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MULLET CULTURE IN QATAR: EFFECTS OF REPLACING FISH MEAL WITH SOYBEAN MEAL ON GROWTH RATES AND FEED UTILIZATION EFFICIENCY OF *LIZA MACROLEPIS* (PISCES: MUGILIDAE)

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إستـزراع البيـاح (البـوري) في قطر : تأثيـر إبدال مسـحوق السمك بمسحوق فول الصويا على معدلات النمو وكفاءة التحول الغذائي في أسمـاك ليزا ماكروليبس (عـائلة : ميوجيليدي)

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لقد أجريت هذه الدراسة لتقييم تأثير إبدال مسحوق السمك (كمصدر للبروتين) بمسحوق فول الصويا في العلائق الصناعية على معدلات النمو والتحول الغذائي ومحتوى الجسم في إصبعيات أسماك البوري (البياح) . وقد تم في هذا الصدد تحضير خمس علائق متساوية في نسبة البروتين (٤٠٪ بروتين) والطاقة الغذائية (٥٤٠ كليو سعر / ١٠٠ جرام غذاء) في حين تم إستبدال صفر ، ٢٥ ، ٥٠، ٧٥، ١٠٠٪ من مسحوق السمك بمسحوق فول الصويا . وقد تم تغذية إصبعيات البوري البالغ متوسط أوزانها ٣,٢٥ جرام بهذه العلائق مرتين يوميا لمدة ٦٠ يوما .

وقد أوضحت نتائج التجربة أن معدلات النمو والتحول الغذائي ومعامل كفاءة البروتين قد تناقصت مع زيادة نسبة فول الصويا في العلائق . كما وجد أن محتوى الجسم من الدهون والرماد قد تناقص بينما إزداد محتوى الجسم من المياه مع زيادة نسبة فول الصويا في الطعام في حين لم يتأثر مستوى البروتين في الجسم خلال التجربة .

Keywords: Arabian Gulf, Fish meal, *Liza macrolepis*, Mullet, Nutrition, Protein, Soybean meal, Qatar.

ABSTRACT

The effects of replacing fish meal (FM) with soybean meal (SBM) in practical diets fed to fingerling mullet, *Liza macrolepis,* on the growth rates, feed utilization and body composition were investigated. Five isocaloric (450 kcal/100 g), isonitrogenous (40% cp) diets were prepared. SBM replaced FM at 0, 25, 50, 75, and 100% levels. The diets were fed to triplicate groups of *L. macrolepis* fingerlings (3.25 g mean weight) twice a day for 60 days.

Fish growth rates, feed conversion (FC), protein efficiency ratio (PER) and protein production value (PPV) were deteriorated with increasing SBM level in the diets. With the exception of body protein, carcass compositions were significantly affected by dietary treatments. Body water was positively correlated to SBM levels, while carcass lipids and ash showed negative correlations.

INTRODUCTION

Despite the worldwide potential of mullets for intensive aquaculture, little attention has been given to their nutritional requirements. Only few studies have been reported on the formulation of practical diets of cultured mullets under different culture conditions [1-5]. Extensive work, however, has been conducted on induced breeding and mass production of mullets [6-13]. In addition, much attention has been given to studying natural feeding of mullets, especially during their larval stages [14-17].

The present study was conducted in the Marine Sciences Department, Faculty of Science, University of Qatar, to address the effects of replacing fish meal with soybean meal on growth rates, feed utilization and body composition of *Liza macrolepis* fingerlings reared under laboratory conditions.

MATERIALS AND METHODS

Culture Facilities and Fish

Liza macrolepis fry were collected from the wild at Al-Wakra coast, during low tides, by the Qatar Marine Aquarium team in January, 1993. The fish were held in a 500 l fiberglass tank, supplied with filtered sea water and provided with continuous aeration, for a one- week conditioning period. During this period, they were fed a commercial sea bream diet (50% cp). Triplicate groups of 10 fingerlings (3.25 g) were stocked in 35 l culture aquaria for a one-week conditioning period to adapt them to the test diets. The aquaria were supplied with a flow-through filtered sea water pumped from a 36 t reservoir. An 8-ton tanker was used to fill the reservoir with sea water during the study. The aquaria were provided with continuous aeration by an air compressor, and fluorescent lighting set at 14:10 Light:dark cycle. Water temperature was maintained at 23±1 °C throughout the study. Feces were siphoned from the aquaria every morning, before the first feeding. At the end of the conditioning period, fish in each aquarium were recounted and weighed to the nearest 0.01 g.

Diets and Feeding Regime

Five isonitrogenous (40% cp), isocaloric (450 kcal GE/100 g) diets were prepared (Table 1). Fish meal (FM, 75% cp) and soy bean meal (SBM, 40% cp, solvent extracted) were used as protein sources. SBM replaced 0, 25, 50, 75, and 100% of FM protein in the diets. The test diets were prepared as described by El-Sayed[5]. Since the SBM used contained only 40% cp, it was impossible to maintain isonitrogenous conditions among diets. Diets 1-4 contained 42, 41, 43, and 40% cp, respectively, while diet 5 (100% SBM protein) contained only 34% cp.

The test diets were fed to triplicate groups of *L. macrolepis* fingerlings, twice a day (9:00-10:00 and 16:00-17:00 hrs) for 60 days. The diets were originally fed at 6% of the fish body weight per day. However, it was noticed that the fish did not consume the total amount of feed given to them. Consequently, the daily ration was reduced to 4% of the fish body weight, at the beginning of the 11th day of the study.

Body Composition Analysis

At the termination of the study, fish in each aquarium were removed, pooled, weighed and frozen for final body composition analyses. Initial body analyses were performed on a pooled sample of 30 fish which were weighed and frozen prior to the study. Proximate analyses of water, protein, lipid and ash in both the test diets and body carcass were performed [19].

Table 1

Composition and proximate analysis of the test diets on dry weight basis

	Diets				
Ingredients (%)	1	2	3	4	5
Fish meal	55.00	43.00	27.00	14.00	0.00
Soybean meal	0.00	25.00	50.00	70.00	80.00
Wheat bran	25.00	10.00	5.00	4.00	7.00
Sun flower oil	4.00	4.00	2.00	2.00	2.00
Whale liver oil	2.00	2.00	3.00	4.00	4.00
Mineral mix[1]	1.00	1.00	1.00	1.00	1.00
Vitamin mix[1]	1.00	1.00	1.00	1.00	1.00
α -cellulose	12.00	14.00	11.00	4.00	5.00
Proximate analysis (% dry weight)					
Crude protein	41.68	41.44	42.66	39.72	33.79
Crude lipid	13.64	12.40	12.84	9.91	10.22
Ash	11.18	7.22	9.52	8.82	7.45
Crude fiber[2]	14.50	16.48	14.45	10.45	8.41
NFE[3]	19.00	22.46	20.43	33.14	38.16
GE (kcal/g)[4]	4.43	4.44	4.47	4.55	4.44

[1]NRC, 1977 [18].

[2]Dietary fiber was calculated based on the fiber contents of dietary ingredients.

[3]Nitrogen free extract, determined by difference.

[4]Gross energy, calculated based on 5.65, 9.5 and 4.1 kcal/g for protein, lipid and carbohydrate, respectively. Fiber energy not included.

Statistical Analysis

A one-way ANOVA was used to test the effect of replacing dietary FM protein with SBM protein on fish growth rates, feed utilization and body composition. Orthogonal polynomial procedures [20] were used to compare means at P=0.05. The least significant difference (LSD) test was used to identify differences among treatment means when F values from the ANOVA were significant. Regression analyses between SBM protein levels in the diets and fish performance and body compositions were performed.

RESULTS

The performance of *L. macrolepis* fed the test diets is summarized in Table 2. The results revealed a significant effect of substituting FM with SBM on fish growth (Fig. 1). The fish meal-based diet (diet 1) produced the best weight gain (%), SGR, FC, PER, and PPV ($P<0.05$). Those parameters declined with increasing SBM inclusion levels in the diets (P<0.05), as indicated from the regression analyses between fish performance and SBM levels (Table 3).

Table 2

Growth rates and feed conversion efficiency of *L. macrolepis* fed the test diets. Figures in the same column with different superscripts are significantly different (P<0.05)

Diet	W_i	W_f	% gain	SGR[1]	FC[2]	PER[3]	PPV[4]
1	3.15	6.68^a	112^a	1.26^a	2.14^a	1.46^a	24.60^a
2	3.28	5.96^b	82^b	0.98^b	3.43^b	1.13^b	18.31^b
3	3.34	5.43^c	63^c	0.81^c	3.94^c	0.87^c	12.52^c
4	3.25	4.86^d	50^c	0.67^c	4.63^d	0.55^d	10.11^d
5	3.12	4.67^d	50^c	0.67^c	4.99^d	0.66^d	8.76^E

W_i = Initial weight (g/fish).

W_f = Final weight (g/fish).

[1]Specific growth rate (%/day)=100(Log$_e$ final weight-Log$_e$ initial weight)/time (days).

[2]Feed conversion = g dry feed intake/g live weight gain.

[3]Protein efficiency ratio = g live weight gain/g protein fed.

[4]Protein Production value = 100 (protein gain /g protein fed).

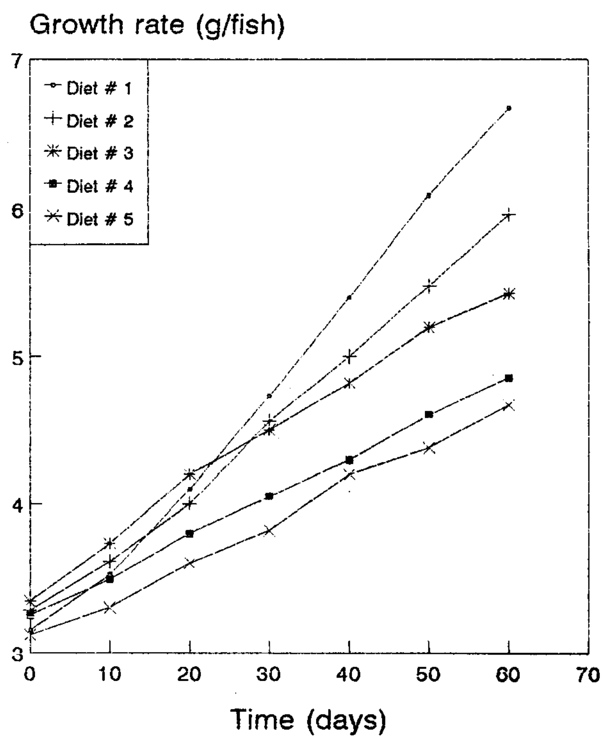

Fig. 1: Growth rates of *M. macrolepis* fed the test diets for 60 days.

With the exception of body protein, body compositions were significantly affected (P<0.05) by dietary treatments (Table 4). Body water was positively correlated (P<0.05) with SBM inclusion levels, while body lipid and ash showed negative relationships (P<0.05).

Table 3

Regression between dietary SBM protein level and fish growth rates, feed utilization and body compositions

Parameter	Regression equation	r	Significance level
% gain	Y = 102.600-0.6240X	-0.941	0.05
SGR	Y = 1.176-0.0596X	-0.925	0.05
FC	Y = 2.446+0.0276X	0.972	0.05
PER	Y = 1.373-0.087X	-0.936	0.05
PPV	Y = 22.841-0.1552X	-0.957	0.01
Water	Y = 64.900+0.0470X	0.920	0.05
Lipid	Y = 36.753-0.0464X	-0.928	0.01
Ash	Y = 18.000-0.0426X	-0.897	0.05

Table 4

Body composition analyses of *L. macrolepis* fingerlings fed the test diets. Figures in the same column with different superscripts are significantly different (P<0.05)

Diet	Body component (% dry weight)			
	Water	Lipids	Protein	Ash
Initial	71.00	25.35	50.00	23.76
1	64.25^a	36.02^a	48.70^a	18.09^a
2	66.17^b	36.61^a	49.00^a	15.18^b
3	68.40^c	34.72^b	48.45^a	15.13^b
4	68.75^c	32.59^c	48.22^a	14.24^c
5	69.00^c	32.21^c	49.91^a	14.69^c

DISCUSSION

The present study indicated that the growth rates and feed conversion efficiency of *L. macrolepis* fed the test diets were poor compared to other mullet species. The study also revealed an inverse effect of SBM inclusion level on growth and feed utilization of the fish. It further indicated that FM appears to be a better protein source for the fish. This finding is in agreement with the results of Pruginin *et al.,* [21] who found that *Mugil cephalus* and *M. capito* reared in a polyculture system with carp, did not grow well on plant protein (sorghum)-based diets. The poor utilization of SBM by *L. macrolepis* may have been related to trypsin inhibitor and/or some essential amino acid deficiency in the meal. It may have also been related to the differences in feed consumption, digestibility and utilization.

The effects of replacing FM with SBM on growth rates of different fish species have been investigated, with varying results. Cho *et al.,* [22] found that reducing FM from 35 to 18% of the diet, concomitant with increasing SBM from 10 to 39%, had no adverse effects on the growth of lake trout. In addition, Reinitz [23] reported that increasing SBM up to 56% of the diet did not cause growth retardation in trout. However, further increase in SBM inclusion level in the feed lead to a significant reduction in fish growth rates [23]. Similarly, growth rates of plaice [24] and channel catfish [25] were depressed by increased SBM levels in the diet. However, blue tilapia, *Tilapia aurea* [26] and hybrid tilapia *Oreochromis* *niloticus* x *O. aureus* [27] fed SBM-based diets supplemented with L-methionine grew at a rate similar to tilapia fed FM-based diets. It appears, therefore, that the dietary effect of replacing FM with SBM on fish performance is species specific.

The method of soybean processing was found to affect trypsin inhibitor, and in turn, nutritive value of SBM. Insufficient heat of SBM has resulted in poor growth rates of carp *Cyprinus carpio,* and the limiting factor for the growth of the fish was not the residual antitrypsin, but inadequate lysine content of SBM [28, 29]. On the other hand, the growth of channel catfish fingerlings fed on SBM-based diets was inversely correlated to trypsin inhibitor activity [29].

Mullets are known to change their feeding habits in nature from carnivorous to herbivorous with age [30, 31]. It is expected, therefore, that the fishes require high animal protein levels during their early life stages, while the ability to utilize plant protein increases with age. In addition, fishes in their early life stages have higher metabolic rates than late juvenile stages, which would be reflected in a higher protein and energy demand. This may explain the higher protein requirement of small size *L. ramada* (24.6 mm) [5] compared to large individuals (50 mm) of the same species [4].

The inverse relationship between body fat and body water is in agreement with the results obtained with *L. ramada* [4, 5].

In conclusion, the present study demonstrated that *L. macrolepis* is not a good candidate for aquaculture due to their poor growth rates, and that SBM is not efficiently utilized by the fish as a replacement for FM during their early life stages.

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REFERENCES

[1] **Yashouv, A.** and **A. Ben-Shachar, 1967.** Breeding and growth of Mugilidae. II. Feeding experiments under laboratory conditions with *Mugil cephalus* L. and *Mugil capito* Cuvier. Bamidgeh, 19: 50-66.

[2] **Vallet, F., J. Berhaut, C. Leray, B. Bonnet** and **P. Pic, 1970.** Preliminary experiment on the artificial feeding of Mugilidae. Helgol. Wiss. Meeresunters., 20: 610-619.

[3] **De Silva S.S.** and **P.A.B. Perera, 1976.** Studies on the young gray mullet *Mugil cephalus* L. 1. Effect of salinity on food intake, growth and food conversion. Aquaculture, 7: 327-338.

[4] **Papaparaskeva-Papoutsoglou E.** and **M.N. Alexis, 1986.** Protein requirements of young gray mullet, *Mugil capito*. Aquaculture, 52: 105-115.

[5] **El-Sayed, A.M., 1991.** Protein requirements for optimum growth of *Liza ramada* fry *(Mugilidae)* at different water salinities. Aquat. Living Resour., 4: 117-123.

[6] **Tang, Y.A., 1964.** Induced spawning of striped mullet by hormone injection. Jap. J. Ichthyol., 12: 23-28.

[7] **Liao, I.C., 1969.** Artificial propagation of gray mullet (*Mugil cephalus* Lennaeus). Fish. Ser. Chin.-Am. Jt. Comm. Rur. Reconstr., 8: 10-20.

[8] **Shehadeh, Z.H.** and **J.N. Ellis, 1970.** Induced spawning of the striped mullet (*Mugil cephalus* L.). J. Fish Biol., 2: 355-360.

[9] **Kuo, C.M., Z.H. Shehadeh** and **C.E. Nash, 1973.** Induced spawning of captive gray mullet (*Mugil cephalus* L.) females by injection of human chorionic gonadotropin. Aquaculture, 1: 429-432.

[10] **Kuo, C.M., C.E. Nash** and **Z.H. Shehadeh, 1974.** A procedural guide to induce spawning in gray mullet (*Mugil cephalus* L.) females by injection of human chorionic gonadotropin. Aquaculture, 3: 1-14.

[11] **Kuo, C.M.** and **C.E. Nash, 1975.** Recent progress on the control of ovarian development and induced spawning of the gray mullet (*Mugil cephalus* L.). Aquaculture, 5: 19-29.

[12] **Lee, C.-S., C.S. Tamaru, G.T. Miyamoto** and **C.D. Kelly, 1987.** Induced spawning of gray mullet *(Mugil cephalus)* by LHRH-a. Aquaculture, 62: 327-336.

[13] **Zheng, C.W., 1987.** Cultivation and propagation of mullet *(Mugil Soiuy)* in China. Naga, 10(3): 18.

[14] **Liao, I.C., Y.J. Lu, T.L. Huang** and **M.C. Lin, 1971.** Experiments on induced breeding of the gray mullet (*Mugil cephalus* Linnaeus). Fish. Ser. Chin.-Am. Jt. Comm. Rur. Reconstr., 11: 1-29.

[15] **Hagiwara, A., C. Lee, H. Eda** and **Y. Oozeki, 1990.** Effect of food and stocking densities on the growth and survival of striped mullet *(Mugil cephalus)* larvae. In: Hirano R. and I. Hanyu, editors. The second Asian Fisheries forum, 137-140. Asian Fish. Soc., Manila, Philippines. 991 pp.

[16] **Houde, E.D., S.A. Berkeley, J.J. Klinovsky** and **R.C. Schekter, 1976.** Culture of larvae of the white mullet (*Mugil curema* Valenciennes). Aquaculture, 8(4): 365.

[17] **Nash, C.E. Kou, C.M.** and **S.C. McConnell, 1974.** Operational procedures for rearing larvae of the gray mullet (*Mugilcephalus* L). Aquaculture, 3: 15-24.

[18] **NRC (National Research Council), 1977.** Nutrient requirements of warmwater fishes. National Academy of Science, Washington, DC, USA, 78 PP.

[19] **AOAC (Association of Official Analytical Chemists), 1980.** Official Methods of Analysis, 12th edition, AOAC, Washington DC.

[20] **Gill J.L., 1981.** Design and analysis of experiments in the animal and medical sciences. Vol. 1. The Iowa State Univ., Press. Ames, Iowa, USA, 409 PP.

[21] **Pruginin, Y., S. Shilo** and **D. Mires, 1975.** Gray mullet: A component in polyculture in Israel. Aquaculture, 5: 291-298.

[22] **Cho, C.Y., H.S. Bayley** and **J. Slinger, 1974.** Practical replacement of herring meal with soy bean meal and other changes in diet for rainbow trout *(Salmo gairdneri)*. J. Fish. Res. Board Can., 31: 1523-1528.

[23] **Reinitz, G.L., 1980.** Growth and survival of lake trout fed experimental starter diets. Prog. Fish. Cult., 42 (2): 100-102.

[24] **Cowey, C.B., J.A. Pope, J.W. Adron** and **J.A. Blair, 1971.** Studies on nutrition of marine flatfish. Growth of plaice *Pleuronectes platessa* on diets containing protein derived from plants and other sources. Mar. Biol., 10:45.

[25] **Andrews, J.W.** and **J.W. Page, 1974.** Growth factors in fish meal component of catfish diets. J. Nutr., 104: 1091-1096.

[26] **Davis, A.T.** and **R.R. Stickney, 1978.** Growth response of *Tilapia aurea* to dietary protein quality and quantity. Trans. Am. Fish. Soc. 107 (3): 479-483.

[27] **Viola, S., Y. Ariel** and **G. Zohar, 1988.** Animal-protein free feeds for hybrid tilapia (*Oreochromis niloticus* X *O. aureus*) in intensive culture. Aquaculture, 75: 114-125.

[28] **Viola, S., S. Mokady** and **Y. Ariel, 1983.** Effects of soybean processing methods on the growth of carp *(Cyprinus carpio)*. Aquaculture, 32: 27-38.

[29] **Wilson, R.P.** and **W.E. Poe, 1985.** Effects of feeding soybean meal with varying trypsin inhibitor activities on growth of fingerling channel catfish. Aquaculture, 46: 19-25.

[30] **Albertini-Berhaut J., 1974.** Biologie des stages juveniles de Teleosteens Mugilidae *Mugil auratus* Risso 1810, *Mugil capito* Cuvier 1829 et *Mugil saliens* Risso 1810. II. Modificatons du regime alimentaire en relation avec la taille. Aquaculture, 4: 13-27.

[31] **Zismann L., V. Berdugo** and **B. Kimor, 1975.** Food and feeding habits of early stages of gray mullet in Haifa Bay region. Aquaculture, 6 (1): 59-75.