomeiko *et al.*, (1989) during storage of liquid smoked fish; maturation occurred which was associated with some migration of total nitrogen (T.N.) from meat to filling medium and some lipid hydrolysis. Maturation was performed or completed at different periods of storage according to the canned fish species, being 3 months for sardines. For shark meat canned in oil or in tomato sauce, however, no chemical or organoleptic changes took place in tissues during 6 months storage at room temperature (El-Tanahy, 1990). As shown in tables (2and 7) the higher the moisture and protein contents before storage, the higher the values after 6 months storage were found. Percent loss of moisture was higher during storage of canned crabmeat in oil compared

to that canned in brine, while the reverse was found considering the percent decrease of protein, where migration of protein showed relatively higher percentage in brine than in oil. Also percent decrease of protein for canned crabmeat in sunflower oil was more pronounced than in olive oil . Nutritional evaluation of protein content by calculation revealed a very small reduction in %RDA values (percent decrease was 1.03-1.46) from 32.00-38.02 to 31.59-37.54% because rounded figures (approximation of figures) showed the same range, being 32-38% of RDA for both zero time and 6 months storage of canned crabmeat products at room temperature. This indicated the negligible changes in the nutritional value of crabmeat during 6 months maturation of the canned product. Because, most people 1ike to eat the filling media with canned meat, no loss in the nutritional value should be encountered when consuming the whole can contents.

As for the fat (tables 2 and 7) h showed very small changes. Nevertheless, due to more loss of protein (table 7) and possible more loss of ash (not determined for stored samples) in surrounding filling media, the fat showed some increase, while losses of oil in filling media may be higher, hence a slight loss of fat was recorded in the canned crabmeat tissues. However, percent increase of fat (in canned crabmeat of brine filling media) was relatively more pronounced for liquid smoked, followed by the customary smoked, being lower in the unsmoked canned samples. On the contrary, the percent decrease of fat was relatively more for canned crabmeat in olive oil than in sunflower oil, being more pronounced for the unsmoked, followed by customary smoked, while it was lower in the aromatized oil samples.

Considering the energy value, carbohydrates were not calculated by difference, because the ash was not determined . Nevertheless, due to extremely low carbohydrate in the canned crabmeat (table3, 0.11-0.29% only) its contribution of carbohydrates in this food of animal source should be very slight (0.44-1.16 kcal/100g), and this amount may be neglected. Energy value, calculated for protein plus fat only and k calories content as % of RDA (percent satisfaction of the daily requirements of adult man when consuming 100g of canned crabmeat, whole can content) are shown in table 8 for canned crabmeat stored for 0 and 6 months at room temperature.

Data of table 8 indicate that the energy value was not affected by storage. Before and after 6 months storage, % of RDA value was 4% for canned crabmeat in brine, being 6% for samples canned in oil, the same figures were recorded in table 3, indicating again that carbohydrates contribution in energy value was negligible, meanwhile a very slight decrease in energy value occurred upon storage.

b. some other quality attributes:

Data presented in table 9 show the T.V.N., T.B.A value and phenol content, as well as the organoleptic evaluation of overall acceptability of canned crabmeat after 6 months storage at room temperature.

T.V.N. decreased during storage possibly due to escape from tissue in to surrounding filling media, provided that the loss was less pronounced for customary smoked canned product, (probably because of relatively more firm outer layer), followed by liquid smoked samples and the unsmoked canned product. Maximum loss was recorded for crabmeat in brine, followed by that canned in sunflower and olive oils, the same order was found for protein losses (tables 7 and 8).

Acid value increased after 6 months of storage at room temperature, percent increase was more evident for liquid smoked (22.50 - 25.56%), followed by the customary smoked (18.13-23%) and lower for unsmoked samples (16.00-18.75%). The possible presence of more organic acids may be the reason for higher lipids hydrolysis in case of smoked compared to the unsmoked samples. Organic acids may be lower in the customary smoked canned crabmeat probably because of the reaction with the phenols, to form resins (phenols were higher in customary smoked samples) compared to that of liquid smoked samples; thereby lipids hydrolysis was more pronounced in the later.

Phenols content decreased in customary canned crabmeat, probably due to some escape into the filling media from tissues or other possible changes as reactions between phenols and aldehydes (Bykov, 1971). On the other side, phenols increased in canned liquid smoked crabmeat. Most probably, this was due to absorption from the surrounding filling media. Both loss and increase (percent change) of phenols was more pronounced in brine than in oil. before and after storage (tables 7 and 9) higher phenols were found in customary than liquid smoked samples; being highest in olive oil, followed by sunflower oil, and then the brine samples. The results indicated also that smoking, specially the mild smoking is more suitable for canned crabmeat.

c. Organoleptic evaluation of canned crabmeat after 6 months storage at room temperature:

Data of table 10 show the organoleptic evaluation of canned crabmeat as influenced by the smoking procedure after 6 months storage.

Table 8. Energy value of canned crabmeat after 0 and 6 months storage at room temperature as derived from protein and fat only (excluding the carbohydrates construction).

Samples of Crabmeat / Storage (months)	Canned Crabmeat								
	Unsmoked			Customary smoked			Liquid smoked (Aromatized)		
	Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine
Zero time									
Kcal/100g	165.13	169.11	106.02	179.64	182.08	118.48	168.65	171.07	107.45
% of RDA	5.69	5.83	3.66	6.20	6.28	4.09	5.82	5.90	3.71
6 months									
Kcal/100g	164.01	168.07	104.78	178.56	181.16	117.28	167.57	170.15	106.25
% of RDA	5.66	5.80	3.61	6.16	6.25	4.04	5.78	5.87	3.66

Table 9. Some quality attributes of canned crabmeat after 6 months storage at room temperature.

Samples of Crabmeat / Indices	Canned Crabmeat								
	Unsmoked			Customary smoked			Liquid smoked (Aromatized)		
	Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine
T.V.N mg/100g	38.53	36.34	28.22	50.75	44.60	37.80	36.34	34.89	27.40
% decrease	15.95	13.81	17.85	12.74	10.51	14.34	13.99	11.81	16.95
% of T.N.	1.18	1.14	0.83	1.37	1.27	1.00	1.08	1.07	0.79
% decrease 1	15.11	12.98	16.16	11.61	9.93	13.04	12.90	10.83	15.96
T.B.A value mg Malondaldehyde/kg	0.6	0.3	0.8	0.7	0.6	1.0	0.4	0.2	0.6
% decrease 1	0	25.0	0	12.5	0	0	0	33.3	0
A.V mg koH/1g fat	0.047	0.58	0.95	0.0220	0.189	0.246	0.185	0.147	0.226
% increase	17.50	16.00	18.75	22.22	18.13	23.00	23.33	22.50	25.56
Phenoles mg/100g	-	-	-	0.56	0.58	0.43	0.40	0.42	0.31
% change 2	-	-	-	-3.45	-3.33	-4.41	+14.29	+16.67	+10.71

1. Relative to values at zero time storage.
2. (+) increase, (-) % decrease, relative to values at zero time storage.

Table 10. Organoleptic evaluation of canned crabmeat products (average score) after 6 months storage at room temperature.

Samples of Crabmeat / Indices	Canned Crabmeat								
	Unsmoked			Customary smoked			Liquid smoked (Aromatized)		
	Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine	Sunflower oil	Olive oil	Brine
Tenderness score	6.50	5.90	6.90	6.40	6.00	7.50	7.25	6.62	8.00
% increase	4.00	2.61	6.15	6.67	4.35	11.11	7.41	5.92	14.29
Flavour score	6.25	6.00	6.25	6.75	6.25	7.25	7.10	6.75	8.00
% increase	0	0	0	3.85	0	3.57	5.19	3.85	6.67
Colour score	6.50	6.25	6.50	6.50	6.25	7.75	7.50	6.25	8.00
% increase	0	0	0	0	3.85	10.71	7.14	3.85	14.29
Juiciness score	4.50	3.50	4.75	4.70	4.60	5.00	5.00	4.65	5.00
% increase	0	0	0	4.44	2.22	0	5.26	3.33	0
Foreign flavour score	1.00	2.00	0	0	0	0	0	0	0
% decrease	24.81	25.00	100	100	100	100	100	100	100
Overall acceptability	6.50	5.50	6.75	7.25	6.75	7.75	7.75	7.25	8.00
% increase	0	0	4.00	3.57	0	6.90	7.14	3.57	10.35

After storage for 6 months, organoleptic properties of liquid smoked canned crabmeat reated best, followed by the customary smoked samples, while unsmoked canned products ranked lower (table 10) provided that Brine samples were the best followed by sunflower and olive oil this order of arrangement was also recorded before storage (table 5). Therefor, the results of panel test stand by the smoking prior to canning, specially when taking into consideration that the improvement rates in eating qualities during 6 months storage were much greater for the smoked canned products. This indicated that maturation was much better for the smoked crabmeat, while unsmoked products canned crabmeat in olive oil still had signs of foreign flavour. According to Dominova and Pronishkina (1977), Hussein *et al.*, (1980) and Kolomeiko *et al.*, (1989) maturation causing the improvement of eating qualities of canned fish during storage was related to changes and migration of protein from tissues, besides the increase of free fatty acids as result of lipids hydrolysis. The rates of protein decrease (table 7), A.V. (free fatty acids indication) increase and overall acceptability improvement (table 9) were in line with previous findings. Higher rates of protein decrease,

A.V. development and overall acceptability increase were found for liquid smoked, followed by customary smoked, being lower for unsmoked samples, these rates were higher for brine samples than crabmeat canned in sunflower oil, being lower in olive oil.

After maturation (storage for 6 month at room temperature), results of organoleptic properties (table 10) and phenols content (table 9) stand for the mild rather than the heavy smoking.

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تصنيع لحم الكابوريا المعلب المدخن بالطريقة العادية وسوائل التدخين

أمانى عبد الله الدشلوطى ، محمد عبد الحفيظ عبد السلام ، ثناء مصطفى حسانين ، وفاء ذكى محمد ، محمد حسن غالى

معهد بحوث تكنولوجيا الأغذية، مركز البحوث الزراعية، الجيزة

لأسباب كثيرة مثل الحاجة إلى منتجات أغذية مخصصة للتصدير لدعم الاقتصاد القومى، وللاستفادة من انخفاض أجور العمال الذين يمارسون العملية الشاقة المرتبطة باستخلاص اللحم من القشور وكذلك لوجود أسواق فى الدول الغنية لمنتجات الكابوريا الأرخص المصنعة فى الدول النامية أجريت هذه الدراسة لتجهيز لحم الكابوريا المعلب المدخن ذو الجودة العالية وبذلك فقد تم تدخين لحم الكابوريا مسبقاً بالطريقة التقليدية أو باستخدام الزيت المعطر (باستخدام مركز دخان مخفف أضيف على الزيت فى العلبة) أو المحلول الملحى المعطر (محلول كلوريد صوديوم مضاف إليه مركز دخان مخفف فى العلبة). كما جهزت أيضاً الكابوريا المعلبة غير المدخنة للمقارنة. وكان وسط التعبئة عند التعليب زيت عباد الشمس أو زيت الزيتون أو المحلول الملحى. كما تم التعليب باستخدام البرطمانات الزجاجية من الصناعة المحلية.

ولقد لوحظ أن غلى الكابوريا الكاملة في الماء وطبخ اللحم المفصول فى المحلول الملحى وكذلك التدخين العادى يؤدى إلى فقد الرطوبة وبالتالى تزداد المكونات الأخرى فى اللحم، ولقد دلت نتائج الاختبارات الحسية لتسعة من منتجات الكابوريا المعلبة على أن الأفضلية كانت فى حالة المنتجات المعاملة بطريقة التدخين السائل يليها فى ذلك المعاملة بالتدخين العادى وفى النهاية تأتى المنتجات الأقل فى الجودة المجهزة بدون تدخين قبل التعليب كما لوحظ أن الفرق والاختلافات فى خواص التذوق بين الكابوريا المعلبة فى المحلول الملحى المعطر والمعلبة فى زيت عباد الشمس المعطر كانت طفيفة بالمقارنة بالمعلبة فى زيت الزيتون المعطر التى كانت خواصها الحسية أقل. ولقد كان هذا مرتبطاً بتركيز الفينولات – فالتدخين الثقيل نسبياً يبدو أنه لا يناسب منتجات الكابوريا المعلبة بينما عدم التدخين على الإطلاق يؤثر تأثيراً سلبياً على الجودة – غير أنه قد أتضح عند إجراء بعض التحاليل مثل النيتروجين الكلى المتطاير (T.V.N) ورقم الحموضة (A.V) وقيمة حامض ثيوباربتيوريك (T.B.A) الجودة العالية لجميع عينات الدراسة كلها. كما إتضح أن الكابوريا المعلبة فى المحلول الملحى المعطر وفى زيت عباد الشمس المعطر وفى زيت الزيتون المعطر والتى ينصح بانتاجها تجارياً لأفضلية خواص التذوق تحتوى على: ٢١-٢٢٪بروتين، ٢-١٠٪ دهن، ٣,٦-٤,٠٪ رماد، ٠,١-٠,٢٪ كربوهيدرات، ٢,١-٢,٢٪ ملح، وكان محتوى الطاقة ١٠٨-١٧٢ كيلو كلورى/١٠٠جم، هذا وإن تناول ١٠٠ جم من هذه المنتجات (لحم الكابوريا الموجود فى عبوة أى برطمان زجاجى سعة ١٣٠ جم) يغطى ٣٣-٣٥٪ من التوصيات الخاصة بالبروتين (RDA) للرجل بعمر ٢٥-٥٠ سنة مما يدل على القيمة الغذائية المرتفعة لهذه المنتجات.

وفى خلال التخزين لمدة ٦ شهور يحدث إنضاج لحم الكابوريا المعلبة وخاصة التى استخدم التدخين لها وقد استدل على ذلك بتحسن التقبل العام للعينات والذى قدر بالإختبارات الحسية،

ونتائج الدراسة الحالية تؤيد ما ذكر فى الدراسات السابقة عن وجود علاقة بين نضج لحم السمك المعلب وهجرة بعض النيتروجين من الأنسجة للمحلول أثناء تخزين المعلبات. ويبدو أيضاً أن التحلل المائى للبيدات مع زيادة الأحماض الدهنية الحرة يشترك أيضاً فى إنضاج لحم الكابوريا المعلبة بناء على تقدير رقم حموضة الدهن.