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Omega-3 Polyunsaturated Fatty Acid Content of Some Popular Species of Arabian Gulf Fish

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ABSTRACT

Twenty of the popular species of fish caught in the Qatari water of the Arabian Gulf were analyzed for the fatty acid content of the edible portions. All species studied contained several fatty acids of the important omega-3 poly-unsaturated group. The level of this group varied from a low of about 0·035 to a high of more than 3 g/100 g edible tissue most of which was made up of the two major acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Sardines had the highest content of the total omega-3 polyenoic fatty acids with more than 3 g/100 g edible tissue followed by Grey Sweet Lip which contained nearly 0·7 g/100 g. Medium levels of around 0·3–0·4 g/100 g were found in Malabar Cavalla, Orange Spot Trevally, Crevalle, Black Spot Snapper, Black-Fin Crevalle, King Mackerel and Mullet. Low levels of less than 0·2 g were found in Common Mojarra, Golden Trevally, Red Snapper, Cobia, Rabbit Fish, Porgy, Greasy Grouper, Grey Dog Shark and Orange Emperor. Low levels were also found in crab (0·22 g) and shrimp (0·08 g). This study shows that there are several species of Arabian Gulf fish considered as good sources of the omega-3 polyunsaturated fatty acids. The widely popular species of Greasy Grouper was found, however, a poor source for this essential group of fatty acids.

INTRODUCTION

Fish is an excellent source of high quality protein needed for normal body growth and well-being. Recently, however, other exciting beneficial effects have been attributed to fish consumption. Among the most interesting of these is the established relationship between fish consumption and reduced incidence of cardiovascular diseases. This beneficial effect was found to be due to the fat of fish and other edible marine animals. Analysis of this fat revealed that it is, unlike other plant or animal fats, rich in the omega-3 polyenoic fatty acids especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). These fatty acids have been shown to act favorably on a broad spectrum of factors implicated in the pathogenesis of atherosclerosis including blood lipids, platelet responsiveness, blood pressure and response to pressor hormones, and eicosanoid formation (Nestel, 1987; Von Schacky, 1987). Analytical laboratories are now busy analysing various species of fish for their content of the omega-3 polyunsaturated fatty acids and tables with this information are already available (Puustinen *et al.*, 1985; Evans *et al.*, 1986; Hepburn *et al.*, 1986; Fogerty & Svoronos, 1987). The present study aimed at providing information on the fatty acid composition of some of the popular species of fish available in the Qatari water of the Gulf.

MATERIALS AND METHODS

Species analyzed

Twenty species of fish caught from the Gulf were sampled for analysis. Samples were collected fresh from the Central Fish Market in Doha. Table 1 gives the common English names and the local names predominantly used in the Arab countries of the Gulf for these species (Kuronuma & Abe, 1972; Sivasubramaniam & Ibrahim, 1982). Samples were collected during one month from mid-October to mid-November, 1987. The prevailing water temperature in the Qatari water of the Gulf during this time tends to be usually warm. Generally the inshore average water temperature varies from 15°C in Jan./Feb. to 35°C in August. In the off-shore waters, the surface temperature varies between 22 and 33°C. In the lagoons the temperature could vary between 15°C in winter and 40°C in summer (Sivasubramaniam & Ibrahim, 1984).

Sample preparation

About 2–5 kg of fresh fish depending on the size were collected as a sample for each species. Individual fishes of uniform size within each sample were

TABLE 1
Names and Weights of Fish Species Sampled

Common local name	*Common English name*	*Average total weight (g)*	*Fat content of edible portion (%)*
Saffi	Rabbit Fish	60	0·80
Oom, Sardine	Sardines	90	13·00
Garfa	Black-Fin Crevalle	140	1·30
Badah	Common Mojarra	185	1·10
Zobaidy	Malabar Cavalla	218	1·60
Naisar	Black Spot Snapper	222	1·50
Yanam	Grey Sweet Lip	225	3·90
Faskar	Porgy	235	0·45
Karari	Crevalle	351	1·70
Sheary	Orange Emperor	380	0·27
Jash	Orange Spot Trevally	400	1·50
Sikin	Cobia	450	0·70
Hamrah	Red Snapper	600	0·70
Beyah	Mullet	1 090	1·80
Rabeeb	Golden Trevally	1 150	0·66
Jarjour	Grey Dog Shark	1 920	0·40
Kanaad	King Mackerel	2 150	1·60
Hamour	Greasy Grouper	2 950	0·35
Rubian	Shrimp	10	0·50
Gubgub	Sea Crab	277	1·00

selected. Size measurements were taken and averages calculated for each sample. The edible portion of each fish was prepared by removing the head, the viscera, the skin, and the bones. After weighing the edible portion of each fish, all portions of the samples were pooled and uniformly homogenized.

Determination of total fat and fatty acids

Portions weighing 2 g of the homogenized samples were extracted in a Soxhlet apparatus using diethyl ether for 3 h. The extracts were passed through anhydrous sodium sulfate and evaporated under vacuum at 30°C. The fat yield was quantitated gravimetrically.

Fatty acids were separated and quantitatively determined by gas liquid chromatography (GLC) as their methyl esters using a method similar to that of Puustinen *et al.* (1985) for sample preparation and fatty acid methylation. Sample size was, however, increased to 3 g instead of 1 g and reagents increased proportionately to obtain higher yields of fatty acids especially with species of low fat content. The oil was extracted from 3 g of tissue by a 2/1 chloroform/methanol mixture and methyl esters of fatty acids were then

prepared using boron trifluoride as a catalyst. A gas liquid chromatograph (Packard Model 430) equipped with a flame ionization detector and a glass column (2 m × 2 mm i.d.) packed with 10% DEGS was used. The column temperature was programmed to retain 150°C for 3 min then raised to 200°C at 5°C/min. Both detector and injector temperatures were kept at 250°C. Nitrogen was used as the carrier gas at a flow rate of 25 ml/min. The flow rates for hydrogen and air were 25 and 250 ml/min, respectively. The various fatty acids were identified and quantitated by comparison with known amounts of standard fatty acid methyl esters (Sigma, USA). Fatty acid content was then calculated as mg/100 g edible portion.

RESULTS AND DISCUSSION

Results of the fatty acid composition of all 20 species samples are presented in Table 2. All species studied contained several fatty acids of the omega-3 polyunsaturated group. The level of this group varied from a low of about 0·035 to a high of about 3·01 g/100 g edible tissue most of which (52–90%) was made up of the two major acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). There was no consistent trend for the DHA/EPA ratio; in 14 species the ratio was in favor of DHA whereas in the other six species EPA predominated. The highest ratio in favor of DHA (7·25) was found in Malabar Cavalla (Zobaidy). In the two crustacean species studied (shrimp and sea crab) the ratio was in favor of EPA. Sardines had the highest content of the total omega-3 polyenoic fatty acids with more than 3 g/100 g edible tissue. Slightly more than half (54·4%) of this amount was in the form of eicosapentaenoic acid. Analyses conducted in Australia (Fogerty & Svoronos, 1987) on oil-drained canned sardines from several countries suggested a wide range for the total omega-3 polyenoic acids from about 0·5 g for a species from Thailand to more than 5 g in a Japanese sample. Several other samples from Norway, Portugal and Scotland were somewhat similar in their content of this group of fatty acids at around 3 g/100 g. This suggests that most species of sardines including Gulf sardines are rich sources of the omega-3 polyenoic fatty acids. The second richest source in this group of fatty acids among the 20 species of this Gulf fish study was Grey Sweet Lip (Yanam) which contained nearly 0·7 g/100 g of edible tissue. Medium levels of around 0·3–0·4 g/100 g were found in Malabar Cavalla (Zobaidy), Orange Spot Trevally (Jash), Crevalle (Karari), Black Spot Snapper (Naisar), Black-Fin Crevalle (Garfa), King Mackerel (Kanaad) and Mullet (Beyah). Low levels of less than 0·2 g/100 g were found in Common Mojarra (Badah), Golden Trevally (Rabeeb), Red Snapper (Hamrah), Cobia (Sikin), Rabbit Fish (Saffi), Porgy (Faskar),

TABLE 2
Fatty Acid Content (mg/100 g edible portion)

Sample no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Fish name	*Rabbit Fish*	*Sardines*	*Black-Fin Crevalle*	*Common Mojarra*	*Malabar Cavalla*	*Black Spot Snapper*	*Grey Sweet Lip*	*Porgy*	*Crevalle*	*Orange Emperor*	*Orange Spot Trevally*	*Cobia*	*Red Snapper*	*Mullet*	*Golden Trevally*	*Grey Dog Shark*	*King Mackerel*	*Greasy Grouper*	*Shrimp*	*Sea Crab*
Fatty acids																				
14:0	3·3	933·0	39·3	12·9	17·2	19·7	80·0	4·6	21·4	3·3	38·8	5·8	11·2	114·9			33·6	2·2	3·5	10·1
15:0	48·1	39·1	5·6	6·9	5·1	5·3	23·2	2·8	6·1	—	7·6	2·1	1·7	47·4	—	—	6·5	—	1·6	4·1
15:1	32·8	2·0	1·3	2·4	2·1	2·9	5·1	5·7	49·3	7·7	2·0	3·2	1·2	7·2	10·6	3·6	0·7	10·4	4·3	3·3
16:0	95·6	1753·1	158·5	169·5	218·3	202·4	499·0	58·0	196·0	34·0	223·6	58·8	83·2	49·8	46·2	39·1	264·6	46·7	30·8	89·7
16:1	32·6	1229·9	55·7	55·0	—	50·7	201·5	13·8	32·5	13·0	59·9	13·1	21·3	201·9	—	—	69·6	18·6	14·1	29·4
17:0	14·7	148·6		12·0	—		13·9					18·6	5·0	33·0	—	—		4·2	2·1	2·2
17:1	30·0	121·7	—	—	25·3	—	—	—	31·0	—	—	—	22·5	18·7	25·9	—	—	—	—	—
18:0	52·8	303·7	55·5	41·6	131·3	103·1	152·7	19·5	118·5	12·8	85·6	51·2	44·9	32·5	48·9	12·4	100·8	12·3	20·9	36·2
18:1	60·7	964·8	61·1	138·0	172·8	179·6	542·7	36·1	126·1	17·8	137·1	54·6	61·9	105·3	43·0	27·1	187·0	24·0	32·9	83·5
18:2 (ω-6)	5·6	131·4	8·8	9·1	14·0	13·5	38·0	1·1	9·0	1·1	11·9	3·2	2·7	20·0	1·0		14·4	1·5	23·2	22·4
18:3 (ω-3)	—	7·0	25·8	0·4	1·3	—	4·1	—	2·5	—	12·8	—	—	13·4	—	—	5·3	—	—	1·7
18:4 (ω-3)		230·3	23·6	20·5	11·3	12·9	60·5	2·6	6·4	—	13·1	—	—	52·1	—	—	11·3	0·6	3·0	11·2
20:2	—	—	—	2·3			—						—	—			—	—		0·6
20:3 (ω-6)	—	6·7	—	3·8	—	—	16·8	—	—	—	—	—	—	—	—	—	—	—	—	—
20:4 (ω-6)	20·7	197·1	20·4	43·0	39·8	71·8	180·0	21·7	24·4	7·4	21·6	26·1	29·0	70·4		8·5	29·0	4·7	31·7	55·1
EPA—20:5 (ω-3)	22·1	1637·9	74·8	36·8	37·0	64·6	278·5	31·3	42·7	9·3	55·9	23·4	29·0	146·1	51·4	15·3	46·6	17·7	43·5	124·6
22:0	—	124·6	8·8	4·7	9·8	—	51·2	—	14·5	—	14·5	—	—	25·5	—	—	13·0	—	—	—
22:1	0·3	159·1		4·7	—	2·1	12·2	1·1	—	—	—	—	—	0·4		10·9	1·7			0·3
22:3 (ω-6)	4·4	—	5·0	22·1	14·7	44·4	132·7	5·0	5·8	1·4	7·8	6·9	5·0	6·8	—	10·9	8·1	4·8	4·1	1·6
22:4 (ω-3)	10·2	106·9	10·6	16·8	31·1	38·0	63·4	3·3	23·9	3·7	23·2	7·9	7·5	11·9	5·3	1·1	22·1	4·3	6·0	12·6
22:5 (ω-3)	16·5	206·0	15·5	35·9	34·5	35·3	131·5	11·4	22·4	1·9	20·0	7·9	6·4	27·6	6·7	9·1	25·5	2·5	6·0	15·8
DHA—22:6 (ω-3)	36·0	822·5	159·2	41·3	268·5	159·3	151·5	30·2	244·1	19·6	238·0	60·9	81·5	38·9	63·8	12·7	195·1	29·2	24·0	56·2
Total ω-3	84·8	3010·6	306·5	151·7	383·7	310·1	689·5	78·8	342·0	34·5	363·0	100·1	124·4	290·0	127·2	38·2	305·9	54·3	82·2	222·1
Total ω-6	30·7	335·2	34·2	78·0	68·5	129·7	367·5	27·8	39·2	9·9	41·3	36·2	36·7	97·2	1·0	19·4	51·5	11·0	59·0	79·1
Ratio DHA/EPA	1·6	0·5	2·1	1·1	7·3	2·5	0·5	1·0	5·7	2·1	4·3	2·6	2·8	0·3	1·2	0·8	4·2	1·7	0·6	0·5
Ratio ω-3/ω-6	2·8	9·0	9·0	1·9	5·6	2·4	1·9	2·8	8·7	3·5	8·8	2·8	3·4	3·0	127·2	2·0	5·9	4·9	1·4	2·8
EPA (%)	26·1	54·4	24·4	24·3	9·6	20·8	40·4	39·7	12·5	27·0	15·4	23·4	23·3	50·4	40·4	40·1	15·2	32·6	52·9	56·1
DHA (%)	42·5	27·3	51·9	27·2	70·0	51·4	22·0	38·3	71·4	56·8	65·6	60·8	65·5	13·4	50·2	33·2	63·8	53·8	29·2	25·3

Greasy Grouper (Hamour), Grey Dog Shark (Jarjour) and Orange Emperor (Sheary). Only two crustacean species were analyzed in this work. Levels of omega-3 polyenoic fatty acids were found higher in crab meat (about 0·2 g/100 g) compared to shrimp (less than 0·1 g/100 g). This study shows that there are several species of Arabian Gulf fish considered as good sources of the omega-3 polyunsaturated fatty acids. It is interesting, however, to note that the widely popular species of Greasy Grouper (Hamour) was found a poor source for this essential group of fatty acids. It should be noted that these results apply only to sizes used in this study. Other factors affecting fatty acid composition including fish size and method of cooking are now under study.

The impressive beneficial effects that have been recently attributed to fish oil in relation to heart disease (and maybe some other degenerative diseases) should not lead to overconsumption of fish, fish oil or omega-3 polyenoic fatty acids. Overconsumption may lead to undesirable effects such as higher rates of hemorrhagic events due to overdosage of omega-3 polyenoic fatty acids (Von Schacky, 1987) or chronic poisoning due to increased ingestion of contaminants widely present in the marine environment such as heavy metals (e.g. mercury, lead, cadmium, etc.) and chlorinated hydrocarbons. Moderate consumption of fish on a regular basis is, however, highly recommended.

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