Determination of the Fatty Acid Composition of Blue Swimmer Crabs (Portunus pelagicus) by Gas Chromatography

Article · August 2019

CITATIONS
0

READS
42

3 authors, including:

B.K. Kolita Kamal Jinadasa
National Aquatic Resources Research and Development Agency
106 PUBLICATIONS **137** CITATIONS
SEE PROFILE

G.D.Thilini M. Jayasinghe
National Aquatic Resources Research and Development Agency
41 PUBLICATIONS **20** CITATIONS
SEE PROFILE

Austin Journal of Nutrition and Food Sciences

Open Access

Austin Publishing Group

Special Article – Fatty Acid Composition

Determination of the Fatty Acid Composition of Blue Swimmer Crabs (*Portunus pelagicus*) by Gas Chromatography

Jayasinghe GDTM[1]*, Jinadasa BKKK[1] and Nethmina NAAN[2]

[1]Analytical Chemistry Laboratory (ACL), National Aquatic Resources Research and Development Agency (NARA), Sri Lanka

[2]Department of Fisheries and Aquaculture, Faculty of Fisheries and Marine Science Technology, University of Ruhuna, Sri Lanka

***Corresponding author:** Jayasinghe GDTM, Analytical Chemistry Laboratory (ACL), National Aquatic Resources Research and Development Agency (NARA), Sri Lanka

Received: May 20, 2019; **Accepted:** July 04, 2019; **Published:** July 11, 2019

Abstract

In the present study conducted for analysed the fatty acid composition of the Blue Swimmer Crabs (BSC) collected from Negombo, down south and Mannar coastal region in Sri Lanka. The fatty acid composition was analysed by Gas Chromatography (GC) techniques after preparation of the Fatty Acid Methyl Esters (FAME). The results showed that stearic acid (C 18:0, 25.41±1.8%) was a predominant fatty acid found in the BSC meat. Among other fatty acids, vaccenic acid (C 18:1 n-7, 20.41±4.1%) and a docosahexaenoic acid (C 22:5 n-3, 20.36±3.1%) contribution was maximum followed compare with other fatty acids. The polyunsaturated (PUFA), monounsaturated (MUFA) and Saturated Fatty Acids (SFA) in BSC were accounted for 44.93%, 34.45 % and 31.86% of the total fatty acids, respectively. Conversely, the levels of unsaturated fatty acids were higher in *P. pelagicus* that are associated with the health benefits for human.

Keywords: Blue swimmer crab; Fatty acids; Saturated; Monounsaturated; Polyunsaturated

Introduction

Blue swimmer crab, BSC (*Portunus pelagicus*) is a very popular marine export species, having the commercial value in Sri Lanka markets. BSC is occurring in the large shoals in shallow coastal water overlying sandy or muddy water. They are common throughout the Indian Pacific region [1]. BSC has a low life cycle in-between three or four years. In Sri Lanka, BSC fishery extends from Negombo to the Southwest coast and fishing season also depend on the location of the individual fishing community, the weather, the type of the fishing gear, economic return of alternative fisheries. According to the Department of Fisheries and Aquatic Resources (DFAR) data published in 2014, annual Sri Lanka total crab production is around 11,000 tons in 2012 and BSC was in a considerable percentage of total crab production [2].

According to the previous study, the BSC contains a lower level of lipid and a high level of protein [3]. Many studies have been done for the fatty acid composition of BSC's and reported Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) level were approximately in 30% from the total lipid [3-5]. Daniz et al noted the BSC collected from Mersin Bay, having 1.13-1.43% oil content in the crabmeat. The highest proportion of fatty acids in BSC were palmitic acid (C16:0), stearic acid (C18:0) and palmitoleic acid (C16:1), etc. They noted that the carapace meat of the BSC was rich in SFAs, PUFAs, and MUFAs [6]. EPA and DHA are considered as the omega-3 polyunsaturated fatty acids, which have a preventive effect on the coronary heart diseases, brain disorders, cancers, rheumatoid arthritis, multiple sclerosis, inflammation, etc [7,8]. But a high level of EPA can cause a bleeding effect. Hence the lower dose of EPA has been recommended for pregnant and nursing mothers [1]. For this reason fatty acid, profile analysis has great importance in term of human health.

Fatty acid profile and the proximate composition of the marine species differ with the sex, different consumption pattern, habitat, age of the species, seasonality, and other environmental factors in the ocean [9]. The taste, nutritional quality and the health benefits of the marine species including crabs are to a large extent and mainly depend on their essential fatty acids and essential amino acid content [10]. So that fatty acid composition is the most important criteria to evaluate the nutrition value of the crabs.

BSC is widely considered as nutritious, but the precise nutritional value, including the fatty acid profile of its' hasn't been studied sufficiently in Sri Lanka. Therefore, this study aimed to provide detailed information regarding the fatty acid profile in edible tissues of BSC.

Material and Methodology

Sample collection

BSC samples were collected from Mannar, Negombo, and down south coast areas of Sri Lanka during from July to November 2014. The total number of sample size (n) was 60, and it represented 30 female and 30 of male BSC. Samples were separately packed in the clean polythene bags and transported on ice-box. Samples were analyzed at the analytical chemistry laboratory, (NARA).

Sample preparation

The carapace width (cm), total weight (g) and sex were recorded before the dissecting. Male and female BSCs were separated and the edible muscle part was removed by sharp forceps and homogenized by mixer grinder. Homogenized samples were packed in seal

Citation: Jayasinghe GDTM, Jinadasa BKKK and Nethmina NAAN. Determination of the Fatty Acid Composition of Blue Swimmer Crabs (*Portunus pelagicus*) by Gas Chromatography. Austin J Nutri Food Sci. 2019; 7(5): 1124.

polythene bags and labelled properly and stored under freezer for further analysis.

The lipids in the muscle tissue were extracted using the method described by Bligh and Dyer, 1959. Lipid content was determined as the percentage value using the gravimetric method. The extract was used to generate the fatty acid methyl ester (AOCS method C2.66).

Gas Chromatography equipped with Flame Ionization Detector (GC-FID) (GC-2014, Shimadzu; Japan) analysis was conducted using 1-µL split injections onto a 105 m (fused silica) DB wax column (Restek, PA). The initial column temperature was held at 100°C for 4 min, before being increased to 240°C at a rate of 3°C min^{-1}. The injector temperature was held constant at 225°C and the detector temperature was 285°C. Helium was used as the carrier gas and column flow was held at 1 mL min^{-1}. The calibration curve was constructed using the Qualmix Fish S FAME mix (Larodan, Sweden). Heptadecanoic acid was added to each and every sample as an internal standard. Statistical analysis was done by using Microsoft Excel 2010 and SPSS software.

Results and Discussion

Fatty acid composition of the BSC meat obtained by the GC-FID is summarized in Table 1. Total 17 fatty acids were identified in the lipid of BSC meat. The average lipid content was in the edible muscle around 0.59±0.14%. The oil content of the male crabs was 0.60±0.11% and the females were 0.58±0.18%. The oil content of the female flesh is lower than the oil content of male flesh, but the difference is not significant ($p>0.05$). Emmanuel et al reported that female and male crabs are very similar in most cases in flesh comparing with an exoskeleton, and whole body [11].

Raghunath et al reported that "The lipid content showed a significant difference ($p<0.01$) in all the tissues except in muscle tissue and the carbohydrate values showed a significant difference ($p<0.01$) only for ovary and hepatopancreas [12]. Hence the oil content was slightly differenced in the flesh or muscle tissues of male and female. But the difference is not significant.

Daniz et al reported the BSCs meat has high PUFAs (43.19-45.98%), MUFAs (23.69-26.52%) and SFAs (24.01-25.30%). Those values are very similar to our study. But they mentioned some of the fatty acids were significantly different in between male and Female crabs ($p<0.05$). Among recorded fatty acids Polyunsaturated fatty acids (PUFA) were observed as the highest (44.92%) Monosaturated fatty acids (MUFA) were recorded as the second most abundant. Saturated fatty acids (SFA) were the lowest (31.86%). The main SFA were stearic (C 18:0) 25.41±1.8%, myristic acid (C14:0) 3.41±0.0%, pentadecanoic acid (C 15:0) 1.97±0.06 % and palmitic acid (C 16:0) 1.07±0.8%. Meanwhile stearic acid was the most dominant one and the palmitic acid was the lowest. Badrul et al reported a lower stearic acid content and higher palmitic acid content in the oil of freshwater crabs [13]. But Xugan et al reported the stearic acid was the most dominant fatty acid found in the BSC collected by the coast of the Gulf [1].

Table 1 indicated that the PUFA predominant component among the investigated fatty acids SFA, MUFA, and PUFA. Their amount of noticed in the following order docosahexaenoic acid (DHA) (C22:6 n-3) 20.36±3.1%, eicosapentaenoic acid (EPA) (C 20:5 n-3) 12.46±2.1%, linoleic acid (C18:2 n-6) 4.65±1.3%, docosapentaenoic acid (C22:5 n-6) 2.25±0.0%, docosatetraenoic acid (C22:4 n-6) 1.70±0.7%, octadecatetraenoic acid (C18:4 n-4) 1.30±0.7%, linolenic acid (C 18:3 n-3) 1.25±0.4% and arachidonic acid (C 20:4 n-6) 0.96±0.14%. Regarding the MUFA, vaccenic acid (C18:1 n-7) 20.41±4.1% is dominated than other MUFA. Figure 1 indicates the SFA, MUFA, and PUFA in the edible part of the muscle of BSC.

Table 1: Fatty acid profile of the BSC.

Oil % (0.59±0.14)			
	Type of fatty acids (FAs)	**FAs nomenclature**	**%**
1	Myristic acid	14:00	3.41±0.0
2	Pentadecanoic acid	15:00	1.97±0.06
3	Palmitic acid	16:00	1.07±0.8
4	Palmitoleic acid	16:10	1.55±0.5
5	Stearic acid	18:00	25.41±1.8
6	Oleic acid	18:1 (n-9)	10.19±1.5
7	Vaccenic acid	18:1 (n-7)	20.41±4.1
8	Linoleic acid	18:2 (n-6)	4.65±1.3
9	Linolenic acid	18:3 (n-3)	1.25±0.4
10	Octadecatetraenoic acid	18:4 (n-4)	1.30±0.7
11	Eicosenoic acid	20:1 (n-9)	0.99±0.07
12	Arachidonic acid	20:4 (n-6)	0.96±0.14
13	Eicosapentaenoic acid	20:5 (n-3)	12.46±2.1
14	Erucic acid	22:1 (n-9)	1.30±0.5
15	Docosatetraenoic acid	22:4 (n-6)	1.70±0.7
16	Docosapentaenoic acid	22:5 (n-6)	2.25±0.0
17	Docosahexaenoic acid	22:6 (n-3)	20.36±3.1
	SFA		31.86
	MUFA		34.45
	PUFA		44.93
	n-3		34.07
	n-6		9.56
	n-9		12.49
	n-3/n6		3.56
	PUFA/SFA		1.41

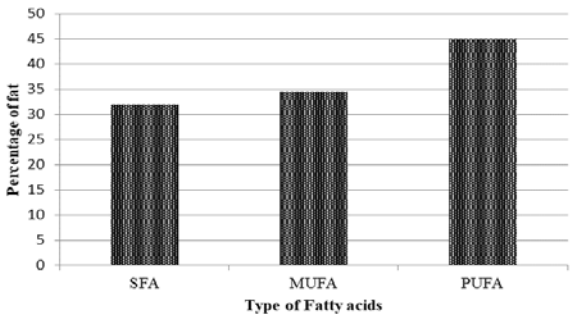

Figure 1: SFA, MUFA and PUFA percentage in the edible part of the muscle of BSC.

EPA and DHA are the major components of the cell membrane

of the phospholipids and both are predominant PUFA for the central nervous system. Because human cannot biosynthesis of these essential PUFA. So that EPA and DHA are considered as " conditionally essential fatty acids" especially for pregnant and lactating women, fetuses, infant and also adolescent [14]. Meanwhile, the EPA and DHA are reducing the cholesterol absorption level in the body, therefore, prevent cardiovascular diseases [15]. Since, high amount of PUFA in the edible portion of the BSC, it appears to be having health benefits for human consumption.

Wu et al reported the fatty acid composition of the meat, gonads, and the hepatopancreas of the BSC in Gulf and mentioned oil percentage of the female and male were different, in which male having a higher oil percentage in the meat than the female BSC. But the oil percentage of the gonads was higher compared with the meat of the females. Compare to the meat and gonads, high Free Fatty Acids (FFA) content found in the hepatopancreas for both female and male BSC. Due to high FFA content in the oil, might affect to oxidation than the meat and gonads during handling and storage. Hence the hepatopancreas of the BSC is having less suitability for processing.

The ration of the n-3 and n-6 PUFA is used as an indicator of the fatty acid nutritional value. Higher ratio considered as the most beneficial for the human being. But the higher content of the n-6 PUFA may lead to many inflammatory diseases [16]. Therefore Food and Agriculture Organization of the united nation (FAO) and World Health Organization (WHO) have recommended the dietary n-3 and n-6 PUFA ratio should at least 0.1-0.2 [1]. While it is more than 0.2 ratio (>0.2) are more health benefits. BSC showed the n-3 and n-6 ratio as 3.56 therefore, the edible muscle parts of the BSC may be considered the healthy seafood item.

Conclusion

This study clearly shows that BSC has a lower level of the lipid with a high level of EPA, DHA like PUFA. The meat of the BSC has high omega -3 fatty acids (n-3) than SFA and it has shown the higher ratio of the n-3 to n-6 (3.56). These indices had shown that BSC meat very healthy for human consumption.

References

1. Wu X, Zhou B, Cheng Y, Zeng C, Wang C, Feng L. Comparison of gender differences in biochemical composition and nutritional value of various edible parts of the blue swimmer crab. Journal of Food Composition and Analysis. 2010; 23: 154-159.
2. Steve C. Sri Lankan blue swimming crab fishery assessment. colombo, Sri Lanka: Seafood exporters'association of Sri Lanka. 2014.
3. Ramamoorthy N, Karuppasamy P, Priyadarshini RSS. Proximate, amino acid and fatty acids composition:The marine crabs from the south coastal of India Journal of Marine Biosciences. 2016; 2: 91-98.
4. Ayas D, Ozogul Y. The chemical composition and meat yield of mature blue swimmer crab (Portunus pelagicus, Linnaeus 1758) in Mersin bay, northeastern Mediterranean, Turkey. Advances in Food Sciences. 2011; 33: 179-184.
5. Abol AB, Mukrim MS, Amin RM, Azra MN, Azmie G, Ikhwanuddin M. Histological profile and fatty acid composition in hepatopancreas of blue swimming crab, Portunus pelagicus (Linnaeus, 1758) at different ovarian maturation stages. Turkish Journal of Fisheries and Aquatic Sciences. 2016; 16: 251-258.
6. Ayas, D, Özogul Y. The chemical composition of sexually mature blue swimmer crab (Portunus pelagicus, Linnaeus 1758) in the Mersin Bay. Journal of Fisheries Sciences com. 2011; 5: 308.
7. Sergeyeva T, Yarynka D, Piletska E, Lynnik R, Zaporozhets O, Brovko O, et al. Fluorescent sensor systems based on nanostructured polymeric membranes for selective recognition of Aflatoxin B1. Talanta. 2017; 175: 101-107.
8. Liang G, Zhai H, Huang L, Tan X, Zhou Q, Yu X, Lin H. Synthesis of carbon quantum dots-doped dummy molecularly imprinted polymer monolithic column for selective enrichment and analysis of aflatoxin B1 in peanut. Journal of Pharmaceutical and Biomedical Analysis. 2018; 149: 258-264.
9. Szumski M, Grzywiński D, Prus W, Buszewski B. Monolithic molecularly imprinted polymeric capillary columns for isolation of aflatoxins. Journal of Chromatography A. 2014; 1364: 163-170.
10. Soundarapandian P, Varadharajan D, Jaganathan K, Ravichandran S. Fatty Acid Composition in Long-eyed Swimming Crab Podophthalmus vigil (Fabricius). Journal of Nutrition & Food Sciences. 2015; 5: 1.
11. Adeyeye EI, Olanlokun JO, Falodun TO. Proximate and mineral composition of whole body, flesh and exoskeleton of male and female common West African fresh water crab Sudananautes africanus africanus. Polish Journal of Food and Nutrition Sciences. 2010; 60.
12. Ravi R, Manisseri MK. Biochemical changes during gonadal maturation Portunus pelagicus (Linnaeus, 1758). Fishery Technology. 2010; 47: 27-34.
13. Islam M, Sarkar M, Rahman M, Khan M, Afroze M. Fatty acid profile of freshwater crab (Paratelphusha lamellifrons) from Padma River of Rajshahi City. Bangladesh. J Nutr Food Sci. 2017; 7: 2.
14. Díaz-Bao M, Regal P, Barreiro R, Fente CA, Cepeda A. A facile method for the fabrication of magnetic molecularly imprinted stir-bars: A practical example with aflatoxins in baby foods. Journal of Chromatography A. 2016; 1471: 51-59.
15. Speltini A, Scalabrini A, Maraschi F, Sturini M, Profumo A. Newest applications of molecularly imprinted polymers for extraction of contaminants from environmental and food matrices: A review. Analytica Chimica Acta. 2017; 974: 1-26.
16. Simopoulos AP. The importance of the ratio of omega-6/omega-3 essential fatty acids. Biomedicine & pharmacotherapy. 2002; 56: 365-379.