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RESEARCH ARTICLE

Fatty Acid Profiles of Four Marine Edible Fishes Parangipettai Coast, India

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ABSTRACT

Analyses of Fatty Acid (FA) Composition in marine fishes promote understanding of potential relationship between fish and health of human nutrition. This study was carried out to determine the fatty acid composition in muscle tissue of four edible fishes namely *Nematalosa nasus*, *Alleger para*, *Atropus atropus* and *Parastromateus niger* which were collected from Parangipettai coast, Tamil Nadu. The compositions of fatty acids showed that total saturated fatty acids (SFA; 31.72-47.46%) were highest, followed by the Monounsaturated fatty acids (MUFA; 27.37-45.23%), polyunsaturated fatty acids (PUFA; 16.14-27.51%). All samples showed a significant amount of omega-3 PUFA (5.77-13.13%) compared to omega-6 PUFA (4.94-6.12%).

Keywords: Fatty acid profile, Fish tissue, PUFA

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1. INTRODUCTION:

Fishes are potential food sources in the nourishing of human being. The good taste of fish flesh comes from their fat contents particularly attribution by unsaturated fatty acids (Ackman and Ratnayake, 1989; Gibson, 1988; Magali *et al*., 1990). The nutritional importance of fish consumption is in great extent associated with the content of omega-3 fatty acids (n-3 Fas) and omega-6 fattyacids (Omega-6 FAs) (Okland *et al*., 2005). Polyunsaturated fatty acids are energy sources and also function in the body as components of membranes, modulators of gene expression and precursors for eicosanoids (self healing agents). Essential nutrients are those that the human body cannot manufacture, must be supplied by diet and without which deficiency states (illness) occur. Linoleic Acid (LA) and Alpha- Linolenic Acid (ALA) are the essential poly unsaturated fatty acids and the parent compounds for the omega-6 and omega-3 lines respectively. Arachidonic Acid (AA, 20: 4n-6) is the precursor to both the series of 2 prostaglandins (PGE2 etc) via the cyclo oxygenase pathway and series 4 leukotrienes via the 5-lipo oxygenase pathway. Both of these compounds are strong inflammatory mediators (Guilliams, 2000).

Polyunsaturated Fatty Acids (PUFA), especially the n-3 and n-6 PUFA,have been considered essential fatty acid and have shown to have curative and preventive effects on cardio vascular diseases, neuro development in infants, cancers and fat glycemic control (Conner, 1997; Kinchella *et al*., 1990).

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Decosa Hexaenoic Acid (DHA) is a major structural component of the graymatter of the brain and the eye retina and an imponent of heart tissue. EPA has been used specifically for treatment of atherosclerosis and hyperlipemia, Schizophrenia and certain cancers (Owen and Ajay, 2005).

The ingestion of gamma-linolenic acid (GLA, 18: 3n-6) from Evening Primrose Oil (EPO) or borage oil counteracts the arachidonic acid cascade when it is converted in to dihomogammalinolenic acid (DGLA, 20: 3n-6). GLA is considered by some to be an essential fatty acid because the important enzyme delta)-6- desaturase is poorly used in many individuals or outcompeted by the overload of Trans fatty acids. Arachidonic Acid (ARA) is the principle omega-6 fatty acid in the brain and together with Docosahexaenoic Acid (DHA) is important in the brain development of infants while GLA is metabolic precursor to ARA, its conversion to ARA, mediated by the enzyme Ä-6 desaturase is slow and this enzyme is present only its low levels in humans (Owen and Ajay, 2005). ARA is an essential fatty acid and precursor for biologically active prostagladins and leukotrienes, which have important roles in the circulatory and central nervous systems. GLA, a precursor of ARA is effective in treatment of atrophic eczema, rheumatoid arthritis, multiple sclerosis, schizophrenia and pre-menstrual syndrome (Owen and Ajay, 2005). Currently, there has been very limited research on this fish species polyunsaturated fatty acids and no report was found in the literature concerning the fatty acid composition of this fish species. Therefore, in these study fatty acids profiles of different tissues of the fish were compared and n-PUFA contents were demonstrated for food fish quality considering a potential healthy food source.

2. MATERIALS AND METHODS

Four fish species were analyzed, namely *Nematalosa nasus*, *Aleper para*, *Aurous atropus* and *Parastromateus niger*, which are commercially available to customers, were collected from local fisher man. Immediately after collection, the different species of fish were separated weighed and washed with distilled water and taken in to the laboratory.

Sample preparation and analysis of fatty acid methyl esters

For fatty acid analysis, each fish specimens were beheaded, eviscerated and filleted manually. The tissue samples were oven dried at 67°C for 24 hrs. After that the samples were grounded finely with pestle and 1 mortar. The preparation and analysis of Fatty Acid Methyl Esters (FAMEs) from these fish tissues ware performed according to the method described by (Anon, 2000; Sahin, 2000). 50 mg of tissue samples were added to 1 ml of 1.2 M Na OH in 50% aqueous methanol with glass beads (3 mm dia) in a screw-cap tube and then incubated at 100°C for 30 min in a water bath. The saponified samples were cooled at room temperature for 25 min, they w1ere acidified and methylated by adding 2 ml 54% 6 N Hcl in 46% aqueous methanol and incubated at 80°C for 10 min in water bath. After rapid cooling, methylated FAs were extracted with 1.25 ml 50% Methyl-Tert 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 0.3 M NaOH. After mixing for 5 min, the top phase was removed for analysis. Following the base wash step, the FAMEs were cleaned in anhydrous sodium sulphate and then transferred in to GC 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).

3. RESULTS and DISCUSSION

The Fatty acid composition of four different fish species are listed in Table 1. The fatty acid compositions in the marine fishes differed greatly. The total saturated fatty acid content (31.72-47.46%) was higher in these species than monounsaturated (27.37-45.23%) and polyunsaturated content (16.14-27.51%) are shown in Table 1.

	Name of the fish			
Fatty acid	***Nematalosa Nasus***	***Aleper para***	***Atropus atropus***	***Parastromateus niger***
C10:0	0.13	-	0.06	-
C11:0	-	-	-	-
C12:0	1.11	2.71	0.76	0.33
C13:0	0.24	0.32	-	-
C14:0	5.44	3.68	7.95	4.44
C15:0	1.73	1.24	1.33	1.57
C16:0	20.1	20.02	23.22	20.0
C17:0	1.72	1.32	1.96	2.36
C18:0	1.70	1.30	11.02	6.00
C19:0	0.26	0.18	0.39	0.67
C20:0	0.49	0.46	0.70	0.72
C21:0	-	-	-	-
C22:0	0.29	0.18	0.39	0.67
C23:0	0.35	-	0.30	0.20
C24:0	0.22	0.13	0.43	0.55
Saturated	32.56	31.72	47.46	37.22
14:0 Iso	0.11	-	-	-
15:0 Iso	0.48	0.26	0.44	0.35
15:0 Anteiso	0.31	0.20	0.31	0.19
16:0 Iso	0.27	0.11	-	0.26
17:0 Iso	0.60	0.37	0.37	0.42
17:0 Anteiso	0.29	0.18	0.23	0.27
20:0 Iso	-	0.99	-	1.07
Branched	2.3	2.11	1.89	2.56
C14:1n-7	0.44	-	-	-
C14:1n-5	8.72	1.34	0.40	-

C14:1n-3	-	-	-	-
C15:1n-6	0.20	-	-	-
C16:1n-7	10.14	10.31	9.80	9.05
C16:1n-5	0.80	0.26	0.24	0.22
C16:1n-6	-	-	-	-
C16:1n-9	-	-	-	0.27
C17:1n-8	0.79	0.66	0.68	0.51
C17:1n-7	3.33	1.99	3.26	2.23
C18:1n-9	14.81	29.33	10.77	16.35
C18:1n-7	0.10	-	0.27	0.13
C19:1n-8	-	-	0.13	0.19
C20:1n-5	-	-	-	-
C20:1n-7	0.46	-	-	0.61
C20:1n-9	-	0.72	0.71	0.42
C20:1n-11	1.41	0.45	0.55	-
C23:1n-9	0.10	-	-	-
C24:1n-6	-	-	-	-
C24:1n-9	0.28	0.17	0.56	0.74
Monounsaturated	37.85	45.23	27.37	30.94
C18:3n-3	1.77	3.19	1.61	-
C20:5n-3	5.42	3.48	4.30	1.69
C22:6n-3	3.81	5.33	3.60	2.43
C18:4n-3	-	0.84	-	-
C22:3n-3	0.23	0.29	0.51	1.65
C19:2n-6	-	-	-	-
C20:2n-6	-	-	-	-
C20:3n-6	-	0.36	-	0.78
C20:4n-6	3.08	2.92	3.79	17.76
C16:2n-6	-	0.42	0.47	0.36
C18:2n-6	2.03	1.19	1.35	2.38
C18:3n-6	0.43	0.23	0.51	0.46
Polyunsaturated	16.77	18.25	16.14	27.51
Saturated	32.56	31.72	47.46	37.22
Monounsaturated	37.85	45.23	27.37	30.94
Polyunsaturated	16.77	19.09	16.14	27.51
Branched	2.3	2.11	1.89	2.56
Omega-3 Fas	11.23	13.13	10.02	5.77
Omega-6 Fas	5.54	5.96	6.12	21.94
Unknown and others	10.52	2.69	7.15	1.89

Table 1: Percentage of fatty acid composition in marine fishes Nematalosa nasus, Aleper para, Atropus atropus and Parastromateus niger

This is similar to the study carried out by (Nair and Gopakumar, 1978) in tropical waters. The higher content of Polyunsaturated Fatty Acid (PUFA) was found in *Parastromateus niger* (27.51%), followed by *Aleper para* (19.01%), *Nematalosa nasus* (16.77%) and 16.14% in *Atropus atropus.*

Among the saturated fatty acids, the Palmitic acid (16:0) was the dominant one in the higher in composition also regarded in *Atropus atropus* (23.22%). This was true for all the species examined (Hege *et al*., 2005). The oleic acid (18:1n-9) was dominant monounsaturated fatty acid which was accounted in *Aleper para* (29.33%) while Arachidonic acid (20:4n-6) was dominant polyunsaturated fatty acid in the level of 17.76% (*Parastromateus niger*). Among the n-6 fatty acids, the same arachidonicacid (20:4n-6) was the dominant fatty acid (8.78%) for all species examined. Bowman and Rand (1980) reported that Arachidonic acid (20:4n-6) is a precursor for prostaglandin and thromboxan which will influence the blood clot and its attachment due to the endothelial tissue during wound healing. Apart from that the acid also plays a role in growth. The total Omega-3 fatty acid (5.77-11.23%) was found to be higher than that of Omega-6 fatty acid (15.54-6.12%) in the four fishes studied which are shown in Table 2.

Name of the fish	ALA	EPA	DHA	AA	LA	GLA	DGLA	SA	DTA
Nematalosa Nasus	1.77	5.42	3.81	3.08	2.03	0.43	-	-	0.23
Aleper para	3.19	3.48	5.33	-	1.19	0.23	0.36	0.84	1.13
Atropus atropus	1.61	4.30	3.6	-	1.35	0.51	-	-	0.51
Parastramateus niger	-	1.69	2.43	8.78	2.38	0.46	0.78	-	1.65

Table 2: Percentage composition of omega-3 and omega-6 fatty acids ALA = Alpha Linolenic acid, EPA = Eicosapentaenoic Acid, DHA = Docosahexaenoic Acid, AA = Arachidonic Acid, LA = Linoleic Acid, GLA = Gamma Linolenic Acid, DGLA = Dihomo Gammalinolenic Acid, SA = Stearidonic Acid, DTA = Docosatrienoic Acid

The same tendency was also reported by (Osman *et al.* 2001) in the Malasian marine fishes. Regarding six n-3 FAs; 18:4n-3 (stearidonic acid), 22:3n- 3 (Docosatrienoic acid), 14:1n-3 (Myristoleic acid), medically important 18:3n-3 (Alpha linolinic acid), 20:5n- 3 (Eicosapentaenoic acid) and 22:6n-3 (Docosahexaenoic acid) was found in the range of 5.77- 11.23 in all fishes (Table 2). Alphalinolinic acid was obsence only in *Parastromateus niger*. The stearidonic acid was found in *Alleger para* in the range of 0.84%. The high level of polyunsaturated fatty acid (16.14- 27.51%), especially 20:4n-6, in fish is most probably due to lower oxygen solubility in warmer water (Smith *et al.,* 1980). Medically importance Omega-6 FAs like (- linolenic Acid (GLA) in the range of 0.2-0.6%, Linoleic Acid (LA) 1-3%, Arachidonic Acid (ARA) 3-9%, Dihomogammalinolenic Acid (DGLA) 0.3-0.8% and some Omega-3 FAs like Stearidonic Acid (SA) 0.84% Docosatrienoic Acid (DTA) 0.2-1.65% were found in these samples.

The contents of ALA, EPA and DHA of the fish ranged from 1.77-1.68s; 1.69-5.42% and 2.43-5.33% respectively. In the present study, we observed that DHA and EPA accounted for 1.69-5.42% of the total fatty acids in the muscle of species. The above three omega-3 fatty acids considered as medically important fatty acids (Owen and Ajay, 2005). Piggott and Tucker (1990) suggested that omega-3: omega-6 ratio is a better index in comparing relative nutritional value of fish. This results also indicates that the

omega-3: omega-6 ratio of the fish were higher than 1, except *Parastromateus niger* (0.26%) (Table3).

Name of the Fish	Omega-3:omega-6 ratio
Nematalosa Nasus	2.02
Aleper para	2.20
Atropus atropus	1.54
Parastramateus niger	0.262

Table 3: Fatty acids omega-3: omega-6 ratios

ARA is the principle Omega-6 FAs in the brain and together with DHA is important in the brain development of infants. While GLA is metabolic precursor to ARA, its conversion to ARA mediated by the enzyme)-6 desaturase, is slow and this enzyme is present only in low levels in humans. Hence it is considered preferable to feed ARA to humans rather than GLA. ARA is also a direct precursor of a number of eicosanoids regulating lipoprotein metabolism, blood rheology and leucocytes function and platelet activation. Good nutritional source of ARA are animal livers and yolk Owen and Ajay (2005). Linoleic Acid (LA) is the most abundant PUFA in the human skin. Among other things, it plays vital role in preserving our epidermal water barrier. Defiance in this EFA (Essential Fatty Acid) results in scaly skin and excessive water loss (Ziboh *et al*., 2000). The Omega-3 FAs such as Stearidonic Acid(SA) and Docosatrienoic acid(DTA) are plays an important role in the Biological Effects; Antiarrhythmic, Anti-inflammatory responses (Penny *et al*., 2006). The results of the present study revealed that the most abundant individual FAs were Palmitic acid, Oleic acid, Arachidonic Acid (AA), docosahexaenoic acid (DHA) is most the tissues. This result was confirmed by several other studies for some tissues of different fish (Silversand *et al*., 1996; Czesny *et al*., 2000). In this present study, we investigated the fatty acid composition of muscle from 4 different fish species and found more amounts of polyunsaturated fatty acids like ALA, EPA, DHA, GLA, ARA, DGLA, SA and LA etc.

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