STUDIES ON THE BIOCHEMICAL COMPOSITION OF SOME FRESHWATER FISHES
II. LIVER

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INTRODUCTION

Although considerable work has been done on the composition of fish liver oils, most of which includes the study of various vitamins and fatty acids (Cunningham and Slater, 1939; Basu and Gupta, 1940; Seshan, 1940; Majumdar, 1941; Ahmad *et al.*, 1945; Kringstad and Folkvord, 1949; Pathak *et al.* 1952; and Balasundaram *et al.*, 1956), little attention has been paid towards the composition of fish liver as a whole. Notable contributions on this sbject where liver has been used as one of the tissues for comparison with others are those of Atwater (1888), Bruce (1924); Bull (1929), Idler and Bitners (1960) and Violet and Idler (1960). So far no work has appeard on the chemical composition of the liver of any fish of India. Since liver is one of the most important organs of the body controlling the metabolism of the fish, the present investigation on the gross chemical composition and energy values of this organ in various freshwater fishes is considered an important and fundamental study.

MATERIAL AND METHODS

Preparation of sample: Fishes were obtained from the Aligarh fish market in a fresh condition. Individuals of a particular size range were sorted out, weighed and measured (See Jafri *et al.*, 1964). From each fish the liver was dissected out and after removing the superficial body fluid and blood from the lobes by soaking them with blotting paper, all the livers were lumped together and macerated in a high speed grinder to produce a homogenate for various estimations.

The methods of various estimations were the same as deseribed in part I. (Jafri *et al.*, 1964).

RESULTS AND DISCUSSION

Protein content: The percentage of liver protein in various species varied between 8.906 and 14.215 on fresh weight basis (Table 1), the average being 11.496%. The values obtained were lower than those of the muscle reported earlier (Jafri *et al.*, 1964) The maximum protein percentage (14.215%) was noted in *Rita rita* and the lowest (9.906%) in *Callichrous pabda*. The values in the other catfishes were more or or less similar. Among the murrels, the average protein percentage was 11.608. Carps on an average had 10.801% liver-protein. The highest was obtained in the mahseer, *Barbus (Tor) putitora* and the next carp with 12.050% was mrigal, *Cirrhina mrigala*.

In the feather-backs the percentage was fairly high (average 12.340%) and in

Mugil corsula and *Mastacembelus armatus*, the protein contents were 10.620 and 11.890% respectively.

It is interesting to note that fishes which possessed a high protein content in their muscle (Jafri *et al.*, 1964) were also rich in their liver protein. For instance, *B. (Tor) putitora* and *R. rita* which had high protein content in the muscle were also found to possess high values for the liver protein and conversely, fishes like *Catla catla* and *C. pabda* which showed lower values in their muscle protein were poor in their liver protein also.

Lipid content: Fish liver is known to be of a high calorific value and an important source of vitamins. The lipid content of the liver was generally high, probably because of its being a centre of fat-deposits (Sinnhuber and Law, 1947). It ranged between 4 and 11% on fresh weight basis in all the fishes analysed (Table 1).

The lipid content of the murrels was found to be the highest of all the fishes examined (11.883% in *Ophicephalus punctatus*). Among the carps, maximum values of about 10% were found in *Barbus sarana* and *B. (Tor) putitora*, The percentage of lipids in *M. corsula* was also high, 6.190% The values for *Notopterus notopterus* and *N. chitala* were 5.008 and 3.351% respectively. Except for the liver of *Clarias magur* which had a high lipid content (8.268%), the liver of other cat-fishes were generally found to be poor in lipid content (Table 1).

A comparison of the values of fat obtained for the muscle (Jafri *et al.*, 1964) with those of liver reveals that fishes possessing a higher fat content in their muscle show a poor lipid value for the liver. Thus the murrels which were observed to have the poorest value for muscle-fat had the maximum amount of lipids in their livers. Similarly, cat-fishes with a very high percentage of fat in muscle were the poorest in liver-lipids.

Moisture and dry matter content: The average percentage of moisture in the liver was about 75. The values in different fishes ranged between 66.865 - 81.542% (Table 1). These agreed with the reported liver values of other fishes (Atwater, 1888; Bruce, 1944; Idler and Bitners, 1960). The percentage of dry matter was highest in the liver of those fishes which had a low moisture content and vice-versa (Table 1).

Moisture and fat relationship: It has been shown by various workers that for each species the added value of fat and water (F+W) is constant (Brandes and Dietrich, 1953; Mikicinska, 1954). In other words an invere relationship has been found to exist between water and fat. This relationship is not only true for the whole fish but also for the various body tissues (Brandes, 1954)

The values of moisture and fat (lipids) in the liver of various species under investigation have been plotted in Fig. 1. As will be seen from figure there is a definite relationship between fat and moisture in various fishes. The F+W values for fishes ranged between 77.966—82.908 (Table 1). It is interesting to note that the mean F+W values for different groups of fishes such as carps, murrels, feather-backs, cat-fishes and mullet were found to vary within a very narrow range. From these findings it appears that there is an inverse relationship between fat and moisture in the liver and that an increase in the fat is at the expense of water.

Carbohydrate content: Carbohydrate content in the liver ranged from 1.824-10.514% (Table 1). The cat-fishes, murrels and feather-backs had more or less similar values (average 5.543, 6.623 and 6.142% respectively). *R. rita*, *M. seenghala*, *M. aor* and *N. chitala* recorded relatively lower

TABLE I. THE RELATIVE VALUES OF BIOCHEMICAL CONSTITUENTS IN THE LIVER OF FRESHWATER FISHES

SPECIES	Portein %	Lipid %	Moisture %	Dry Matter %	F+W Values	Carbohydrate %	Ash %	Phosphorus %	Calcium %	Total Iron mg/100 gm.
CARPS:										
1. Cirrhina mrigala (Ham.)	12.050	6.824	74.668	25.332	81.492	5.143	1.315	0.695	0.014	47.500
2. Catla catla (Ham.)	8.906	5.174	74.344	25.656	79.518	10.338	1.238	0.405	0.019	25.000
3. Labeo rohita (Ham.)	10.780	2.693	79.369	20.631	82.062	5.979	1.179	0.415	0.025	22.500
4. Labeo calbasu (Has.)	10.780	6.143	75.362	24.638	81.505	6.240	1.475	0.560	0.013	41.000
5. Labeo gonius (Ham.)	9.374	0.547	77.785	22.215	78.332	10.514	1.780	0.505	0.055	21.875
6. Barbus sarana (Ham.)	10.155	10.189	70.409	29.591	80.598	7.710	1.537	1.082	0.029	55.000
7. Barbus stigma (Cuv. & Val.)	10.620	6.543	74.300	25.700	80.843	6.907	1.630	0.545	0.030	32.500
8. Barbus (Tor) putitora (Ham.)	13.750	9.926	72.006	27.994	81.932	3.042	1.276	0.500	0.012	22.500
CAT - FISHES:										
9. Mystus seenghala (Sykes)	12.960	4.665	77.766	22.234	82.431	2.963	1.646	0.718	0.016	40.625
10. Mystus aor (Ham.)	11.875	4.648	78.260	21.740	82.908	3.941	1.276	0.467	0.020	22.500
11. Bagarius bagarius (Ham.)	12.185	2.251	78.274	21.726	80.525	5.742	1.548	0.572	0.017	45.000
12. Rita rita (Ham.)	14.215	1.115	81.542	18.458	82.567	1.824	1.304	0.420	0.014	48.750
13. Pseudeutropius garua (Ham.)	12.495	3.753	76.444	23.556	80.197	5.922	1.386	0.567	0.018	45.000
14. Wallagonia attu (Bloch)	10.780	4.500	75.547	24.453	80.047	7.873	1.300	0.959	0.012	31.350
15. Callichrous pabda (Ham.)	8.906	1.365	79.872	20.128	81.237	8.587	1.270	0.467	0.039	25.000
16. Callichrous bimaculatus (Bloch)	10.468	1.548	79.030	20.970	80.578	7.522	1.432	0.482	0.036	45.000
17. Clarias magur (L.)	13.590	8.268	71.249	28.751	79.517	6.519	1.374	0.500	0.020	41.500
MURRELS:										
18. Ophicephalus punctatus Bloch	12.490	11.883	66.865	33.135	78.784	7.666	1.096	0.397	0.024	31.250
19. Ophicephalus striatus Bloch	11.715	9.330	71.933	28.067	81.263	5.672	1.350	0.420	0.012	45.000
20. Ophicephalus marulius Ham.	10.620	8.272	73.160	26.840	81.432	5.532	1.416	0.510	0.012	37.500
FEATHER-BACKS:										
21. Notopterus notopterus (Pallas)	11.870	5.008	73.328	26.672	78.336	8.595	1.199	0.345	0.037	38.120
22. Notopterus chitala (Ham.)	12.810	3.351	78.728	21.272	82.079	3.689	1.422	0.590	0.014	35.000
MULLET:										
23. Mugil corsula (Ham.)	10.620	6.190	73.768	26.232	79.958	8.006	1.416	0.500	0.022	32.500
SPINY-EEL:										
24. Mastacemblus armatus (Lacep.)	11.890	3.962	74.004	25.996	77.966	8.644	1.500	1.082	0.020	47.500

N. B. All percentages are on fresh weight basis.

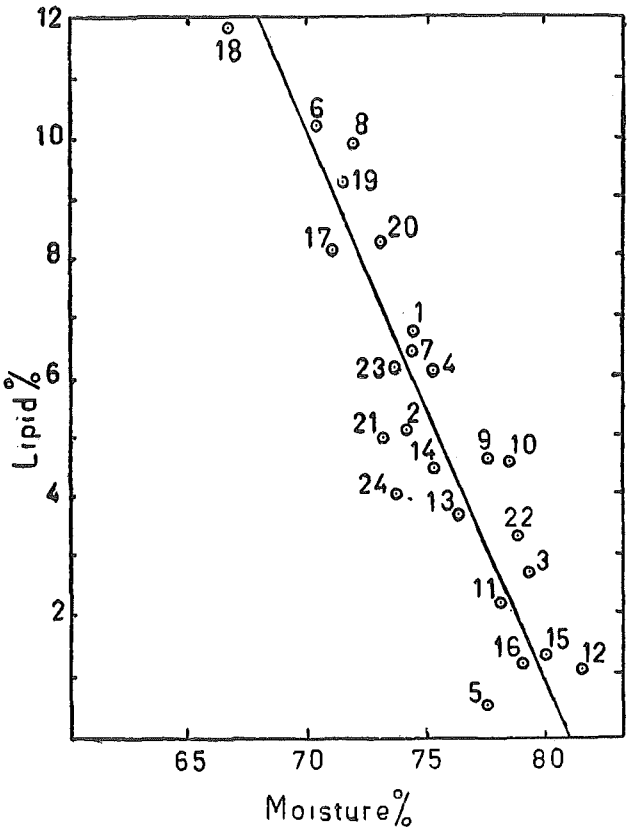

Fig. 1. Relationship between fat and moisture contents in the liver of various freshwater fishes. The numbers in the figure refer to the numbers in Table 1.

values. The average carbohydrate content in the liver of carps was about 7%. *B. (Tor) putitora* was the poorest in its liver carbohydrate. The values for the mullet and spiny-eel were more or less similar (8.000 and 8.644% respectively). Carbohydrate values of the liver were found to be higher than those of the muscle in the same species (Jafri *et al.*, 1964) A higher percentage of carbohydrate in the liver probably suggests that the fish liver is the main centre of glycogen deposition.

Ash content: The ash content of the liver of various species varied very little, 1.096—1.780% (Table 1) and showed no significant difference from those of the muscle. The average ash content of all the species examined came to about 1. 4%.

Phosphorus: Phosphorus is one of the most important minerals regulating the metabolism of fish. It is present in the tissues in the form of phospholipids, phosphoprotein, etc. Liver of fishes contains more phosphorus than the muscle. In various species examined it ranged between 0.345—1.082% (the average being 0.570%) *M. armatus* recorded the highest (1.082%) phosphorus in the liver. Carp liver was also rich in phosphorus. Values obtained for *B. sarana* and *C. mrigala* were 1.082 and 0.695% respectively. Among the cat-fishes, *M. seenghala* and *Wallagonia attu* showed high values, 0.718 and 0.959% respectively. The average phosphorus content in the liver of feather-backs and murrels came to 0.467 and 0.442% respectively.

It seems important to point out that a higher phosphorus content in the muscle was generally associated with a high phosphorus value in the liver. A comparison of the values of phosphorus with those of fat will reveal that no relationship between the two exists in the liver. This is in contrast to the direct relationship between phosphorus and fat such as has been found in the muscle (Jafri *et al.* 1964). Probably the entire phosphorus content of the liver is not associated with lipids in the form of phospholipids as it occurs in the muscle. Perhaps in liver it is present in some other forms such as phosphoglycerides.

Calcium: The calcium content in most fishes was found to range between 0.012 and 0.025% (Table 1). Slightly higher values occurred in th liver of *Labeo gonius*, *Barbus stigma*, *Callichorous bimaculatus* *C. pabda* and *N. notopterus*. The average calcium content of all fishes examined was about 0.022% The calcium values of the liver were generally lower than the values of muscle. It has, however, been noted that in those species where the calcium content in muscle was higher, the liver calcium was also proportionately high. In this respect its quantitative distribution in liver and muscle seems to be more or less similar to that of phosphorus.

Iron: The total iron (ic) content in the liver was much higher than that of the muscle. This is because of the presence of a large amount of blood in the liver. The values obtained for different fishes varied from 21.875—55.000 mg per 100 gm of fresh tissue (Table 1). The maximum value was found in *B. sarana*. In other carps the values were low. In cat-fishes the average iron content was higher than carps. Average values for murrels and feather-backs were very similar. In the spiny-eel the total iron content was much higher and in the mullet about 33 mg. of iron was recorded.

Energy value: Energy values of the liver were calculated for fat, protein and carbohydrate fractions using the factors 9.3 for fat and 4.1 for protein and carbohydrate. The total values in the liver of all the fishes examined varied between 76.128 and 193.150 calories per 100 gm. of fresh tissue (Table 2). As compared to the muscle, the enrrgy values of the liver were much higher. The highest value were noted in the murrels (average 166.152 calories). Liver of carps with an average value of 128.766 calories came next to murrels. In cat-fishes the average value was about 105 calories. The calorific values for feather-backs, mullet and the spiny-eel were 114.644, 133.933 and 121.035 respectively. Higher energy value of the liver are because of higher lipid content in them.

Summary

Promixate chemical composition of liver in 24 species of freshwater fishes showed that the protein content of the liver was lower than that of the muscle. Murrels possessed the highest values for fat (lipid). Fishes which had a higher lipid content in their liver were found to be poor in their muscle-fat and vice versa.

The values for moisture, dry matter and ash in various fishes did not show any marked difference from those of the muscle. The percentages of phosphorus and iron in the liver were fairly high while the total calcium was rather low. Energy values for different fractions showed maximum calories in the murrels and the lowest in cat-fishes.

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TABLE - II. ENERGY VALUES OF DIFFERENT FRACTIONS OF THE LIVER OF FRESHWATER FISHES

SPECIES	PROTEIN Calories per 100 gm of fresh tissue	LIPIDS Calories per 100 gm of fresh tissue	CARBOHY-DRATE Calories per 100 gm of fresh tissue	TOTAL CALORIES per 100 gm of fresh tissue
CARPS :				
1. Cirrhina mrigala	49.405	63.463	21.086	133.954
2. Catla catla	36.514	48.118	42.385	127.017
3. Labeo rohita	44.198	25.044	24.513	93.755
4. Labeo calbasu	44.198	57.129	25.584	126.911
5. Labeo gonius	38.433	5.087	43.107	86.627
6. Barbus sarana	41.635	94.757	31.611	168.003
7. Barbus stigma	43.542	60.849	28.318	132.709
8. Barbus (Tor) putitora	56.375	92.311	12.472	161.158
CAT-FISHES:				
9. Mystus seenghala	53.136	43.384	12.148	108.668
10. Mystus aor	48.687	43.226	16.158	108.071
11. Bagarius bagarius	49.958	20.934	23.542	94.434
12. Rita rita	58.281	10.369	7.478	76.128
13. Pseudeutropius garua	51.229	34.902	24.280	110.411
14. Wallagonia attu	44.198	41.850	32.279	118.327
15. Callichrous pabda	36.514	12.694	35.206	84.414
16. Callichorous bimaculatus	42.918	14.396	30.840	88.154
17, Clarias magur	55.719	76.892	22.627	155.238
MURRELS :				
18. Ophicephalus puntctus	51.209	110.511	31.430	193.150
19. Ophicephalus striatus	48.031	86.769	23.255	158.055
20. Ophicephalus marulius	43.542	76.929	26.781	147.252
FEATHER-BACKS :				
21. Notopterus notopterus	48.667	46.574	35.239	130.480
22. Notopterus chitala	52.521	31.164	15.124	98.809
MULLET :				
23. Mugil corsula	43.542	57.567	32.824	133.933
SPINY-EEL :				
24. Mastacembelus armatus	48.749	36.846	35.440	121.035

chemical composition of some freshwater fishes', in full, of which the present paper formed part.

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