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Effect of Dietary Lipid Levels on Survival and Growth of the Threatened Freshwater Catfish *Mystus montanus*

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Özet: ***Türü tehlike altındaki tatlı su kedibalığı*** Mystus montanus ***fingerlinglerinde besindeki lipid seviyesinin gelişim ve yaşama oranı üzerine etkisi.*** *Mystus montanus* fingerlingleri (0.93 ± 0.03 g) %6 -%14 arasında lipid içeren 6 farklı formülasyondan olusan yemler ile beslenmiştir. Balıklara her uygulama için kendi vücut ağırlıklarının %5'i kadar besin verilmiş ve bu üç kez tekrarlanmıştır. 49 günün sonunda tüm uygulamaların sonuç boyları birbirinden önemli derecede farklı bulunmuştur ($p<0.05$). Minimum ve maksimum besin dönüşüm oranları (FCR), 1.58 ile %7 lipidle beslenen, 4.28 ile de %14 lipidle beslenen balıklarda sırasıyla tespit edilmiştir. Balıkların yaşama oranlarının formülasyon ile hazırlanan yemlerin verilmesiyle artış gösterdiği ancak %7'lik lipitten fazlasında daha üst bir gelişme gözlenmemiştir. Bu sonuçlar, türü tehlike altında olan kedi balığı *M. montanus* fingerling yemlerinde en uygun lipid miktarının %7 olduğunu göstermiştir.

Anahtar Kelimeler: *Mystus montanus*, kedi balığı, lipid gereksinimi, gelişim, yaşama oranı.

Abstract: *Mystus montanus* fingerlings (0.93 ± 0.03 g) fed on six different formulated diet containing 6% - 14% lipid. They were fed to the fish at the ration levels of 5% of their total body weight with three replicates per treatment. After 49 days, final weights were significantly greater ($p<0.05$) in all treatments. Food conversion ratio (FCR) was 1.58 at 7% lipid inclusion fed fishes and 4.28 at 14% lipid inclusion were noticed as minimum and maximum respectively. Fish survival was increased by providing formulated diet, but no further improvement was found after 7% lipid inclusion. This result indicated that the optimal lipid inclusion in the diet for the threatened catfish *M. montanus* fingerling is 7%.

Key Words: *Mystus montanus,* threatened catfish, lipid requirement, growth, survival.

Introduction

Fish nutrition in general has extensively reviewed by Love (1980) and Rao and Vijayarahavan (1984). According to Ellis and Reigh (1991) lipid is a major source of metabolic energy in fish. Being highly digestible, it has greater sparing action than dietary carbohydrate or protein, there by playing a definite role in feed utilization. Since dietary lipid level is a dominant factor in determining palatability (Boonyaratpalin, 1991), it is important that a proper amount of lipid should be incorporated in fish diet. Excess amount of lipid in diet besides creating problems associated with feed manufacturing may produce fatty fish (Cowey and Sargent, 1977). The ability of fish to use lipid as a ready source of energy and to spare protein for growth has been investigated in many fish species (Sargent *et al.*, 1989). Studies indicate that fish can use 20-30% of the dry diet ingredients as fat, provided adequate amounts of choline, methionine and tocopheral are present in the ration (Lee and Sinnhuber, 1972). Moreover fats have distinct advantage of being almost completely digestible. In fish ration, the neutral lipid component is a useful element for diet formulation and is especially desirable in feed of fry and fingerlings, which require high energy intake for rapid growth. The aim of the present study was to evaluate the effect of different dietary lipid levels on survival and growth of the threatened freshwater catfish *Mystus montanus*.

Materials and Methods

Six iso-nitrogenous diets were formulated using semi-purified ingredients with six different levels of protein (6%, 7%, 9%, 11%, 13% and 14%; Table 1). The dietary ingredients of each diet were mixed for about 10 min. Cod liver oil was gradually added to the mixture and the ingredients were mixed for another 5 min. Subsequently, sufficient quantity of water was added to the mixture, which was then blended for another 5 min and extruded through a pelletizer having 0.1 mm dia. The freshly prepared moist pellets were shade dried for 15 min and fed to the fishes at 5% of their total body weight.

Thirty-day-old induced bred fingerlings of *M. montanus* (0.93 ± 0.03 g) were used for this trial. Fingerlings were maintained on pellet diet throughout the experimental period. Prior to the initiation of the feeding trial fishes were acclimatized to test diets for one week. Each diet was fed to triplicate group of fishes for 7 weeks. Ten fishes were reared in each aquarium (capacity: 25 L). Aquaria were cleaned and refilled with freshwater (DO 5.8 mg/L; pH 6.8 - 7.2 and temperature 28 ± 2°C) once in alternate days. The fishes were fed twice a day at 10.00 h and 17.00 h at a rate of 5% of their total body weight per day. Fish were weighed every week to know their growth performance. Mortality was recorded and their survival rate was calculated. Faeces were collected from the aquaria prior to feeding. The unfed was collected 2 h after feeding with minimal disturbance to the fish and were dried at 60°C in hot air oven and weighed for further calculations.

Biochemical composition of fish and ingredients were analyzed by appropriate methodologies for protein (Lowery *et al.*, 1951), lipid (Bragdon, 1951) and carbohydrate (Carrel *et al.*, 1956) ash, moisture and dry matter (Mollah and Alan, 1990). Gross energy of the diets was calculated using kilocaloric values of 4.5/g for protein, 8.5/g for lipid and 3.49/g for carbohydrate (Khan and Jafri, 1991). The scheme of energy budget followed in the present work is that of the IBP formula of Petrusewicz and Macfadayen (1970). The data were subjected to mean, standard deviation, one-way ANOVA and Tukey's multiple range test (Zar, 1984).

Results

The compositions of the experimental diets are presented in Table 1. In all the six diets prepared protein (39.76%) and carbohydrate (9.11%) were constant in nature. But lipid level varied between 6.42 and 14.42%. In the present study, *M. montanus* readily accepted all the six different diets and survival was the highest in diet L_1, (96.3 ± 1.5%) followed by L_0 (92.3 ± 2.5%), L_5 (92.3 ± 3.5%), L_2 (89.6 ± 4.7%), L_4 (88.6 ± 3.7%) and L_3 (84.0 ± 5.2%). Biochemical compositions of the feed ingredients are presented in Table 2. Beef waste and coconut oil cake have high protein (52.4% and 43.69) and lipid (10.9% and 11.56%) content respectively, but rice bran possessed less protein (13.45%) and high carbohydrate (19.61%).

The specific growth rate (SGR) increased from 1.27% d^{-1} to 1.34% d^{-1} with increase in dietary lipid level from 6.42% to 7.42% and thereafter decreased (Table 3). For instance SGR decreased from 1.10% d^{-1} to 0.646% d^{-1} with the increase in lipid level from 9.42% to 14.42%. The highest SGR (1.34 ± 0.008%$^{-1}$) was noticed in fish fed with diet L_1 which contained 7.42% lipid and 2.73 Kcal/g of gross energy. High energy content (3.33 Kcal/g) diet (L_5) produced low growth (0.646 ± 0.008% d^{-1}) rate. SGR was significantly different ($P < 0.05$) among different dietary groups.

The values of feed conversion ratio (FCR) ranged between 1.58 and 4.28; and FCR was better (1.58 ± 0.009) among the groups, where SGR and weight gain were also high in diet L_1. High FCR values (4.28 ± 0.12) were noticed in maximum dietary lipid level (14.42%; L_5). Protein efficiency ratio (PER) were ranged between 0.595 and 1.38 among the dietary groups. Increasing dietary lipid level (7.42 - 14.42%) produced elevated values in PER (1.0 - 0.595). Carcass composition of the experimental fish was given in Table 4. Moisture level was increased (80-83%) as the dietary lipid level (6.42 - 14.42%) increased. An inverse relationship was noticed between moisture and dry matter, when moisture increased, dry matter decreased and vice versa. The high carcass protein (60%) lipid (12.6%) and carbohydrate (1.01%) were noticed in diet L_1. In other diets the carcass composition varied according to the dietary lipid level.

Table 1. Proximate composition of diets (% in dry matter basis).

Ingredients (%)	L_0	L_1	L_2	L_3	L_4	L_5
Beef waste	65	65	65	65	65	65
Dextrin	5	5	5	5	5	5
Coconut oil cake	10	10	10	10	10	10
Rice bran	10	10	10	10	10	10
Cod liver oil	0	1	3	5	7	8
Vitamin&mineral premix [1]	2	2	2	2	2	2
Nutrient contents						
Protein (%)	39.76	39.76	39.76	39.76	39.76	39.76
Lipid (%)	6.42	7.42	9.42	11.42	13.42	14.42
Carbohydrate (%)	9.11	9.11	9.11	9.11	9.11	9.11
Ash (%)	6.11	6.11	6.11	6.11	6.11	6.11
Gross energy (Kcal/g)	2.65	2.73	2.90	3.07	3.24	3.33
E/P protein (g/Kcal)	6.66	6.86	7.29	7.72	8.14	8.37

[1]*Supplevite - M (Sarabhai chemicals, India) 250 g supplevite - M provides vit A 5,00,000 IU; vit D_3 1,00,000 IU; vit B_2 0.2g; vit E 75 units; vit K 0.1g; calcium pentothenate 0.25g; nicotinamide 1.0g; vit B_{12} 0.6 mg; choline chloride 15g; calcium 75g; magnesium 2.75g; zinc 1.5g; iron 0.75g; copper 0.2g; cobalt 0.045g.*

Table 2. Biochemical composition of feed ingredients (% in dry matter basis).

Ingredients	Protein (%)	Lipid (%)	Carbohydrate (%)	Ash (%)	Gross energy (Kcal/g)	E/P ratio (g/Kcal)
Beef waste	52.4	10.9	5.6	6.8	4.25	8.1
Rice bran	13.45	4.58	19.61	12.5	1.99	14.8
Coconut oil cake	43.69	11.56	10.13	4.43	3.99	9.1

Table 3. Growth performance of *M. montanus* fingerlings fed different lipid diets (values given in mean ± standard deviation).

Diet Nos.	Initial weight (g)	Final weight (g)	SGR (% d^{-1})	PER	FCR	Survival (%)
L_0	0.93 ± 0.03	4.46^e ± 0.38	1.27^d ± 0.01	1.23^c ± 0.01	1.83^b ± 0.10	92.3^c ± 2.5
L_1	0.93 ± 0.03	4.85 ^{f}± 0.13	1.34 ^{d}± 0.008	1.38 ^{d}± 0.03	1.58^a ± 0.009	96.3 ^{d}± 1.5
L_2	0.93 ± 0.03	3.75 ^{d}± 0.25	1.10^c ± 0.009	1.0^c± 0.06	2.63 ^{c}± 0.08	89.6 ^{b}± 4.7
L_3	0.93 ± 0.03	3.09 ^{c}± 0.10	0.948 ^{b}± 0.01	0.783^b ± 0.008	3.16^d ± 0.08	84.0 ^{a}± 5.2
L_4	0.93 ± 0.03	2.75 ^{b}± 0.15	0.848 ^{b}± 0.02	0.743^b ± 0.05	3.53 ^{e}± 0.05	88.6^b ± 3.7
L_5	0.93 ± 0.03	2.25 ^{a}± 0.21	0.646^a ± 0.008	0.595^a ± 0.02	4.28^f ± 0.12	92.3 ^{c}± 3.5

**Means in a given column having the same letter superscript are not significantly different at p<0.05 by one way ANOVA and Tukey's multiple range test.*

Table 4. Carcass composition of *M. montanus* fingerlings fed different lipid diets

Diet Nos.	Moisture (%)	Dry matter (%)	Protein (%)	Lipid (%)	Carbohydrate (%)	Ash (%)
Initial	80.5	19.4	57.6	7.3	0.933	24.5
L_0	80.7	19.2	58.4	11.6	1.01	23.8
L_1	81.2	18.7	60.0	12.6	1.01	22.1
L_2	82.3	17.6	59.2	10.6	1.08	22.9
L_3	82.8	17.1	59.2	11.0	0.933	23.0
L_4	82.9	17.0	58.4	10.0	1.01	24.5
L_5	83.1	16.8	57.6	8.3	1.08	25.8

Disscussion

From the present results it is possible to suggest that 6.42 - 7.42% lipid level is suitable for *M. montanus*. According to Bogut and Opacak (1996) the optimum growth was attained in *Oncorhynchus kistuch, O. keta, O. nerka, O. tshawytsch* and *O. mykiss* at 9.5% lipid level. Lipid requirement of *Clarias gariepinus, C. isheriensis, C. batrachus, C. macrocephalus, C. fuscus Heterobranchus longifilis, H. kidorsalis, Heteropneustes fossilis* and *Silurus glanis* ranged between 5% and 10%. De Silva *et al.* (1991) recommended that 10% to 20% lipid in fish diet for optimum growth without any excess fatty carcass. However, the optimum lipid requirements of Indian major carps and common carp were determined as 4% to 6% (Singh, 1991). The earlier reports on fish such as *Ictalurus punctatus* (Dupree, 1969), *Salmo gairdneri* (Watanabe *et al.*, 1979) and *Sciaenops ocellatus* (Williams and Robinson, 1988; Ellis and Reigh, 1991) indicated a dietary lipid requirement of 6% to 11%. The ability of fish to use lipid as a major source of energy has been investigated in many fish species (Jafri *et al.*, 1995).

The SGR increased from 1.27 to 1.34% d^{-1} with increase in dietary lipid from 6.42 - 7.42% and thereafter decreased in the present study. Similar results are also available in the literature (Akand *et al.*, 1991). For instance SGR increased from 1.62 to 1.98% d^{-1} with the increase in lipid level from 3% to 10% and beyond which SGR decreased in *H. fossilis* (Akand *et al.*, 1991). The highest SGR (1.34% d^{-1}) was observed in fish fed with diet which contained 7.42% lipid and 2.73 Kcal/g energy value. Previous workers suggested that the high energy content in the diet could be the reason for the decreasing SGR and weight gain and also found an inverse relationship between dietary energy and growth (Page and Andrews, 1973).

The values of FCR ranged between 1.58 and 4.28 and FCR was better among the groups, where the SGR and weight gain were also high in diet L_0, L_1 and L_2. Akand *et al.* (1991) reported FCR values ranged between 1.6 and 2.3 for *H. fossilis* and *C. batrachus.* In the present study PER ranged between 0.595 and 1.38 among the test diets. Increasing dietary lipid level produced elevated values in PER and similar trend was also noticed by previous authors (De Silva *et al.,* 1989). Low PER was obtained in L_3, L_4 and L_5 and it could be due to inadequate dietary lipid as suggested by Daniels and Robinson (1986).

The body composition of fish fed with lipid diets showed the following relationships with protein and lipid content of diets. High dietary lipid levels generally resulted in low moisture, protein and carbohydrate content (Fagerlund *et al.,* 1983). However in *Dendex dendex* fed with diets containing 17.3% lipid, whole body lipid (5 - 6.2%) was lower than that of fingerlings or juveniles of other marine species being farmed in the mediterranean area. Body lipid contents of 9.2, 9.4 and 13.2% have been reported by Vergara and Jauncey (1993) for gilthead sea bream, which were given practical diets containing 13 - 16% lipid from fish meal. In the present study, 7.3 - 12.6% of body lipid was found which was fed with a dietary lipid level of 6.42 - 14.42%. The positive correlation between body lipids and dietary lipid may indicate that when dietary lipid was supplied in excess, a proportion of this lipid was deposited as fats. This is in agreement with the results on rainbow trout (Lee and Putnam, 1973) and channel catfish (Garling and Wilson, 1976).

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