Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 24(6): 153 – 165 (2020)
www.ejabf.journals.ekb.eg

Chemical Composition, Nutritional Value, Safety, and Acceptability of Egyptian Red Sea Coast Fresh and Dried Spider Conch (*Lambis Lambis*) Meats

Hesham F. Amin*[1], Nesma E. Hamza[1], Moharram, Y.G.[2]

1; Department of Fish Processing and Technology, Faculty of Fish Resources, Suez University, Suez, Egypt.
2; Department of Food Science Technology, Faculty of Agriculture, Alexandria University, Alexandria, Egypt.
***Corresponding Author: hesham.ameen@suezuniv.edu.eg**

ARTICLE INFO
Article History:
Received: June 26, 2020
Accepted: Aug. 29, 2020
Online: Sept. 6, 2020

Keywords:
Spider conch,
chemical composition,
nutritional value,
safety,
acceptability.

ABSTRACT
The present study investigated the chemical composition, nutritional value, safety, and acceptability of fresh and dried spider conch (*L. lambis*) meats collected from the Red Sea Coast, Egypt. The results indicated that both fresh and dried conch samples are considered good protein sources with up to 55% on dry wt. basis. The protein contained both essential and non-essential amino acids especially glutamic acid, aspartic acid, arginine, leucine, and lysine and had an acceptable calculated protein efficiency ratio (C-PER) (1.7 – 2.05) and computed biological value (C-BV) (77.24 – 77.42). The concentrations of Na (20898.33 and 14234 mg/kg), K (10098.33 and 6530.67 mg/kg), Ca (6000 and 6200 mg/kg) and P (4005 and 3600 mg/kg), in both types of fresh and dry conch meat, covered their daily level intakes of man. In contrast, both types of meat are considered free from Co (<0.001mg /kg) and the dry samples had Pb (0.94 mg /kg) which is less than its maximum permissible limits (2 mg /kg; FAO/ WHO, 1989). Oil of fresh and dried conch meats (3.85% and 3.77% on dry wt. basis, respectively), were rich in unsaturated fatty acids (USFAs) particularly omega-3 ones and with a $\omega^6 : \omega^3$ ratio of 2.08:1 and 1.46:1, respectively. Both types of conch meats were nearly free from *Staphylococcus aureus* and *Vibrio spp*, with a total aerobic bacteria count (APC) less than 10^6 and 10^5, respectively, the ICMSF (2002) upper acceptable limits for fish and dry fish in addition to low molds and yeasts count. The sensory panelists rated the overall acceptability of the dried conch meat to be fair to good.

INTRODUCTION

Interest in marine mollusks consumption has increased in coastal areas as a good source of protein, minerals, and vitamins **(Periyasamy *et al*., 2011)**. Mollusks are an invertebrate with soft bodies. Mollusks meat composition and safety are affected by several factors such as species, sex, maturity, feeding regime, and seasonal conditions **(Periyasamy, *et al*., 2011)**. It includes bivalves, cephalopods, and gastropods group

(Ponder and Lindberg; 2008). Some species of gastropods such as conch, abalone, limpets and whelks are used as food **(Vazhiyil and Kumarapanicker; 2017)**. **Blanco and Montero (1992)** found that moisture; protein and ash contents in *Strombus galeatus* meat collected from the Pacific coast of Costa Rica were 72, 23 and 3%, respectively. Other chemical compounds (fat, crude fiber and carbohydrates) were low. Therefore, the caloric value of this meat was low and ranged from 126.5 and 129 kcal/100g meat. According to **Jiménez-Arce (1993)** the mean values of moisture, protein, fat, carbohydrates, fiber, and ash in the meat of *Strombus gracilior* collected from Playa Panamá, varied from 70.9 to 72.6; 19.09 to 26.89; 0.91 to 0.94; 1.35 to1.85; 0.0 to 0.44; and 2.30 to 3.71%, respectively depending on its size and sex. Meat of the harvested strawberry conch (*Strombus luhuanus*) and spider conch (*Lambis lambis*) from Maluka Province, Indonesia, composed of 72.52 to 73.42 and 77.20 to 77.90% moisture; 17.45 to 17.94 and 15.52 to 16.97% protein; 1.25 to 1.41 and 1.23 to 1.29% fat, 4.57 to 4.65 and 2.84 to 1.68% ash; and 4.21 to 4.58 and 2.16 to 3.21% carbohydrate, respectively. **Leiwakabessy and Lewerissa (2017)** found that fifteen amino acids were identified in the meat protein of both conchs; nine of them were essential amino acids. Glutamic acid was the main amino acid in the meat of spider conch, and histidine was the lowest in strawberry one. Results of **Fenglei *et al*., (2017)** showed that marine snail (*Rapana venosa*) edible meat contained a considerable level of eicosapentaenoic acid (C20:5) and docosahexaenoic acid (C22:6) omega-3- fatty acids. Ash of Costa Rica *Strombus galeatus* meat composed of the following range of phosphorus (P), calcium (Ca), potassium (K), sodium (Na), magnesium (Mg), iron (Fe), zinc (Zn), and copper (Cu) were: 403.0-465; 233.5-315.7; 89.7-315.0; 122.3-145.5; 217.5-266.3; 1.5-5.3; 2.0-8.7; and 0.2-0.5 mg /100g, respectively. Both lead (Pb) and cadmium (Cd) as contaminant heavy metals were also detected in the range of 0.19-0.21 and 0.046-0.062 mg/kg, respectively **(Blanco and Montero; 1992)**. The range of Na and K in *Strombus gracilior* meat from Playa Panamá was 1440.88- 1376.97 and 1898.33- 2393.09 µ/g, respectively while Cu, Mg, and Fe were found in lower values compared with Na and K **(Jiménez-Arce, 1993)**.

Detection of pathogens in the meat of conch is important from the safety viewpoint. **Levine and Griffin (1993)**, and **Lai (2001)** isolated *Vibrio fluvialis*, *Pseudomonas maltophilia*, *Enterobacter sakazakii, and Klebsiella pneumonia* from conch meat as pathogens of public health concern. Steaming was acceptable postharvest handling process for eliminating the microbiological load of mussels to undetected level and reduced *V. alginolyticus* count to less than 1 Log CFU/g estimated **(Ahmed and Amin, 2018)**.

As in many coastal regions around the world, increasing human activities can affect the safety of seafood products. Preservation by proper drying and dry salting as practiced widely through the world improved the microbiological quality of the product, and inhibited the growth of food-borne pathogens beside it decreases some heavy metals due to salting out **(Amin *et al*., 2018)**.

People in the coastal along the red sea in Egypt are largely consumed marine mollusks, particularly spider conch (*Lambis lambis)* meat either in fresh or dried forms **(El-Naggar, 2019)**. The latter form is locally known as Srombaa. Limited knowledge is available about the composition, production, and safety of this product. Therefore, this study was designed to assess chemical composition, nutritional value, safety, and acceptability for both fresh and dried spider conch (*L. lambis)* meat.

MATERIALS AND METHODS

Materials, sample collection and preparation:

Nearly twenty five kilograms of both live mollusks and sun dried meat of spider conch (*L. lambis*) were collected from El-Quseir city; on the Egyptian red sea coast during the summer season of 2019. Fresh mollusks, with total weight range from 600 to 800g, were kept on ice in insulated boxes during transport to the laboratory. After sorting, the internal body was removed from its shell by boiling in hot water at 98°C for 3 to 5 minutes. The claw (both viscera and the operculum) was separated out from their bodies to get the edible meat, foot, and adductor muscle. The obtained fresh edible meat, weight range from 65 to 110g, was cleaned several times with potable water to remove pigments and foreign impurities, then minced, packaged in clean glass jars and stored at -18°C until analysis. The dried spider conch meats, each one with weight range from 20 to 30g, were finely ground then packed and stored as mentioned above for further analysis.

Methods:

Chemical analysis:-

Moisture, crude protein, and ash contents of fresh and dried spider conch (*L. lambis*) meats were determined according to **AOAC (2000)**. Sodium chloride content was determined by silver nitrate method **(AOAC, 2000)**. Fat content was determined according to **Bligh *et al*., (1959)** using chloroform: methanol (2:1 v/v) mixture. Carbohydrate content was calculated by difference. The pH value was measured after mixing 10 g meat sample with 100 ml of distilled water using a calibrated pH meter (HANNA PH211 pH meter, HANNA Instruments, USA).

Method of **Pauwels *et al*., (1992)** was followed to prepare ash samples to determine some minerals and heavy metals using nitric acid, perchloric acid, and deionized water. The Na, Ca, K, Fe, Zn, Cu, Co, As and Pb contents of digested ash samples were quantified by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) **(AOAC, 2012)**. Meanwhile, P content was colorimetrically determined according to **Murphy and Rilley (1962)**.

Amino acids profile was identified as mentioned by **Mohanty, *et al*., (2012)**, after acid hydrolysis of protein with 6N HCl at 110°C for 24 h. The obtained hydrolyzate was neutralized with 6N NaOH, and was derivatized using a kit (AccQ-Fluor Reagent, WAT052880, Waters). Thereafter, the hydrolysates were injected in High-Performance Liquid Chromatography (HPLC, 1525, Water) equipped with a C_{18} RP column and a fluorescence detector (2475, Waters). The identification and quantification of the amino acids were carried out by comparing with the retention times and peak areas of amino acid standards (WAT088122, Waters).

Fatty acids profile was determined after esterifying the extracted fat to methyl esters of fatty acids as described in **AOAC (2000)**, then fatty acids were identified and quantified using Gas Chromatography (Hewlett Packard model 5890) equipped with FID detector according to **AOAC (2000)**. The detector temperature was held at 300°C, and the flame was maintained with 30 mL/min H_2 and 300 mL/min air. Helium was used as the detector auxiliary gas at a flow of 30 mL/min.

Nutritional value:-

The caloric value of meat of both fresh and dried spider conch (*L. lambis*) was calculated from the obtained results of their proximate composition using the following formula as reported by **Falch *et al*., (2010)**.

[Caloric value (kcal/100g) = (lipid×9) + (protein×4) + (carbohydrate×4)]

Both Protein Efficiency Ratio (C-PER) and Biological Value (C-BV) were computed as mentioned in **FAO/WHO (1985)**. The three following equations were used to calculte C-PER;

PER_A= -0.684 + 0.456 Leucine – 0.047 Proline

PER_B= -0.468 + 0.456 Leucine + 0.105 Tyrosine

PER_C= -1.816 + 0.435 Methionine + 0.780 Leucine +0.211 Histidine – 0.944 Tyrosine

C-BV was estimated as the following:

C-BV= 39.55 + (8.89 Lysine as g/100g protein)

Microbiological analysis:-

Fresh and dried spider conch (*L. lambis*) samples for such analysis were directly transferred into sterile pouches, sealed, and stored in an insulated box containing ice made of deionized sterile water. In the lab, the meat of fresh samples was separated from the shells under aseptic conditions and homogenised at 2000 rpm for 2.5 minutes using a sterile homogenizer (MPW 302, Universal Laboratory Aid, made in Poland), while the dried samples were aseptically ground into powder using an electronic mixer. Five grams of each type of representative samples were diluted with 45 ml 0.1% peptone water (DM185D, MAST, UK) to prepare 10^{-1} dilution. Other serial dilutions were prepared from 10^{-1} one.

The spread plate method **(Buck, and Cleverdon, 1960)** was used to enumerate total bacterial count using Nutrient Agar (MPN, UK) and *Staphylococcus aureus* using Mannitol Salt Agar medium **(ICMSF, 2002)**. The plates were incubated at 35±2°C for 24 hours. Bacterial population numbers within 30 to 300 colonies were recorded as colony forming units per gram of sample (CFU/g).

Isolation and counting of *Vibrio* spp. were performed by adding 5g of sample to a sterile bag containing 45 ml of alkaline peptone water (APW lab M, UK) with pH 8.6 and 1% NaCl. After stomaching for 2 min, the bag was incubated for 6-8 hours at 35±2°C **(FDA, 2001)**. Then culture was spread into thiosulphate-citrate-bile salts-sucrose (TCBS Lab M, UK) agar plates with 1%NaCl and incubated for 24 h at 35±2°C **(FDA, 2001)** and record as CFU/g.

Potato Dextrose Agar (lab M, UK) medium was used for the enumeration of yeasts and molds. Plates containing 10-150 colonies were counted after incubation at 35 ± 2°C for 3-5 days and recorded as CFU/g.

Sensory evaluation

Twenty trained panelists (Fish Processing and Technology Department of Faculty of Fish Resources Suez Univ., Egypt) evaluated appearance, odor, flavor, texture, color, taste and overall acceptability of dried meats, a form which is consumed, of spider conch (*L. lambis*) using a 9-point hedonic scale, whereas a rating of 9 for extremely good, and 1 means extremely poor **(Amerine et al. 1965)**. The mean value of each criterion was expressed of sensory attributes score.

Statistics Analysis:

The t-test analysis and Standard deviation were performed to estimate the amount of variation of a set of values, using IBM SPSS Statistics version 22. All data represent the mean of three replicate experiments (n = 3).

RESULTS AND DISCUSSION

1. Proximate composition, Minerals:

Results in the **Table (1)** revealed that moisture was the major component of fresh spider conch (*L. lambis*) meat followed by protein, oil, carbohydrates, and ash. This is corresponds somewhat to what **Leiwakabessy and Lewerissa (2017)** found that moisture (77.55%) was the highest components of fresh spider conch (*L. lambis*) meat collected from Maluku Province, Indonesia, then protein, carbohydrates, ash, and oil respectively. According to **Periyasamy et al., (2011)** the chemical composition of mollusks edible parts was influenced by many factors such as seasonal conditions, maturity, and feed.

Table (1): Proximate composition, some minerals, and heavy metals in fresh and dried spider conch (*L. lambis*) meats.

Component	Spider conch (*L. lambis*)		MPL of some metals
	Fresh	Dried	
Moisture%	79.2±0.30[a]	10.83±0.14[b]	……….
Proximate composition% on dry weight basic			
Crude protein(N_2×6.25)	56.05±0.21[b]	67.96±0.29[a]	……….
Crude oil	3.85±0.12	3.77±0.16	……….
Crude ash	9.86±0.15[b]	12.02±0.16[a]	……….
Carbohydrates	30.24±0.06[a]	16.25±0.6[b]	……….
Macro Minerals(mg/kg)			
Na	20898.33	14234	……….
K	10098.33	6530.67	……….
Ca	6000	6200	……….
P	4005	3600	……….
Micro Minerals(mg/kg)			
Fe	93.7	52.09	100
Zn	15.43	38.37	100
Cu	15.50	7.20	30
Heavy metals (mg/kg)			
Pb	13.4	0.96	2
Co	<0.001	<0.001	……….
As	46.70	19.00	1

[a, b] Letters denote significant difference (P<0.05 Paired t test)

MPL: Maximum Permissible Limits in shellfish muscle (mg/Kg on dry weight basis) according to international standards (**FAO, 1983; FAO/WHO limit, 1989 and WHO, 1989, Mokhtar *et al*., 2009**).

Through the determined minerals, Na was detected in the highest concentration followed by K, Ca, P, Fe, Zn, and Cu respectively in the ash of the spider conch (*L. lambis*) fresh meat, (**Table, 1**). The presence and concentration of such minerals in such meat depend on the feeding system, environmental condition and pollution, as well as the collection medium (**Younis, 2019; Saleh et al., 2019**). **Jane *et al*., (1983)** stated that the presence of Fe in spider conch meat may be due to presence of sediment particles in its guts. Results of **Jiménez-Arce, (1993)** indicated that flesh of *Strombus gracilior* from Playa Panamá contained high values of Na (1376.97-1440.88 mg/kg), and K (1898.33-2393.09 mg/kg), but very low level of Cu and Fe.

As shown in **Table (1)** dried spider conch (*L. lambis*) meat had low moisture content and oil level. This means that most of the water in fresh spider conch meat existed in free form and easily evaporated during drying process. Also, most of the oil of this meat is found in unsaturated structure and easily hydrolyzed by oxidation during drying. Decline of moisture content led to an apparent rise in protein (21.25%), and ash (21.91%) and high reduction in carbohydrates (46.26%) respectively in spider conch dried meat.

Washing of the edible meat of spider conch (*L. lambis*) after separating from the shell before drying and the presence of the most of minerals in this meat in water soluble salts form may be caused the high reduction in its content of Na (32%), K (35%), P (10%), Fe (44.4%) and Cu (53.5%). On the contrary, an increase in levels of Ca (3.3%) and Zn (148.6%) were appeared in dried meat. This indicates that such minerals may be present in water-insoluble and complicated forms **(Younis et al, 2019)**. **Fikry (1996)** stated that Zn concentration in conch tissues is higher than in shell due to its necessity for the biological reaction. It mainly precipitates with calcium carbonate to form zinc carbonate. **Mansour et al., (2005)** mentioned that Zn, Cu, and Fe are essential as cofactors in the metabolic process of the soft bodies of gastropods.

2. Amino acids profile

King *et al*., (1990) stated that protein quality of food is usually evaluated by its amino acid. **Table (2)** presented the amino acids profile of fresh and dried spider conch (*L. lambis*) meats. Protein of both conch meat composed of the same 17 amino acids, seven of them were non-essential amino acids. These acids can be arranged depending on their concentration in the following decreasing order, glutamic, aspartic, arginine, leucine, glycine, alanine, lysine, valine, threonine, proline, serine, isoleucine, tyrosine, phenylalanine, methionine, cysteine and histidine respectively. Slight losses in values of some amino acids such as tyrosine, proline, methionine and cysteine were found in protein of dried conch meat comparing with fresh one. In general, results in this table were resemble with these reported by **Leiwakabessy and Lewerissa (2017)** for amino acids pattern of fresh edible part of *L. lambis* conch collected from Maluku Province, Indonesia.

Table (2): Amino acids (g/100g protein) and nutritional value (Kcal/100g) of fresh and dried spider conch (*L. lambis*) meat protein.

Component	Spider conch (*L. lambis*)		Amino acids FAO/ WHO Provisional Pattern*
	Fresh	Dried	
1- Amino acid (g/100g protein) a) Essential amino acids			
Threonine (THR)	2.91 (72.75%)	2.70 (67.5%)	4
Valine (VAL)	3.05 (61.25%)	2.99 (60.04%)	4.98
Isoleucine (ILE)	2.33 (69%)	2.32 (69%)	11
Leucine (LEU)	5.26	5.27	
Phenylalanine (PHE)	2.03 (71.33%)	1.99 (65.17%)	6
Tyrosine (TYR)	2.25	1.92	
Histidine (HIS)	0.73	0.73	
Lysine (LYS)	4.24 (78.52%)	4.26 (78.89%)	5.4
Methionine (MET)	1.63 (70.74%)	1.59 (63.64%)	3.52
Cysteine (CYS)	0.86	0.65	
b) Non-essential amino acids			
Arginine (ARG)	6.31	6.25	
Aspartic (ASP)	6.53	6.54	
Serine (SER)	2.84	2.73	
Glutamic (GLU)	11.15	11.14	
Glycine (GLY)	5.24	5.28	
Alanine (ALA)	5.06	4.98	
Proline (PRO)	2.88	2.14	
Nutritional value Caloric Value (Kcal/100g)	79	330.6	
C-PER**	2.05	1.70	
C-BV***	77.24	77.42	

Tryptophn not determined

FAO/WHO/UNU (1985) Energy & protein requirement. Technical Report Series No.724.

** C-PER Calculated Protein Efficiency Ratio

*** C-BV Computed Biological Value

3. Fatty acids profile:

As mentioned to data in **Table (3)** unsaturated fatty acids represented 70% and 47% of the oils of spider conch (*L. lambis*) fresh and dried meat respectively. Ease of oxidation of such fatty acids maybe was behind its reduction in dried meat. Arachidonic acid C20:4 was the main fatty acids in oil of spider conch fresh meat followed by Palmitic acid C16:0, Docosapentatenoic acid (DPA) C22:5, Docosatetraenoic acid C22:4, Eicosaenoic acid C20:1, Arachidic acid C20:0, Docasadienoic acid C22:2, Oleic acid C18:1, Linoleic acid C18:2, Myristic acid C14:0, Eicosapentaenoic acid (EPA) C20:5, Linolenic acid C18:3 and Palmitoleic acid C16:1 respectively. This sequence was changed in dried meat to Palmitic acid C16:0, Oleic acid C18:1, Arachidic acid C20:0, Myristic acid C14:0, Arachidonic acid C20:4, Eicosaenoic acid C20:1, Docosapentatenoic acid (DPA) C22:5, Docosatetraenoic acid C22:4, Linoleic acid C18:2, Docasadienoic acid C22:2, Palmitoleic acid C16:1, Linolenic acid C18:3 and Eicosapentaenoic acid (EPA) C20:5 respectively. An increase of saturated fatty acids and high loss in unsaturated ones especially with high numbers of unsaturated bonds were percept in dried meat. Such changes increased from the ratios of saturated to unsaturated fatty acids (from 0.4 to 1.11) and lowered from omega-6 to omega-3 fatty acids (from 2.08 to 1.46) in oils due to the drying process. **Fenglei et al., (2017)** mentioned that edible meat of *Rapana venosa* snail has high contents of omega-3 fatty acids, especially eicosapentaenoic acid (EPA) (C20:5$\boldsymbol{\omega}^3$) and docosahexaenoic acid (DHA) (C22:6$\boldsymbol{\omega}^3$), and low $\boldsymbol{\omega}$6/$\boldsymbol{\omega}$3 fatty acid ratio.

Table (3): Major fatty acids of fresh and dried spider conch (*L. lambis*) meat oil.

Fatty acids %	**Spider conch (*L. lambis*)**	
	Fresh	**Dried**
a) Saturated		
Arachidonic acid (C14:0)	**3.76**	**7.38**
Palmitic acid (C16:0)	**12.89**	**25.32**
Arachidic acid (C20:0)	**7.64**	**10.57**
b) Unsaturated		
Palmitoleic acid (C16:1)	**1.38**	**2.24**
Oleic acid (C18:1)	**4.02**	**11.34**
Linoleic acid (C18:2)	**3.95**	**3.05**
Linolenic acid (C18:3)	**1.61**	**1.97**
Eicosaenoic acid (C20:1)	**7.65**	**5.41**
Arachidonic acid (C20:4)	**15.74**	**5.67**
Eicosapentaenoic acid (EPA) (C20:5)	**١.٩٢**	**٠.٤٧**
Docasadienoic acid (C22:2)	**٤.٤٩**	**٢.٢٦**
Docosatetraenoic acid C22:4	**9.29**	**3.18**
Docosapentatenoic acid (DPA) (C22:5)	**10.07**	**3.33**
c) Saturated to unsaturated FAs ratio	**0.40**	**1.11**
d) ω^6: ω^3 ratio	**2.08:1**	**1.46:1**

4. Safety:

It was evaluated by determining some polluted heavy metals (Pb, Co, and As) and some pathogenic bacteria, *Vibrio* spp. and *Staphylocuccus aureus* in addition to total bacterial, molds and yeasts counts. Results in the **Table (1)** revealed that levels of both Pb and As in spider conch (*L. lambis*) fresh meat were more than Maximum Permissible Limit (MPL) (**Mokhtar et al., 2009**). Meanwhile, such meat can deem nearly free from Co. As may be found in organic and/ or inorganic form. According to **USEPA (2012)** inorganic As is toxic and may represent 2% of total As in conch tissue. Organic forms of As especially arsenosugars, which observed in shellfish, are not known its possible toxicity. Dried spider conch (*L. lambis*) meat contained 7.2% of Pb level which found in fresh meat. This caused decreasing in the Pb level of dried meat to less than its MPL. The main source of Pb pollution of food is the gasoline fuel **(Mansour et al., 2005)**. Also 40.68% of As level in fresh meat was detected in dried meat of this conch. This remain part of As in dried conch meat is still higher than the MPL, **Table (1)**.

Results in **Table (4)** observed that count of APC in fresh meat of spider conch was less than 10^6, the acceptable limit for fresh as reported by **ICMSF (2002)**. **Lakshmanan, (2005)** stated that the upper acceptable limit of APC for spoilage of fresh water and marine species is 10^7. Also dried spider conch had less count of APC ($1.2×10^3$ CFU/g) than that stated by **ICMSF (1986)** for dried fish, 10^5 CFU/g.

Table (4): Microbiological quality of fresh and dried spider conch (*L. lambis*) meat.

Microbial count (CFU/g)	Spider conch (*L. lambis*)	
	Fresh	**Dried**
1. Total bacterial count	$2.6×10^5$	$1.2×10^3$
2. Staphylococcus aureus	< 1 estimated	< 1 estimated
3. *Vibrio* spp.	< 1 estimated	< 1 estimated
4. Molds and yeasts	$3.2×10^4$	$3× 10^2$

Both *Vibrio* spp. and *staphylococcus aureus* didn't detect in both fresh and dried meat of this conch, **Table (4)**. This indicates a good microbial safety of these products **(Kim et al. 2017)**. Also, the molds and yeasts count was considered acceptable for fresh meat ($3.2×10^4$ CFU/g) and low in dried one ($3× 10^2$ CFU/g) of spider conch. Increasing of salt content and reduction in water activity, table (5), are mainly responsible for the good microbiological quality of dried conch meat **(Paludan-Müller et al.; 2002)**.

5. Nutritional value:

As previously mentioned above in **Table (1)**, meats of both fresh and dried spider conch (*L. lambis*) consider a good source of protein, oil, ash, carbohydrates, and macro and micro minerals. The caloric value was 4.19 times higher in dried meat than fresh one, **Table (2)**. The low caloric value of the meat of such a product makes it more convenient for overweight and obese people. Values of Na, K, Ca and P of the fresh and dried meat of this conch provide their recommended nutritional requirements as reported by **DA-CH (2000)**, **AFSSA (2001)** and **WHO (2004)**. Such minerals with Fe, Zn and Cu play an essential role in regulating body functions and metabolic processes **(FAO/WHO, 1989)**.

Protein of both these fresh and dried conch meats had 10 essential amino acids, **Table (2)**. Although, the levels of such acids were below those recommended in amino acid pattern of **FAO/WHO/UNU, (1985)**, the C-PER and C-BV of fresh and dried meat, **Table (2)**, consider acceptable comparing with cereal grains and legume seeds **(FAO, 1968)**. C-BV value of these fresh and dried conch meats was much resembled to that of casein protein **(United States Dairy Export Council, 1999)**.

Oil in fresh meat of this conch was rich in omega-3 fatty acids especially C20:4, C22:4, C22:5, and C20:1 and had a good ratio of omega-6: omega-3 (2.08: 1), **Table (3)**. In spite of the oxidation of unsaturated fatty acids in dried meat, it is still had 1.40: 1 omega-6 to omega-3 ratio, **Table (3)**. In both conch meats, their omega-6: omega-3 ratio agreed with that stated by **Simopoulos (2002)** (2-3: 1) for healthy fat recommended to protect and reduce the risks of cardiovascular, inflammatory, cancer and autoimmune diseases.

6. Acceptability:

pH value, salt content and sensory properties of the dried spider conch (*L. lambis*) meat (Srombaa) were illustrated in **Table (5)**. The results in this table indicated that dried conch meat (Srombaa) had high pH value, medium salt content, having dull appearance, dark amber color, herbal odor, slightly high salty taste, tough and hard texture, and the total acceptability of this product by panelists was ranged from fair to good.

Table (5): pH, Salt content and Sensory properties of dried spider conch (*L. lambis*) meat.

Test	Value
pH	8.24
Salt content	4.25
Appearance	6
Color	6
Odor	8
Taste	8
Texture	4
Total acceptability	6-7

CONCLUSION

According to the results of this study, the spider conch (*L. lambis*) fresh and/ or dried meats are nutritious, safe and acceptable. The potential for using spider conch meat in food processing will share in the production of protein sources for humans. Utilization of the meat of this conch needs future studies to improve its sensory quality, reduce oil oxidation and produce new edible products.

REFERENCES

AFSSA (Agence Française de Sécurité Sanitaire des Aliments) (2001). Report from the AFSSA Expert Committee on Human Nutrition. Vitamin and mineral fortification of commonly eaten foods: meeting the nutritional and safety needs of the consumer. 8 November. (transcripted version – 15 January 2002). Case No. 2000-SA-0239. Annex 4b, 15. https://www.anses.fr/en/system/files/NUT2000sa0239RaEN.pdf

Ahmed O.M. and Amin H.F. (2018). Detection and Survival of *Vibrio* Species in Shrimp (*Penaeus indicus*) and Mussel (*Mytilus galloprovincialis*) at Landing and after Processing at Seafood Markets in Suez, Egypt. J. Food and Dairy Sci., Mansoura Univ., 9 (12): 411 – 417.

Amerine, M.A.; Pangborn, R.M. and Roessler, E.B. (1965). Principles of Sensory Evaluation of Food. Academic Press, New York, pp.367–374.

Amin H.F.; Ahmed O.M.; Rasmey A.M. and Younis A.M., Bekhit A.A. (2018). Effect of technological processing on the safety of Indian mackerel (*Rastrelliger kangurata*) from Suez, Egypt. *Egypt*. J. Aquat. Biol. *Fis*h.; 22(5): 283- 294.

AOAC (Official Method of Analysis) (2000). Association of Official Analytical Chemists, Gaithersburg, Md, USA, 17th. ed.969.3 and 991.39 Fatty acids in oils and fats preparation of methyl esters. Boron trifluorid-AOAC-IUPAC method codex- Adopted-AOAC method, Ch.4, pp. 119-20.

AOAC (Official Method of Analysis) (2012). Official Methods of Analysis. 19th. Ed., Vol. (1), No. (985.01), Ch.3, 6.

Blanco, M.A. and Montero C.M. (1992). Chemico-nutritional composition of meat of Strombus galeatus (Mesogastropoda: Strombidae. Rev. Biol. Trop.; 40(1): 89-93.

Bligh, E.G. and Dyer, W.J. (1959). A rapid method of total lipid extraction and purification. Can. J. Biochem. Physiol., 37: 911-917.

Buck, J.D. and Cleverdon, R.C. (1960). The Spread Plate as a Method for the Enumeration of Marine Bacteria. Limnol. and Oceanogr., 5(1): 78- 80.

DA-CH (2000). Referenzwerte für die Nährstoffzufuhr. 1. Auflage. Deutsche Gesellschaft für Ernährung, Östereichsche Gesellschaft für Ernährung, Schweizerische Gesellschaft für Ernährung, Schweizerische Vereinigung für Ernährung, Umschau Braus, Frankfurt am Main.

El-Naggar M.; Younis A.M.; Amin H.F.; Ahmed O.M. and Mosleh Y.Y. (2019). Assessment of Polycyclic Aromatic Hydrocarbons and Heavy Metals Contamination in the Egyptian Smoked Herring (Clupea harengus). Polycycl. Aromat. Comp.
https://doi.org/10.1080/10406638.2018.1555173

Falch, E.; Overrien, I.; Solberg, C. and Slizyte, R. (2010). Composition and calories. In L. M. L. Nollet, & F. Toldrá (Eds.). Seafood and Seafood Product Analysis, Part III, Boca Raton, FL: CRC Press, Taylor & Francies Group, pp. 257– 288.

FAO (Food and Agriculture Organization of the United Nations) (1968). Amino Acid Content of Foods and Biological Data on Proteins. Food Consumption and Planning Branch, Nutrition Division, FAO, Rome.

FAO/WHO/UNU (1985). Report of a joint expert consultation: Energy and protein requirements. Technical Report Series, Geneva: WHO, No.724.

FAO/WHO (1989). Evaluation of certain food additives and the contaminants mercury, lead and cadmium WHO Technical Report Series No. 505.

FDA (2001). Bacteriological Analytical Manual, U.S. Food & Drug Administration, Elliot. E.L, Kaysner. C.A, Jackson. L and Tamplin. M.L. ch.9, pp. 171- 187.

Fenglei, L.; Ronge, X.; Xueqin, W.; Quancai, P. and Pengcheng L. (2017). Proximate composition, amino acid and fatty acid profiles of marine snail Rapana venosa meat, visceral mass and operculum. J. Sci. Food Agric.; 97: 5361–5368.

Fikry, A.M. (1996). Heavy Metal Pollution in Timsah Lake. M.Sc. Thesis. Fac. Sci., Suez Canal University.

ICMSF (International Commission of Microbiological Specification for Food) (1986). *Microorganisms in Food 2. Sampling for Microbiological Analysis: Principles and Specific Applications*, University of Toronto Press, Toronto, Canada.

ICMSF (International Commission of Microbiological Specification for Food) (2002). Microorganisms in foods 7: microbiological testing in food safety management. Kluwer Academic/ Plenum Publishers, New York, USA.

Jane, E.; Anthony, P.N.; Hadgis, R.; Milam, G.A.; Herzfeld, L.; Janette T. and Ritchey, S.J. (1983). Yields, Proximate Composition and Mineral Content of Finfish and Shellfish. J. Food Sci.; 48: 313 – 314.

Jiménez-Arce G. (1993). Chemical and nutritional composition in the marine snail Strombus gracilior (*Mesogastropoda: Strombidae*) of various sizes and sexes in Playa Panamá, Costa Rica. Revista de Biologia Tropical, 01 Dec., 41(3A): 345-349.

Kim, H.W.; Hong, Y.J.; Jo, J.I.; Ha, S.D.; Kim, S.H.; Lee, H.J. and Rhee, M.S. (2017). Raw ready-to-eat seafood safety: microbiological quality of the various seafood species available in fishery, hyper and online markets. Lett. App. Microbiol., 64(1): 27-34.

King, D.J.; Wiseman, A.; Chalk, P.A. and Coulson, C.J. (1990). An assay for lanosterol 14 alpha-demethylase from *Saccharomyces cerevisiae*. Biochem. Soc. Trans., 18(5): 1001-1002.

Lakshmanan, R.; Miskin, D. and Piggott, J.R. (2005). Quality of vacuum packed cold-smoked salmon during refrigerated storage as affected by high-pressure processing. J. Sci. Food Agric., 85: 655–661.

Lai, K.K. (2001). *Enterobacter sakazakii* infections among neonates, infants, children, and adults. Case reports and a review of the literature. Medic. (Baltimore), 80: 113–122.

Leiwakabessy and Lewerissa (2017). Amino acid profile of Strombus luhuanus and Lambis lambis from Waisarisa and Suli water, Maluku Province, Indonesia. AACL – Bioflux, 10(5): 1174-1179.

Levine, W.C. and Griffin, P.M. (1993). *Vibrio* infections on the Gulf Coast: results of first year of regional surveillance. Gulf Coast Vibrio Working Group. J. Infect. Dis., 167(1): 479–483.

Mansour, A.M.; Nawar, A.H. and Madkour, H.A. (2005). Metals concentration of recent invertebrates along the Red Sea Coast of Egypt: a Tool for monitoring environmental hazards. Sedimentol. Egypt, 13: 171-185.

Mohanty; Paria; Das et al., (2012). Nutrient profile of giant river-catfish Sperata seenghala (Sykes). Nat. Acad. Sci. Let., 35(3): 155–161.

Mokhtar, M.; Aris, Z.A. and Munusamy, V. (2009). Assessment Level of Heavy Metals in Penaeus Monodon and OreochromisSpp in Selected Aquaculture Ponds of High Densities Development Area. Eur. J. Sci. Res., 30(3): 348-360.

Murphy and Rilley (1962). A modified single solution method for determination of phosphate in natural waters. Anal. Chim. Acta., 27: 31-36.

Paludan-Müller, C.; Madsen, M.; Sophanodora, P.; Gram, L. and Møller. P.L. (2002). Fermentation and microflora of plaa-som, a thai fermented fish product prepared with different salt concentrations. Int. J. Food Microbiol., 73(1): 61-70.

Pauwels, E.; Van, R.; Verloo, M. and Mvondo, Z.A. (1992). Manuel de laboratoire de pédologie. Publications Agricoles 28. AGCD, Brussels.

Periyasamy, N.; Srinivasan, M.; Devanathan, K. and Balakrishnam, S. (2011). Nutritional value of gastropod, Babylonia spirata (Linnaeus, 1858) from

Thazhanguda, Southeast Coast of India. Asian Pacific J. Trop. Biomed., pp. S249-S252.

Ponder and Lindberg (2008). Phylogeny and evolution of the mollusca. University of California Press, Los Angeles, California; pp. 1-18.

Saleh S.M.; Younis A.M.; Ali R. and Elkady E.M. (2019). Phenol removal from aqueous solution based modified silica nanoparticles. *Korean J. Chem*. Eng., 36: 529-539.

Simopoulos, A.P. (2002). The importance of the ratio of omega-6/omega-3 essential fatty acids. Biomed Pharmacoth., 56: 365–379.

United States Dairy Export Council (1999). Reference Manual for U.S. Whey Products 2nd Ed.

USEPA (Environmental Protection Agency) (2012). National Coastal Condition Report IV.
http://water.epa.gov/type/oceb/assessmonitor/nccr/upload/0_NCCR_4_Report_508_bookmarks.pdf.

Vazhiyil, V. and Kumarapanicker, G. (2017). Shellfish Nutritive Value, Health Benefits, and Consumer Safety. Compr. Rev. Food Sci. Food Saf., Vol. 00.

Younis A.M.; Aly-Eldeen M.A. and Elkady E.M. (2019). Effect of different molecular weights of chitosan on the removal efficiencies of heavy metals from contaminated water. *Egypt*. J. Aquat. Biol. *Fish*., 23(4): 149-158.

Younis A.M. (2019). Environmental Impacts on Egyptian Delta Lakes' Biodiversity: A Case Study on Lake Burullus. A.M. Negm et al. (eds.), Egyptian Coastal Lakes and Wetlands: Part II – Climate Change and Biodiversity, Handbook of Environmental Chemistry, DOI 10.1007/698_2017_120, Springer International Publishing AG 2017.

WHO (World Health Organization) (2004). Food and Health in Europe: a new basis for action. WHO Regional Publications, Eur. Ser. No. 96.