マダイの飼料鉄要求II

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Requirement of Red Sea Bream for Dietary Iron—II*[1]

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In order to determine the amount of dietary iron required by red sea bream, *Chrysophrys major*, the effect of dietary iron on some biological and chemical characteristics of the blood were examined by using fish which received diets with different levels of iron over a 90-day feeding trial. The fish fed dietary iron levels lower than 15 mg/100 g showed lower values for mean corpuscular constants of blood and iron content and iron saturation index of blood serum, and higher values for total iron binding capacity and unsaturated iron binding capacity of blood serum than those found for the fish receiving higher dietary iron levels. From these results, it is concluded that the iron requirement of red sea bream is approximately 15 mg per 100 g diet.

In the previous study[1], no significant difference in the growth rate and feed efficiency was recognized between groups of red sea bream fed the diets with and without supplementary iron. However, it was noticed that the fish fed the diet without iron supplement showed a microcytic hypochromemia and an anisocytosis of erythrocyte.

The present study, therefore, has been made to determine the adequate content of iron in the diet for preventing the development of anemia.

Experimental

Fish

The methods for fish selection and grouping were the same as those reported previously[2]. The fish were reared on the experimental diets over a 90-day period at 25°C.

Diets

The composition of experimental diets was the same as that of the diet YR-2[3] except for mineral mixture. The composition of seven mineral mixtures used in the experimental diets was listed in Table 1. The Fe content of the basal diet containing a mineral mixture without Fe supplement was analysed to be 0.1 mg/100 g. Therefore, when the other six mineral mixtures were added to the basal diet at a 8% level, the Fe content of each experimental diet was calculated to be 5.03, 9.99, 14.93, 19.86, 29.75 and 39.62 mg/100 g, respectively. The preparation of diet and feeding were conducted as described in the previous paper[2].

Analytical Methods

The methods for blood sampling and biological analysis of erythrocyte were the same as those

Table 1. Composition of mineral mixtures

Mineral mix. No.	0	5	10	15	20	30	40
$FeCl_2 \cdot 4H_2O$	—	0.222	0.445	0.667	0.889	1.334	1.778
KCl	5.18	5.18	5.18	5.18	5.18	5.18	5.18
$NaH_2PO_4 \cdot 2H_2O$	30.805	30.805	30.805	30.805	30.805	30.805	30.805
Trace metals*	0.294	0.294	0.294	0.294	0.294	0.294	0.294
α-Cellulose	64.309	64.087	63.864	63.642	63.420	62.975	62.531
Fe (mg/8 g mineral mix.)	—	4.93	9.89	14.83	19.76	29.65	39.52
Fe (mg/100 g diet)	0.10	5.03	9.99	14.93	19.86	29.75	39.62

* $AlCl_3 \cdot 6H_2O$, 9.0 mg; $ZnSO_4 \cdot 7H_2O$, 178.5 mg; $MnSO_4 \cdot 4$–$6H_2O$, 40.0 mg; CuCl, 5.5 mg; KI, 8.5 mg; $CoCl_2 \cdot 6H_2O$, 52.5 mg.

Contribution from Fish. Res. Lab., Kyushu Univ., No. 122.

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presented in the previous paper[1]. Plasma protein content was determined with Atago Hand Protein Refractometer. Fe content and total iron binding capacity (TIBC) of blood serum were analyzed by bathophenanthroline[4] and magnesium carbonate method[5], respectively. The unsaturated iron binding capacity (UIBC) and Fe saturation index were calculated by subtracting serum Fe content from TIBC and by dividing serum Fe content by TIBC, respectively. Serum triglyceride and phospholipid content were analyzed by acetylacetone method[6] and the modified HOEFLMARY-FRIED method[7], respectively.

Results and Discussion

As shown in Table 2, any interrelation was not found between dietary Fe level and either of red blood cell count (RBC), plasma protein content or phospholipid content of blood serum. Triglyceride content of serum, however, increased with the elevation of dietary Fe level up to 10 mg/100 g. Among the groups receiving dietary Fe levels higher than 10 mg/100 g, little difference was recognized in hemoglobin (Hb), hematocrit (Ht), specific gravity and percentage of immature erythrocyte. On the other hand, the group receiving

Table 2. Biological and chemical characteristics of blood of red sea bream fed diets containing different levels of Fe

Group No.	0	5	10	15	20	30	40
Fe (mg/100 g diet)	0.10	5.03	9.99	14.93	19.86	29.75	39.62
Hb (g/d*l*)	4.7±0.9*1	6.8±0.6	7.0±0.6	7.5±0.4	6.7±0.9	7.7±0.7	7.4±0.5
Ht (%)	24.7±4.3	31.0±3.1	30.5±3.2	31.9±1.7	28.9±4.3	33.0±4.0	30.8±2.5
RBC ($\times 10^6$/mm^3)	2.975 ±0.384	—	3.191 ±0.324	3.206 ±0.263	2.881 ±0.280	—	3.055 ±0.296
Specific gravity	1.036 ±0.003	1.041 ±0.002	1.041 ±0.003	1.042 ±0.001	1.040 ±0.003	1.043 ±0.003	1.041 ±0.001
Immature erythrocyte (%)	27.74	10.28	5.22	5.36	6.40	4.83	5.13
MCH ($\gamma\gamma$)*2	16.1±4.5	—	21.9±2.1	23.5±1.9	23.3±1.8	—	24.1±1.7
MCV (μ^3)*3	84.8±22.3	—	95.6±9.2	98.8±7.9	100.3±8.1	—	100.3±6.2
MCHC (%)*4	18.9±2.4	21.9±1.1	22.8±1.2	23.6±0.8	23.4±1.1	23.4±1.3	24.0±1.2
Plasma protein (g/d*l*)	3.6±0.4	3.7±0.6	3.8±0.5	3.8±0.7	4.0±0.4	3.7±0.3	3.5±0.3
Serum Fe (μg/d*l*)	24	57	60	65	65	63	69
TIBC (μg/d*l*)	560	528	510	493	493	500	504
UIBC (μg/d*l*)	536	471	450	428	428	437	435
Fe saturation index (%)	4.29	10.80	11.76	13.18	13.18	12.60	13.69
Triglyceride (mg/d*l*)	156	308	354	343	348	—	—
Phospholipid (mg/d*l*)	524	526	546	515	—	—	—

*1 Standard deviation
*2 Mean corpuscular hemoglobin: Hb (g/d*l*) × 10/RBC ($\times 10^6$/mm^3)
*3 Mean corpuscular volume: Ht (%) × 10/RBC ($\times 10^6$/mm^3)
*4 Mean corpuscular hemoglobin concentration: Hb (g/d*l*) × 100/Ht (%)

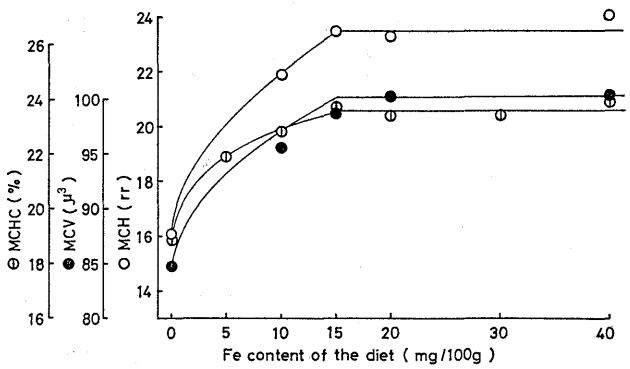

Fig. 1. Relationships between dietary Fe level and mean corpuscular constants of red sea bream.

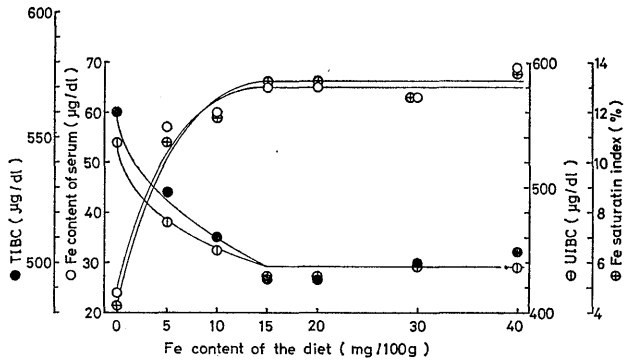

Fig. 2. Relationships between dietary Fe level and Fe content, total iron binding capacity (TIBC), unsaturated iron binding capacity (UIBC) or Fe saturation index of blood serum of red sea bream.

a minimal Fe level (0.1 mg/100 g diet) manifested the lowest values for Hb, Ht, specific gravity and the highest percentage of immature erythrocyte, followed by the 5 mg Fe/100 g diet group with a low Hb and a high percentage of immature erythrocyte. In the groups reared on the diets containing Fe levels lower than 15 mg/100 g, was noticed the decrease in the mean corpuscular constants (MCH, MCV and MCHC), serum Fe content and Fe saturation index as contrasted to the increase in TIBC and UIBC with the decrease of dietary Fe level (Table 2 and Figs. 1 and 2).

These findings show that the fish fed dietary Fe levels lower than 15 mg/100 g develops microcytic hypochromemia caused by Fe-deficiency. Therefore, the adequate dietary Fe level for red sea bream was estimated about 15 mg per 100 g of diet, based on data of the effect of dietary Fe level on mean corpuscular constants of blood, and Fe content, Fe saturation index, TIBC and UIBC of blood serum.

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