EFFECT OF STARVATION AND REFEEDING ON TISSUE PROXIMATE ANALYSIS OF HEPATIC AND MUSCULAR TISSUES OF *TILAPIA MOSSAMBICA* (PETERS)

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ABSTRACT

Starvation in *Tilapia mossambica* (Peters) induced higher depletion of carbohydrate reserves in all the tissues. While liver and red muscle showed higher lipolysis, the white muscle had higher proteolysis. The refeeding process resulted in replenishment of tissue reservs in white muscle, while those of liver and red muscle were at lower level than normal, suggesting the possibility of impairment of synthetic activities in liver and red muscle after prolonged starvation. The carbohydrate synthetic efficiency in white muscle seem to be considerably elevated on refeeding. The lipid reserves of all the tissues were depleted even after refeeding and hence the course of starvation and refeeding was envisaged to decrease the tissue fat depots.

INTRODUCTION

Majority of fishes live through severe depletion of food for at least a part of every year in their natural environment (Love 1970) and hence they are known to be well adapted for mobilizing their body constituents during starvation. Starvation and refeeding exerts significant effects on carbohydrate and fat metabolism (Mc Garry et al 1973). Sharp decline in the liver glycogen during starvation and its rapid replenishment during refeeding was reported in several animals (Raptz and Musacchina 1957, Gist 1972). Decreased lipid content in the liver of 5 years old gold fish starved for 25 days was reported (Stimpson 1965). Contrary to this, studies on *A. Japonica* have shown that glycogen was more readily utilized than lipids in liver during 3 months of starvation (Tashima and Cahill 1965). However, the information on starvation and refeeding on fishes is scanty and hence the present work has been undertaken in order to elucidate the possible changes in the nutritive values of fishes through the study of tissue proximate analysis.

MATERIALS AND METHODS

The freshwater fishes belonging to the species *Tilapia mossambica* were selected for the present study, owing to their survival for prolonged periods of

starvation (Richard and Fleming 1969). The fishes were maintained in laboratory conditions for one month, before using them for experimentation. The fishes were divided into three batches. The first batch of fishes were fed regularly, while the other two batches were maintained for starvation for 30 days. Among them the third batch of animals were refed after the starvation period regularly for a period of 30 days. The first batch of fishes were taken as controls, the second batch as starved and the third batch as refed animals. These animals were pithed and the tissues like liver, red muscle and white muscle were isolated and taken for biochemical assays.

Total proteins (Lowry et al 1951), total carbohydrates (Caroll et al 1956), total lipids (Folch et al 1957) and free fatty acids (Natelson 1971) were estimated in these tissues. Dry weight and water content of the tissues were estimated gravimetrically as described elsewhere (Bhaskara Haranath 1979).

Results and Discussion

The data presented in the table reveal the impact of starvation and refeeding on the tissue proximate analysis of hepatic and muscular tissues. In normal fishes, liver contains highest levels of proteins, carbohydrates and lipid reserves. Red muscle seems to have close relationship with that of liver in the biochemical components which is in confirmity with the earlier workers.

Starvation of fishes resulted in a general depletion in all the tissue reserves. The pattern of depletion in all the tissues revealed the greater utilization of carbohydrate reserves than the others. This observation suggests the major contribution of carbohydrates towards the energy release during total calorific depletion and this is in consonance with the earlier workers (Emerson 1967, Humphrey et al 1973). Among the three, red muscle seems to mobilize higher carbohydrate reserves, while the white muscle had the least. Lipid reserves of all the tissues were mobilized at a lessr level than that of carbohydrates. The tissues studied had an increase in the level of free fatty acids, the increase being more in red muscle. Elevated fatty acid levels suggest the lipolytic activities of these tissues. The white muscle had higher protein depletion than its lipid constituency unlike the other tissues. Since the white muscle of fishes exhibits highest proteolytic activity during starvation (Siamak 1976) higher level of protein depletion in this tissue can be expected. The dry matter in all the tissues had considerable depletion, suggesting the mobility of tissue constituents towards the energy release during starvation. These tissues showed the accumulation of water to a varying degree, which is in agreement with the earlier reports (Sutton 1968, Soutter and Higgins 1977).

The studies on feeding of the fishes after starvation revealed an overall elevation in the tissue constituents. The protein content of red and white muscles reached to that of normal indicating the setting-in of active protein biosynthetic mechanisms in these tissues on refeeding. However, liver could not replenish

TABLE 1. *Level of total proteins, total carbohydrates, total lipids, free fatty acids, dry weight and water content in the tissues of normal* (N), *starved* (S) *and refed* (RF) T. mossambica.

Compouent	LIVER			RED MUSCLE			WHITE MUSCLE		
	N	S	RF	N	S	RF	N	S	RF
Total proteins (mg/g wet wt)	135.7 ±10.28	82.95 ±6.36 −38.87 P<0.001	101.03 ±7.22 −32.92 P<0.001	114,99 ±10.32	78.47 ±10.12 −31.76 P<0.001	113.84 ±9.28 −1.0 NS	107.25 ±10.31	68.63 ±5.2 −36.01 P<0.001	101.24 ±11.23 −5.6 NS
Total carbohydrates	109.92 ±6.85	29.34 ±3.27 −73.31 P<0.001	88.58 ±6.89 −19.48 P<0.001	12.77 ±0.95	3.15 ±0.19 −75.3 P<0.001	10.84 ±1.15 −15.11 P<0.001	2.13 ±0.12	0.696 ±0.07 −67.32 P<0.001	3.8 ±0.17 +78.4 P<0.001
Total lipids (mg/g dry wt)	380.06 ±23.24	230.76 ±26.13 −39.28 P<0.001	333.33 ±20.27 −12.29 P<0.001	146.28 ±12.28	98.08 ±8.39 −32.95 P<0.001	106.38 ±11.21 −27.28 P<0.001	112.99 ±7.38	88.19 ±10.21 −28.29 P<0.001	110,29 ±11.18 −2.39 NS
Free fatty acids (mg/g dry wt)	17.37 ±1.36	29.39 ±1.87 +69.2 P<0.001	16.95 ±1.71 −2.42 NS	11.14 ±0.87	25.95 ±2.93 +132.94 P<0.001	20.48 ±3.21 +83.84 P<0.001	10.81 ±0.87	16.9 ±1.23 +56.34 P<0.001	14.25 ±1.16 +31.82 P<0.001
Dry weight (mg/g wet wt)	282 ±20.5	238 ±15.33 −15.6 P<0.001	280 ±25.2 −0.71 NS	206 ± 10.84	187 ±10.32 −4.37 P<0.05	210 ±15.82 +1.94 NS	201 ±8.37	175 ±10.27 −12.93 P<0.001	195 ±17.15 −2.98 NS
Water content (mg wet wt)	719 ±52.85	772 ±61.25 +7.52 P<0.05	720 ±64.14 +0.28 NS	794 ±40.28	813 ±33.46 +2.4 P<0.05	790 ±31.09 0.5 NS	799 ±28.93	825 ±18.77 +3.25 P<0.05	805 ±79.23 +0.75 NS

the tissue-protein content even after refeeding indicating either efflux of tissue protein into the blood or possible impairment of tissue-protein synthetic activities in response to prolonged starvation. The carbohydrate reserves of the tissues were replenished on refeeding, suggesting the operation of carbohydrate synthetic mechanisms. However, the carbohydrate level of liver and red muscle were still below the normal level. But the white muscle had significantly elevated carbohydrate content over that of normal, indicating the improved synthetic efficiency of the tissue on refeeding. The lipid content of liver and red muscle was still below normal level, where as that of white muscle attained normalcy suggesting starvation and refeeding might decrease the fat reserves of the tissues. The free fatty-acid contents of red and white muscle were highly elevated, while that of liver showed non-significant change. This observation might suggest elevated lipolysis or diminished lipogenesis in the tissues in response to refeeding. The dry matter and water content of the tissues attained normal level supporting the possible replenishment of tissue constituents in response to the course of refeeding.

In general it can be concluded that the course of starvation and refeeding in fishes seems to decrease the lipid storage in the tissue and to elevate the carbohydrate synthetic capacity of white muscle.

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