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RESEARCH ARTICLE

FATTY ACID COMPOSITION OF COMMERCIALLY IMPORTANT FISH FROM NAGAPATTINAM COAST, TAMIL NADU, INDIA

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ABSTRACT

The present study was undertaken to evaluate the differences in the fatty acid composition between the species of finfishes of Nagapattinam coast, Tamil Nadu, India. The values of 20:0 and 20:2*n*-6 fatty acids did not significantly differ ($P > 0.05$) between *S. fimbriata* and *E. malabaricus*. The levels of saturated (SFA), monounsaturated (MUFA) polyunsaturated (PUFA) fatty acids varied between two fishes. The fatty acid composition showed quantitative differences in the percentages of individual acids between the species. Total fatty acids included 43.23% of SFA, followed by 37.29% of PUFA and 24.48% MUFA in *S. fimbriata*. In *E. malabaricus* total SFA content was 49.02%, MUFA 32.51% and PUFA 23.47% of the total fatty acid composition.

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INTRODUCTION

All animals and plants contain three major classes of fatty acids - saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids. There are two classes of PUFA namely *n*-6 and *n*-3. There are several fatty acids within each of the above classes, differing 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). All plants and animals (terrestrial and marine) synthesize SFA and MUFA. Unlike plants, mammals and fish cannot synthesize linoleic (LA) and α-linolenic (ALNA) acids. During recent years, fish lipids have been recognized as being beneficial for human health. Many studies have been carried out on the metabolism and function of polyunsaturated fatty acids (PUFAs) in general and on the levels and ratios of *n*-3 and *n*-6 fatty acids in particular. Today it is known that *n*-3 fatty acids, or a balanced *n*-3/*n*-6 ratio in the diet, are quite essential for the normal growth and development. They also play an important role in the prevention and treatment of coronary artery disease, diabetes, hypertension and cancer (Salem *et al*., 1996; De Lorgeril *et al*., 1999; Goodstine *et al*., 2003). From the point of view of human health it is thus important to increase the consumption of fish or fish products, which are rich in polyunsaturated fatty acids of the *n*-3 family and poor in polyunsaturated fatty acids of the *n*-6 family (Burr, 1989; Sargent, 1997). Significant attention has been paid to study the fatty acids composition of fish, due to numerous health benefits attributed to fish lipids. In general, the lipids of marine fish are characterized by low concentrations of linoleic (LA, C18:2*n*-6) and linolenic (LNA, C18:3*n*-3) acids and high levels of eicosapentaenoic (EPA, C20:5*n*-3) and docosahexaenoic (DHA, C22:6*n*-3) acids (Steffens, 1997). There are high concentrations of polyunsaturated EPA and DHA in marine fish because some microalgae can contain up to 27% of EPA (Brown *et al*., 1997). The essential C18:2*n*-6 and C18:3*n*-3 fatty acids are important in the human diet because they affect the fluidity, flexibility and permeability of the membranes and are precursors of the eicosanoids (prostaglandins, thromboxanes and leukitrienes), that act as messengers of the cell and metabolic regulators (Gil, 2002). The Omega-3 fatty acid found in fish helps to keep the heart healthy throughout the life (Naylor *et al*., 2000).

MATERIAL AND METHODS

The marine fishes were collected regularly during four seasons (premonsoon, monsoon, postmonsoon and summer) from Nagapattinam coast for a period of one year from July 2016 to

June 2017. The collected samples were immediately brought to laboratory in an iced condition. The freshness of fishes was examined by observing the brightness of the eyes, colour of the gills and the texture of the muscles. The size groups of two finfish species i.e. 10-15 cm in *Sardinella fimbriata*, and 30-40 cm in *Epinephelus malabaricus* were chosen for the present study. For the purpose of identification, the publications of Munro (1955) and Fischer and Bianchi (1984) have been referred. The edible tissues of pooled samples (10 individuals) of each species were oven dried at 60°C for 24 hours and used in the analysis of fatty acids. For fatty acid analysis, the dried samples were homogenized with chloroform: methanol (3:1 v/v) mixture and the fats were extracted. After fat extraction, they were esterified with 1% H_2SO_4 and fatty acid methyl esters (FAME) were prepared by following the procedure of AOAC (1995). The FAME was injected into the Gas Chromatography (Hewlett Packard 5890) capillary column (25 m X 0.32 mm i.d.) coated with 5% phenyl silicone at the temperature from 170 to 310°C for 23.33 minutes. Quantification was done with a calibrated plotter integrator and peaks identified using the standards for the most common FAME's. The reported fatty acid compositions are expressed as percentage of total FA's.

RESULTS AND DISCUSSION

The lipids from fish species are special in nature and differ from mammalian lipids. The difference is that fish lipids include up to 40% of long chain fatty acids (14-22 carbon atoms), which are highly unsaturated. Mammalian fat will rarely contain more than two double bonds per fatty acid molecule (Shamasundar, 2001). Gopakumar (1997) who studied the fatty acid composition of various Indian food fishes as *Sardinella longiceps*, *Euthynnus affinis*, *Mugil cephalus* found the levels of SFA to be 41.8%, 52.8% and 41.1%; The MUFA levels were found to be 23.6%, 27.4% and 36.9%; and PUFA levels 32.1%, 15.1% and 13% respectively. In the present study on *S. fimbriata* and *E. malabaricus*, the levels of SFA were 43.23% and 49.02%; the levels of MUFA were 24.48% and 32.51%; and PUFA levels were 37.29% and 23.47% respectively (Table 1). A close similarity was observed in major components of all species studied now, but the overall contribution of PUFA was found more. It has been reported that the types and amounts of fatty acids in fish tissues vary mainly with what the fish eat, but other factors may also influence their fatty acid composition. Size or age, reproductive status, geographic location and different seasons influence fat content and composition of fish muscle (Alasalvar *et al*., 2002). The levels of individual fatty acids in fish will depend, of course, on the total fat content and percentage distribution of the fatty acids changes as the fat content of the fish rises and falls. When the fat content increases, the contribution of the monounsaturated fatty acids increases from around 30% to 60%, while the level of polyunsaturated fatty acids decrease from 50% to 20% (Childs and King, 1993). The fatty acid content of a fish may also change according to diet. As might be expected, the saturated fatty acids dominate the pattern, but essential fatty acids like eicosapentaenoic (EPA, C20:5*n*-3) and docosahexaenoic (DHA, C22:6*n*-3) acids are present in all species studied. The results on the variations of EPA and DHA are in good agreement with previous reports on different species (Shirai *et al*., 2002). The fluctuations in the fatty acid profiles in the present study illustrate how fatty acid differs between species.

Table 1. Fatty acid composition (Mean ± S.D.) of finfish species collected from Nagapattinam coast (% of total fatty acids)

Fatty Acid	*Sardinella fimbriata*	*Epinephelus malabaricus*
12:0	0.54 ± 0.12^{a}	0.70 ± 0.11^{cb}
14:0	6.82 ± 0.25^{a}	9.22 ± 0.21^{b}
16:0	27.29 ± 0.21^{b}	28.66 ± 0.15^{bc}
18:0	5.22 ± 0.19^{a}	8.64 ± 0.31^{b}
20:0	0.82 ± 0.11	n.d.
22:0	0.74 ± 0.12^{c}	n.d.
16:1*n*-7	5.61 ± 0.34^{a}	5.32 ± 0.35^{a}
18:1*n*-9	11.63 ± 0.25^{a}	15.61 ± 0.11^{cd}
20:1*n*-9	5.33 ± 0.05^{a}	8.63 ± 0.17^{b}
22:1*n*-9	3.31 ± 0.24^{b}	4.35 ± 0.12^{c}
16:2*n*-6	0.65 ± 0.10^{c}	0.32 ± 0.05^{a}
18:2*n*-6 (LA)	5.32 ± 0.13^{bc}	4.62 ± 0.15^{ab}
18:3*n*-6	1.32 ± 0.12^{c}	0.75 ± 0.11^{a}
20:2*n*-6	0.31 ± 0.06	n.d.
20:3*n*-6	0.55 ± 0.10^{b}	0.45 ± 0.13^{ab}
20:4*n*-6 (AA)	2.35 ± 0.15^{b}	0.85 ± 0.11^{a}
22:4*n*-6	0.13 ± 0.02	n.d.
22:5*n*-6	0.51 ± 0.13^{a}	0.14 ± 0.02^{a}
18:3*n*-3 (LNA)	0.98 ± 0.10^{b}	3.98 ± 0.21^{c}
18:4*n*-3	0.45 ± 0.14^{a}	0.75 ± 0.15^{b}
20:3*n*-3	1.42 ± 0.13^{a}	2.85 ± 0.21^{bc}
20:4*n*-3	1.85 ± 0.21^{c}	0.75 ± 0.17^{a}
20:5*n*-3 (EPA)	7.32 ± 0.15^{c}	3.25 ± 0.16^{a}
22:5*n*-3	3.74 ± 0.21^{b}	0.38 ± 0.03^{a}
22:6*n*-3 (DHA)	12.34 ± 0.28^{d}	5.65 ± 0.11^{b}
Σ SFA	43.23	49.02
Σ MUFA	24.48	32.51
Σ PUFA	37.29	23.47
Σ *n*-3 series	28.27	18.02
Σ *n*-6 series	8.02	5.55
n-3/*n*-6	3.32	3.42
EPA/DHA	0.68	0.69

Mean values ± S.D. of determinations for duplicate samples; n.d. - not detected
Means in the same row sharing different superscripts are significantly different ($P < 0.05$); Values without letters within a row are not significantly different ($P > 0.05$). LA - linoleic acid; AA – arachidonic acid; LNA - linolenic acid; EPA - eicosapentaenoic acid; DHA - docosahexaenoic acid; SFA - saturated fatty acids; MUFA - monounsaturated fatty acids; PUFA - polyunsaturated fatty acids.

The muscle of the three species *Sardinella maderensis*, *S. aurita* and *Cephalopholis taeniops* contained high concentrations of omega-3 fatty acids (PUFA), ranging from 16.0 to 29.1% with 20:5 and 22:6 acids as major components (Hamilton *et al*., 2014). Nair and Suseela (2000) suggested that the marine animals are the richest sources of PUFA. Total PUFA may account for about 15-25% of the total fatty acids, where 20:5 and 22:6 acids together accounted for about 90% which is more or less in agreement with the present study. The nutritional quality of fish is to a greater extent associated with the content of omega-3 (*n*-3) fatty acids. The *n*-3 and *n*-6 fatty acids are the two biochemical families within the PUFAs, and they also have different biological effects (James and Cleland, 1996). Traditionally, fish with high fat content, like rainbow trout, has been considered to be nutritionally important species since it has a relatively high content of *n*-3 fatty acids. However, it has been demonstrated that there is an inverse relationship between amount of *n*-3 of fatty acids and total fat content (Kristinsson and Rasco, 2000). This implies that it is important from the nutritional point of view to place attention upon getting species with high proportions of *n*-3 fatty acids instead of only focusing on the fat content. Previous studies have also demonstrated the beneficial role of lean fish, as well as fatty fish consumption, in the prevention of cardiovascular disease (Kromhout, 2001). The present study showed moderate levels of *n*-3 fatty acids. The increase in lipid level during summer may also be explained by an enhanced feeding activity due to higher sea water temperature and increased day length which have a positive influence on appetite (Anil *et al*., 2016). The samples collected during summer showed characteristic variation in the quantity of fatty acid in the present study also.

Conclusion

The results of the present study clearly revealed that two species of finfishes studied are containing good quantities of SFA, MUFA and PUFA. These fishes can provide the required level of PUFA to the consumer without the need to supplement with another source.

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