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OMEGA-3 POLYUNSATURATED FATTY ACIDS CONTENT OF POMFRETS (*STROMATEUS* SP, *PARASTROMATEUS* SP) AND MACKEREL (*SCOMBEROMORUS* SP) FROM KARACHI COASTAL WATERS

RIAZ FATIMA, R. B. QADRI, VIQARUDDIN AHMED* AND KANIZ FIZZA*

PCSIR Laboratories Complex , Off University Road, Karachi-75280, Pakistan

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Three commercially important fish were analyzed for fatty acid profile with particular reference to n-3 PUFAs, the EPA (20:5n-3) and DHA (22:6n-3) in their muscle lipid. The data revealed that black pomfret and mackerel were rich sources of n-3 PUFAS while white pomfret was not. The data also showed that temperature of coastal waters has profound effect on the percentage composition of saturates and unsaturates.

Key words: Lipid, Omega-3 polyunsaturated fatty acids, Pomfrets, Mackerels.

Introduction

The recognition of nutritional qualities of seafood, especially, the recent emphasis on the health effects of omega-3 polyunsaturated fatty acids (n-3 PUFAs) has motivated the use of marine fish,shellfish and allied animals as a best source of food rice in n-3 PUFAs. High consumption of n-3 PUFAs may reduce the risk from cardiovascular diseases, diabetese, help to fight against inflammatory and immunological disease and supress tumor growth of certain sites [1-3].

Researchers have recognized that seafood lipids are the best natural source of highly unsaturated fatty acids particularly in respect to the longer chain (C20, C22) n-3 polyunsaturated fatty acids [4].

The objective of the present study was to determine the fatty acids profile with particular emphasis on n-3 PUFAs of muscle lipids of white pomfret (*Stromateus* spp) black pomfret (*Parastromateus* spp) and mackerel *Scomberomorus* spp). The fish which are selected for study are commercially important and popular among the local population and are available abundant throughout the year along the coastal area of Pakistan.

Materials and Methods

Samples of three different species of fish were collected from various locations along the Karachi Coastal area during the period Apr. - Jul. and Oct. - Jan., 1991. Samples were frozen immediately after collection and kept frozen until assayed.

Fish samples (100 g) were extracted for total lipid content by the method of Bligh and Dyer [5]. Extracted lipids were stored at 40° under nitrogen until used. For G.C. analysis extracted lipid was methylated with 0.5% sodium methoxide in methanol and refluxed. After 45 min., the solution was diluted with distilled water and extracted with hexane, dried over sodium sulphate (anhydrous) and diluted in hexane.

The recovered methyl esters were analysed on fused silica capillary column 30 m x 0.32 mm 1.D coated with SUPEL-COWAX 10 in G.C 9A Shimadzu gas chromatography equipped with a flame ionization detector. Chromatographic conditions were as follows: Injection port temperature 300°, flame ionization detector temperature 300°, column initial temperature, 150° for min. rising to 250x at 5°/min. with a final hold time of 10 min. The carrier gas used was N_2 at a pressure of 6 psi. Retention times and peak areas were computed automatically by computing integrator. Compounds were tentatively identified by comparison with the retention times of known standards (Sigma Chemical Co. St. Louis, MO).

* HEJ Research Institute of Chemistry, Karachi University, Karachi-75270, Pakistan

Results and Discussion

The average muscle lipid percentages and fatty acids composition of white pomfret (*Stromateus* sp.), black pomfret (*Parastromateus* sp) and mackerel (*Scomberomorus* sp) are given in the Table 1. In general, samples collected during October to January had higher lipid content compared to samples collected during Apr. – Jul. It is well documented that the content of fish lipid varies with species, season, physiological status, diet and location [5-7].

Table 1 presents the average values of fatty acid composition of fish lipids for the species studied. These values are as weight percent of total fatty acid methyl esters. Fatty acids are designated by number of carbon atoms : number of double bonds. Common names are not indicated because

TABLE 1a. TOTAL LIPIDS (g/100g) IN MUSCLE.

	April – July	October – January
White Pomfret	1.4	1.63
Black Pomfret	2.1	2.3
Mackerel	3.5	7.5

fatty acids in fish are primarily unsaturated and they are mixture of several isomers. The isomers of fatty acids are those fatty acids which were present in traces, were not accounted in this study.

The distribution of saturated fatty acids (saturates), monosaturated fatty acids (monoenes) and polyunsaturated fatty acids (polyenes) in three species of fish examined was found to be as follows: During Apr.-Jul. saturates were identified from C10 to C24, monoenes C14and polyenes from C18 to C22 and during Oct.-Jan. from C14 to C22, C14 to C24 and C18 to C22 respectively in white pomfret. The identified fatty acid of black pomfret were from C14 to C24 saturates, C14 to C24 monoenes and C18 to C22 polyenes during Apr-Jul and Oct.-Jan. The detected fatty acids of mackerel were from C10 to C24 saturates C16 to C24 monoenes and C18 to C22 polyenes in both Apr.-Jul. and Oct.-Jan.

During Apr. – Jul. the total saturates accounted were about 42.68, 42.62, 39.07% total monoenes 44.7, 21.88, 20.96% and total polyenes 11.15, 22.78, 28.99% in white pomfret, black pomfret and mackerel respectively. During Oct. – Jan. the accounted total saturates were found to be 35.08, 39.5% 37.8% total monoenes 46.5, 23.12, 24.23% and total polyenes 16.64, 33.83, 36.67% in white pomfret, black pomfret and mackerel respectively.

TABLE 1b. FATTY ACID COMPOSITION (WEIGHT %) DERIVED FROM TOTAL LIPIDS OF WHITE, BLACK POMFRET AND MACKEREL/(THE DATA DENOTE THE MEAN OF EIGHT DIFFERENT SAMPLES OF EACH SPECIES COLLECTED DURING THE PERIOD).

Fatty acids	White pomfret		Black pomfret		Mackerel	
	April-July	October-January	April-July	October-January	April-July	October-January
10:0	0.0354	0	–	–	0.2431	0.12431
12:0	0.0574	0	–	–	–	–
13:0	0.0338	0	–	–	–	–
14:0	4.6510	3.115	1.2202	0.8555	2.1744	2.2583
15:0	0.5204	0.1115	0.7536	0.2588	0.5837	0.5135
16:0	21.8510	20.7564	27.4846	25.5880	23.2948	22.5335
17:0	2.4750	2.2111	1.1586	0.9255	1.4762	1.2125
18:0	9.1110	8.3695	8.3424	10.5510	6.0664	7.0664
19:0	0.4412	0.1118	0.749	0.2555	0.6901	0.6982
20:0	0.4112	0.2939	1.775	1.0253	0.2885	0.2950
22:0	2.910	0.1115	0.9520	0.9589	3.1050	3.0125
24:0	0.1853	0	0.1852	0.0855	1.7822	0.1855
Total saturates	42.6827	35.0807	42.6206	40.504	39.704	37.8997
14:1	0	0.0708	0.5122	0.8012	–	–
16:1	2.2555	3.1398	2.4870	2.556	5.0153	6.7551
18:1	18.2555	19.8511	12.2211	14.5005	13.5171	15.6551
20:1	2.6690	3.5110	0.8589	0.09583	0.5678	0.4560
22:1	2.2551	2.3954	3.2798	2.9550	0.2822	0.5822
24:1	19.3110	17.5475	2.5309	1.3550	1.5830	1.6855
Total monoenes	44.7461	46.5156	21.8899	23.126	20.9654	24.1339
18:2	0.02115	0.3062	0.6315	–	1.4272	1.3121
18:3	0.0350	0.1927	0.2132	0.0428	0.7107	0.8552
18:4	0.0275	0.0421	0.4314	0.5511	0.3594	0.5351
20:2	0.1555	0.2596	0.6466	1.850	0.5447	0.2355
20:3	0.1555	0.45556	1.0401	3.5510	4.4420	4.8751
20:4	4.4552	4.5574	2.2553	3.5510	3.0269	3.8950
20:5	0.0541	0.9112	5.0823	8.5551	7.1503	8.5120
22:3	0.0554	0.0332	–	–	–	–
22:4	0.0985	0.7981	2.2798	2.0198	0.5610	0.5421
22:5	2.9798	4.5590	0.6534	0.0152	1.5610	1.3351
22:6	3.1123	4.5251	9.551	16.2511	9.2135	14.5551
Total polyenes	11.1499	16.6401	22.784	36.3671	28.9967	36.6723

The prominent fatty acids in all species of fish were as follows: In white pomfret saturates C16:0 palmitic acid (21.85% Apr.-Jul., 20.75% Oct.-Jan.). C18:0 stearic acid (9.11% Apr.-Jul., 8.36% Oct.-Jan.), monoens C18:1 Oleic acid (18.25% Apr.-Jul., 19.85% Oct.-Jan.), C24:1 nervonoic acid (19.31% Apr.-Jul., 17.54% Oct.-Jan.) and polyenes C20:4 arachidonic acid (4.45% Apr.-Jul., 4.55% Oct.-Jan.) and C22:6 docosahexaenoic acid (3.11% Apr.-Jul., 4.52% Oct.-Jan.) were investigated. In black pomfret slight variations in, prominent saturates, monoenes and polyenes were obtained (Table 1.) In mackerel the principal fatty acids were accounted as saturates C16:0 palmitic acid (23.29% Apr.-Jul., 22.53% Oct.-Jan.). C18:0 stearic acid (6.06% Apr.-Jul., 7.06% Oct.-Jan.), monoenes C16:1 palmitoleic acid (5.01% Apr.-Jul., 6.75% Oct.-Jan.). C18:1 oleic acid (13.51% Apr.-Jul., 15.65% Oct.-Jan.) and polyenens C20:5 eicosapentaenoic acid (7.15% Apr. Jul., 8.51% Oct.-Jan.) and C22:6 docosahexaeinoic acid (9.21% Apr.-Jul., 14.55% Oct.-Jan.). The values of fatty acids of all three fish were found to be slightly different from other cold and warm waters regions (8-10). Such variations have been attributed to number of factors by different workers [6-7].

The data showed that C16:0 palmitic acid was the predominent saturate found in all the three species in all the months. Ackman and Eaton pointed out that C16:0 was a key metabolite in fish and that its level was not influenced by diet [11].

The saturates were higher than monoenes and polyenes in all three species of fish. However, total unsaturates were more than total saturates. A well established characteristic feature of fish of both temperature and cold water is its marked ability to synthesize more unsaturates [12].

As already discussed, we are particulary interested in the amount of those fatty acid purported to be of therapeutic value. The amount of C20: 5 n-3 (EPA) and C22: 6 n-3 (DHA) of all three fish muscle lipid are also reported in Table 1. It may be noted that polyenes (20:5 n-3 and 22: 6 n-3) ranged from 0 to 0.91% and 0 to 4.52% respectively in white pomfret. The corresponding values ranged from 0 to 8.55% and 0.07% to 16.25% in black pomfret. In mackerel EPA 20: 5n-3 ranged from 0.052% to 8.51% and DHA 22:6n-3 upto 14.55% during the period of study.

From this it is clear that all three species of fish muscle lipids contain omega-3 polyunsatured fatty acids (EPA and DHA). However, the values varied among the same and different species. This variation, however, could possibly be attributed to species as well as variation of the environmental factors such as temperature, depth of ocean and nutritional status of fish caught from different areas of coastal water [13]. It was also found that from April-July, the EPA and DHA were detected from negligeble to accepted quantity in all three fish. It was noted that smaller amount of unsaturates particularly polyunsaturates or polyenes were detected in all three fish muscle lipids in the months of Apr. – Jul. Polyenes, EPA and DHA were found to be completely absent in some fish during hottest, months of Karachi summer (44°). The results are in agreement with findings of other studies [14]. Temperature has a profound effect on the composition of fatty acids and inverse relationship exist between temperature of tissue and unsaturation of fatty acids [13]. Karakhanis and Mager also reported that higher temperature of Indian water may be one of the factors for the presence of less polyunsaturates in the fish [14]. In a study by Lewis several marine ectotherm caught in artic waters were found to have lower percentages of saturates notably stearic acid and palmatic acid and higher proportions of palmitoleic acid than those species of tempeature waters [15]. Farkas and Herodek have demonstrated that C20 and C22 polyunsaturates of certain fresh water crustaceans increase with decreasing water temperature [16]. The studies of Johnson and Roots with goldfish also support the rule that higher temperatures results in the perferential deposition of fatty acids of lower unsaturation [17].

In this study it was found that black pomfret and mackerel are richer sources of omega-3 polyunsaturated, EPA and DHA particularly during the month of Oct.-Jul., while white pomfret is not.

Various factors such as geographical location of the catch, season of the year, feeding habits, sex and age influence the lipid content in fishery products. In order to establish the composition, exhaustive sampling of individual species throughout the year is required. In this investigation attempts have been made to collect data on the composition of fish lipid of three popular fish species from this region.

References

1. J. Dyerberg., Nut. Rev., **44,** 125 (1986).
2. J. E. Kinsella, Fd. Technol., **40,** (2), 89 (1986a).
3. M. E. Stansby, *Chemistry and Biochemistry of Marine Food Products*, R. E. Martin, G. J. Flick, C. E. Hebard and O. R. Ward (eds.), (Avi Publishing Co, West Port, 1982).
4. J. E. Kinsella, Fd. Technol., **42** (5), 146 (1988).
5. E. J. Bligh and D. J. Dyer, Can. J. Biochem. Physiol., **37,** 911 (1959).
6. R. G. Ackman, *Nutritional Evaluation of Long Chain Fatty Acids in Fish*, S. M. B. Barlow and M. E. Stansby (eds) (Academic Press, New York, 1982).
7. J. E. Kinsella, L. Pasati, J. Weiharauch, Crit. Rev. Fd. Sci. Nutri., **5,** 299 (1975).
8. Q. Khalid, A. S. Mirza, A. H. Khan, JAOCS, **9,** 247 (1968).

9. B. Y. Krishnoji and C. Bandyopadhyay, J. Fd. Sci. Technol., **23,** 334 (1986).
10. A. K. M. A. Bhuiyan, W. M. N. Ratanayake, R. G. Ackman, JAOCS, **63** (3), (1986).
11. R. G. Ackman and C. A. Eaton, J. Fish. Res. Bd. Can.,**23,** 991 (1966).
12. K. S. Markley, *Fat and Oil: Fatty Acids*, K. S. Markley (ed) (Interscience Publishers, New York, London, 1968), Part 5, 3255. 3200.
13. D. C. Malins and J. C. Wekell, *Progress in the Chemistry of Fats and Other Lipids,* **10,** (4), 356 (1969).
14. Y. D. Karkhanis and N. G. Magar, JAOCS, **32,** 492 (1955).
15. R. W. Lewis, Comp. Biochem. Physiol., **6,** 75 (1962).
16. T. Frakas and S. J. Herodek, J. Lipid Res., **5,** 369 (1964).
17. P. V. Johnston and B. Roots, Comp. Biochem. Physiol., **11,** 303 (1964).