Effects of the Deletion of Mg or Fe from Semi Purified Diets on Growth and Efficiency of Feed Utilization of Yellow Croaker Nibea albiflora

El-Zibdeh, Mohammad
Fishery Research Laboratory, Faculty of Agriculture, Kyushu University

Ide, Kentaro
Fishery Research Laboratory, Faculty of Agriculture, Kyushu University

Furuichi, Masayuki
Fishery Research Laboratory, Faculty of Agriculture, Kyushu University

https://doi.org/10.5109/24122

出版情報：九州大学大学院農学研究院紀要. 40 (3/4), pp.391-397, 1996-03. Kyushu University
バージョン：
権利関係：

J. Fac.Agr., Kyushu Univ., **40**(3·4),391-397(1996)

Effects of the Deletion of Mg or Fe from Semi Purified Diets on Growth and Efficiency of Feed Utilization of Yellow Croaker *Nibea albiflora**

Mohammad El-Zibdeh, Kentaro Ide and Masayuki Furuichi

Fishery Research Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka 81 l-33, Japan

(Received November 27,1995)

Yellow croaker *Nibea albiflora*, (mean initial weight 28.7 g) were fed on casein based semi purified diets with (control) or without, supplement of either magnesium (No-Mg) or iron (No-Fe) over a 14 weeks period at 22-23.5℃. At the end of feeding trial growth performance, hematological characteristics and chemical analysis of the body composition were examined. Growth, feed efficiency and hepatosomatic index in fish fed Fe deficient diet differed significantly from those of control fish. Moreover, hemoglobin content, hematocrit value and plasma Fe content of the fish fed on diet without Fe supplement exhibited significantly lower values, while higher values of plasma triglyceride, total cholesterol and unsaturated iron binding capacity (UIBC) were detected compared to the control group. No difference, however, was noted in the hematological characteristics between the Mg deficient diet and the control. In fish fed Fe deficient diet, slight reduction in bone lipid and in the ash **contents** of Mn and Cu was observed, though Fe level remained similar to the control. The results obtained from the present study show that Mg requirement can be met from either or both diet or surrounding water, whereas, dietary Fe is essential to prevent anemia in yellow croaker.

INTRODUCTION

Several workers have reported that Fe and Mg are certainly required for the health maintenance of a variety of fishes (Sakamoto and Yone, 1978a, b; Ikeda *et al.*, 1973; Ogino et al, 1978; Satoh *et al.*, 1983a, b; Knox *et al.*, 1983). The development of anemia, poor growth and high mortality are the main signs observed in fish fed Fe or Mg deficient diets.

In the previous two studies reported the dietary phosphorus requirement and the effect of calcium or trace elements deficient diet on efficiency of feed utilization of yellow croaker *Nibea albiflora*, the optimum dietary P was found to be at the level of 0.6-0.7%. However, the supplements of Ca and trace elements in diet were not found to have any severe effects on growth performance as well as feed efficiency (El-Zibdeh *et al.*, 1995a, b).

The present study deals with the effect of the deletion of either iron or magnesium from semi purified diet on growth, feed efficiency, hematology and body composition of yellow croaker as part of a series of studies on dietary mineral requirements for this fish. The experiment was carried out under the laboratory conditions at the Fishery Research Laboratory of Kyushu University.

* Contribution from Fish. Res. Lab., Kyushu University, No.214.

MATERIALS AND METHODS

The basal diet and experimental mineral mixture are shown in Table 1. Diet formulation, experimental design and feeding trials were the same as described previously (El-Zibdeh *et al.*, 1995a, b).

Yellow croaker were reared from egg in laboratory. During two weeks prior to the experiment, all fish were acclimated in experimental aquaria (150 L) after transferring them from outdoor tanks. In each aquarium 30 fish with initial mean weight of 28.7-t 1.12 g were assigned at random and kept under ambient temperature during the first four weeks after which fish were maintained at 22.0-23.5 ℃ using heating system. Weights of fish were determined at 4-week intervals throughout the experiment of 14 weeks. A photoperiod of 12 h of incandescent light (12 darkness) was provided daily.

At the end of feeding trial, blood samples were taken from 10 fish in each group by cardiac puncture. Hemoglobin content (Hb), hematocrit value (Ht) and serum total protein were determined by cyanmethemoglobin method, microhematocrit and ATAGO hand refractometer, respectively. K, P, and Mg in pooled samples of blood serum were quantified by Rapid Blood Analyzer (RaBA-Super) and Unikit (Chugai Pharmaceutical Co.). Fe contents and unsaturated iron binding capacity (UIBC) in blood serum were measured by the Nitroso-PSAP method. Combined samples of vertebrae or liver from all fish of each group were subjected to the proximate analysis. P, Ca, Mg, Mn, Cu, Fe and Zn Ash contents of vertebrae and liver were determined by a Perkin-Elmer (3300) Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

The change in body weight over the experimental period is shown in Fig. 1. Fish group fed Mg deficient diet was not significantly different from the control fish . However, significantly low growth was observed in fish group fed diet without Fe. Lower values of feed efficiency and hepatosomatic index (HSI) were also observed in the group that received Fe deficient diet in comparison to other groups (Table 2). There were no differences in condition factor, daily growth rate, daily feed intake and male gonadosomatic index (GSI) among all groups. The female GSI values were higher in fish of the two deficient diets than the control group. Dietary deficient Mg or Fe had no apparent effect on mortality rate.

Distinct effect of Fe deficiency was clearly seen in the hematological characteristics and mineral contents of yellow croaker (Table 3). Fish fed on Fe deficient diet have shown significantly lower values of hemoglobin, hematocrit and plasma Fe content. However, an extremely high values of triglyceride together with total cholesterol and UIBC were also detected in the same fish group. Changes in the contents of lipid and minerals of bone ash are shown in Fig. 2. Bone lipid, Mn and Cu were lower and Zn was higher in the group received Fe deficient diet than control group, while Fe content was similar to the control. However, comparable values were detected in bone mineral contents of the Mg deficient fish and the control. Chemical analysis (not shown) of the liver showed that Mg or Fe deficient diet had no consistent effect on the moisture, crude

Table 1. Composition of the basal diet and mineral mixture for yellow croaker.

Ingredients	%
Casein *1	50
Squid meal	5
Dextrin	10
a -Starch	5
Pollack liver oil	10
Vitamin mixture *2	3
Mineral mixture*3	8
CMC*4	3
Attractants*5	1
α -Cellulose	5
Total	100
DE (Kcal/100g diet)*6	353

*1 Vitamin free milk casein.

*2 Halver's vitamin mixture (1957) + α -Cellulose

*3 Mineral mixture supplemented to test diets

Test. group	Control	No-Mg	No-Fe
Major *elements (g)*			
KC1	26.15	26.15	26.15
$MgSO_4 \cdot 7H_2O$	27.25	.....	27.25
$NaH_2PO_4 \cdot 2H_2O$	171.25	171.25	171.25
Fe-citrate	5.91	5.91	.....
Ca-lactate	98.04	98.04	98.04
Trace elements (mg)			
$AlCl_3 \cdot 6H_2O$	35.60	35.60	35.60
$ZnSO_4 \cdot 7H_2O$	710.00	710.00	710.00
$MnSO_4 \cdot 4\text{-}6H_2O$	159.20	159.20	159.20
CuCl	22.00	22.00	22.00
KI	34.00	34.00	34.00
$CoCl_2 \cdot 6H_2O$	208.80	208.80	208.80
α -Cellulose (g)	70.23	97.48	76.14
Total (g)	400	400	400

Mg and Fe levels in test, diets

Test diet	Control	No-Mg	No-Fe
Mg (%)*7	0.04	0.01	0.04
Fe (μg/g)*7	169.5	145.2	26.5

*4 Carboxymethylcellulose.

*5 DL-Alanine, 0.3 g ; L-Asp. Na, 0.3g ; 5 -ribonucleaotide. Na, 0.032g. Glu. Na, 0.368 g.

*6 Digestible energy (assumed from the values for carp (Ogino *et al., 1976):* 4 kcal/g protein, 8 kcal/g lipid and 3.5 kcal/g carbohydrate).

*7 Dry weight basis.

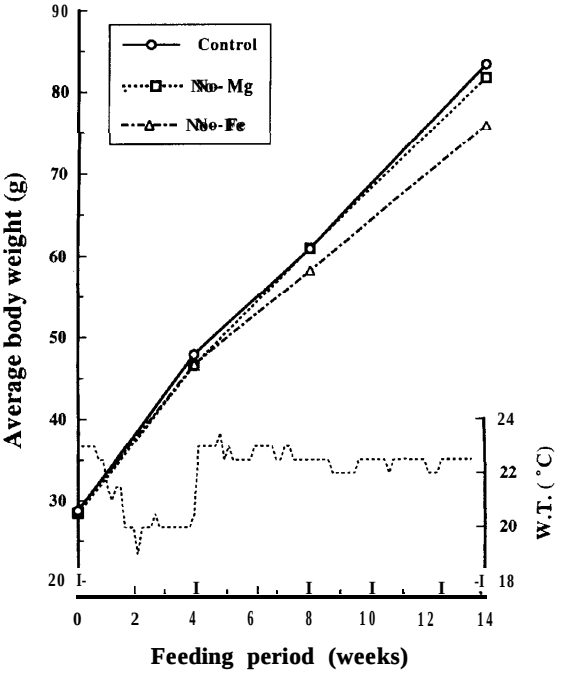

Fig. 1. Growth of yellow croaker fed on purified test diets without Fe or Mg supplements for 14 weeks. Doted line indicates the change in the rearing water temperature (W.T.).

Table 2. Effect of magnesium (No-Mg) or iron (No-Fe) deficient diets on growth and efficiency of feed utilization of yellow crosker.

Experimental group	Control	No-Mg	No-Fe
Average body weight (g) at start	28.7±2.75	28.4 ±3.63	28.9±2.75
after 14 weeks	83.3± 10.75'	81.7±14.50[a]	75.8± 14.85'
Average weight gain (%)	190	187	162
Feed efficiency (%)	86	90	76
Daily growth rate (%)	1.2	1.2	1.1
Daily feed intake (%)	0.7	0.7	0.6
Hepatosomatic index* 1	2.66±0.79[a]	2.59±0.60[a]	2.04±0.45[b]
Gonadosomatic index*2 (female)	2.53 ±1.30[b]	6.22 ±7.04[b]	8.43±3.11[a]
(male)	1.26±0.79[a]	1.68±1.39[a]	1.79±0.71[a]
Condition factor*3	20.0±1.5[a]	20.5±1.4[a]	20.3± 1.4'

Values within the same row which bears different letters are significantly different, $P<0.05$ (ANOVA, Fisher' s LSD test).

*1 Liver weight (g) × 100 / body weight (g)

*2 Gonad weight (g) × 100 /body weight (g).

*3 Body weight (g) × 10 / [body length (cm)] '.

Table 3. Effect of feeding with magnesium (No-Mg) or iron (No-Fe) deficient diets on the hematological characteristies and mineral contents of the blood serum of yellow croaker.

Supplemented diet		Control	No-Mg	No-Fe
Hematocrit	(%)	28.28±3.09[a]	28.15±7.84[a]	21.53±3.40[b]
Hb	(g/100ml)	7.47±0.95[a]	7.00± 1.68	3.89±0.65[b]
Total protein	(g/100ml)	2.59f0.26'	2.52±0.51[a]	2.74±0.31[a]
Triglyceride	(mg / 100ml)	181	108	228
Total cholesterol	(mg / 100ml)	49	60	72
Ca	(mg / 100ml)	**6.0**	**4.8**	**4.9**
P	(mg /100ml)	4.4	4.9	4.7
Ca / P		1.4	1.0	1.0
Fe	(μg / 100ml)	98	82	56
UIBC	(μg/ 1001111)	93		391
Mg	(mg /100ml)	1.0	0.9	0.8

Values within the same row which bears different letters are significantly different, $P<0.05$.

lipid, crude protein, ash and the various minerals. However, liver in both control and Mg deficient fish had almost similar values of Mg (29.5 μg/g), whereas reduced level of Fe was detected in the Fe deficient fish (25 μg/g) than that of the control (44.6 μg/g).

Several symptoms of Mg deficiency has been reported such as poor growth, eye cataract, anorexia, sluggishness, lose of appetite and high mortality in many fish species (Gatlin *et al.*, 1982; Knox, et *al.*, 1983; Satoh *et al.*, 1983 a, b; Ogino and Chiou, 1976). The deletion of Mg from the diet in the present study showed slightly reduced weight gain and feeding efficiency compared to the control. Weight gain, serum Mg and bone ash Mg were significantly lower in rainbow trout fed Mg deficient diet for 8 weeks (Satoh *et al.*, 1983 b; Ogino and Chiou, 1976). Our results have shown that plasma and bone-Mg concentration are maintained at normal level during periods of Mg restriction. No signs of deficiency appeared under conditions of dietary Mg restrictions. This may suggest that Mg deficiency imposed on yellow croaker has no apparent effect. Shearer *et al.* (1992) reported that a water borne concentration of 46 mg/l was adequate for rainbow trout fed a Mg free diet. Therefore, it is possible that the Mg content in the rearing water may be sufficient to meet the requirement of yellow croaker for this element since the content of Mg in sea water was found to exceed the above value (53 mg/*l*).

In this study, fish group given diet containing little iron (26.5 μg/g diet) developed a hypochromic microcytic anemia together with pale coloration of gill and liver due to iron deficiency. Sakamoto and Yone (1978a, b) reported similar symptoms due to dietary Fe deficiency in red sea bream and carp. Thus, the present finding clearly indicates that the addition of an adequate amounts of iron to diet is needed for preventing the development of anemia in yellow croaker.

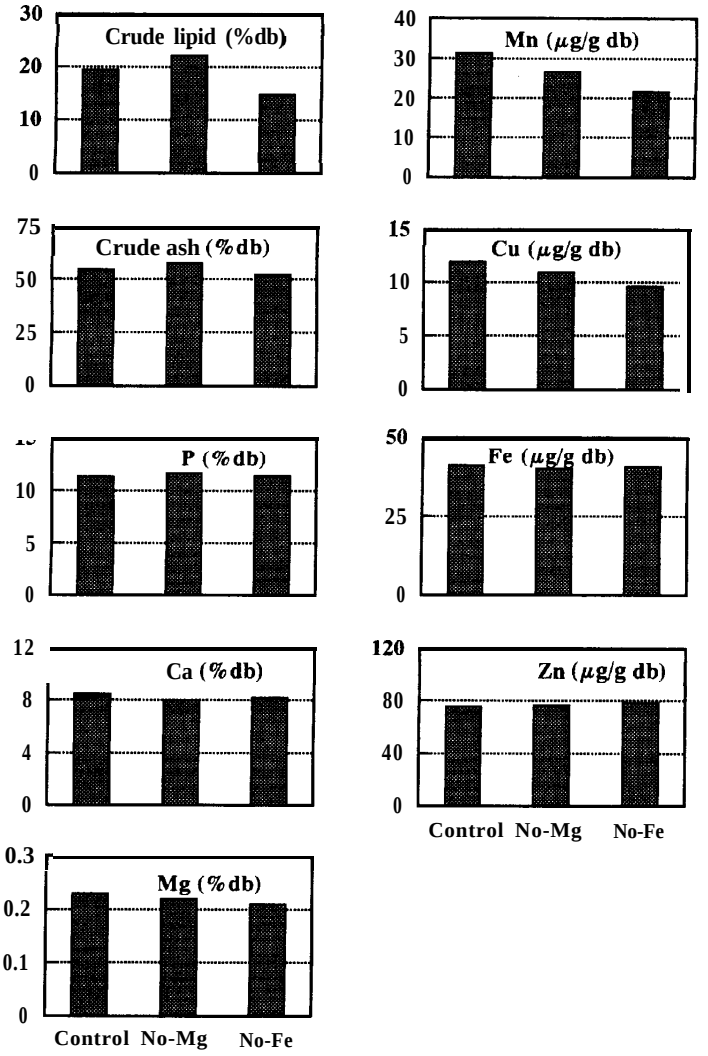

Fig. 2. Effects of feeding with (control) and without Fe or Mg deficient diets upon lipid, ash and mineral contents of bone of yellow croaker (db; dry weight basis).

REFERENCES

El-Zibdeh, M., K. Ide, T. Yoshimatsu, S. Matsui and M. Furuichi 1995a Requirement of yellow croaker *Nibea albiflora* for dietary phosphorus. *J. Fac Agr., Kyushu Univ., 40:* 147-155

El-Zibdeh, M., K. Ide, T. Yoshimatsu, S. Matsui and M. Furuichi 1995b. Effects of the deletion of Ca or trace elements from semi-purified diet on growth and feed utilization of yellow croaker, *Nibea*

albiflora. J. Fm :. Agr., Kyushu Univ., **40**:157-166

Gatlin-III, D. M., E. H. Robinson, W. E. Poe and R. P. Wilson 1982 Magnesium requirement of fingerling channel catfish and signs of magnesium deficiency. *J. Nutr.*, 112: 1182-1187

Ikeda. Y., H. Ozaki and K. Uematsu 1973 Dietary iron requirement in the yellow tail *Seriola quinqueradiata. J. Tokyo Univ., 59:* 91-99

Knox, D., C. B. Cowey and J. W. Adron 1981 Studies on the nutrition of salmonid fish. The magnesium requirement of rainbow trout (*Salmo gairdneri*). *Br. J. Nutr.*, 45: 137-148

Knox, D., C. B. Cowey and J. W. Adron 1983 Studies on the nutrition of rainbow trout (*Salmo gairdneri*). Magnesium deficiency: the effect of feeding with a Mg-supplemented diet. *Br. J. Nutr.*, 50: 121-127

Ogino, C. and J. Y. Chiou 1976 Mineral requirements in fish-II, magnesium requirement of carp. *Bull. Japan. Soc.* Sci. *Fish,* 42: 71-75

Ogino, C., F. Takashima and J. Y. Chiou 1978 Requirement of rainbow trout for dietary magnesium. *Bull. Japan. Soc. Sci. Fish,* 44: 1105-1 108 (In Japanese)

Ogino, C. and G. Y. Yang, 1980 Requirements of carp and rainbow trout for dietary manganese and copper. *Bull. Japan. Soc. Sci. Fish, 46: 455-458* (In Japanese)

Sakamot o, S. and **Y.** Yone 1978a Requirement of red sea bream for dietary iron-II. Bull. *Japan. Soc. Sci. Fish, 44: 223-225*

Sakamoto, S. and Y. Yone 1978b Iron deficiency symptoms of carp. Bull. *Japan. Soc. Sci. Fish, 44:* 1157-1160

Satoh. S., H. Yamamoto, T. Takeuchi and T. Watanabe 1983a Effects on growth and mineral composition of carp of deletion of trace elements or magnrsium from fish meal diet. *Bull. Japan Soc. Sri.* Fish, 49: 431- 435 [In <Japanese)

Satoh, S.. H. Yamamoto, T. Takeuchi, and T. Watanabr 1983b Effects on growth and mineral composition of rainbow trout of deletion of trace elements or magnesium from fish meal Diet. Bull. *Japan. Soc. Sri Fish, 49:* 425-429 (In Japanese)

Shearer, K. D. and T. Asgard 1992 The effect of water-borne magnesium on the dietary magnesium requirement of the rainbow trout (*Oncorhynchus mykiss*). *Fish Physiol & Biochem. 9:* 387-392