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Effect of Starvation on Organ Weight and Chemical Component of Red Sea Bream*

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To determine the effect of starvation on the organ weight and chemical components of red sea bream, *Chrysophrys major*, wild fish were starved for 90-days at 13-18°C. At fixed days (0, 1, 2, 4, 9, 15, 30, 70 and 90th day). ten fish were selected for the determination of the fork length, weight, and chemical components of the whole body and organs. The condition factor decreased over the starving period. The weight of liver and intestine with adipose tissue declined drastically from the 9th day till the 30th day, and the weight of the heart decreased after the 30th day. However, the weight of spleen increased till the 15th day before the onset of the decline. A decreasing lipid content was first recognized in the liver, and then in the vertebrae and dorsal muscle. Glycogen in the liver increased till the 4th day, and decreased rapidly thereafter. Protein in the dorsal muscle was catabolized severely from the 9th day till the 30th day. The moisture contents of liver and dorsal muscle increased with the decline in lipid, glycogen, and protein content. Mineral composition of the vertebrae was not affected by the starvation.

INTRODUCTION

In the previous paper (Sakamoto and Yone, 1978), the effect of starvation on the hematological characteristics, the contents of chemical components, and activities of enzymes in blood serum of red sea bream were reported. In the present study, the weight and chemical components of various organs of the same individuals used in the previous study were concurrently determined.

MATERIALS AND METHODS

Wild red sea bream (fork length: 11.6-16.1 cm) were presented for this study immediately after the net fishing. Fish were starved for 90 days in 1501 aquaria with a flow rate of approximately 150 *l* per hour. The water temperature dropped from 18°C to 13°C during the experimental period. At fixed days (0, 1, 2, 4, 9, 15, 30, 70 and 90th day), ten fish were selected. After the sampling of blood, the fork length and the weight of whole body, liver, in-

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testine with adipose tissue, spleen, and heart were measured individually. As an indicator of the change of organ weight, the ratio of organ weight to fork length was calculated, because the body weight decreases gradually during the starving period, whereas the fork length does not change. Liver, dorsal muscle, intestine, and vertebrae were sampled from each fish in the same amount to determine the contents of moisture, protein, lipid, glycogen, ash, calcium, and phosphorus. Moisture contents of the liver, dorsal muscle, intestine, and vertebrae were determined by a 24 hour drying in an electric oven at 105°C. The Soxhlet extractor and ethyl ether were used to extract lipids of the liver, dorsal muscle, and intestine. Lipids of vertebrae were extracted with methyl alcohol for 24 hours, followed by a 16 hour extraction with ethyl ether. Protein contents of the liver and dorsal muscle and glycogen content of the liver were determined by semi-micro Kjeldahl method (Mitsuda, 1964) and Carroll's method (Carroll *et al.*, 1956), respectively. The calcium and phosphorus content of vertebrae were quantified by orthocresolphthalein complexone method (Conerty and Briggs, 1966) and molybdenum blue method (Tausky and Shorr, 1953), respectively, after dry ashing with an electric furnace at 450°C for 48 hours.

RESULTS AND DISCUSSION

As shown in Table 1 and Fig. 1, the decline in the condition factor was recognized over the starving period, and was remarkable till the 30th day. This indicates that the body components are drastically catabolized early in the starving period, and the basal metabolism declines with the prolonged starvation. Liver weight was stable till the 9th day, during which the de-

Table 1. Effect of starvation on the condition factor and the ratio of liver, intestine, heart, and spleen weight to fork length of red sea bream.

Days of starvation	0	1	2	4	9
Fork length (cm)	13.5 ±0.9[1]	13.4 ±0.7	14.0 ± 1.0	13.4 ±0.8	14.6 ± 1.1
Body weight (g)	57.0 ill.3	52.0 ±8.0	64.3 ±15.0	53.3 ±7.8	69.4 ±15.6
Condition factor[2]	2.29± 0.11	2.15±0.20	2.29± 0.07	2.21±0.08	2.21± 0.09
Ratio of liver Wt to FL[3]	20.5 ± 2.8	21.2 ±4.1	19.9 ± 3.1	20.1 ±3.9	20.3 ± 3.1
Ratio of intestine Wt to FL[3]	67.2 ±10.3	64.2 i5.6	63.5 ± 4.8	63.3 i9.3	62.7 ± 4.6
Ratio of heart Wt to FL[3]	1.68" 0.19	1.58±0.24	1.64± 0.11	1.62±0.18	1.65± 0.18
Ratio of spleen Wt to FL[3]	0.98± 0.24	1.03±0.38	1.24± 0.37	1.34-t0.51	1.46-c 0.31

Days of starvation	15	30	70	90
Fork length (cm)	13.7 ±0.8	13.6 ± 0.9	12.8 ± 0.8	13.3 io. 5
Body weight (g)	54.0 ±8.3	51.3 ±10.1	40.2 ± 8.3	42.1 ±4.6
Condition factor	2.09 to. 12	2.03-t 0.06	1.88± 0.12	1.80±0.04
Ratio of liver Wt to FL	16.7 ±1.4	13.6 ± 1.0	13.1 ± 1.8	13.0 f1.4
Ratio of intestine Wt to FL	57.1 ±7.7	49.6 ± 5.6	56.7 ±10.1	53.7 ±9.8
Ratio of heart Wt to FL	1.67t0.14	1.62, 0.11	1.56± 0.15	1.42±0.12
Ratio of spleen Wt to FL	1.48±0.53	1.19± 0.29	0.91± 0.23	0.68±0.13

1) Standard deviation. 2) Body weight (g) ×100 / Fork length(cm)^3. 3) Each organ weight(g) ×10^5 / Fork length(cm)^3.

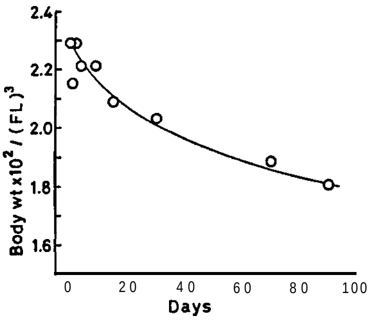

Fig. 1. Change in condition factor of red sea bream during starving period.

crease in intestine weight was slight. During the period from the 9th day to the 30th day, however, the weight of both organs declined severely (Table 1 and Fig. 2). The gain in weight of intestine at the 70th and 90th day were

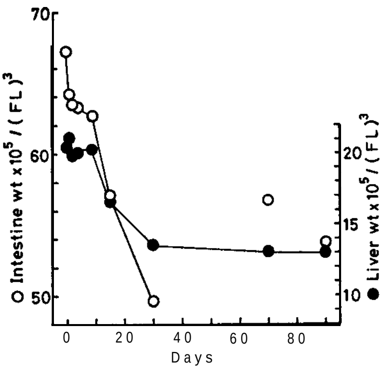

Fig. 2. Change in ratio of liver and intestine weight to fork length of red sea bream during starving period.

caused by the water deposition in the intestinal tissue and lumen. On the other hand, the decrease in heart weight started after the 30th day following that of liver and intestine weight, and the rate of decline became greater with the prolonged starvation (Table 1 and Fig. 3). Spleen weight rose in the early stages of starvation before its decline (Table 1 and Fig. 3). As shown in Table 2 and Fig. 4, the lipid content decreased extremely up to the 15th day in the liver, after the 15th day in the vertebrae, and after the 30th day in the dorsal muscle. These results definitely show that the lipid in liver is an important energy source in the early stages of starvation, and that the lipid in vertebrae and dorsal muscle is utilized later. Glycogen content of the liver elevated till the 4th day, but declined to a lower level than the normal range after the 15th day (Table 2 and Fig. 5). Protein content of the liver did not decrease remarkably during the starving period, but in the

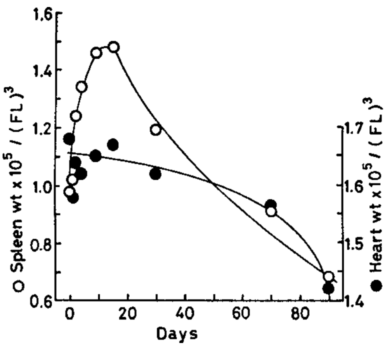

Fig. 3. Change in ratio of heart and spleen weight to fork length of red sea bream during starving period.

dorsal muscle a considerable decline was recognized from the 9th day to 30th day (Table 2 and Fig. 6). On the other hand, the blood sugar level was maintained within the normal range during the starvation (Sakamoto and Yone, 1978). From these results, it is reasonable to presume that lipid, glycogen, and protein of tissues and organs are utilized to maintain the level of blood sugar, which some organs require as the energy source, during the period of starvation. The moisture contents of liver and dorsal muscle increased with the decreasing lipid, glycogen, and protein content (Table 2 and Fig. 7). This was particularly expressed in the relationship between the moisture content and the lipid content in the liver (Fig. 8). In the vertebrae, the decline of lipid content resulted in the elevation of ash content after the 15th day (Table 2 and Fig. 9). However, calcium and phosphorus content and Ca/P ratio of the vertebrae were maintained at a steady level during the starvation

Table 2. Effect of starvation on the content of chemical components of liver, dorsal muscle, and vertebrae of red sea bream.

Days of starvation	0	1	2	4	9	15	30	70	90
Liver									
Moisture (%)	73.7	**71.5**	**73.3**	**74. 7**	75.0	75. 5	76. 4	78. 6	79. 1
Lipid (%)	4.9	**5.9**	**5.1**	**3.8**	4.2	3.9	3. 7	3.1	3.0
Protein (%)	18. 2	**19.0**	18.3	**17. 4**	17. 4	17. 6	17. 9	16. 4	16. 2
Glycogen (%)	1. **65**	**1.92**	**1. 69**	**2. 44**	1. 66	0.79	0: 39	—	—
Dorsal muscle									
Moisture (%)	77. 1	0. 6	0. 5	0. 6	0. 9	78.2	84.2	83.7	83.8
Lipid (%)	0. 6	20. 7	20. 8	20. 1	20. 2	19.6 0.7	0.6	0. 4	0.3
Protein (%)	20. 7						13.3	13. 9	13.9
Intestine									
Moisture (%)	77.6	78.0	76.9	—	—	—	—	95. 1	93. 7
Vertebrae									
Lipid (% db)*	19.5	21. 2	20. 7	19.6	23.0	19. 1	16.8	2. 8	1. 7
Ash (% db)	53.9	53. 9	52.5	53. 6	51.4	53.9	56. 4	66. 0	67. 8
Ca (mg/g ash)	351	354	360	340	349	343	345	353'	366'
P (mg/g ash)	189	192	191	192	190	192	191	186	185
Ca/P ratio	1.86	1.84	1.88	1.77	1.83	1.79	1.81	1.90	1.98

* % of dry weight basis.

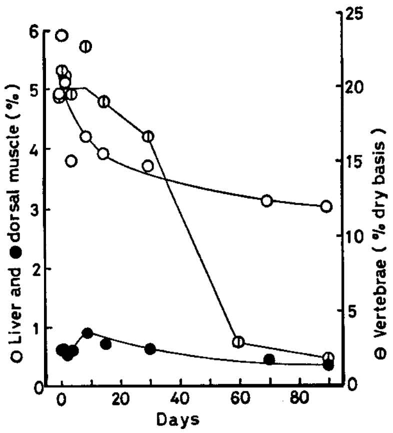

Fig. 4. Change in lipid content of liver, dorsal muscle, and vertebrae of red sea bream during starving period.

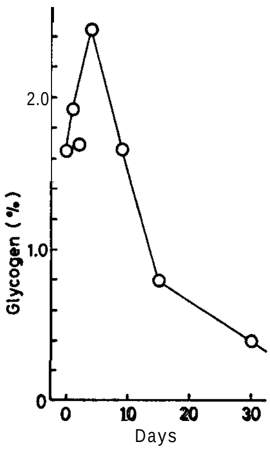

Fig. 5. Change in glycogen content of liver of red sea bream during starving period.

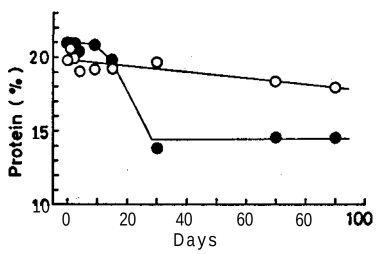

Fig. 6. Change in protein content of liver and dorsal muscle of red sea bream during starving period. O: Liver, ●: Dorsal muscle.

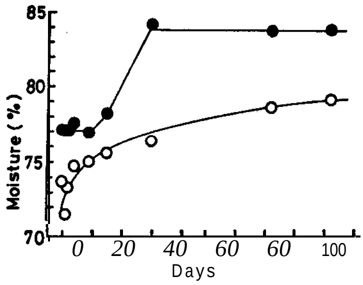

Fig. 7. Change in moisture content of liver and dorsal muscle of red sea bream during starving period. ○: Liver, ●: Dorsal muscle.

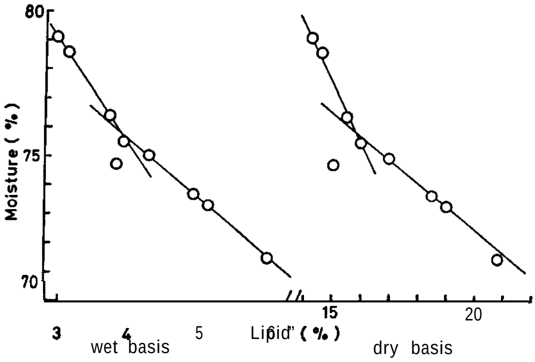

Fig. 8. Relationship between the moisture content and the lipid content of liver of red sea bream during starving period.

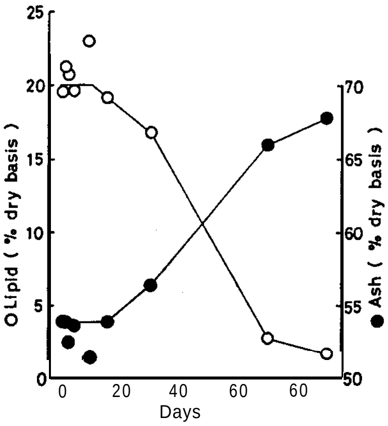

Fig. 9. Change in ash and lipid content of vertebrae of red sea bream during starving period.

(Table 2). From these results, it is evident that starvation scarcely influences the mineral composition of bone. The phenomena recognized in starved red sea bream and other fishes (Inui and Ohshima, 1966; Inui and Egusa, 1967; Love, 1970; Inui and Yokote, 1974; Shimeno, 1974; Sakaguchi, 1976) resemble those in starved terrestrial animals (Cahill Jr., 1974; Van Itallie, 1974). Therefore, the metabolism pattern of fishes during starvation may be similar to those of terrestrial animals.

REFERENCES

Cahill Jr., G. F. 1974 Intermediary metabolism of protein, fat, and carbohydrate. *In* "Harison's Principles of Internal Medicine", 7th ed., ed. by M. M. Wintrobe *et al.*, McGraw-Hill, New York, pp. 396-408

Carroll, N. V.. R. W. Longley, and J. E. Roe 1956 The determination of glycogen in liver and muscle by use of anthrone reagent. ***J. Biol. Chem.*, 220**(2): 583-593

Conerty, H. V. and A. R. Briggs 1966 Determination of serum calcium by means of orthocresolphthalein complexone. ***Am. J. Clin. Path.*, 45**(3) : 290-296

Inui, Y. and S. Egusa 1967 Histological changes observed in glass eel liver during starvation. ***Bull. Japan. Soc. Sci. Fish.*, 33**(3) : 181-189

Inui, Y. and Y. Ohshima 1966 Effect of starvation on metabolism and chemical composition of eels. ***Bull.*** Japan. ***Soc.*** Sci. ***Fish.*, 32**(6) : 492-501

Inui, Y. and M. Yokote 1974 Gluconeogenesis in the eel-I. Gluconeogenesis in the fasted eel. ***Bull. Freshwater Fish. Res. Lab.*, 24**(1): *33-46*

Love, R. M. 1970 ***The Chemical Biology of Fishes.*** Academic Press, London, pp. 222-257

Mitsuda, H. 1964 ***Jikken Eiyo*** Kagaku. Izumi-shobo, Kyoto, pp. 49-57 (in Japanese)

Sakaguchi, H. 1976 Changes of biochemical components in serum, hepatopancreas and muscle of yellowtail starvation. ***Bull. Japan. Soc. Sci. Fish.*, 42**(11): *1267-1272* (in Japanese with English summary)

Sakamoto. S. and Y. Yone 1978 Effect of starvation on hematological characteristics, and the contents of chemical components and activities of enzymes in blood serum of red sea bream. ***J. Fac. Agr., Kyushu Univ.*, 23**(1・2): 63-69

Shimeno, S. 1974 Studies on carbohydrate metabolism in fishes. ***Rep. Fish. Lab., Kochi Univ., No. 2: 62-76*** (in Japanese with English summary)

Tausky. H. H. and E. Shorr 1953 A microcolorimetric method for the determination of inorganic phosphorus. ***J. Biol. Chem.*, 202**(2): *675-685*

Van Itallie. T. B. 1974 Starvation and protein-calorie malnutrition. *In* "Harrison's Principles of Internal Medicine", 7th ed., ed. by M. M. Wintrobe et ***al.***, McGraw-Hill, New York, pp. 422-427