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Changes in chemical composition during growth of *Clarias batrachus* (Linnaeus)

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Abstract. In the muscle of *Clarias batrachus*, variations in total nitrogen, protein nitrogen, non protein nitrogen, total water and water soluble nitrogen, total protein, pure protein, albumin, fat, moisture, ash, total inorganic and acid soluble phosphorus were found markedly influenced by the size of the fish. Excepting the ash which decreased upto 2nd size group, a substantial fall in the relative concentration of these constituents was noted with the increasing length, the minimum being in 3rd size group. The fishes of larger size group (4th size group) contained slightly higher values. The fat value increased with the increasing size up to 2nd size group of fishes, whereas in the other size group, its value remained low. The moisture contents were found inversely related with the fat contents. The observed variations in different chemical constituents of fish with the increase in size appear to be related to the metabolic variations occurring during the growth and maturation cycle. In all size groups the electrophoretic patterns were more or less identical.

Keywords. Chemical changes during growth; *Clarias batrachus.*

1. Introduction

Multiplication of cells at the young state results in a higher proportion of extracellular space and therefore a larger proportion of extracellular fluid (Love 1958a). Increase in cell diameter which is directly proportional to length, occurs when the number of cells comes to a stable figure. Besides, there is also an increase in the thickness of the myocommata with the increase in fish size. These changes occurring during growth processes bring about remarkable changes in the chemistry of fish muscle. Ironside and Love (1958) pointed out a decrease in the solubility of muscle protein while a fall in DNA contents was observed by Love (1958b). Parker and Vanstone (1966) observed a decline in the water contents of fish less than 7·5 cm long. Other workers reported an increase in muscle or liver oil during the growth of many fishes (Hornell and Nayudu 1923; Arevalo 1948; Ripley and Bolomey 1964). Khawaja (1969) studied changes in fat, protein, moisture and ash in the Indian fishes. *Cirrhina mrigala, Ophicephalus punctatus, Mystus seenghala* and *Wallagonia attu.* However, the turnover of various nitrogen, protein and phosphorus fractions and other chemical constituents have not yet been reported in the air-breathing cat fish, *Clarias batrachus* which is also a commercially important cat fish of India. The results of this study are reported here.

2. Materials and methods

Specimens were collected from a pond and kept in a laboratory in a continually aerated aquarium. The fishes were weighed and measured to the nearest millimeter and divided into four size groups on the basis of size and weight. Three fishes from each size group were killed by decapitation. The muscle were removed and kept in glass plate covered with petridishes. A weighed amount of muscle was taken from each individual for chemical analysis. The techniques described earlier (Bano 1975) were adopted for the estimation of various chemical constituents. For electrophoresis muscle samples from each size group were removed, washed with distilled water and homogenized in a glass mortar with two volumes of phosphate buffer (Connel 1953). It was then centrifuged for 15 min and the supernatant was used for electrophoresis. The electrophoresis in starch gel was carried out as described by Hasnain *et al* (1973). The two sexes could not be analysed separately since specimens of any one sex were not available in sufficient number. Similarly to avoid the seasonal or environmental differences the study was completed within a fortnight and all fishes were procured from the same pond.

3. Results

The values for different fractions of nitrogen, protein, phosphorus, fat, moisture and ash in the muscle of *C. batrachus* are given in table 1. With the growing size, distinct variations can be observed in the concentrations of these constituents. The pattern of variations was similar in nitrogen, protein and phosphorus fractions. Maximum values were obtained in the 1st size group of fishes. Beyond that the

Table 1. Variations in the chemical constituents of the muscle during growth of *Clarias batrachus* Linn.

Size Range (cm) Weight Range (gm)	I Size group 16-17 38-49	II Size group 19-20 60-74	III Size group 22-23 87-115	IV Size group 25-26 108-141
Name of the constituents	Mean ± S.E.	Mean ± S.E.	Mean ± S.F.	Mean ± S.E.
Total nitrogen gm%	3·325 ± 0·05	3·26 ± 0·06	3·15 ± 0·05	3·16 ± 0·03
Protein nitrogen gm%	3·05 ± 0·03	3·04 ± 0·06	2·94 ± 0·04	2·95 ± 0·02
Total water soluble nitrogen mg %	869·51 ± 30·95	819·44 ± 11·11	633·88 ± 40·91	780·55 ± 10·01
Water soluble nitrogen mg %	603·51 ± 14·62	593·44 ± 10·03	460·55 ± 51·39	569·88 ± 22·13
Non-protein nitrogen mg %	266·00 ± 17·01	226·00 ± 13·31	203·33 ± 10·47	210·66 ± 12·34
Protein nitrogen Total nitrogen (PN/TN)	0·920	0·931	0·935	0·934
Total protein gm %	20·78 ± 0·32	20·41 ± 0·42	19·67 ± 0·34	19·79 ± 0·22
Pure protein gm %	19·11 ± 0·24	19·00 ± 0·42	18·42 ± 0·28	18·47 ± 0·16
Albumin gm %	3·77 ± 0·09	3·70 ± 0·06	2·87 ± 0·32	3·56 ± 0·13
Total phosphorus mg %	316·26 ± 7·46	311·45 ± 0·53	300·80 ± 5·76	308·80 ± 5·76
Total phosphorus mg %	316·26 ± 7·46	311·46 ± 0·53	300·80 ± 5·76	308·80 ± 5·76
Acid soluble phosphorus mg %	493·33 ± 21·33	474·66 ± 11·62	468·00 ± 11·54	488·00 ± 24·00
Inorganic phosphorus mg %	159·00 ± 1·00	142·66 ± 6·33	136·00 ± 5·03	137·16 ± 3·60
Fat gm %	0·78 ± 0·02	0·53 ± 0·20	0·63 ± 0·06	0·61 ± 0·17
Moisture gm %	77·46 ± 0·07	78·25 ± 0·62	77·69 ± 0·03	77·83 ± 0·51
Ash gm %	1·39 ± 0·01	1·17 ± 0·03	1·27 ± 0·04	1·28 ± 0·02

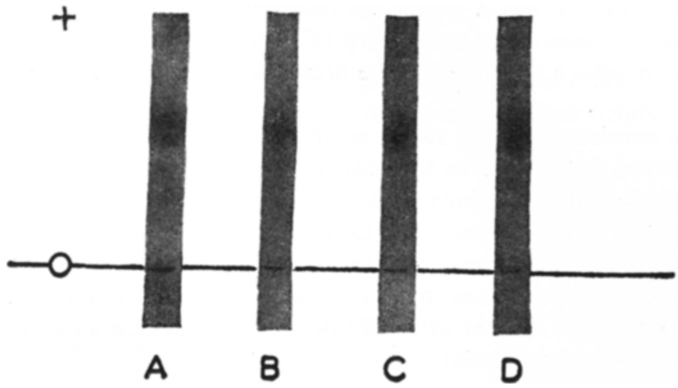

Figure 1.

values declined gradually reaching minimum in the fishes of 3rd size group. It is interesting to note that a slight increase was again observed in the fishes belonging to 4th size group. Larger individuals (20-23 cm, 25-26 cm) contained higher ratio of PN/TN (protein nitrogen/total nitrogen) than that of smaller individuals. Whereas with the increase in size, the pattern of variations in fat and ash contents was not similar, the fat contents increased up to 2nd size group and remained low thereafter. There was a steady fall in ash value with the increasing length up to 2nd size group, but it was not maintained in larger size groups and the values were found again high. The moisture contents were inversely related to the changes in fat contents. However, no such relationship was observed between protein and moisture contents.

In all size groups identical electrophoretic patterns were obtained in the skeletal muscle extracts of *C. batrachus* (figure 1). The fractions were on the anodal side and the intensity of the staining of the bands was higher with the increase in the size of the fish.

4. Discussion

Concomitant with an increase in length which also marks the maturation in larger size fishes, considerable changes in the chemical composition occur. In the present study the variations observed in several constituents therefore seems related with the variations in the metabolism during growth and maturation. The initial fall in nitrogen, protein and phosphorus fractions and ash may be due to the reduction in cell number with an increase in size (Love 1958b). A decrease in the solubility of muscle proteins has been found to occur because of three-fold increase in the thickness of the myocommata with the doubling of fish length (Ironside and Love 1958). Unlike other animals the fish continues to grow throughout its life, but in older age the rate of growth falls down considerably and this decrease is reflected in its chemical composition (Qasim and Bhatt 1966). A slight rise seen in the 4th size group of *C. batrachus* therefore can be attributed to the slowing down of growth in larger individuals. More or less similar conclusions were drawn by Khawaja (1969) on a few fresh water fishes. Of them two cat fish species *M. seenghala* and *W. attu* had a close resemblance in the changes with *C. batrachus*. On the contrary, fat contents in the present study showed a trend that resembled the changes in the fat contents of a sneakhead (*O. punctatus*) and a carp (*C. mrigala*). A negative correlation between fat and moisture as existed in the present analysis was also reported in these fishes.

Though no consistency in the relationship between size and mineral composition has been reported for any fish in the past, in *C. batrachus* a definite correlationship was observed in various fractions of phosphorus which declined with the increase of size in the range of 20-23 cm. The fishes of larger size contained slightly higher values. The fall in ash contents occurred in the fishes up to 19-20 cm. Further growth again led to an increase in its contents. These observations are in accordance with the study of Ono *et al* (1953) on phosphorus fractions though contrary to the findings of Siddiqui (1968).

It appears that the quantity of food which the fish consumes also greatly influences its chemical composition. In *C. batrachus* the adults take more nutritive food in the form of insects, shrimps, worms and algae whereas the fry and fingerlings mainly feed on protozoans, small crustaceans, rotifers etc (Mookerji and Mazumdar 1950). Therefore a possibility exists that variations in different chemical constituents might also be due to changes in food as reported in *Gadus morhua* by Rae (1967) where a change in diet brought about changes in different enzymes of digestive tract in accordance with the nature of diet. Morishita *et al* (1964) observed a reduction in the proteolytic and amylolytic activity of the alimentary canal in five Japanese fish species.

It has been reported that in fishes, the fecundity increases with length, weight or age (Qayyum nd Qasim 1964). The build-up of gonad is usually accomplished at the expense of the body reserves as the dietry material seems inadequate to meet the huge demands made by sex organs. Therefore, in larger fishes this greater demand results in more depletion of reserves, as is the case with *C. batrachus*. The higher concentration of various constituents in smallest fish (16–17 cm) presumably indicates the immature condition of these fishes. In larger fishes a steady fall in them may demonstrate the spawning. It is supported by the findings already reported by Bano (1975) where the chemical components were found high before the spawning and low after that. A corollary to the present finding is apparent in the work of Khawaja and Jafri (1967) who showed a gradual decline in lipid, protein and ash with increase in size of *O. punctatus* captured just after spawning. Love (1960) observed that the immature *Gadus morhua* contained the same water level, while the medium sized fish, spawning for the first time, had the highest water contents. The largest fish which spawned atleast once already was found to have the highest water content and in the most depleted condition. Hornell and Nayüdu (1923) interpreted the relationship differently concluding that the older fishes are able to lay down the reserves more readily because their growth is then slower. But in the light of Orton's (1929) suggestion of over reproduction with age, the increased lipid seems more likely to act as an extra energy reserves at the spawning time to assist recovery.

The electrophoretic patterns of each size group indicates that the smallest fish contained more protein than the fish of other size as the bands of the 1st size group were more darkened than the bands of the rest of the size groups.

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