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https://doi.org/10.5109/24120

出版情報：九州大学大学院農学研究院紀要. 40 (3/4), pp.375-382, 1996-03. Kyushu University
バージョン：
権利関係：

J. Fac.Agr., Kyushu Univ., 40(3・4), 375-382 (1996)

Effects of the Deletion of Ca or Trace Elements from Purified Diet on Growth and Efficiency of Feed Utilization of Redlip Mullet*

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(Received November 27, 1995)

Purified diets with and without supplement of Ca or trace elements were fed to fingerling redlip mullet, *Liza haematocheila*, (initial body weight: 4.98 g) for 13 weeks at 22-24.5 ℃. The essentiality for these minerals was examined in terms of weight gain, feed efficiency, condition factor, hepatosomatic index and the chemical analysis of blood, liver and vertebrae. Feeding fish groups with the Ca or trace elements deficient diet resulted in reduced growth compared to the control fish. No difference, however, was noted in the hematological characteristics among all groups. Ca and inorganic P levels in blood serum and lipid content of vertebrae were decreased distinctly in fish fed Ca deficient diet. In fish group fed trace elements deficient diet, lower levels of Cu and Mn and increased levels of lipid were detected in vertebrae and liver compared to the control group. From these findings, it appears that the supplement of Ca and trace elements in diet, for redlip mullet, is required.

INTRODUCTION

Mullets are widely spread throughout tropical and temperate seas and cultured intensively in several countries (Wu, 1984; Nash et al., 1980). Like other mullets, redlip mullet *L. haematocheila* is considered to be an important food source in the far east and the adjacent Asian countries.

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)*. However, investigations concerning the mineral nutrition of this fish have received almost no attention.

In our laboratory a series of studies were conducted to determine various mineral requirements for redlip mullet. The present experiment was performed in order to examine the effect of the deletion of calcium or various trace elements (T.E.) from diet on growth, food conversion, hematology and mineral composition of redlip mullet.

MATERIALS AND METHODS

Diets

The basal diet was formulated from purified ingredients; vitamin free milk casein as the protein source, dextrin and α -starch (gelatinized starch) as the digestible carbohydrate

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* Contribution from Fish. Res. Lab., Kyushu University, No. 212.

source, pollack liver oil as lipid source and various vitamins. Three mineral mixtures with (control) and without Ca or T.E. were prepared independently (Table 1). To each diet the mineral mixture was supplemented at 8% level.

Experimental Design

Experiments were conducted in 150-L rectangular flow-through aquaria (flow and aeration rates of 1.2-1.8 l/min. and 400-600 ml/min., respectively). Rearing water temperature was maintained at 22-24.5 ℃, controlled by using a heating system.

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

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

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

Test group	Control	No-Ca	No-T. E.
Major elements (g)			
KCI	26.15	27.25	26.15
MgSO . 7HO	27.25	27.25	27.25
NaHPO. 2H0	171.25	171.25	171.25
Fe-citrate	5.91	5.91	5.91
Ca-lactate	98.04	……	98.04
Truce elements *(mg)*			
AlCl. 6H0	35.60	35.60	……
ZnSO 7H0	710.00	710.00	……
MnSO. 4-6H 0	159.20	159.20	……
CuCl	22.00	22.00	……
KI	34.00	34.00	……
CoCl.6HO	208.80	208.80	……
α -Cellulose (g)	70.23	168.27	71.40
Total (g)	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).

Prior to initiation of the experiment, the fish underwent a 2-3 weeks conditioning period during which they were readily adjusted to a purified diet and acclimated to indoor-laboratory conditions. The control diet was fed to fish during the conditioning period.

Fish and Feeding

At the start of the experiment, redlip mullet fingerlings (average body weight 4.98 ± 0.11 g) were counted into three groups of 30 fish in each aquarium. Pellet size of the experimental diet was adjusted according to the progress in fish growth. Fish groups were fed 2-3 times/day ad libtum for 13 weeks.

Measurements and Analytical Methods

Body weight of individual fish from each experimental group was measured at a biweekly interval. Blood samples were taken by cardiac puncture from 10 fish in each group for hematocrit, hemoglobin and serum total protein measurements. Calcium and inorganic phosphorus in pooled samples of blood serum were quantified by Rapid Blood Analyzer (RaBA Super). A composite samples of vertebrae and/or liver were combined from all fish of each group and subjected for proximate analysis. Mineral contents of vertebrae were determined by a Per-kin-Elmer (3300) Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

Growth of fish fed on the test diet without supplements of either Ca or T.E. was significantly lower ($P<0.05$) than that of fish fed the control diet (Fig. 1 and Table 2). Feed efficiency, condition factor and hepatosomatic index were not influenced by either Ca or T.E. deficient diets.

Hematocrit value and hemoglobin content together with serum total protein, Ca and P contents are shown in Fig. 2. The deletion of Ca or T.E. from diets did not alter hematocrit value, hemoglobin and serum total protein contents. Ca and P levels in blood serum of the fish given diet without Ca were significantly lower ($P<0.05$) than the control fish. Similarly, Ca content of vertebrae of the same group was slightly lower than the control fish, whereas, no change was observed in P content (Fig. 3). These results could demonstrate the incapability of redlip mullet to meet its requirement of Ca by direct absorption of adequate amount of Ca from water (Templetone and Brown, 1963; Ichikawa and Oguri, 1961). However, in similar feeding trials conducted on channel catfish, carp and rainbow trout, fishes were able to assimilate Ca directly from surrounding water (Andrews *et al.*, 19'76; Ogino and Takeda, 1976,1978). The deletion of T.E. from the diet resulted in a drastic decrease in both Cu and Mn contents in vertebrae, while Zn remains similar to the control fish (Fig. 3). In rainbow trout the deficiency of dietary Mn developed malformation such as the shortening of the body length and feeding with Cu deficient diet resulted in poor growth of carp in addition to the distinct decrease of these minerals in body tissue of both species, however, such effects were not induced by the deletion of Zn (Ogino and Yang, 1980; Satoh et *al.*,1983 a, b, c). The reduced growth in fish group fed T.E. deficient diet observed in the present study could be attributed to the

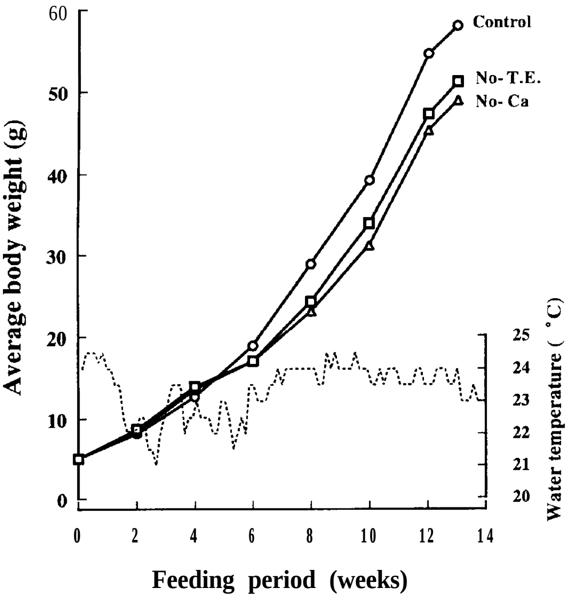

Fig. 1. Growth of redlip mullet fed on purified test diets with (control) and without calcium (No-Ca) or trace elements (No-T.E.) supplements for 13 weeks.
Doted line shows the change in the rearing water temperature.

Table 2. Effect of feeding calcium (No-Ca) or trace elements (No-T. E.) deficient diets on growth and efficiency of feed utilization of redlip mullet.

Experimental group	Control	No-Ca	No-T. E.
Number of fish at start	30	30	30
after 13 weeks	27	27	26
Average body weight (g)			
at start	5.0±0.10	5.0f0.10	5.0±0.10
after 13 weeks	58.0±3.1^a	48.9±2.57^b	51.1±2.46^b
Average weight gain (%)	944	785	790
Feed efficiency (%)	95	91	95
Hepatosomatic index*1	10.6 ±0.05^a	1.18±0.07^a	1.19±0.07^a
Condition factor*2	12.53±0.36^a	12.53f0.16,’	12.73±0.23^a

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 Body weight (g) $\times 10^3$ / [body length (cm)] ^{3}.

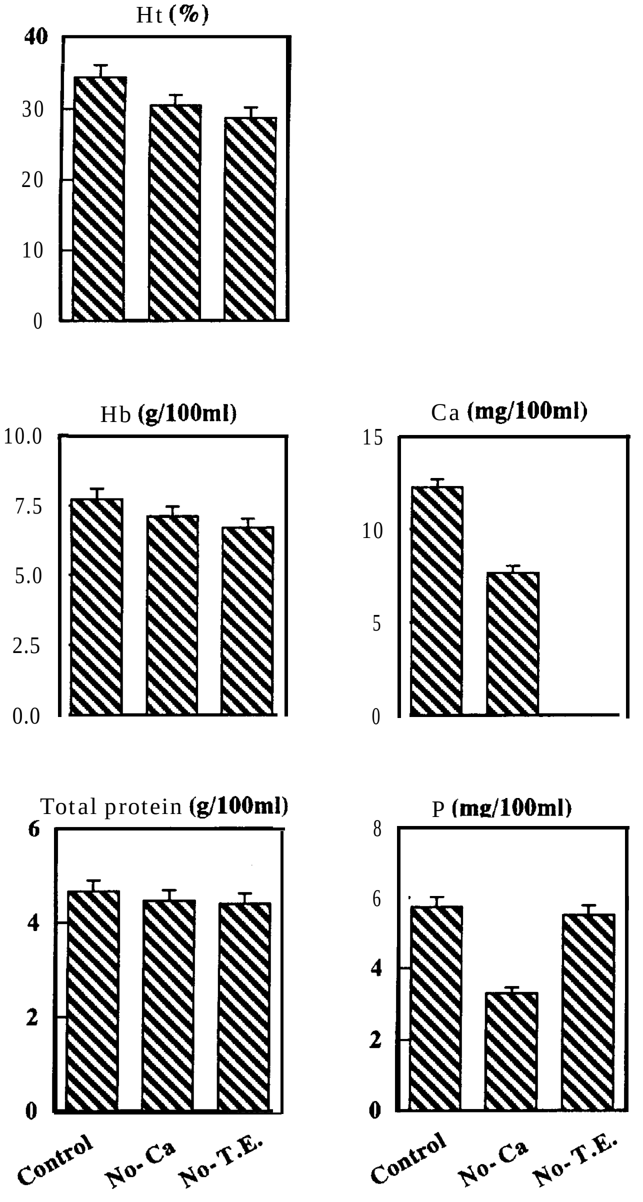

Fig. 2. Influence of feeding the diets with (control) and without calcium (No-Ca) or trace elements (No-T.E.) supplements upon hematocrit, hemoglobin and serum total protein, Ca and inorganic P levels of redlip mullet.

inadequacy of trace elements in the test diets given to redlip mullet,

Almost no variations in the moisture, crude protein and ash contents of liver in both Ca and T.E. deficient fish were observed in comparison with the control (Fig. 4). In vertebrae of fish group received Ca deficient diet, decreased lipid content was detected, while increased level was observed in those fed T.E. deficient diet than the control (Fig. 3). The reason for this incident was unknown, however, the poor appetite and thus the feed intake in fish fed the Ca deficient diet could inversely affect the growth, resulted in a reduced lipid content of the body tissue. On the other hand, low level of Zn in fish tissues

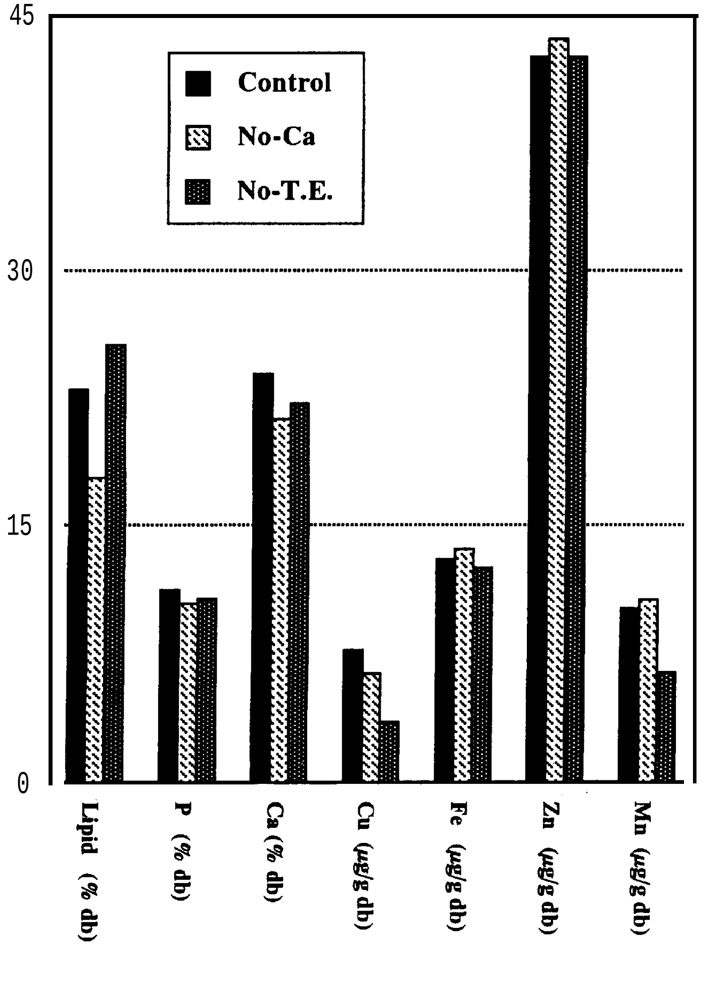

Fig. 3. Effect of feeding the diets with (control) and without calcium (No-Ca) or trace elements (No-T.E.) on lipid and mineral contents of vertebrae of redlip mullet. db; dry basis.

was reported to have an inhibitory effect on the digestible enzymatic activity resulted in low levels of protein and lipid in rainbow trout (Ogino and Yang, 1978). Nevertheless, in this experiment both vertebrae and liver of fish fed the T.E. deficient diet have shown higher lipid contents than that of the control. It is possible therefore that an abrupt inadequacy of some T.E. other than Zn could be related to this phenomenon, since both Mn and Mo deficiency tends to result in abnormal metabolism in mammals (Ashley, 1972). The same thing may be intimated in the case of redlip mullet and influence the lipid levels in various body tissues.

Judging from the results of the present experiment, the addition of Ca as well as T.E.

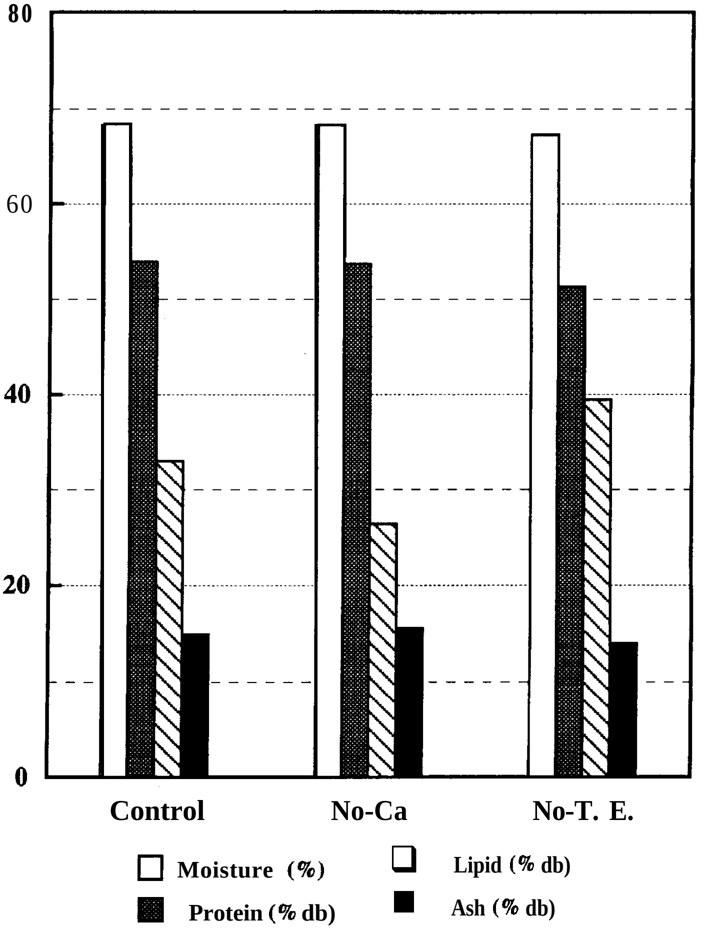

Fig. 4. Proximate composition of liver of redlip mullet fed on control and calcium (No-Ca) or trace elements (No-T.E.) deficient diets for 13 weeks. db; dry basis.

to diet for redlip mullet is necessary to maintain normal growth and chemical constituents of the body.

REFERENCES

Andrews, J. W., T. Murai and C. Campell 1973 Effects of dietary calcium and phosphorus on growth, food conversion, bone ash and hematocrit levels of Catfish. *J. Nutr.*, 103: 766-771

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

Ashley, L. M., 1972 Nutritional Pathology *In* "Fish Nutrition", ed. by J. E. Halver, Academic Press, New York and London, pp. 439-535

Ichikawa, R and M. Oguri 1961 Metabolism of radionuclides in fish. I. Strontium calcium discrimination in gill absorption. *Bull. Jap Soc. Sci.* Fish, 27: 351

Nash, C. E. and Z. N. Shehadeh 1980 Review of breeding and propagation techniques for grey mullet, *Mugil cephalus* L. ICLARM studies and reviews 3., In "Cent. Living Aquatic Resour. Manage", Manila, pp. 1-6

Ogino, C. and H. Takeda 1976 Mineral requirement in Fish-III. Calcium and phosphorus requirements in carp, 1976. Bull. *Jap. Soc. Sci. Fish., 42: 793-799*

Ogino, C. and H. Takeda 1978 Requirements of rainbow trout for dietary calcium and phosphorus. *Bull. Japan Soc. Sci. Fish.,, 44:* 1019-1022

Ogino, C. and G-T. Yang 1978 Requirement of rainbow trout for dietary zinc. ***Bull.*** *Jap. Soc. Sci.* Fish., 44: 1015-1018

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

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

Satoh, S., T. Takeuchi, Y. Narabe and T. Watanabe 1983b Effects of several trace elements from fish diets on growth and mineral composition of rainbow trout fingerlings. *Jap. Soc. Sci. Fish., 49:* 1909-1916

Satoh, S., H. Yamamoto, T. Takeuchi and T. Watanabe 1983c Effects on growth and mineral composition of carp of deletion of trace elements or magnesium from fish meal diet. *Bull. Jap. Soc. Sci. Fish., 49: 431-435*

Templeton W. L. and V. M. Brown 1963 Accumulation of calcium and strontium by brown trout from waters in the United Kingdom. *Nature,* 198: 198

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: 211* 1-21 *17*

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