Determination of fatty acids composition in Persian Gulf shrimp, Metapenaeus affinis

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ABSTRACT

The aim of this work was to analyze the fatty acid profile in Persian Gulf shrimp, *Metapenaeus affinis* that is one of the edible and well-known shrimps and has suitable amount of fatty acids specific polyunsaturated fatty acids (PUFA). It has been reported that, a high dietary consumption of marine n-3 fatty acids may prevent the development of atherosclerosis and thrombosis. The fatty acids profile were analysed in the male and female shrimps. The maximum amount of saturated fatty acids (SFA) was 35.88 percent of total fatty acids in Bandar Abbas (St. A) samples. Highest monounsaturated fatty acids (MUFA) were 19.59% in station C and uppermost of PUFA was in Bushehr samples equal to 47.2 %. The figures of SFA showed significant difference between stations ($p<0.05$). MUFA hadn't significantly different ($p>0.05$) and finally PUFA differed statistically only between station A and B. ω3 and ω9 in station A also had statistically differ with other stations and demonstrate that ω3 lower but ω9 higher than other stations. Difference in percentage of fatty acids among stations may consequence of consuming different nutrients by each group of shrimp.

Keywords: Persian Gulf; Metapenaeus affinis; fatty acids composition; PUFA; MUFA

INTRODUCTION

Shrimps are an important marine food and use in large quantity in the world, because marine organisms have suitable amount of fatty acids specific polyunsaturated fatty acids. It has been reported that, a high dietary consumption of marine n-3 fatty acids may prevent the development of atherosclerosis and thrombosis [1-3]. Indeed, long chain n-3 polyunsaturated fatty acids (PUFA), including eicosapentaenoic acid (EPA or 20:5n-3) and docosahexaeonic acid (DHA or 22:6n-3), are found mostly in fish and shrimp, but are contained in some other food as well. However, fish oil is major and the best source of these fatty acids. PUFA n-3 fatty acids essential for neural development in the infant in pregnancy and during the first year after birth [4].

More importantly, n-3 PUFA has preventive effects in coronary heart diseases, inflammatory and autoimmune disorders, inflammation and arrhythmias [5-7]. Lipid content and fatty acids profile of fish (and shrimp) are known to vary between and within species [8, 9]. Some factors, such as temperature, salinity, season [10], type and availability of food, habitat, stage of maturity and individual variability, are believed to be important factors contributing to these variations [11].

Metapenaeus affinis is one of the edible and well-known shrimp that consumption widely in many countries. In this study fatty acids of male and female of *Metapenaeus affinis* in three stations were determined and compared. As a result of different habitat they may feed different material so it had studied if they have any discrepancy by comparison of percentage of each fatty acid.

It is guessed that shrimp sex also may cause significant difference in fatty acid composition between male and female because according to some researches lipid content and fatty acids profile of fish (and shrimp) are different among and within species [8, 9].

MATERIALS AND METHODS

Location

Sampling stations are located in eastern along Hormoz Strait, middle and western parts of north Persian Gulf, including 3 big ports: Bandar Abbas (St. A), Bushehr (St. B) and Mahshahr (St. C) respectively (Fig. 1).

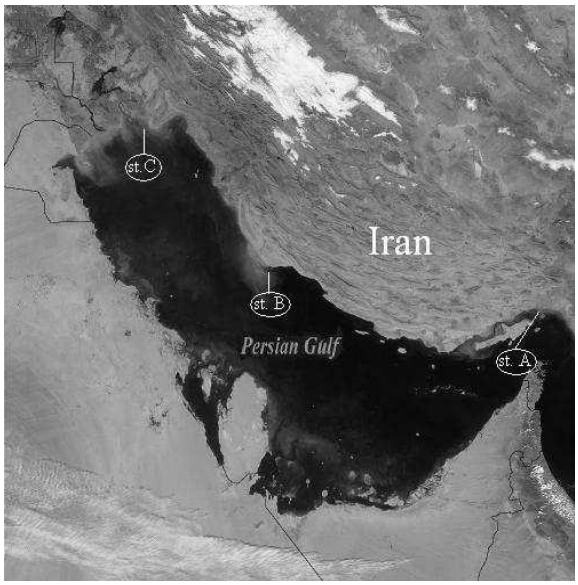

Figure 1. Persian Gulf map with its important ports

Sampling

Sampling was carried out using bottom trawl pulled by research vessel during a week in May 2008. 34 samples (12.5 – 14 gr weight) were caught from each station, after that samples were immediately cooled in crushed ice, sexing was done, packed in labeled polythene bags and transported to the Food and Drug Control Laboratories (FDCLs) in Tehran by airplane. The range of length and their weight were measured. Head, carapace and tail were removed and flesh frozen at -80 ^{0}C after being soaked in liquid nitrogen, until analyze process. Only minced body muscles used for further analysis of lipid and fatty acid.

Lipid extraction

Lipids were extracted and purified from the body muscle samples using modified Bligh and Dyer method [12]. Cold extraction and chloroform-methanol are other name of this method. At the first 2 g of sample was blended with 4 ml methanol and mixed well then added and mixed 4 ml chloroform in two steps. For maximum extraction, mixture was motionless for few hours, and then has been mixed by shaking again. 2 ml deionized water added and mixed. After separation of phases, divided beneath one and vacuum-dried chloroform by Buchi R-215 rotary under 474 millibar pressure and 40°C of water bath (Buchi manual).

Saponification

For determination of fatty acids by GC the samples should be esterified or methylated. In this study extracted lipid was methylated according to AOCS 1989 (Ce 2-66 method). First, prepared a sulfuric acid solution in methanol by adding cautiously, 2 ml concentrated sulfuric acid to 230 ml anhydrous methanol and Add extracted lipid in a 125 ml boiling flask and dissolved in 60 ml methanolic sulfuric acid solution, attached the condenser to the flask and reflux for one hour. Then cooled and transferred to a 250 ml reparatory funnel and add 100 ml distilled water.

Then extracted twice with 50 ml portions of petroleum ether and washed the combine extracts with 20 ml portions of distilled water until free of acids (test the wash water with methyl red indicator), dried with sodium sulfate, and evaporated the solvent under stream of nitrogen on the steam bath [13].

Fatty acids

FAMS (Fatty Acid Methyl Ester) analysis was conducted in Shimatzu GC 17A, split rate 1:10, flame ionization detector (FID) and capillary column BPX70 SGE (50 m; 0.32 mm and 0.25 μm). The temperature of the injection port and detector were 230^{0}C and 250^{0}C, respectively. The initial oven temperature was 125^{0}C followed by an increase to 215^{0}C at a rate 4^{0}C/min then 15 min fixed in 215^{0}C. The injected carrier gas was 1μl hydrogen. Identification of fatty acids carried out by comparison of their retention times with those of authentic external standards (Dr Ehrenstorfer GmbH).

Statistical analysis

Data were imported to Microsoft Excel 2007 and after arrangement and grouping moved to SPSS version 15.0 for statistical tests. One-way ANOVA and Tukey's posteriori test were used to analyze statistical differences between three station's samples. T-test was used to recognize differences of fatty acids composition between male and female.

RESULTS

This study showed that the maximum amount of SFA was 35.88 percent of total fatty acids in Bandar Abbas (St. A) samples. Highest MUFA was 19.59% in station C and uppermost of PUFA was in Bushehr samples equal to 47.2 %. Table 1 illustrate an average composition of fatty acids in all stations and the result of analyze of variance and Tukey test as well.

Table 1. The amount of fatty acid in *Metapenaeus affinis*

Name	Station A			Station B			Station C		
	Male	Sig.	Female	Male	Sig.	Female	Male	Sig.	Female
14:0	0.98	NS	1.23	0.9	*	1.24	0.92	*	1.37
15:0 iso	0.99	*	0.85	0.93	*	0.79	1.06	*	0.85
15:0	2.27	NS	2.16	1.12	NS	1	1.2	*	0.8
16:0 iso	0.32	NS	0.45	0.32	*	0.39	0.33	*	0.39
16:0	16.07	*	17.99	14.8	*	16.38	16.09	*	17.52
17:0	2.43	*	1.77	1.98	*	1.5	2.26	*	1,56
18:0	13.57	*	10.84	10.79	*	9,62	11.5	*	9.71
20:0	0.1	NS	0.12	0.14	*	0.22	0.15	*	0.19
Saturates	36.72	*	35.42	30.97	NS	31.13	33.51	NS	32.39
14:1	0.11	NS	0.1	0.11	*	0.13	0.11	*	0.12
16:1 n-7	3.47	*	6.39	3.77	*	6.36	4.42	*	7.33
16:1 n-5	0.88	*	0.79	0.72	NS	0.75	0.83	*	0.74
17:1	0.17	NS	0.14	0.11	NS	0.14	0.08	*	0.11
18:1 n-9	7.7	*	8.62	6.68	*	7.68	6.7	*	7.96
18:1 n-7	3.72	*	3.48	4.04	NS	4.48	4.28	*	4
18:1 n-5	0.14	NS	0.16	0.1	NS	0.13	0.13	NS	0.13
20:1 n-9	0.67	*	0.83	0.41	*	0.53	0.43	*	0.55
22:1 n-11	ND	*	0.33	0.15	NS	0.14	0.11	NS	0.13
Monosaturated	16.88	*	20.83	16.1	*	20.33	17.11	*	21.08
16:2 n-4	0.44	*	0.37	0.33	NS	0.36	0.37	*	0.34
16:3 n-4	0.37	NS	0.41	0.28	NS	0.28	0.25	NS	0.25
16:4 n-3	1.2	*	3.11	1.86	NS	1.59	1.42	NS	1.35
16:4 n-1	0.66	NS	0.77	0.67	NS	0.67	0.64	*	0.47
18:2 n-6	1.5	NS	1.31	1.35	*	1.07	1.23	*	0.96
18:2 n-4	0.14	NS	0.15	0.17	NS	0.19	0.17	*	0.19
18:3 n-6	0.28	NS	0.28	0.36	NS	0.43	0.32	NS	0.35
18:3 n-3	0.27	*	0.23	0.24	NS	0.22	0.21	*	0.19
18:4 n-6	ND	*	0.18	0.09	*	0.11	0.09	NS	0.09
18:4 n-3	0.24	*	0.26	0.34	NS	0.33	0.26	*	0.33
20:2 n-9	0.38	NS	0.42	0.44	*	0.5	0.45	NS	0.46
20:2 n-6	0.28	*	0.41	0.41	*	0.51	0.46	*	0.58
20:3 n-3	0.73	*	0.58	0.75	*	0.61	0.74	*	0.61
20:4 n-6	8.99	*	6.34	8.62	*	6.83	8.84	*	6.34
20:4 n-3	0.21	NS	0.19	0.34	NS	0.28	0.23	NS	0.25
20:5 n-3	13.48	NS	12.73	16.8	*	15.66	16.12	*	15.18
21:5 n-3	0.18	*	0.21	0.29	*	0.26	0.27	NS	0.26
22:3 n-6	0.75	NS	0.76	0.55	NS	0.52	0.52	NS	0.51
22:4 n-6	0.84	NS	0.78	0.82	NS	0.76	0.78	NS	0.8
22:5 n-6	0.27	NS	0.26	0.3	NS	0.28	0.34	NS	0.28
22:5 n-3	1.59	NS	1.48	1.54	*	1.43	1.52	NS	1.4
22:6 n-3	12.72	NS	11.19	13.18	*	11.41	12.63	NS	12.16
Polyunsaturated	45.51	*	42.43	49.75	*	44.28	47.87	*	43.34
Others	0.9		1.31	3.18		4.26	1.52		3.18
n-3	30.61	NS	29.99	35.36	*	31.78	33.4	*	31.73
n-6	13.76	*	11.11	13.32	*	11.26	13.37	*	10.71
n-9	8.08	*	9.04	7.12	*	8.18	7.15	*	8.43
n-3/n-6	2.22	*	2.7	2.66	NS	2.82	2.5	*	2.96

NS = Not significant ($p > 0.05$) and * = Statistical Significant ($p < 0.05$)

Table 2. The average composition of *M. affinis* fatty acids in male and female and their statistical comparison

Name	Penaeus monodon (14)	Sparus aurata (11)	Pandalus borealis (15)	Metapenaeus affinis This study (average)
14:0	1.13	1.9	1.1	1.14
15:0 iso	0.38	NW	0.4	0.9
15:0	NW	NW	1.3	1.38
16:0 iso	NW	NW	0.5	0.37
16:0	21.38	19.39	16.3	16.6
17:0	2.22	1.38	0.7	1.86
18:0	11.72	7.56	5.0	10.78
20:0	NW	0.46	0.4	0.16
Saturates	37.29	34.2	25.4	33.18
14:1	NW	0.99	NW	0.12
16:1 n-7	1.74	4.86	5.0	5.54
16:1 n-5	NW	NW	1.3	0.78
17:1	0.36	NW	NW	0.12
18:1 n-9	8.46	4.45	10.2	7.6
18:1 n-7	2.59	15.33	3.9	3.98
18:1 n-5	NW	NW	0.5	0.13
20:1 n-9	1.1	0.88	1.2	0.58
22:1 n-11	NW	NW	0.8	0.16
Monosaturated	14.6	27.17	24.2	19.03
16:2 n-4	0.59	NW	1.8	0.36
16:3 n-4	NW	NW	1.2	0.3
16:4 n-3	1.08	NW	1.0	1.82
16:4 n-1	NW	NW	0.4	0.64
18:2 n-6	14.32	3.0	1.4	1.21
18:2 n-4	NW	NW	0.7	0.17
18:3 n-6	NW	NW	NW	0.34
18:3 n-3	0.52	0.96	0.8	0.22
18:4 n-6	NW	NW	NW	0.1
18:4 n-3	0.62	NW	0.2	0.3
20:2 n-9	NW	NW	1.3	0.45
20:2 n-6	NW	0.61	1.2	0.45
20:3 n-3	NW	NW	NW	0.66
20:4 n-6	3.22	11.82	6.7	7.45
20:4 n-3	NW	NW	0.4	0.25
20:5 n-3	10.24	7.56	11.6	14.99
21:5 n-3	NW	NW	0.6	0.25
22:3 n-6	NW	NW	NW	0.6
22:4 n-6	0.4	3.19	1.1	0.8
22:5 n-6	NW	NW	1.0	0.29
22:5 n-3	0.77	1.69	2.0	1.48
22:6 n-3	13.35	9.19	14.5	12.16
Polyunsaturated	44.82	38.60	50.5	45.29
Others	3.29	NW	NW	2.5
n-3	26.34	19.40	NW	32.13
n-6	17.56	NW	NW	12.03
n-9	NW	NW	NW	8.07
n-3/n-6	1.55	3.21	NW	2.67

NW = not written

The figures of saturated fatty acids showed significant difference between stations ($p<0.05$). Monounsaturated fatty acids hadn't significantly different ($p>0.05$) and finally PUFA differed statistically only between station A and B. ω3 and ω9 in station A also had statistically differ with other stations and demonstrate that ω3 lower but ω9 higher than other stations. Table 1 shows amount of fatty acid in *Metapenaeus affinis* (in this study) and some other marine organism. According to the results *M. affinis* have a considerable content of fatty acids in comparison with the well-known shrimp, *Penaeus monodon*, and has suitable nutritive value (fatty acids).

Table 2 represents the average composition of *M. affinis* fatty acids in male and female and their statistical comparison (t-test).

In all stations male's ω3 fatty acid were higher than female with 35.36% as maximum of them in male samples of Bushehr station. ω6 fatty acid also in male of all stations were higher than female and with 13.76% in Bandar Abbas as highest. ω9 fatty acid was higher in females in all stations with maximum 9.04% in Bandar Abbas station. T-test showed significant difference among some fatty acids including 15:0iso, 16:0, 17:0, 18:0, 16:1n-7, 18:1n-9, 20:1n-9, 20:2n-6, 20:3n-3 and 20:4n-6 ($p<0.05$). In contrast some fatty acids like 18:1n-5, 16:3n-4, 18:3n-6, 20:4n-3, 22:3n-6, 22:4n-6 and 22:5n-6 hadn't significantly different ($p>0.05$) and maybe not affected by shrimp sex in this species.

CONCLUSION

Difference in percentage of fatty acids among stations may consequence of consuming different nutrients by each group of shrimp in their habitat but difference between male and female presumably control with sex, especially about fatty acid that was different in male and female in all stations.

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