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CHEMICAL AND SENSORY EVALUATION OF SOME PRODUCTS PROCESSED FROM SEA CUCUMBER (*HOLOTHURIA ATRA*)

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Abstract

Sea cucumbers are considered under-utilized natural fishing resources along the Egyptian red sea coast. Sea cucumber (*Holothuria atra*) is the predominant species in large amounts in the red sea coast.

Therefore this work was carried out to utilize the sea cucumber throught its processing as new products such as dried sea cucumber (DSC), canned in 3% brine (A), canned in vegetable oil (B), canned in citric acid/sodium citrate buffer (C) at pH 3.5, canned in tomato sauce (D) and sea cucumber fingers (SCF).

Weight composition was calculated for whole fresh animal. The chemical composition and mineral content of fresh and processed sea cucumber were determined. Absorption % rehydration % and sensory evaluation of dried product were compared to the locally dried sample. Also, sensory evaluation of other products was conducted. Moreover, ranking method and critical differences were used to the preferable products to find out the best product and testing the significance between them.

In general, the results indicated that the best product was D followed by S.C.F. and D.S.C. respectively which may be recommended for the production on commercial scale to benifet from our natural fishing resources.

INTRODUCTION

Sea cucumbers are an important food in the Indo-pacific region, where they are marketed fresh and processed (Halstead, 1965 and Tanikawa, 1985). The sea cucumber (*Stichopas Japonicus*) is commonly consumed in Japan (Borgstrom, 1962). Zaitsev *et al.*, 1969 reported that sea cucumbers are usually marketed as frozen, cooked dried, cooked-salted and cooked-salted-dried products. In South East Asia, the animal is in big demand among the Chinese population where it is purchased in dry form, then it is cleaned after soaking in water and cooked in many delicious ways, the dried product contained 43% protein, 2% fat, 27% moisture, 21% mineral and 7% insoluble ash (EZ EL-DIN, 1986). Moreover, sea cucumbers contains vit. B12, thiamine, riboflavin, vit. C, phosphorus and calcium in large quantities in addition to hight quality glycoprotein

(Zaitsev *et al.*, 1969 and Moon e*t al.*, 1996). Nevertless, sea cucumbers are not marketed widely and considered an under-utilized fishery resources (Maria *et al.*, 1989).

In Egypt, the most common type of sea cucumbers in the red sea is a black one *(Holotharia atra)* which is found often in large numbers laying on the sand in shallow water, it has no commercial value. Harvesting of sea cucumber in the Egyptian red sea area has never been carried out up to now. The fishermen have observed it on the sand and reefs but, they have no interest in collecting it as it is economically, unattractive since there is no local demand.

The objective of this work was to manufacture new products from the under-utilized sea cucumber of the Egyptian red sea coast. The chemical and sensory properties of these products were also evaluated.

MATERIALS AND METHODS

1- Materials:

sea cucumber (*Holotharia atra*) samples were obtained from the red sea coast at El-Dahhar region in Hourgada, Egypt. Harvesting of sea cucumbers was carried out by our selves because the animals are easy to be cuptured as they offer no resistance. Sea cucumbers was 15-25 cm long, 0.5-0.75 kg, free moving, soft and cylindrical body with dark black color for the outer skin layer. A small opening was made near the mouth to help evisceration and expel the in~erior liquid. After eviscerating, samples were washed in clean sea water and boiled for 45min in brine (4% salt),the cooked animals were buried overnight in clean and moist sand to soften the outer skin layer which is removed by using stiff brush. The dressed animals were preserved in ice box and immediately transferred to the laboratory for proximate chemical composition and mineral analysis within 24 hr.after being harvested. The remaining animals were frozen at -20°C for later processing. The weight composition of sea cucumber was calculated.

2- Technological Methods:

2-1 Dried sea cucumbers:(D.S.C.)

The frozen sea cucumbers were thawed, boiled in 3-4% brine for 45-60 min., rinsed with cold water and dried at 35-40°C (sun-drying) for six days.

2-2 Sea cucumber fingers (S.C.F.)

The frozen sea cucumbers were minced three times through 4.5mm plate and mixed with garlic 1%, cumin 1% and black pepper 0.8% then, it was shaped as fingers and frozen. The frozen fingers were immersed in a soft dough. The dough consists of corn flour 94%, egg yolk 2%, skim milk 2% and sodium chloride salt 2% in water with ratio of 2:3 respectively then, The fmgers were immediately coated by powderd rusk and stored at - 20°C. The frozen fingers were fried in cotton seed oil (deep frying) for 3min. and evaluated organolepticaly.

2-3 Canned sea cucumbers:

For canning sea cucumber, the frozen samples were thawed and boiled in 3% citric acid / sodium citrate buffer at pH 3.5 for p lhr. Then, the cooked animals were canned inglassjarsin3% brine (A), in vegetable oil (B), in 3%citric acid/sodium citrate buffer at PH 3.5 (C) and ina special mixture consists of tomato sauce 66%, minced garlic 7%,cuminl %,saltl % and water 25% (D) and there after sterilized at 121°c for 15 min.

3- Analytical methods:

Moisture, protein, fat and ash contents were determined according to the methods described in the A.O.A.C.(1990). Minerals were determined according to the method of Anon (1982) using Atomic absorption Spectrophotometer, Perkin Elmer, Model 2380. The absorption % (related to the dried product) and the rehydration % (related to the total water) were calculated as the percentage of weight change from the raw to dried to rehydrated state respectively.

4- Sensory evaluation:

Sensory evaluation was carried out on all the products, canned sea cucumbers products, sea cucumber fingers fried in vegetable oil and dried sea cucumber which was rehydrated and cooked then, organolepticaly evaluated and compared to the locally dried sample (L.D.S.C.) obtained from a fisherman at Hourgada. A 20 member panelists wer asked to evaluate the products for color, texture, taste, odor and overall acceptability using a 9- point hedonistic scale. Ranking method was used (the same panel) to find out the best product among the products which had the lowest sum of ranks. For testing the signifiance between the prodcucts, the critical values differences between the sum of ranks were used according to Basker (1988).

RESULTS AND DISCUSSION

The studies and investigations concerning the sea cucumber along the Egyptian red sea coast are considered very little.

1- Weight composition:

Weight composition of fresh sea cucumber (*Holothuria atra*) is shown in table 1.

Table 1. Mean of weifht composition of fresh sea cucumber (*Holothuria atra*)

weight	Whole fresh sea cucmber	Parts of sea cucumber			
		Sheath	Viscera	Interior liquid	Tentacles
g	615	261.4	129.2	205.4	19
%	100	42.5	21	33.4	3.1

It could be observed that the weight composition of the sea cucumber was as follows: sheath (a cylindrical body consists of several layers of muscular, connective and covering tissues) 42.5%, viscera 21 %, interior liquid 33.4%, and tentacles 3.1 % in relation to the whole sea cucumber weight. These results are nearly close to that reported by Zaitsev *et al.*, (1969).

2- Chemical composition:

Table 2 show the proximate chemical composition of fresh and processed sea cucumber (*Holothuria atra*). From the results, it could be observed that on wet weight basis, the fresh sea cucumber flesh had moisture 90.12%, protein 6.15%, fat 0.32% and ash 3.21%. This reveal hight high moisture content, moderate protein and ash contents and little fat content of fresh sea cucumber flesh. Of the products manufactured from the sea cucumber which included sea cucumber fingers (S.C.F.), canned in 3% brine (A), canned,ip vegetable oil (B), canned in 3% citric acid/sodium citrate buffer at pH 3.5 (C), canned in tomato sauce (D) and dried sea cucumber (D.S.C.), the moisture content (25.00 - 84.55%) decreased while the protein, fat and ash contents (10.72-52.60,0.9-2.9 and 3.60- 17.33 ,respectively) increased than that of fresh sea cucumber . These results are confirmed by the findings of Maria *et al.* (1989) and Sidwell (1981).

3- Mineral content:

Data presented in table 3 show the mineral content of fresh and processed sea

Table 2. Proximate chemical composition of fresh and processed sea cucumber (*Holothuria atra*).

Fresh and processed sea cucmber	%			
	Moisture	Protein	Fat	Ash
Fresh Flesh	90.12	6.15	0.32	3.21
S.C.F.	65.06	28.08	1.85	4.80
A	84.55	10.72	0.90	3.60
B	83.85	11.05	1.11	3.79
C	83.10	11.40	1.35	4.00
D	83.55	11.23	1.22	3.90
D.S.C	25.00	52.60	2.90	17.33

- SCF= sea cucmber finger.
- A= sea cucumber canned in 3% brine.
- B = sea cucumber canned in vegetable oil.
- C = sea cucumber canned in 3% citric acid/ sodium citrate buffer at pH 3.5
- D = sea cocumber canned in tomato sauce (a special mixture).
- D.S.C. = Dried sea cucumber.

Table 3. Mineral content of fresh and processed sea cucumber (*Holothuria atra*).

Fresh and* processed sea cucmber	Mineral content							
	mg/100 g					ppm		
	Na	K	Ca	P	Mg	Fe	Zn	Cu
Fresh Flesh	13.0	43.0	83.0	11.0	8.0	18.6	1.3	1.0
S.C.F.	24.0	18.0	70.0	38.0	10.0	22.3	1.5	0.8
A	610	8.0	63.0	33.0	15.0	14.6	0.7	0.6
B	14.0	6.0	68.0	34.0	16.0	15.1	0.3	0.7
C	503	7.0	65.0	36.0	21.0	17.7	0.2	0.8
D	95.0	12.0	69.0	35.0	20.0	16.8	0.4	0.7
D.S.C.	280	240	588	97.0	25.0	112.8	22.2	3.8

* For explanation, see table (2).

cucumber (*Holothuria atra*). It could be noticed that fresh sea cucumber had higher content of Ca and K than other mineral (Na, P, Mg, Fe, Zn and Cu). These results agree with the findings of Zaitsev *et al.*, (1969) who reported that Ca and K were present in raw sea cucumber in large quantities.

Previously reported values for other species of sea cucumber Include: Ca. 34-67 mg/100 g; P, 11-14 mg/100 g; Fe, 3-46 ppm; and Cu,9.6-28 ppm (Sidwell, 1981). In our study, the Ca was higher and the Cu was lower than few values preyiously reported.

Drying of sea cucumber led to remarkable increase of mineral content, with the exception of D.S.C., there was a significant loss of K and an increase of Na content during canning of sea cucumber and processing of S.C.F. The increase of Na in canned sea cucumber products may be due to the 3% NaCl or Na citrate buffer used to boil the sea cucumber prior to canning or to Na citrate used in filling the canning jars. Also, with the exception of D.S.C., processing and canning increased P and Mg and decreased Fe, Zn and Cu. The results of the mineral content of fresh and processed sea cucumber (*Holothuria atra*) are in agreement with the finding of Maria *et al.*, (1989).

Finally, it is worth to mention that the studies on the sea cucumber as food are very little and no information is available for Na, K, Mg and Zn in raw sea cucurmber.

4- Dried sea cucumber (D. S. C.):

Absorption and rehydration percent and sensory evalpatio,n of dried sea cucumber (*Holotharia Atra*) are presented in table 4. From the presented data, it could be seen that the yield of D. S. C. was 14.3%in relation to the fresh dressed weight (weight change from the fresh to dried state). Absorption % of D.S.C. (155.6%) was higher than that of locall dried sea cucumber (L. D. S. C.) which recorded 41.59 %, this might be due to the unduly processing steps of L.D.S.C. which leadtoprotein denaturation and decreasing the absorption % . The weight of fresh dressed samples of L.D.S.C. was unavailable, therefore, the total loss of water and rehydration % were not calculated. On the other hand, from the same table, cooked D.S.C. had higher scores of color, flavor, texture and overall acceptability when compared to the locally dried sea cucumber.

5- Sensory evaluation of other products manufactured from sea cucumber:

Organoleptic score values for color, flavor, appearance, texture and overall acceptability of sea cucumber fingers (S.C.F.) and canned sea cucumber in 3%tr~ne (A), in vegetable oil (B), in 3% citric acid /sodium citrate buffer at pH 3.5 (C) and in tomato sauce (D) are given in table 5. It could be observed that the best color (mean score

Table 4. Absorption and rehydration percent and sensory evalation of dried sea cucumber (*Holothuria atra*).

Sample	Weight (g) of sample					Absorption %	Rehydration %	Mean of scores of cooked-dried samples				
	Fresh dressed	After drying	Total loss of water	After rehydreating	Rehydrting water			Color	Flavor	Appearance	Texture	Overall acceptability
D.S.C.	150	21.4	128.6	54.7	33.3	155.6	25.89	6	7	6	7	6.5
L.D.S.C.	-	21.4	-	41.0	19.6	91.59	-	5	6	6	5	5.5

- **D.S.C.**= Dried sea cucumber processed in the Lab
- **L.D.S.C.**= Locally dried sea cucumber.
- **Absorption %** = Attributed to the weight after drying.
- **Rehydration %** = Attributed to the total loss of water.
- Dried sample cooked in water for 1 hr. (after rehydrating in tap water for 5hr), after cooked in tomato sauce for 30 min sensory evaluation was carried out on a 9 point hedonic scale.

Table 5. Sensory evalation of other products manfactured from sea cucumber* ***(Holothuria atra).***

Properties	S.C.F. **	Canned products**			
		A	B	C	D
Color	8.50	5.00	5.75	5.00	8.00
Flavor	7.50	4.00	4.00	4.00	8.00
Appearance	8.00	4.50	4.00	4.00	8.00
Texture	7.50	4.00	4.50	4.00	8.00
Overall acceptability	7.88	4.38	4.50	4.25	8.00

*= values are mean of the scores given by panelists on a 9 point hedonic scale
**= For explanation the products, see table 2.

Table 6. Results of ranking method and critical differences* used for preferable sea cucumber products.

Product*	S.C.F	D	D.S.C.	L.D.S.C.
Sum of ranks	32	29	64	75
Diference Vs:				
S.C.F.		3	32	43
D			35	46
D.S.C.				11
Significance level	P=0.05		P=0.01	
Critical difference	21.00		25.40	
Product: D	a		a	
S.C.F.	a		a	
D.S.C.	b		b	
L.D.S.C.	b		b	

* = For explanation, see tables (2) and (4)
** =The lowest sum of ranks means the best product.
* = The preferable products differs significantly (different letters) when the rank sum differences are grater than or equal to the critical difference

8.5) was recorded for S.C.F. followed by D (8.0). Concerning the appearance, each S.C.F. and D had the same score value (8.0). In respect to flavor, texture and overall acceptability, the D product had higher mean scores than S.C.F.. In general, according to the sensory evaluation given in tables (4 and 5), The best product was D followed by S.C.F. and D.S.C. respectively. The products A, B and C were nearly unacceptable. Therefore, the ranking method and critical differences were used only for the preferable products (D,S.C.F. and D.S.C.) to f~nd out the best product and testings the signif~cance between these products. From the results found in table 6, it could be reported that the lowest sum of ranks (recorded, 29) which means the best product was recorded for D followed by S.C.F. (recorded, 32), D.S.C. (recorded, 64) and L.D.S.C. (recorded, 75) respectively. 0n the other hand, the preferable products differs signif~cantly whenthe differences of sum ranks between these products are greater than or equal o the critical difference. Therefore, from the results (table 6) it could be noticed that there is no significant difference between D and S.C.F.,as well as between D.S.C. and L.D.S.C., while the significant difference was obtained between the front two products (D and S.C.F.) and the latter two products (D.S.C. and L.D.S.C.) either at significance level of 0.05 0r 0.01.

Finally, D, S.C.F. and D.S.C. are the new products processed from the under utilized sea cucumber along the Egyptian red sea coast and may be recommended to production on commercial scale. Nevertheless, future studies will be taken into consideration for this field to utilize our natural fishing resources.

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التقييم الكيماوى والحسي لبعض المنتجات المصنعة من خيار البحر

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يعتبر خيار البحر من المصادر السمكية الطبيعية الغير مستفاد منها عبر ساحل البحر الأحمر بجمهورية مصر العربية، ويعتبر النوع السائد هو *Holothuria atra* وبكميات كبيرة جداً.

لذلك أجرى البحث بغرض الاستفادة من خيار البحر الموجود عبر ساحل البحر الأحمر، وذلك بتصنيعه إلى منتجات جديدة شملت خيار البحر المجفف، المعلب في محلول ملحى ٣٪ (أ) ، المعلب في زيت نباتي (ب)، المعلب في Buffer من حمض الستريك وسترات الصوديوم (ج) المعلب في صلصة طماطم (د) وأصابع خيار البحر.

تم حساب النسبة المئوية لأجزاء خيار البحر منسوبة للوزن الكامل (التركيب الوزني) كما تم تقدير التركيب الكيماوي ومحتوى المعادن لخيار البحر الطازج والمنتجات المصنعة منه، كما تم حساب النسبة المئوية للتشرب والنسبة المئوية للاسترجاع وتقييم حسي لمنتجات خيار البحر المجففة ومقارنة ذلك بعينة مجففة محلياً، اجرى أيضاً التقييم الحسي لمنتجات خيار البحر الأخرى، علاوة على ذلك استخدمت طريقة الـ Ranking والفروق الحرجة لتحديد أحسن المنتجات المفضلة حسياً واختبار المعنوية بين المنتجات المفضلة.

وقد أوضحت النتائج بصورة عامة أن أفضل المنتجات هو خيار البحر المعلب في صلصة الطماطم يليه أصابع خيار البحر ثم خيار البحر المجفف (على الترتيب). وتقترح هذه المنتجات للإنتاج على نطاق تجارى للاستفادة من مصادرنا السمكية الطبيعية.