Effects of the Deletion of K, Mg or Fe from Purified Diets on Growth and Effkiency of Feed Utilization of Redlip Mullet

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

Yoshimatsu, Takao
Fishery Research Laboratory, Faculty of Agriculture, Kyushu University

Matsui, Seiichi
Fishery Research Laboratory, Faculty of Agriculture, Kyushu University

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

https://doi.org/10.5109/24121

出版情報：九州大学大学院農学研究院紀要. 40 (3/4), pp.383-390, 1996-03. Kyushu University
バージョン：
権利関係：

J. Fac.Agr., Kyushu Univ., **40**(3·4),383-390(1996)

Effects of the Deletion of K, Mg or Fe from Purified Diets on Growth and Efficiency of Feed Utilization of Redlip Mullet*

Mohammad El-Zibdeh, Takao Yoshimatsu, Seichi Matsui and Masayuki Furuichi

Fishery Research Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka 81 l-33, Japan
(*Received November* 27, *1995*)

Redlip mullet, *Liza haematocheila,* with mean initial weight 4.98± 0.11 g were given test diets deficient with K, Mg or Fe and a control diet for 13 weeks at 21-24.5 ℃. At the end of feeding trial growth performance, hematological examinations and chemical analysis of liver and vertebrae were accomplished. Weight gain data generally indicated that the test diet without K or Mg caused slight growth depression. No significant differences were detected between each of the three deficient groups and the control in the following parameters: feed efficiency, condition factor, hepatosomatic index and the proximate composition of the liver. Similarly, no obvious effect was noted in the hematological characteristics between K or Mg deficient groups and the control. However, significantly lower hemoglobin content, hematocrit value, serum total protein and serum Fe content were recognized in fish fed on the diet without Fe supplement. Reduced iron concentration in bone ash and increased levels of Zn and Mn were detected in the Fe deficient fish compared to the control group. These results show that K or Mg requirement for redlip mullet are likely to be satisfied from surrounding water. However, the supplement of Fe in a diet is essential to prevent anemic symptoms development due to iron deficiency.

INTRODUCTION

Knowledge in the area of redlip mullet (*L.haematochiela*) nutrition is still inadequate to include all of the nutritional requirements of this mugilid species. Although the requirement of redlip mullet for various nutrients such as protein and lipid have been determined (Arakawa et al., 1980; Yoshimatsu et *al.,* 1992,1993), one class of nutrient which has not been yet investigated is the minerals. Our laboratory has determined the optimum phosphorus requirements in two age stages and the essentiality of calcium and trace elements of redlip mullet (El-Zibdeh *et al.,* 1995, 1996). As one part of a series of studies on dietary mineral demands for the present fish, the aim of this study is to find out the effect of the deletion of K, Fe or Mg from purified diets on growth, hematology and chemical composition of the fish tissues.

MATERIALS AND METHODS

The experimental design, measurements and analytical methods were the same as described previously (El-Zibdeh et al., 1995).

* Contribution from Fish. Res. Lab., Kyushu University, No. 213

Diets

The basal diet was formulated from purified ingredients to contain 50% crude protein. Dietary ingredients were commercially obtained: vitamin free casein, dextrin and a-starch, pollack liver oil and various vitamins. The control and the other three mineral mixtures deficient with K, Fe or Mg were independently prepared, while adding corresponding amount of α-cellulose. To each diet the mineral mixture was supplemented at 8% level (Table 1).

Table 1. Composition of basal diet fed to redlip mullet.

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

*1. Halver's vitamin mixture (1957) + α-Cellulose.
*2. Mineral mixture supplemented to test diets.

Test group	Control	No-K	No-Fe	No-MR
Major elements (g)				
KCl	26.15	.....	26.15	26.15
$MgSO_4 \cdot 7H_2O$	27.25	27.25	27.25	.....
$NaH_2PO_4 \cdot 2H_2O$	171.25	171.25	171.25	171.25
Fe-citrate	5.91	5.91	.....	5.91
Ca-lactate	98.04	98.04	98.04	98.04
Trace elements (mg)				
$AlCl_3 \cdot 6H_2O$	35.60	35.60	35.60	35.60
$ZnSO_4 \cdot 7H_2O$	710.00	710.00	710.00	710.00
$MnSO_4 \cdot 4\text{-}6H_2O$	159.20	159.20	159.20	159.20
CuCl	22.00	22.00	22.00	22.00
KI	34.00	34.00	34.00	34.00
$CoCl_2 \cdot 6H_2O$	208.80	208.80	208.80	208.80
α-Cellulose (g)	70.23	96.38	76.14	97.48
Total (g)	400	400	400	400

*3. Carboxymethylcellulose.
*4. 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 carbohydrates).

Fish and Feeding

At the start of the experiment, redlip mullet fingerlings (average body weight 4.98± 0.11g) were sorted into four groups of 30 fish and placed each in an individual tank. Fish groups were fed 2-3 times/day until satiation. The feeding trial was conducted for 13 weeks at 21.0-24.5 ℃.

RESULTS AND DISCUSSION

The changes in body weight of all groups over 13 weeks of feeding are shown in Fig. 1. Fish groups fed either K or Mg deficient diets exhibited slightly lower growth rate than that of the control (Table 2). However, there were no significant differences in feed efficiency, condition factor and hepatosomatic index between the three deficient groups and the control. Mortality rate was not affected also by any mineral deficient diets.

In Fig. 2 that shows some hematological characteristics, only fish group given the Fe deficient diet showed significantly lower values of hemoglobin, hematocrit and total serum protein. K and Fe deficient fish have shown significantly lower contents of K or Fe in serum than the control fish. Changes in the contents of bone lipid and minerals in all groups are shown in Table 3. A considerable decrease of Fe and an increase of both Zn

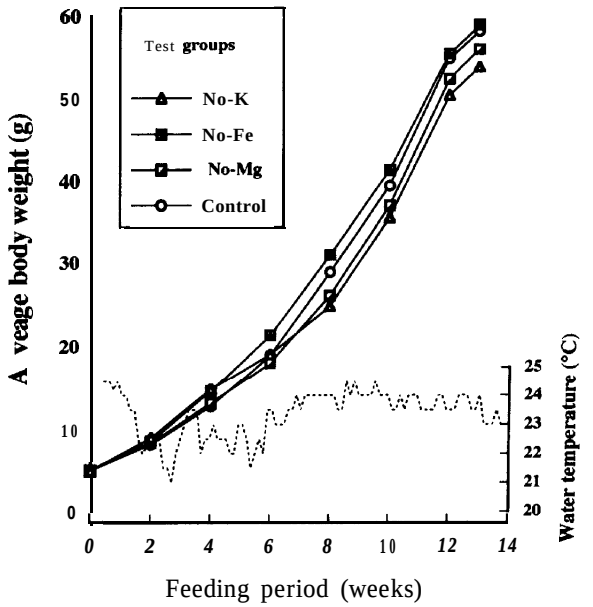

Fig. 1. Growth of redlip mullet fed on purified test diets without K, Fe or Mg supplements for 13 weeks. Doted line shows the change in rearing water temperature.

Table 2. Effect of feeding potassium(No-K), iron (No-Fe) or magnesium (No-Mg) deficient, diet. on growth and efficiency of feed utilization of redlip mullet.

Test groups		Control	No-K	No-Fe	No-Mg
No. of fish	at start	30	30	30	30
	after 13 weeks	27	28	30	27
Average body weight (g)					
	at start	5.0f0.10	5.0±0.10	5.0±0.10	5.0±0.10
	after 13 weeks	58.0±3.1*	53.6±2.0*	58.7±1.7*	55.2±2.9*
Average weight gain (%)		944	905	1015	877
Feed efficiency (%)		95	98	99	93
Condition factor		12.5±0.36*	12.1±0.15*	12.1±0.30*	12.0±0.16*

Mean±SEM.

† Body weight (g) X 10^{3} / [body length (cm)] ^{3}.

* Values are not significantly different, P>0.05 (ANOVA, Fisher' s LSD test).

Table 3. Chemical components of vertebrae of redlip mullet fed K, Fe or Mg deficient diets.

Experimental group		Control	No-K	No-Fe	No-Mg
Crude lipid (%db)		22.95	21.70	22.45	22.55
P	(% db)	11.20	9.70	10.50	11.00
Ca	(% db)	23.88	21.53	21.98	22.10
Mg	(% db)	0.29	0.27	0.30	0.28
K	(% db)	0.02	0.03	0.02	0.03
Cu	(μg/g db)	7.63	7.66	7.13	8.86
Fe	(μg/g db)	13.00	15.70	9.50	22.60
Zn	(μg/g db)	42.57	43.79	116.17	42.03
Mn	(μg/g db)	10.13	8.83	38.69	9.13

db; Dry basis.

and Mn concentrations were detected in the vertebrae of fish fed the Fe deficient diet than those of the control. However, there was no significant deference between bone mineral contents of the K or Mg deficient fish and the control. Hepatosomatic index and moisture, crude lipid, crude protein and ash contents of the liver were not altered by the four test diets given to redlip mullet (Fig. 3).

In a study on the dietary requirements of K for chinook salmon, fish were not able to meet their requirement of K directly from sea water (Shearer, 1988). As a result various signs of K deficiency such as anorexia, convulsions, tetany and death has been reported . On the other hand, Wilson and El Naggar (1992) found that, with K concentration of 4 mg/l or higher in the rearing water, channel catfish do not have a dietary requirement for

K, but for optimal whole body K balance a requirement of 0.26% of dietary K was necessary. Sakamoto and Yone (1978 a, b) reported that red sea bream can sequester K directly from rearing water. In the present study the only effect of K deficiency was observed in the sharp reduction of K content in blood serum. However, K^+ in gill is known to be remarkably efficient being capable of pumping into plasma from the rearing water. It is possible, therefore, that reduced serum K could be as a result of the active transport mechanism of K into other body tissues in order to arrive at an optimal levels of K to

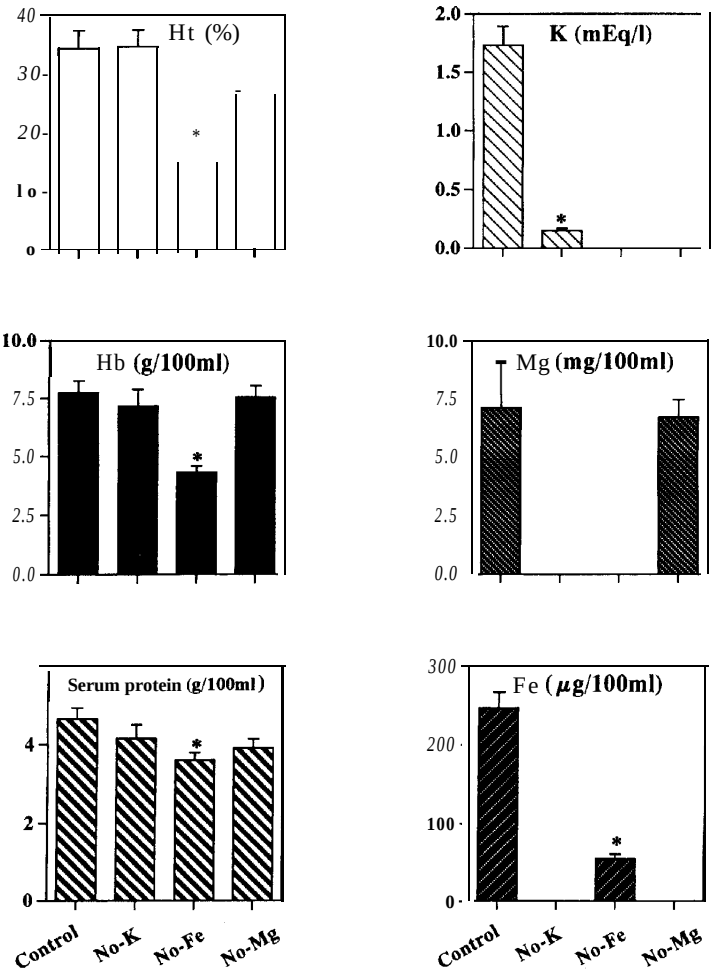

Fig. 2. Effects of feeding with K, Fe or Mg deficient diets upon hematological characteristics and mineral **contents** of blood serum of redlip mullet.

prevent any deficiency development in redlip mullet due to the deletion of dietary K.

Several symptoms of Mg deficiency including poor growth, eye cataract, anorexia, sluggishness, lose of appetite and high mortality have been reported in many fish species (Gatlin et al., 1982; Knox et *al.,* 1981; Satoh *et al.,* 1983). The deletion of Mg from the diet in the present study manifested slightly lower weight gain and feed efficiency compared to the control. In rainbow trout fed Mg deficient diet for 8 weeks, weight gain, serum Mg and bone ash Mg were significantly lower than the control fish (Knox *et al.,*

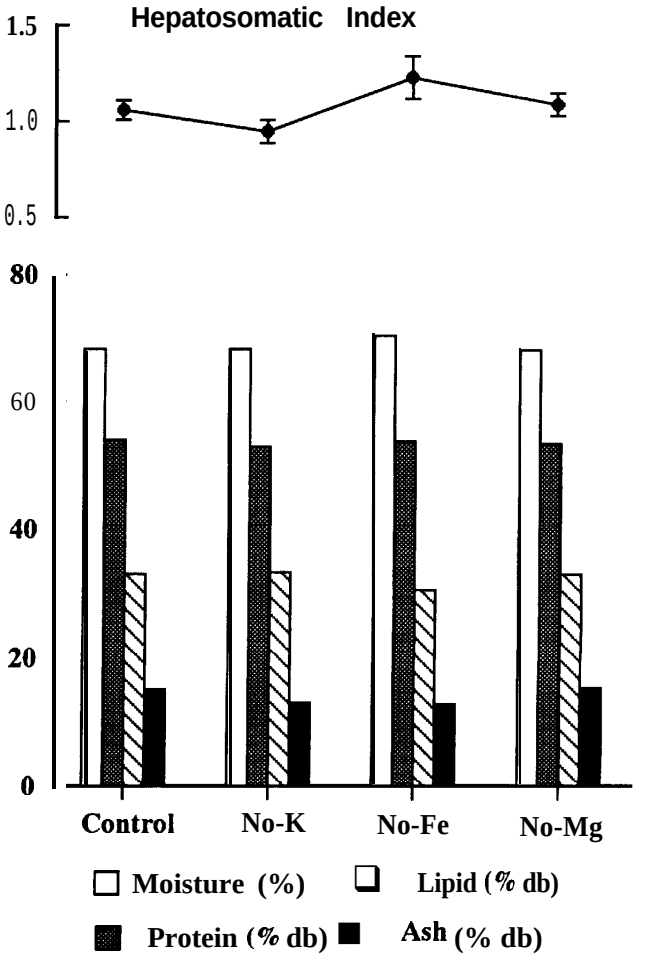

Fig. 3. Hepatosomatic index [Liver weight (g) X 100 /body weight (g)] and proximate composition of liver of redlip mullet fed K, Fe or Mg deficient diets for 13 weeks. db; dry basis.

1983). Our results have shown that serum and bone Mg concentration are maintained at normal level during periods of Mg restriction. This could be suggest that feeding with Mg deficient diet has no sever effect on redlip mullet. It is possible, therefore, that the Mg content in the rearing water can be taken by fish and prevents the development of any signs of deficiency under conditions of dietary Mg restrictions.

Feeding fish on Fe deficient diet developed a hypochromic microcytic anemia together with pale coloration of gill and liver. The increased levels of total bone Zn and Mn due to Fe deficiency suggest an inhibitory effect on the bioavailability of both trace elements in redlip mullet. Thus, the present study clearly indicates that the addition of an adequate amounts of iron to diet is needed for preventing the development of anemia in redlip mullet. These results agree with those reported the essentiality of Fe in red sea bream and carp (Sakamoto and Yone, 1978a, b).

REFERENCES

Arakawa, T., C. Kitajima and Y. Yone, 1980 Effect of dietary protein levels on the growth and feed efficiency of mullet, *Liza haematochiela*. *Bull.* Nagasaki *Pref. Inst. Fish., 6: 43-47*

El-Zibdeh, M., T. Yoshimatsu, S. Matsui, C. Kitajima and M, Furuichi, 1995 Requirement of redlip mullet for dietary phosphorus. *J. Fac. Agr., Kyushu Univ., 40:* 147-155

El-Zibdeh, M., T. Yoshimatsu, S. Matsui and M. Furuichi, 1996 Effect of the deletion of Ca or trace elements from purified diets on growth and efficiency of feed utilization of redlip mullet. *J. Fac. Agr., Kyushu Univ.*, **40**:00-00

Cowey, C. B., D. Knox, J. W. Adron, S. George and B. firie, 1977 The production of renal calcinosis by magnesium deficiency in rainbow trout. *Br. J. Nutr.*, 38: 127-135

Gatlin III, D. M., E. H. Robinson, W. E. Poe and R. P. Wilson, 1982 Magnesium requirement of channel catfish and signs of magnesium deficiency. *J. Nutr.*, 112: 1182-l 187

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 requirement in fish-II, magnesium requirement of carp. *Bull. Jap. Soc. Sci. Fish., 42: 71-75*

Ogino C., F. Takashima and J. Y. Chiou, 1978 Requirement of rainbow trout for dietary magnesium. *Bull. Jap. Soc. Sci. Fish., 44:* 1105-1108

Sakamoto, S. and Y. Yone, 1978a Requirement of red sea bream for dietary iron-II. *Bull. Jap. Soc. Sci. Fish., 44; 223-225*

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

Sakamoto, S. and Y. Yone, 1981 Requirement of red sea bream for dietary Na and K, 1978. *J. Fac. Agr, Kyushu Univ., 23: 79-84*

Satoh, S., H. Yamamoto, T. Takeuchi and T. Watanabe, 1983 Effects on growth and mineral composition of rainbow trout of deletion of trace elements or magnesium from fish meal diet. *Bull. Jap. Soc. Sci. Fish., 49: 425-429*

Shearer, K. D. 1988 Dietary potassium requirement of juvenile chinook salmon. *Aquaculture, 73:* 119-129

Wilson, R. P. and G. El-Naggar, 1992 Potassium requirement of fingerling channel catfish, *Ictalurus punctatus. Aquaculture*, **108**:169-175

Wu, H. 1984 *The fishes of Fujian Province.* ed. by Fishes of Fujian Province Editorial Subcommittee, Fujian Sci. Tech. Press, Fujian (China), pp. 493-494

Yoshimatsu, T., M. Furuichi and C. Kitajima 1992 Optimum levels of protein in purified experimental

diets for redlip mullet. *Bull. Japan. Fish. Soc.*, *58: 2* 111-2117

Yoshimatsu, T., M. Furuichi and C. Kitajima 1993 Effects of dietary lipid levels on the growth, efficiency of feed utilization and body composition of young redlip mullet. *J. Fac. Agr., Kyushu Univ.*, *37:* 273-281