BIOCHEMICAL COMPOSITION OF THE MUSCLE OF SOME FRESHWATER FISHES DURING THE PRE-MATURITY PHASE

(MISS) D. K. KHAWAJA
Department of Zoology, Aligrarh Muslim University, Aligarh

Biochemical composition of the muscle of juveniles belonging to 18 different species of freshwater fishes showed that the protein percentage in juveniles was higher than the adults. The fat, on the other hand, was much lower. This suggests that the body fat increases with the onset of maturity. No clear inverse relationship was found between fat and protein in juveniles.

Moisture percentage was very high in juveniles. This was probably because of low fat content. In most species the sum of fat and water contents (F + W) was found to be constant. The percentages of ash, calcium and phosphorus were higer in juveniles than those of adults. Dry matter percentage varied inversely with the moisture and in most species carbohydrate was generally low.

In juveniles although the calorific value of protien-fraction was high the total calorific value was lower than the aduls.)

INTRODUCTION

Marked variations have been noted by earlier workers in the biochemical composition of the same fish from time to time (Lovern and Wood, 1937; Hart *et al.*, 1940; Arevalo, 1949; Venkataraman and Chari, 1951; Idler and Bitners, 1958, 1960; and Vasavan *et al.*, 1960). The magnitudes of these variations in a fish during various periods of its life history are attributed to many physiological factors, of which maturity perhaps is the most important. In a few earlier investigations the changes in the fat content of fish muscle during the pre-maturity phase have been noted (Bruce, 1924; Wilson 1939; and Sekharan, 1955) and more recently considerable information on other biochemical factors including the nutritive value, mainly of the adult fishes has been given by Jafri *et al* (1964). However, no attempt has been made to study the biochemical composition and calorific value of the juvenile fishes (during the pre-maturity phase). The present communication therefore, is the

first from India dealing with the biochemical analysis of the muscle of 18 different species of immature fishes. A comparison between the biochemical composition of juveniles and adult fishes has brought to light many interesting changes which the fish undergoes from the pre-maturity to the post-maturity phase.

Materials and methods

Freshly collected fishes from the Aligarh fish market were dissected and their gonads examined to ensure that all the individuals analysed were immature. The two sexes were not analysed separately as in most cases sex determintation in very small fishes was found to be difficult. In each species, individuals of a definite size-range and weight were taken. As the fishes were very small, a fairly large number of individuals, usually ten or more, were required to obtain a sample of flesh. To avoid seasonal differances, all estimations were carried out during the same months (August and September). These were appropriate months in the sense that the juveniles of a large number of fishes from the current brood were only available during these months (Qasim and Qayyum, 1961).

Methods of various estimations were the same as described elsewhere (Jafri *et al.*, 1964).

Results and discussion

A. Protein

Protein content in the muscles of the juveniles of all the species analysed ranged from about 10 to 19% on fresh weight basis (Table 1). In general, the carps were found to contain the highest protein content the average being 18%. Amongst the carps, the juveniles of *Cirrhina mrigala, C. reba* and *Barbus sarana* contained the highest percentages and the minimum value was recorded in *Catla catla.* Fairly high values of protein was recorded in cat-fishes and murrels (average about 17%). Among cat-fishes, *Callichrous bimaculatus* showed the minimum protein content. Otherwise the values in cat-fishes and murrels were more or less identical.

The juveniles of feather-backs were found to be rather poor in protein. The values ranged from about 10% in *Notopterus notopterus* to about 11% in *N. chitala.* In spiny-eel, *Mastacembelus armatus* the percentage of protein was only about 12%.

A comparison of the portein values of the muscle of juveniles with those of the adults of the same species reported earliar (Jafri *et al.*, 1964) would indicate that except for a few species like *Ophicephalus punctatus, O. striatus, N. notopterus, N. chitala* and *M. armatus,* the protein content of the juveniles was generally higher. Their high protein content may be because of greater energy requirements for growth and metabolism. However, low portein percentages recorded in juveniles of some species like *O. punctatus* and *O. striatus* seems difficult to interpret and it may seem probable that the growth requirments of these species are met with by the reserves mobilized by tissues other than muscle. In *N. notopterus, N. chitala* and *M. armatus* also where the juveniles possessed lower protein content than the adults, and their fat contents were also low but the carbohydrate values were very high. This probably indicates that the energy store in muscle during the pre-maturity phase is in the form of carbohydrate reserves. The adults of these fishes have low carbohydrate content (Jafri *et al.*, 1964). It is interesting to note that in *N. notopterus* the carbohydrate content falls from about 8% in the juveniles to 2% in the adults. Relatively low percentage of portein in the juveniles of these forms also signifies the transformation of portein into carbohydrate

through gluconeogenesis of amino-acids In cat-fishes, the protein values of the juveniles are of special interest, for unlike the adults they are subjected to little variations from one species to the other. Excepting *C. bimaculatus* the percentages of protein in all other cat-fishes were almost identical and the same was true in murrels also. It is therefore evident that in cat-fishes and murrels, specific variations in the protein content occur only after the fish has attained maturity. This may possibly be due to differences in the rate of feeding of adults and juveniles. It is well known that there are little fluctuations in the feeding rates of juveniles but in adults the fluctuations are more marked as they are governed by gonad maturity and spawning (Qayyum and Qasim, 1964).

A close examination of Table 1 will reveal that species which are closely related systematically have similar protein values. This is because the protein distribution in the muscle is somewhat group specific. Similar feature has been reported in adult fishes (Jafri *et al.*, 1964).

B. FAT

The muscle fat of juveniles was low. The values fell within a range of 0.020% – 2.219% on fresh weight basis (Table 1). In carps the values were slightly higher than in other fishes (average 0.135%). High values were noted in *Cirrhina reba* and *B. sarana* and lowest in *Labeo calbasu.* Among the cat-fishes the fat content varied from 0.034% in *Mystus seenghala* to 0.113% in *Callichrous bimaculatus.* It is interesting to note that adults of cat-fishes, on an average, showed the highest fat content (Jafri *et al.*, 1964) but the juveniles of the same species recorded the lowest fat content (average 0.064%).

Among murrels, the juveniles of *O. punctatus* showed 0.457% fat but in *O. striatus* the value was very low (0.028% only). Relatively higher fat content (0.771%) was observed in the juveniles of feather-back, *N. chitala,* but in the other feather-back the fat content was low (about 0.070%). The highest fat content (2.219%) was recorded in the juveniles of spiny-eel, *M. armatus.* These data indicate that in juveniles the fat content is not group specific and that it varies considerably from one group to the other, even from species to species. A comparison of the fat values of juveniles with those of the adults (Jafri *et al;* 1964) reveals that except in *O. punctatus* where the fat content is slightly higher than adults, in all the other species the muscle fat in juveniles is lower than the adults. Evidently the degree of fatness increases as the fish advance towards maturity and consequently the muscles of the fish in the post-maturity phase become more fatty than in the pre-maturity phase. Dill (1921) has noted that the immature fish shows lower fat content when compared to the mature fish. Differences have also been observed between the fat content of immature and mature herring by Bruce (1924) who noted that the older and more sexually mature fish had a higher fat content. In Manx herring in any given age group, the more the sexual maturty, the higher the fat percentage (Milroy, 1908). Wilson (1939) while working on the fat content of flounder has also recorded differences between the fatness of immature and mature fishes. He found that the larger fishes tended to be fatter than the smaller ones. In the ribbon fish, *Trichiurus haumela* the maturing individuals are on the whole fatter than the immature ones (Sekharan, 1955).

The fat content of adult fishes has been found to be inversely related to protein (Jafri *et al.*, 1964). In juveniles although this is not strictly applicable as a rule, the inverse relationship does exist, however. In adult fishes the strict corre-

lation may be because the rising values of fat are generally accompanied with low values of protein probably because some protein gets converted into fat to meet the increasing demands of gonad maturation. Since no such changes are likely to occur in juveniles the increase in fat may not always be aasociated with a corresponding decrease in protein.

C. MOISTURE

Moisture precentage in the muscle of juveniles were found to be very high ranging from about 78 to 80%. Among the carps, *C. reba* and *B. sarana* showed relatively low moisture content. Unlike adult fishes, the moisture percentage of the juveniles showed marked consistency. In all the species analysed the values came to about 80%. The differences in the moisture content between juveniles and adults suggest that sexual maturity in fishes brings about a decrease in the degree of hydration of muscle. A similar decline was noted in the moistre percentage by Bruce (1924) in herring muscle. A higher precentage of moisture in the muscle of juveniles is to be expected in view of the inverse relationship between the fat and moisture fractions in fish tissues. The muscle of juveniles is relatively poor in fat and consequently it has a higher fraction of moistre.

D. FAT-WATER RELATIONSHIP

Several earlier authors have shown a reciprocal relationship between fat and moisture in fish tissues (Brandes, 1954; Mikicinska, 1954; and Brandes and Dietrich, 1958). In the juveniles also the sum of fat and water (F+W) in all the spices analysed shows a remarkable consistency and varies little from one spices to another. The range of F+W variation was from 78.546 to 80.979 (Table 1) and except for some species namely *C. reba* and *B. sarana*, the F+W values in all other species come to about 80. This indicates that there is a greater degree of consistency in the F+W values of juveniles than in adults.

E. DRY MATTER AND ASH

The dry matter precentage varied inversely with the moisture. It ranged from 19.518 to 21.784% (Table 1). As compared to the adult fishes the dry matter in juveniles was low probably because the juveniles have a higher moisture content.

The percentage of ash varied from 1.040 to 2.096% (Table 1). The juveniles contained slightly more ash than the adults. Since the ash content represents the total inorganic or mineral constituents, the slightly higher values of ash in juveniles may be because of their greater mineral requirements. The juveniles of *N. notopterus, N. chitala* and *M. armatus* however, showed slightly lower values of ash than those of adults.

F. CARBOHYDRATE

Carbohydrate content did not show any definite pattern of distribution in juveniles. In *N. notopterus, N. chitala* and *M. armatus* the values were very high, otherwise in all other fishes these were very low and ranged from 0.031 to 2.217% (Table 1). Among the cat-fiches the highest value was observed in *C. bimaculatus*. It seems interesting to point out that the adults of the same species noted above also show somewhat less consistent values of carbohydrate (Jafri *et al.*, 1964). In juveniles the highest carbohydrate content generally occurred in those species which had very low fat and protein values. This may presumably be due to an interconversion of fat and protien fractions into carbohydrate to fulfill the energy requirements of active growth. In comparison to the adult fishes the amount of carbohydrate in the muscle of juveniles was generally low.

G. Calcium

Calcium content in the muscle of juveniles was fairly high ranging from 0.017 to 0.095% on fresh weight basis (Table 1). The feather-backs (*N. notopterus* and *N. chitala*) showed the highest calcium content (0.069%). The carps came next and the cat-fishes were the poorest. Unlike the adults, the calcium content in juveniles of *O. punctatus* was very high. Similarly in other species also the calcium content of juveniles was higher than in adults. This possibly suggests a greater requirement of calcium in the pre-maturity phase for rapid growth.

H. Phosphorus

Like calcium the phosphorus content was also high in juveniles. It varied from 0.322 to 0.605% on fresh weight basis (Table 1). The cat-fishes were relatively rich in phosphorus than the carps. The average for both the groups came to about 0.4%. The highest value amongst carps was noted in *Labeo bata*. Murrels, feather-backs and spiny-eel showed lower values. A high phosphorus content in the juveniles may also be because of greater demands of phosphorus by the growing fish. In adults it has been noted that the fishes which were rich in fat had a higher phosporus content. This probably indicates that the phosphorus in muscle is perhaps associated with fat (lipids). No such relationship could be seen in juveniles probably because they are poorer in fat.

1. Calorific value

Energy values in terms of calories were calculated for protein, fat and carbohydrate fractions using the same factors as in adults (Jafri *et al.*, 1964). Energy values for protein fraction were found to be high in juveniles, 42 to 80 calories per 100 gm of fresh muscle (Table 2). Highest values were recorded in carps (*C. reba* and *B. sarana*) and lowest in feather-backs and spiny-eel. The energy values for fat-fraction were generally low in the juveniles (Table 2). For carbohydrate fraction the highest calories were recorded in *N. notopterus, N. chitala* and *M. armatus.*

The total calorific value in juveniles ranged from about 73 to 94 calories per 100 gm of fresh tissue. This was lower than the adults.

Summary

Biochemical composition of the muscle of juveniles belonging to 18 different species of freshwater fishes showed that the protein percentage in juveniles was higher than the adults. The fat, on the other hand, was much lower. This suggests that the body fat increases with the onset of maturity. No clear inverse relationship was found between fat and protein in juveniles.

Moisture percentage was very high in juveniles. This was probably because of low fat content. In most species the sum of fat and water contents (F+W) was found to be constant. The percentages of ash, calcium and phosphorus were higher in juveniles than those of adults. Dry matter percentage varied inversely with the moisture and in most species carbohydrate was generally low.

In juveniles although the calorific value of protein-fraction was high the total calorific value was lower than the adults.

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TABLE - 1

THE RELATIVE VALUE OF BIOCHEMICAL CONSTITUENTS IN THE MUSCLE OF

SPECIES	Local Name	No. of individuals analysed	Average length (cm)	Average weight (gm)	Protein %
CARPS:					
1. *Cirrhina mrigala* (Ham.)	Mrigal	51	8.5	5.6	19.060
2. *Cirrhina reba* (Ham.)	Reba	20	12.2	17.5	19.680
3. *Catla catla* (Ham.)	Katla	30	10.1	11.6	16.560
4. *Labeo rohita* (Ham.)	Rohu	27	5.8	2.7	18.440
5. *Labeo bata* (Ham.)	Bata	20	13.0	22.1	16.870
6. *Labeo calbasu* (Ham.)	Kalmonch	16	12.9	23.6	16.870
7. *Labeo gonius* (Ham.)	Keli	15	15.5	34.4	18.000
8. *Barbus sarana* (Ham.)	Puthi	17	11.7	23.1	19.680
CAT-FISHES:					
9. *Mystus seenghala* (Sykes)	Seenghara	12	25.4	108.0	17.500
10. *Mystus aor* Gunther	Jhabaria	16	18.7	39.8	17.500
11. *Bagarius bagarius* (Ham.)	Gonch	15	13.4	12.5	17.500
12. *Wallagonia attu* (Bloch)	Lanchi	21	16.0	18.3	17.810
13. *Callichrous bimaculatus* (Bloch)	Pabda	43	8.6	4.3	16.250
MURRELS:					
14. *Ophicephalus punctatus* Bloch	Soli	53	4 8	0.7	17.810
15. *Ophicephalus striatus* Bloch	Sol-dharidar	16	10.5	39.4	17.500
FEATHER-BACKS:					
16. *Notopterus notopterus* (Pallas)	Chital	5	17.8	48.6	10.310
17. *Notopterus chitala* (Ham.)	Chital	5	14.4	23.0	11.250
SPINY-EEL:					
18. *Mastacembelus armatus* (Lacep)	Bam	9	15.9	11.1	11·870

All percentages are on fresh weight basis

SOME FRESHWATER FISHES DURING THE PRE-MATURITY PHASE

Fat %	Moistue r %	F + W Values	Dry matter %	Ash %	Carbohydrate %	Calcium %	Phosphorus %
0.138	79.280	79.418	20.720	1.324	0.198	0.053	0.350
0.340	78.216	78.556	21.784	1.244	0.520	0.043	0.470
0.035	80.402	80.437	19.598	1.428	1.575	0.062	0.440
0.102	79.899	80.001	20.101	1.267	0.292	0.091	0.440
0.096	79.888	79.984	70.112	2.096	1.050	0.035	0.605
0.020	80.284	80.304	19.716	1.772	1.054	0.055	0.420
0.069	79.900	79.969	20.100	2.000	0.031	0.095	0.375
0.286	78.260	78.546	21.740	1.384	0.390	0.045	0.382
0.034	80.210	80.244	19.790	1.810	0.446	0.018	0.322
0.043	80.264	80.307	19.736	1.890	0.303	0.034	0.407
0.082	80.312	80.394	19.688	1.697	0.409	0.057	0.560
0.049	80.190	80.239	19.810	1.792	0.159	0.017	0.510
0.113	80.338	80.451	19.662	1.082	2.217	0.042	0.410
0.457	79.965	80.422	20.035	1.532	0.236	0.080	0.390
0.028	80.482	80.510	19.518	1.598	0.392	0.038	0.360
0.070	80.472	80.542	19.528	1.040	8.108	0.072	0.390
0.771	79.870	80.641	20.130	1.077	7.032	0.067	0.405
2.219	78.760	80.979	21.240	1.048	6.103	0.055	0.322

TABLE II

CALORIFIC VALUE OF DIFFERENT FRACTIONS OF MUSCLE OF SOME FRESHWATER FISHES DURING THE PRE-MATURITY PHASE

SPECIES	PROTEIN	FAT	CARBOHYDRATE	Total calories per 100 gm of fresh muscle
	Calories per 100 gm of fresh muscle	Calories per 100 gm of fresh muscle	Calories per 100 gm of fresh muscle	
CARPS:				
1. *Cirrhina mrigala* (Ham.)	78.146	1.283	0.811	80.240
2. *Cirrhina reba* (Ham.)	80.688	3.162	2.132	85.982
3. *Catla catla* (Ham.)	67.896	0.325	6.457	74.678
4. *Labeo rohita* (Ham.)	75.604	0.948	1.197	77.749
5. *Labeo bata* (Ham.)	69.167	0.892	4.305	74.364
6. *Labeo calbasu*	69.167	0.186	4.321	73.674
7. *Labeo gonius* (Ham.)	73.800	0.641	0.127	74.568
8. *Barbus sarana* (Ham.)	80.688	2.659	1.599	84.946
CAT – FISHES:				
9. *Mystus seenghala* (Sykes)	71.750	0.316	1.828	73.894
10. *Mystus aor* Gunther	71.750	0.399	1.242	73.391
11. *Bagarius bagarius* (Ham.)	71.750	0.762	1.676	74.188
12. *Wallagonia attu* (Bloch)	73.021	0.455	0.651	74.127
13. *Callichrous bimaculatus* (Bloch)	66.625	1.050	9.098	76.773
MURRELS:				
14. *Ophicephalus punctatus* Bloch	73.021	4.250	0.967	78.238
15. *Ophicephalus striatus* Bloch	71.750	0.260	1.607	73.617
FEATHER-BACKS:				
16. *Notopterus notopterus* (Pallas)	42.271	0.651	33.242	76.164
17. *Notopterus chitala* (Ham.)	46.125	7.170	28.831	82.126
SPINY-EEL:				
18. *Mastacembelus armatus* (Lacep)	48.667	20.636	25.022	94.325

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