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Variation in the fatty acid profile of lion fishes *Pterois volitans* (Linnaeus, 1758) and *Pterois antennata* (Bloch, 1787) of Parangipettai coast, Tamil Nadu, India

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ABSTRACT

An attempt has been made to invigorate the fatty acid profile of two different lion fishes such as P.volitans and P.antennata. Dominant quantity of SFA was noticed as 45.35%, 41.98% and 37.90 % in the liver, abdominal muscle and ovarian tissues of P.antennata than P.volitans. Significantly a low level of 42.35%, 40.98% and 35.04 % was observed in the above tissues of P.volitans. A maximum SFA was noticed in the testes and ovaries of P.antennata than P.volitans. A higher percentage composition of 37 % MUFA was observed in the liver of P.volitans than P.antennata. The percentage composition of 40.02% SFA was found in the abdominal muscle of P.volitans than 38.67 % in the marine lion fish P.antennata. Whereas the level varied reversely as 42.02% and 41.02 % in P.antennata and P.volitans respectively in the liver of both the species. A maximum SFA profile was observed in the testes and ovaries of P.antennata than P.volitans. A higher percentage composition of 37 % MUFA was observed in the liver of P.volitans than P.antennata. The MUFA level of 26.07 % found more in the testes of P.volitans which is comparatively less of 25.38 % in P.antennata. There was no much differences were observed with PUFA concentration of the liver of male lion fishes of both species. Levels (Percentage) of SFA, MUFA, PUFA and HUFA of different tissues of male and female of both the species of lion fishes. There was no significant difference noticed among the species and between tissues of male female fishes. Correlation matrix among the tissues of test organisms namely fishes was resembled with the value $p < 0.01$.

INTRODUCTION

The invasive Indo-Pacific red lionfish, *Pterois volitans* (Linnaeus, 1758) and *Pterois antennata* (Bloch, 1787), are now established along the Southeast coast of the United States and the Caribbean and is presently invading the Gulf of Mexico (Morris & Whitfield 2009; Schofield 2009; Whitfield *et al.*, 2002, 2006). Lionfish were first observed in South Florida waters in 1985 (Morris & Akins 2009), but were not considered established until several individuals were documented off North Carolina in 2000 (Whitfield *et al.*, 2002).The popularity of lionfish in the aquarium trade and the number of other non-native marine ornamentals observed in South Florida waters (Schofield *et al.*, 2010), it is largely assumed that lionfish were released intentionally or unintentionally by home aquarium hobbyists or commercial aquarists (Morris and Whitfield 2009). Lionfish have been found in a variety of habitats ranging from wrecks and solid substrate in proximity to coral reefs (Fishelson 1997) to mangroves (Barbour *et al*. 2010), consumption of marine fish offers numerous health benefits, mostly attributed to high concentrations of n-3 polyunsaturated fatty acids, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

Fatty acids consist of three major classes found in all animals and plants. They are saturated fatty acids (SFA) monosaturated fatty acids (MFA) and polyunsaturated fatty acids (PUFA). n-3 and n-6 are the two classes of PUFA.

There are several fatty acids which differ in chain length and in case of unsaturated fatty acids in the number, position and geometry (cis and trans) of double bonds (FAO/WHO,1994).Unlike plants, mammals and fish cannot synthesize linoleic acid (LA) and œ-linoleic (œ-LNA) acids. Lipids of marine fish species are generally characterized by low levels of linoleic acid (18:2n-6) and linoleic acid (18:3n-3) and high levels of long-chain n-3 polyunsaturated fatty acids (Steffens, 1997). Omega-3 fatty acids are helpful in pronouncing less inflammatory responses towards bronchial asthma, lupus erythematous, multiple sclerosis, kidney disease and also inhabit cancer. Fatty acids are of great importance to humans for prevention of coronary artery disease (Conner, 2000; Kinsella, 1987; Simopoulos, 1991; Mozaffarian *et al*., 2005).

DHA is a major component of brain, eye retina and heart muscle, DHA has been considered as important for brain and eye development and also good cardiovascular health (Ward and Singh 2005). EPA has also been reported to be useful in brain disorders and cancer treatment (Fenton *et al.*, 2000). Fish lipids are a good source of EPA and DHA. The objective of the present study is to evaluate the variation of SFA, MFA, PUFA and HUFA level in the most significant body tissues such as abdominal muscle, gonads, and liver of marine lion fishes *P. volitans* and *P. antennata*.

MATERIALS AND METHODS

Sample preparation and analysis of fatty acid methyl esters

For fatty acid analysis, visceral organs of both fish species such as abdominal muscle, gonads and liver were dissected sex wise, eviscerated and filleted manually. The tissue samples were oven dried at 67^{o}C for 24hrs.After that the samples were grounded finely with pestle and mortar. The preparation and analysis of fatty acid methyl esters (FAME's) from these fish tissues ware performed according to the method described by Sahin *et al*., (2000). 50 mg of tissue samples were added to 1 ml of 1.2M Na OH in 50% aqueous methanol with glass beads (3mm dia) in a screw-cap tube and then incubated at 100^{o}C for 30 min in a water bath. The saponified samples were cooled at room temperature for 25 min, they were acidified and methylated by adding 2 ml 54% 6 N HCl in 46% aqueous methanol and incubated at 80^{o} C for 10 min in water bath. After rapid cooling, methylated FAs were extracted with 1.25 ml 50% methyl-tetra butyl ether (MTBE) in hexane. Each sample was mixed for 10 min and the bottom phase removed with a Pasteur pipette. Top phase was washed with 3 ml 0.3M NaOH. After mixing for 5 min, the top phase was removed for analysis. Following the base wash step, the FAME's were cleaned in anhydrous sodium sulphate and then transferred in to GC (Gas chromatography) sample vial for analysis. FAMEs were separated by gas chromatograph (HP 6890 N, Agilent Technologies, USA). FAMEs profiles of the tissues were identified by comparing the commercial Eucary data base with MIS Software package (MIS Ver. No. 3.8, Microbial ID. Inc., Newark, Delaware). The reported FA compositions are based upon a single injection and are expressed as percentage of total FA's. Using ABSTAT 3.01 statistical package, correlation matrix was computed.

RESULTS

The percentage composition of 40.02% SFA was found in the abdominal muscle of *P. volitans* than 38.67 % in the marine lion fish *P. antennata*. Where as in the level varied reversely as 42.02 and 41.02 % in *P. antennata* and *P. volitans* respectively in the liver of both the species. However, as far SFA, there is no much deviation was observed in the testes of both the species of fishes. A highest level of SFA was found as 45.35, 41.98 and 37.90 % in the tissues such as liver, abdominal muscle and ovary of *P. antennata* than *P. volitans*, a significantly low level of 42.35, 40.98 and 35.04 % was noticed in the mentioned tissues of *P. volitans* (Table. 1 and 2). A highest SFA profile was noticed in the testes and ovaries of *P. antennata* than *P. volitans*. A higher percentage composition of 37 % MUFA was observed in the liver of *P. volitans* than *P. antennata*. The MUFA level of 26.07 % found more in the testes of *P. volitans* which is comparatively less of 25.38 % in the case of *P. antennata*. A similar trend was noticed in the ovaries of both the species. However, a highest PUFA composition of 30 % was noticed in the abdominal tissues of male *P. antennata* than *P. volitans* which encountered 27.27%. No much difference was observed with PUFA concentration of the liver of male lion fishes of both species. A similar trend was recorded in the female tissues including ovary of both the species. Levels (Percentage) of SFA, MUFA, PUFA and HUFA of different tissues of male and female *P. volitans* and *P. antennata* were found in the following order are given in Table 3 and 4.

Table.1 Fatty acid profile in the abdominal muscle, liver, Testes and ovary of male and female *Pterois volitans* of Parangipettai coast

Carbon chain	Fatty acid	Ab. muscle	Liver	Testes	Ab. muscle	Liver	Ovary
C10:0	Capric acid	0.06	0.8	0.09	0.05	0.9	0.07
C11:0	Undecyclic acid	0.08	0.1	0.12	0.09	0.14	0.13
C12:0	Lauric acid	0.58	0.61	0.51	0.61	0.58	0.52
C13:0	Tridecyclic acid	0.23	0.33	0.21	0.25	0.34	0.23
C14:0	Myristic acid	11.61	11.22	11.54	11.01	11.28	11.68
C15:0	Penta decyclic acid	1.2	1.32	1.11	1.31	1.3	1.01
C16:0	Palmitic acid	18.8	19.84	14.22	19.01	18.98	13.16
C17:0	Margaric acid	0.87	1.13	0.53	0.91	1.14	1.11
C18:0	Stearic acid	5.05	4.01	4.14	5.41	5.91	4.51
C19:0	Nonadecyclic acid	0.19	0.22	1.71	0.18	0.23	1.08
C20:0	Arachidic acid	0.34	0.32	0.28	0.21	0.31	0.27
C21:0	Heneicosanoic acid	0.22	0.16	0.32	0.23	0.18	0.31
C22:0	Pehinic acid	0.15	0.17	0.17	0.66	0.19	0.28
C23:0	Tricosanoic acid	0.14	0.18	0.19	0.65	0.19	0.21
C24:0	Lignoceric acid	0.5	0.61	0.48	0.4	0.68	0.47
∑ of SFAs		**40.02**	**41.02**	**35.62**	**40.98**	**42.35**	**35.04**
C14:1ω-3	Cis-3Myristoleic acid	0.05	0.11	0.06	0.04	0.1	0.05
C14:1ω-5	Trans-5 Myristoleic acid	0.32	0.62	0.31	0.31	0.52	0.29
C14:1ω-7	Cis-7Myristoleic acid	0.21	0.33	0.41	0.24	0.37	0.39
C15:1ω-6	Cis-6Pentadecenoic	0.55	0.61	0.42	0.61	0.67	0.41
C16:1ω-5	Cis-5Palnitoleic acid	0.24	0.31	0.21	0.21	0.33	0.25
C16:1ω-6	Cis-6Palnitoleic acid	0.73	0.81	0.53	0.62	0.77	0.51
C16:1ω-7	Trans-7Palnitoleic acid	11.89	12.86	10.11	11.05	13.01	10.12
C16:1ω-9	Trans-9-Palnitoleic acid	0.51	0.62	0.42	0.49	0.81	0.39
C17:1ω-7	Cis-7-Heptadecenoic acid	0.35	0.34	0.31	0.34	0.59	0.33
C17:1ω-8	Trans-8-Heptadecenoic acid	0.61	0.69	0.51	0.51	0.51	0.52
C18:1ω-5	Cis-5-Octadecenoic acid	0.13	0.82	0.14	0.14	0.72	0.11
C18:1ω-7	Cis-7-Octadecenoic acid	0.22	0.64	0.21	0.28	0.54	0.2
C18:1ω-9	Oleic acid	9.54	11.54	8.62	8.78	11.81	7.11
C19:1ω-8	Vouadecenoic acid	0.08	0.11	0.18	0.06	0.06	0.11
C20:1ω-5	Cis-5-Eicosenoic acid	0.2	0.54	0.11	0.25	0.51	0.14
C20:1ω-6	Cis-6-Eicosenoic acid	0.29	0.31	0.21	0.31	0.29	0.21
C20:1ω-7	Cis-7-Eicosenoic acid	0.19	0.29	0.17	0.21	0.21	0.16
C20:1ω-9	Trans-9-Eicosenoic acid	1.02	1.62	1.01	1.11	1.31	1
C22:1ω-7	Trans-7-Docosenoic acid	0.91	2.11	1.11	1.22	1.84	0.98
C22:1ω-9	Cis-9-Docosenoic acid	0.05	0.92	0.12	0.09	0.51	0.13
C24:1ω-3	Cis-3-Tetracosenoic acid	0.31	0.35	0.34	0.32	0.64	0.41
C24:1ω-6	Cis-6-Tetracosenoic acid	0.16	0.18	0.15	0.15	0.16	0.16
C24:1ω-9	Trans-9-Tetracosenoic acid	0.15	0.16	0.41	0.19	0.43	0.51
∑ of MUFAs		**29.71**	**37**	**26.07**	**27.53**	**36.71**	**24.49**
C16:2ω-6	Hexa decenoic	0.31	0.11	0.05	0.32	0.08	0.16
C18:2ω-3	Trans-3-Linoleic	0.22	0.19	0.11	0.22	0.17	0.17
C18:2ω-6	Linoleic	1.27	0.28	2.57	1.62	1.55	2.51
C18:3ω-3	Alfalinolenic	5.37	6.12	2.21	5.31	5.16	2.16
C18:3ω-6	Gammalinolic	0.31	0.72	1.14	0.44	0.22	1.15
C18:4ω-3	Stearidonic	0.22	0.66	1.57	0.23	0.54	1.5
C19:2ω-6	Octadecenoic	0.18	0.52	1.41	2.17	0.48	1.65
C20:2ω-6	Eicosadienoic	2.17	0.44	2.17	1.77	0.41	1.51
C20:3ω-6	Dihomogaummalinoteic	2.98	0.17	0.88	1.91	0.16	2.18
C20:4ω-6	Arachidonic acid	3.81	2.18	1.35	3.42	1.18	0.92
C20:5ω-3	Eicosapentaenoic	5.12	3.12	1.46	2.39	2.11	1.44
C20:5ω-6	Cis-6-Eicosapentaenoic	0.12	0.12	1.27	2.63	1.15	1.28
C22:3-ω3	Docosatrienoic	0.18	0.64	1.57	2.16	0.92	1.55
C22:4ω6	Docosatetraenoic	3.16	0.13	1.58	1.57	0.86	2.38
C22:5ω-3	Decosapentalnoic	0.29	0.46	2.97	0.12	0.78	1.98
C22:6ω-3	Docosahexaenoic	1.56	3.16	3.57	3.22	2.15	3.92
∑ of PUFAs		27.27	**19.02**	**25.88**	**29.5**	**17.92**	**26.46**
C14:0 ISO		0.07	-	0.06	0.05	0.41	-
C15:0 ISO		0.37	-	0.12	-	0.31	0.14
C15:0 Anteiso		0.19	0.12	-	0.12	0.16	0.14
C16:0 ISO		0.17	0.14	0.19	0.17	0.12	0.13
C17:0 ISO		0.4	0.55	0.51	-	0.14	0.41
C17:0 Anteiso		0.26	0.28	-	0.16	0.35	0.31
C19:0 ISO		-	0.12	0.42	0.41	0.16	0.12
C20:0ISO		-	0.14	0.16	0.12	0.55	0.11
C20:0 Anteiso		0.39	0.21	0.35	0.39	0.06	0.46
∑ of Branched		**1.85**	**1.56**	**1.81**	**1.42**	**2.14**	**1.82**
Unknown & others		1.15	**1.4**	**10.62**	**0.57**	**0.88**	**12.19**
ω3/ω-6		12.96/14.31	14.35/4.67	13.46/12.42	13.76/15.74	11.83/6.09	12.72/13.74
ω3/ω6 Ratio		0.91	3.1	1.1	0.87	1.94	0.9

Table. 2 Fatty acid profile in the abdominal muscle, liver, Testes and ovary of male and female *Pterois antennata* of Parangipettai coast

Carbon chain	Fatty acid	Ab. muscle	Liver	Testes	Ab. muscle	Liver	Ovary
C10:0	Capric acid	0.25	0.92	0.05	0.31	0.81	0.06
C11:0	Undecyclic acid	0.27	0.92	0.11	0.64	0.21	0.08
C12:0	Lauric acid	0.49	0.48	0.44	0.51	0.61	1.51
C13:0	Tridecyclic acid	0.36	0.36	0.21	0.38	0.42	1.32
C14:0	Myristic acid	11.58	12.01	11.01	10.68	12.55	10.11
C15:0	Penta decyclic acid	1.31	1.24	1.11	1.02	1.32	0.57
C16:0	Palmitic acid	17.92	18.64	12.14	16.89	19.01	13.51
C17:0	Margasic acid	0.10	1.97	1.16	1.11	1.87	1.52
C18:0	Stearic acid	5.04	5.01	6.01	5.81	6.02	4.32
C19:0	Nonadecyclic acid	0.27	0.18	1.05	1.32	0.16	1.12
C20:0	Arachidic acid	0.32	0.41	0.31	1.01	0.41	1.31
C21:0	Heneicosanoic acid	0.24	0.35	0.22	0.85	0.36	0.56
C22:0	Pehinic acid	0.18	0.28	0.98	0.19	0.55	0.81
C23:0	Tricosanoic acid	0.16	0.16	0.88	0.15	0.43	0.62
C24:0	Lignoceric acid	0.18	0.12	0.16	0.71	0.52	0.48
∑ of SFAs		**38.67**	**42.41**	**35.84**	**41.58**	**45.25**	**37.90**
C14:1ω-3	Cis-3Myristoleic acid	0.10	0.11	0.04	0.08	0.12	0.11
C14:1ω-5	Trans-5 Myristoleic acid	0.30	0.62	0.28	0.28	0.68	0.26
C14:1ω-7	Cis-7Myristoleic acid	0.25	0.38	0.40	0.24	0.42	0.38
C15:1ω-6	Cis-6Pentadecenoic	0.68	0.69	0.42	0.41	0.71	0.41
C16:1ω-5	Cis-5Palnitoleic acid	0.31	0.31	0.26	0.30	0.11	0.25
C16:1ω-6	Cis-6Palnitoleic acid	0.52	0.78	0.49	0.48	0.51	0.41
C16:1ω-7	Trans-7Palnitoleic acid	11.00	12.78	9.72	10.82	12.10	8.92
C16:1ω-9	Trans-9-Palnitoleic acid	0.41	0.83	0.32	0.39	0.71	0.31
C17:1ω-7	Cis-7-Heptadecenoic acid	0.35	0.61	0.32	0.36	0.54	0.30
C17:1ω-8	Trans-8-Heptadecenoic acid	0.52	0.61	0.51	0.58	0.51	0.54
C18:1ω-5	Cis-5-Octadecenoic acid	0.11	0.71	0.13	0.17	0.63	0.14
C18:1ω-7	Cis-7-Octadecenoic acid	0.31	0.51	0.22	0.42	0.62	0.23
C18:1ω-9	Oleic acid	7.82	12.01	6.98	7.01	11.00	6.00
C19:1ω-8	Vouadecenoic acid	0.11	0.05	0.16	0.16	0.06	0.17
C20:1ω-5	Cis-5-Eicosenoic acid	0.24	0.48	0.72	0.22	0.41	0.16
C20:1ω-6	Cis-6-Eicosenoic acid	0.35	0.31	0.23	0.31	0.32	0.17
C20:1ω-7	Cis-7-Eicosenoic acid	0.18	0.32	0.18	0.17	0.64	0.18
C20:1ω-9	Trans-9-Eicosenoic acid	1.01	1.01	1.13	1.11	1.17	1.01
C22:1ω-7	Trans-7-Docosenoic acid	1.11	0.92	0.64	0.82	0.92	0.98
C22:1ω-9	Cis-9-Docosenoic acid	0.12	0.84	0.72	0.13	1.62	0.64
C24:1ω-3	Cis-3-Tetracosenoic acid	0.31	0.62	0.51	0.30	1.10	0.52
C24:1ω-6	Cis-6-Tetracosenoic acid	0.16	0.54	0.48	0.17	0.17	0.46
C24:1ω-9	Trans-9-Tetracosenoic acid	0.41	0.91	0.52	0.40	0.43	0.11
∑ of MUFAs		**26.68**	**36.96**	**25.38**	**25.33**	**35.50**	**22.66**
C16:2ω-6	Hexa decenoic	0.34	0.06	1.15	0.32	0.04	1.14
C18:2ω-3	Trans-3-Linoleic	0.29	0.15	1.18	0.27	0.13	1.01
C18:2ω-6	Linoleic	1.82	1.44	0.82	1.77	1.31	0.81
C18:3ω-3	Alfalinolenic	5.61	4.15	2.56	5.41	4.16	2.41
C18:3ω-6	Gammalinolic	0.46	0.46	1.18	0.51	0.31	1.31
C18:4ω-3	Stearidonic	0.28	0.51	1.66	0.32	0.47	1.44
C19:2ω-6	Octadecenoic	2.19	0.41	1.75	2.18	0.40	1.71
C20:2ω-6	Eicosadienoic	1.82	0.43	1.42	1.91	0.39	1.51
C20:3ω-6	Dihomogaummalinotec	1.81	0.15	2.52	1.97	0.17	3.13
C20:4ω-6	Arachidonic acid	1.96	1.15	1.12	1.94	1.17	1.12
C20:5ω-3	Eicosapentaenoic	2.95	1.92	1.46	2.91	1.97	1.51
C20:5ω-6	Cis-6-Eicosapentaenoic	2.97	1.44	1.37	3.01	1.51	1.32
C22:3-ω3	Docosatrienoic	2.68	1.11	1.66	2.45	1.32	1.56
C22:4ω6	Docosatetraenoic	1.96	2.00	1.00	1.56	1.71	2.78
C22:5ω-3	Decosapentalnoic	0.04	1.11	1.01	1.07	1.01	1.11
C22:6ω-3	Docosahexaenoic	2.82	2.12	3.76	3.51	2.13	3.72
∑of PUFAs		30.00	**18.61**	**25.62**	**31.11**	**18.20**	**27.41**
C14:0 Iso		0.14	0.04	0.12	-	-	0.11
C15:0 Iso		0.16	0.12	0.11	0.03	-	-
C15:0 Anteiso		-	0.14	0.05	0.11	-	0.12
C16:0 Iso		0.12	-	0.31	0.12	0.10	0.04
C17:0 Iso		0.51	0.12	0.22	-	0.12	0.29
C17:0 Anteiso		0.12	-	0.60	0.33	0.31	0.21
C19:0 Iso		0.11	0.41	0.11	0.22	0.11	0.50
C20:0 Iso		0.14	0.33	018	0.41	0.13	0.11
C20:0 Anteiso		0.66	0.29	0.11	0.22	0.23	0.47
∑ of Branched		1.96	**1.45**	**1.81**	**1.44**	**1.00**	**1.85**
Unknown & others		2.69	**0.57**	**11.35**	**0.57**	**0.05**	**10.18**
ω3/ω-6		14.67/15.33	11.07/7.54	13.29/12.33	15.94/15.17	11.19/7.01	12.76/14.65
ω3/ω6 Ratio		0.96	1.47	1.10	1.10	1.60	0.87

Table 3 Levels (Percentage) of SFA, MUFA, PUFA and HUFA of different tissues of male and female *P. volitans*

	Male			Female		
	Liver	Abdominal	Testes	Liver	Abdominal	Ovary
SFA	41.02	40.02	35.62	42.35	40.98	35.04
MUFA	37.00	29.71	26.07	36.71	27.53	24.49
PUFA	27.27	25.88	19.02	29.50	26.46	17.92
ω3	14.35	13.46	12.96	13.76	12.72	11.83
ω6	14.31	12.42	4.67	15.74	13.74	6.09
ω3/ ω6 Ratio	3.1	1.1	0.91	1.94	0.90	0.87

Table 4 Leves (Percentage) of SFA, MUFA, PUFA and HUFA of different tissues of male and female *P. antennata*

	Male			Female		
	Liver	Abdominal	Testes	Liver	Abdominal	Ovary
SFA	42.41	38.67	35.84	45.25	41.58	37.90
MUFA	36.96	26.68	25.38	35.50	25.33	22.66
PUFA	30.00	25.62	18.61	31.11	27.41	18.20
ω3	14.67	13.29	11.07	15.94	12.76	11.19
ω6	15.33	12.33	7.54	15.17	14.65	7.01
ω3/ ω6 Ratio	1.47	1.10	0.96			

Table 3 Correlation matrix for SFA, MUFA and PUFA concentrations in the Abdominal muscle, Liver, Testes and Ovary of male and female *P.volitans* and *P.antennata* of Parangipettai coast

	Lion fishes	*P.voli*	*P.ante*	*P.voli*	*P.ante*	*P.voli*	*P.ante*	*P.voli*	*P.ante*	*P.voli*	*P.ante*	*P.voli*	*P.ante*
AbM	*P.voli* ♂	1											
AbM	*P.ante* ♂	0.9738	1										
Liv	*P.voli* ♂	0.9713	0.9671	1									
Liv	*P.ante* ♂	0.9669	0.9687	0.9853	1								
Tes	*P.voli* ♂	0.9466	0.9619	0.9519	0.9697	1							
Tes	*P.ante* ♂	0.9395	0.9591	0.9377	0.9532	0.9717	1						
AbM	*P.voli* ♀	0.9773	0.9943	0.9741	0.9726	0.9607	0.9580	1					
AbM	*P.ante* ♀	0.9673	0.9936	0.9608	0.9634	0.9635	0.9644	0.9908	1				
Liv	*P.voli* ♀	0.9683	0.9713	0.9912	0.9950	0.9631	0.9506	0.9760	0.9671	1			
Liv	*P.ante* ♀	0.9675	0.9733	0.9833	0.9963	0.9689	0.9602	0.9768	0.9696	0.9936	1		
Ov	*P.voli* ♀	0.9463	0.9641	0.9389	0.9608	0.9913	0.9835	0.9592	0.9667	0.9526	0.9628	1	
Ov	*P.ante* ♀	0.9521	0.9658	0.9384	0.9514	0.9678	0.9788	0.9653	0.9700	0.9438	0.9574	0.9818	1

All significant at 5% level (P<0.001)

A highest percentage composition (n-3 and n-6 ratio) of 3.1 and least of 0.87 % were noticed in the abdominal tissues of *P. volitans* male and female respectively. Furthermore, a least level of 0.87 % was recorded in the ovarian tissues of female *P. antennata*, where a uniform level of 1.10 % was observed in both the abdominal muscle of female and testes of male *P. antennata* respectively. There was no significant difference noticed among the species and between tissues of male female fishes. Correlation matrix for both of lion fishes were depicted in the table.5 and significant level was found as P > 0.01.

DISCUSSION

In general, the fatty acid profiles of different organ tissues in both spawning and non-spawning herring exhibited notable similarities, with high, but variable proportions of omega-3 highly unsaturated fatty acids (HUFA), predominantly C20:5n- 3 (EPA) and C22:6n-3 (DHA), along with substantial proportions of monoene C18:1n-9 and saturated fatty acid C16:0. Many differences in the relative distribution of individual fatty acids were observed among organ tissues from both fish groups. Fatty acid contents in the flesh of both spawning and non-spawning herring decreased in the order of MUFAN SFAN PUFA a characteristic lipid profile of most fatty fish (Kozlova and Klotimchenko, 2000). In white muscle, head, liver and gonad, the PUFA fraction was higher ($p < 0.05$) in winter than summer. The highest percentage of PUFA was usually accompanied with a slight level of SFA. In liver organ, the variation of PUFA fraction was statistically related to MUFA. Generally, marine fish show higher contents of PUFA (especially EPA and DHA) due to their diets and therefore, a high ratio of PUFA to SFA *(PIS)* (Osman *et al.*, 2001).

The FA profile is thus characterized by a dominance of SFA and MUFA, representing 60–75% of the total FA. The high amounts of SFA and MUFA in our samples are in good agreement with data in the literature. These SFA and MUFA are generally abundant in fish from warm or temperate regions, whereas PUFA show high levels in fish from cold regions (Dey, Buda, Wiik, Halver, & Farkas, 1993; Wodtke, 1981). The very low amount of arachidonic acid

(20:4n6) found in the fish studied here, could be related to the low percentage of linoleic acid (18:2n6) in the samples. The n3 PUFA levels were generally higher than those of n6 PUFA, as is typical for marine fish (Green and Selivonchick, 1987). When compared to some other marine reef fish species (e.g., red snapper, dolphin fish etc.,) of the Southeast U.S. and Caribbean, lionfish are higher in n-3 fatty acids and contain a relatively low amount of saturated fatty acids.(Morris *et al*., 2011).

In the current investigation the percentage of different types of omega-3 fatty acids, and non-omega 3 in thirty types and different tissues, such as abdominal muscle, liver and gonads of both fish species of fish were resembled the previously determined consequences of FA level in Persian Gulf area in cold season. According to this study, head in Shourt, Oncarhynchus mgkiss and Saurida tumbip, had the highest amount of omega 3. Fliger in 1997 did not show any differences in the contents of omega 3 fatty acids in head and muscle of antractic fish (Phleger et al., 1997). We have found the maximum amount of omega 3 fatty acids in total body of Trout (ghezel-ALA), Bartail flathead (Zaminkan-e-dom navari) and Malabar blood snapper (Sorkhoo-malabari). Many investigators showed that large numbers of popular fish are poor sources of omega-3 fatty acids (Heran and Sgoutas 1987; Wang et al., 1990). In our study, fish species including *Silver pomfret* (Halva sefid), Longfin trevally (Gish-e-deraz bale) and *Xiphophorus Hellerii* (domshamshiri) were poor source of omega-3 fatty acids. Nonetheless fish is one of the valuable sources of fatty acids and the liver tissues of Trout (Ghezel-ALA), Pickhandle barracuda (Kotr-e-sade), Bartail flathead contained the highest amount of omega 3 fatty acids. This is consistent with the results of another study that showed fish liver had the highest quantity of fatty acids compared with other organs.

Many attempts have been made on lipid content of muscle at 2.7% which was found to be better when compared with *Anadontostoma chacunda* (2.6%) (Osman *et al*., 2007), Nibea soldado (1.13%) (Chakraborty *et al*., 2004). The fish Nemipterus japonicus shows a high lipid content in muscle than in liver and skin. The total lipids of the liver, muscle and skin are showing some remarkable variation. This finding is in line with what has been reported by Kinsella *et al*., (1977) showing that the distributions of lipid content from various parts of the fish body is different. But, the deposition of lipids as an energy reserve is encountered in the species of fish. The lipids besides providing energy serve as source of essential fatty acids in fish tissues. Fishes are often classified on the basis of their fat content into lean, medium and fatty fishes (Metcalfe and Schmitz, 1961). Fishes are termed as lean fish when the fat content is more than 10%, while medium fish have 5-10%fat.

Cod liver (Gadiformes order) has been included in this study with comparative purposes, by considering that cod liver oil has been traditionally used to obtaining LCPUFA. In this species, although the muscle contains small amounts of lipids, mainly phospholipids, the liver contains 60–70% of triglycerides (Jangaard et al., 1967; Addison et al., 1968). Other Gadiformes species here studied – hake – shows also a high FA content, thus this species could become a new fish oil producer, such as Argentine hake (Merluccius hubbsi) (Mendez, 1997). Nevertheless, important differences were observed in the FA content among the species of this family: European hake reached much higher EPA + DHA percentages (28.9%) than Mediterranean hake (13.3%) and forkbeard (15.5%). This fact could be explained by considering differences in water temperature in their respective habitats. In this sense, it has been described that the phytoplankton – the primary producers in the marine alimentary chain –biosynthesize higher LCPUFA amounts when water medium reaches lower temperatures (Berge and Barnathan, 2005; Body and Vlieg, 1988). In this sense, a previous observation has been made in the FA composition of roes from European hake and Mediterranean hake (Rincon Cervera *et al*., 2009).

CONCULSION

Over all, a higher level of SFA, MUFA and HUFA level was found in the testes and ovarian tissues of both the lion fishes than in liver and abdominal tissues. Baseline information obtained from this study would immensely helpful in developing captive broodstock and spawners genetic improvement purposes. An intensive research has to be paid to assess the occurrence of FA profile in the juvenile lion fishes of the same species.

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