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CONTENTS OF SELECTED MACRONUTRIENTS IN VARIOUS LOCAL FRESH WATER FISH

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The muscle of seventeen commonly consumed freshwater fish species collected from local lakes and fish hatcheries was estimated for calcium, sodium, potassium and magnesium by the atomic absorption technique. The fish species included in the study were: *Chela cachius, Ompok bimaculatus, Puntiusticto, Mastacembelus armatus, Mystus seenghala, Tor putitora, Cyprinus carpio, Rita rita, Wallago attu, Catla catla, Heteropneustes fossilis, Tilapia nilotice, Carassius auratus, Cirrhinus mrigala, Labeo rohita, Ophiocephalus punctatus.* The macronutrient contents of these fish were studied from the viewpoint of nutritional quality and the recommended dietary standard (EDI) laid down internationally for the safe consumption of fish. The observed calcium, potassium, magnesium and sodium contents ranged respectively from 62 to 591mg/g, 692 to 3045mg/g, 162 to 524mg/g and 209 to 1215mg. The levels of the macronutrients were examined from the viewpoint of relationship to weight/age of the relevant fish and their species specificaly. The farm and hatcheries fish were found to contain elevated levels of the macronutrients as compared with those in lake fish. Almost all fish species were found to be potentially good source of the macronutrients.

Key words: Macronutrient analysis; Freshwater fish analysis.

Introduction

The importance of the participation of metal ions in life cycle is well recognized. The macronutrients such as sodium, potassium, magnesium and calcium significantly contribute to maintain biologic life and are considered essential for regulating the metal content by homeostatic control mechanism [1,2]. Sodium and potassium are involved in metabolic processes and actively participate in nerve impulse conduction via brain. Magnesium and calcium are mobile metal ions forming complexes with nucleic acid and are necessary for muscle activity and metabolic functions. Calcium participates in blood circulatory system forming crystalline salts in the form of phosphates and oxalates [3]. The role of these macronutrients in conjuction with other essential trace elements (such as Cu, Fe, Zn, etc.) is also well documented [4,5]. Freshwater fish are a potential source of these macronutrients as they are heavily consumed in our country. However, eversince the outbreak of the 'Minamata disease' in Japan, caused by consuming methylmercury loaded fish [6], the essential macronutrients were also suspected of contaminating fish when present in excessive amount. The present study was conducted to assess, in the first place, the nutritional status of local freshwater fish and, then, to examine possibility of correlating the levels of the above cited macronutrients with the weight/age and origion of the fish, together with their concentration dependence on the nature of biota. The base-line study thus provides the required information on the amounts of Na, K, Ca and Mg in the edible muscles of seventeen species of freshwater fish. The lake/hatchery fish samples were collected from local agencies engaged in catching fish and from contractors catering fish sale at different locations in close vicinity of sites of catch (Fig. 1).

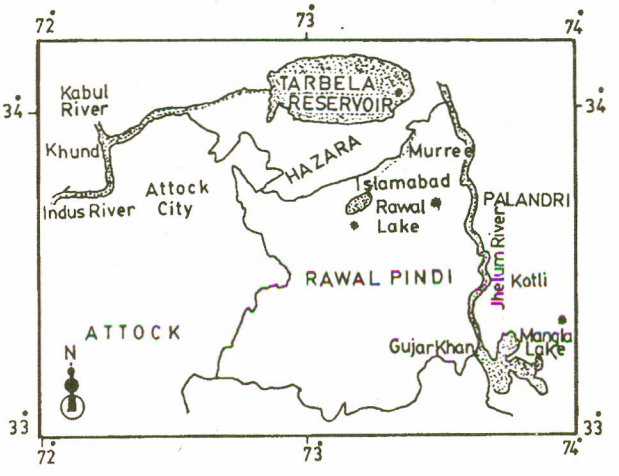

Fig.1. Location of sampling sites * for local freshwater fish.

Experimental

The scientific and local names of the fish included in the study, alongwith their code and taxonomic data, are given in Table1. The fresh muscle samples were frozen immediately after catch and transported to the laboratory for onward processing. The procedure consisted in briefly washing the sample with distilled water to remove any adhering contaminants, followed by draining and grinding in an electric blender to get a homogeneous mass. The samples were digested according to the procedure

TABLE 1. CODE LIST OF FRESHWATER FISH INVESTIGATED.

Code No.	No. of sample	Scientific name	Local name	Location
FW-1	5	*Chela cachius*	Chilwa	Rawal Lake
FW-2	7	*Ophiocephalus punctatus*	Doali	"
FW-3	10	*Ompok bimacultus*	Naili	"
FW-4	12	*Puntius ticto*	Chidoo	"
FW-5	13	*Mastacembelus armatus*	Baam	"
Fw-6	12	*Labeo rohita*	Rohu	"
FW-7	10	*Mystus seenghala*	Singhara	Mangla Lake
FW-8	12	*Tor putitora*	Mahaseer	"
FW-9	10	*Cyprinus carpio*	Gulfam	"
FW-10	9	*Rita rita*	Khagga	"
FW-11	11	*Mastacembelus armatus*	Baam	Terbela Lake
FW-12	13	*Wallago attu*	Mulee	"
FW-13	12	*Catla catla*	Thaila	"
FW-14	14	*Heteropneustes fossilis*	Singhi	"
FW-15	8	*Tilapia nilotica*	Tilapia	Fish Hatchery
FW-16	6	*Carassius auratus*	Gold fish	"
FW-17	9	*Cirrhinus mrigala*	Mori	ADBP Fish Farm

published earlier [7]. The macronutrient analysis were performed on the Hitachi atomic absorption spectrophotometer (Model 170-10) employing an air-acetylene flame under optimum analytical conditions set for each element separately. Standard fish samples, acquired from National Institute of Health, were run routinely to verify both accuracy and precision of the method. Blank runs were conducted as a matter of routine to check any background errors. Calibration of the instrument and quantification of the results were done with necessary background corrections. All reagents used during the investigation were of high purity spectroscopic grade (E. Merk).

Results and Discussions

The estimated concentrations of the macronutrients in the edible muscles of various fish are given in Table 2. A total of 173 samples belonging to seventeen fish species were analysed, and the results in the Table appear as averaged for the respective number of samples. The overall analytical precision was within ± 1.0% and the data showed a 100% incidence of occurrence of all the macronutrients in all the samples analysed. *Mystus seenghala* (FW-7) showed the minimum calcium content of 62mg/g, while the maximum concentration of the element was found in *Cirrhinus mrigala* (FW-17), to be 591mg/g. The calcium content, therefore, ranged from 62 to 591mg/g, in agreement with the reported range of 4 to 446mg/g for commercial freshwater fish [8]; the upper level being in close agreement, while the lower one being quite divergent. No direct correlation was observed between the weight of the fish and the calcium content; the smallest fish (FW-16 and FW-15) are associated with high and moderately low calcium concentration thereby indicating that the distribution of calcium in the muscle of these fish is based on species-specificity rather than weight.

The potassium concentrations ranged from 692 to 3045mg/g and were found to be quite scattered for various fish. For instance, *Labeo rohita* (FW-6), with an average

TABLE 2. CONCENTRATIONS (µg/g, WET WEIGHT) OF SELECTED MACRONUTRIENTS IN EDIBLE MUSCLE OF VARIOUS FRESH WATER FISH* AT ± S. LEVEL.

Species Code No.	Weight (g)	Ca	K	Mg	Na
FW-1	27 ± 10	120 ± 37	1514 ± 452	251 ± 65	330 ± 100
FW-2	60 ± 18	123 ± 42	2320 ± 540	237 ± 54	940 ± 362
FW-3	90 ± 26	101 ± 30	1612 ± 417	379 ± 99	575 ± 188
FW-4	35 ± 12	98 ± 28	2423 ± 732	444 ± 129	490 ± 142
FW-5	170 ± 56	152 ± 46	2250 ± 510	277 ± 78	430 ± 140
FW-6	900 ± 33	194 ± 55	1870 ± 408	232 ± 70	425 ± 130
FW-7	1050 ± 430	62 ± 20	1985 ± 521	206 ± 58	385 ± 106
FW-8	850 ± 310	222 ± 65	2250 ± 545	278 ± 69	560 ± 120
FW-9	900 ± 250	187 ± 57	2370 ± 600	303 ± 101	140 ± 45
FW-10	1150 ± 270	104 ± 35	2375 ± 621	298 ± 96	1251 ± 380
FW-11	720 ± 270	319 ± 94	2470 ± 700	268 ± 88	1175 ± 350
FW-12	3100 ± 1020	90 ± 26	2623 ± 813	303 ± 96	1012 ± 341
FW-13	8000 ± 5700	111 ± 37	2875 ± 910	274 ± 85	872 ± 250
FW-14	850 ± 350	88 ± 28	3045 ± 965	284 ± 80	432 ± 112
FW-15	20 ± 9	108 ± 32	1375 ± 385	524 ± 147	111 ± 103
FW-16	15 ± 18	417 ±102	692 ± 210	310 ± 100	835 ± 217
FW-17	700 ± 165	591 ±123	2975 ± 725	162 ± 55	209 ± 162

*Prercent incidence = 100%.

weight of 900g, had a potassium content of 1870mg/g, while *Cyprinus carpio* (FW-9), with the same average weight, had a corresponding potassium content of 2370mg/g. On the contrary, species FW-11 and FW-17, with almost similar weights, were found to have identical (within experimental limits of accuracy) potassium content. In the case of magnesium, the minimum concentration (162mg/g) was found in *Cirrhinus mrigala* (FW-17) and the maximum (524mg/g) in *Tilapia nilotica* (FW-15), both from local fish farms. The open lake fish, in general, had a comparable magnesium content, but no correlation existed between the weight/age of the fish and the macronutrient content. As in case of calcium and potassium, the distribution of magnesium was found to be species-specific. However, in this case the dispersion in the concentration was relatively low.

Sodium levels ranged between 140-121µg/g and had the general distribution characteristic as described in the case of calcium, potassium and magnesium. *Mystus seenghala* (FW-7),belonging to Mangla lake and having a comparable weight with *Cyprinus carpio* (FW-9), had almost thrice as much sodium contents, although the habitat of the two fish was the same.

The calcium content of the various fish was found to increase on the average in the order: Rawal Lake < Mangla Lake < Terbela Lake. A similar behaviour was observed in the case of sodium and potassium, the exception being that of magnesium. It was also clearly indicated that the fish from these lakes also contained on the average far less amounts of macronutrients met with in case of fish from hatcheries and farms. The Rawal Lake fish has an averaged minimum calcium, sodium and potassium over all the samples analyzed. The Terbela Lake fish, on the other hand has maximum content of these elements. No apparant correlation was observed between the weight of the fish and the macronutrient content.

According to the findings of the present study the local freshwater fish are rich in nutritional quality. Majority of the fish species have macronutrient levels at par with the daily dietary allowances (RDA) recommended for safe intake by human beings. The estimated adequate daily dietary intakes (EDI) for calcium, sodium, magnesium and potassium, as recommended by NRC [9], are 120mg/kg, 290mg/kg, 279mg/kg and 704mg/kg, respectively, for the edible muscles. On this basis, the freshwater fish species, *Ompok bimaculatus* (FW-3), *Puntius ticto* (FW-4), *Mystus seenghala* (FW-7), *Rita rita* (FW-10), *Wallago atta* (FW-12), *Catala catla* (FW-13), *Heteropneustes fossilis* (FW-14) and *Tilapia nilotica* (FW-15) were found to be deficient in their Ca content. In the case of potassium, only two fish species, *Heteropneustes fossilis* (FW-14) and *Cirrhinus mrigala* (FW-17) qualified for good nutritional quality, while most of the remaining fish species were close to the EDI standard. In the case of magnesium in freshwater fish the laid down EDI standard of 279mg/kg was met by most of the fish species, with the exception of *Cirrhinus mrigala* (FW-17), which was found to be below the stipulated standard. The case of sodium was no different: *Cypirnus carpio* (FW-9) lacked badly in sodium content as did the other fish with a range of sodium between 200 - 500mg/kg. On the whole, the local freshwater fish were found to be a potential source of these macronutrients and their consumption does not pose any physiological problem for the consumers.

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References

1. G.W. Bryan and L.G. Hummerstone, J. Mar. Biol. Assoc., **53,** 839 (1973).
2. H. Overhoff and W. Forth, Biologisch Essentielle Elementte, Deut. Arzteblatt., 301 (1978).
3. H. Vahrenkamp, Metalle in Lebensprozessen, Chemic Unserer Zeit, **7,** 97 (1973).
4. R. Establier, Inv. Pesq, **34,** 399 (1970).
5. M. Jaffar and M. Ashraf, Pak. j. sci. ind. res., **31,** 23 (1988).
6. M. Fujiki, 6th Int. Conf. Water Pollut. Res. Paper No.12 (1972).
7. M. Ashraf and M. Jaffar, Toxicol. Environ. Chem., **19,** 63 (1989).
8. T. Shinoda, Y. Aoyagi and T. Sughara, Joshi Eiyo Daugwku Kiya, **11,** 171 (1980).
9. Nat. Res. Counc. Committee on Dietary Allowances, Food and Nutrition Board, Recommended Dietary Allowances (Nat. Acad. Sci., Washington DC, 1980), 9th ed., pp.185.