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GROWTH AND BODY COMPOSITION OF EUROPEAN CATFISH (*SILURUS GLANIS* L.) FED DIETS CONTAINING DIFFERENT PERCENTAGES OF PROTEIN

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Abstract

European catfish (*Silurus glanis*) were fed anchovy-based diets containing 30, 35, 40, or 44% crude protein to satiation for 112 days. Data were collected to determine the relationship between dietary protein level and mean weight gain, specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER), daily growth index (DGI), average daily growth (ADG), feed efficiency (FE), and survival. The highest mean weight gain and SGR were obtained with the 40% (59.94 g and 0.74, respectively) and 44% (56.15 g and 0.71) diets. The best FCR (0.97), PER (2.62), DGI (2.18), ADG (1.14), and FE (1.04) were obtained with the 40% protein diet (2.75 kcal/g, digestible energy). Survival was 100% in all treatments. Results indicate that the optimum level of dietary protein for European catfish is 40%.

Introduction

The European catfish, *Silurus glanis*, is also known as wels or sheatfish. It has been cultivated extensively in ponds in central and eastern Europe for over 100 years, was introduced in France in the 1950s, and introduced in Spain more recently (Linhart et al., 2002). *Silurus glanis* has very good growth performance when cultured in cages and intensive indoor recycling units (Adamek et al., 1999). Production of farmed European catfish in ten countries (Austria, Bulgaria, Croatia, Czech Republic, France, Hungary, Greece, Macedonia, Poland, and Rumania) averaged approximately 2000 tons in 2002 (Linhart et al., 2002). This species has not yet been cultured in Turkey although it is an economically valuable fish that lives in

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almost all inland waters and 912 tons were captured in 2003 (Anon, 2005).

The protein requirements of channel catfish (*Ictalurus punctatus*), African catfish (*Clarias gariepinus*), bagrid catfish (*Pseudobagrus*), walking catfish (*Clarias batrachus*), and black catfish (*Rhamdia quelen*) have been well studied. Most commercial catfish diets contain 32% crude protein (NRC, 1993). Yet other concentrations of dietary protein have also been reported. The optimum dietary protein content for black catfish fry is 37% (Salhi et al., 2004). A diet containing 42% protein and 19% lipid is suitable for optimum growth and effective protein utilization in bagrid catfish fingerlings (Kim and Lee, 2005). Hybrid catfish (*C. batrachus* x *C. gariepinus*) postlarvae require 35-40% dietary crude protein for maximum growth (Giri et al., 2003). The protein requirement of *C. gariepinus* and *C. isheriensis* (30-40 g fingerlings) ranged 37-40% (Hoffman et al., 1997).

The present study was designed to determine the quantitative dietary crude protein requirements for optimum growth of European catfish fingerlings using anchovy-based diets.

Materials and Methods

Experimental fish. Silurus glanis fingerlings from the Keban Dam of the General Directorate of State Hydraulic Works were brought to the laboratory of the Department of Fisheries and Aquaculture of the Faculty of Agriculture at the University of Ankara. The fingerlings were acclimated for one month during which they were fed a commercial salmonid diet to satiation twice per day. Since the nocturnal *S. glanis* may be reluctant to feed during the daytime (Boujard, 1995), fingerlings were accustomed to expect food after knocking on the tanks, a strategy that proved efficient.

Experimental facilities and procedures. The experiment was conducted in 150-l conical fiberglass tanks containing 100 l of water for 112 days. A 14 h light:10 h dark photoperiod was used to simulate the natural light cycle. An aquaponic system (Rakocy et al., 2004) integrating fish culture and plant production was used. The plants (tomatoes and cucumbers), embedded in a gravel filter, extract organic wastes from the water and the purified water is recycled back to the fish tanks at a daily exchange rate of 5% (1-1.5 l/min) of the tank volume. *Nitrosomonas* and *nitrobacter* bacteria were added to the gravel beds to enhance the decomposition of nitrogenous compounds.

Three replicates of 10 fish per tank were established for each treatment. The average individual weight of the fingerlings was 46.4 g at the beginning of the experiment. The length and weight of all fish were measured every two weeks. Fish were anesthetized with 0.05 ml/l Quinaldine (Merck Schuchard, FRG) before weighing. Fish were fed *ad libitum* twice per day with one of four experimental diets based on anchovy fishmeal as the sole protein source (Table 1). Proximate analyses of the moisture, crude protein (N x 6.25), lipid, and ash of the feed were determined in triplicate by standard methods (AOAC, 1997). Digestible energy was calculated from the diet ingredients.

Water quality, tested weekly according to APHA (1980), was 0.12±0.003 ppm total ammonia (NH_3-N), 0.50±0.043 ppm nitrite (NO_2-N), 0.47±0.034 ppm nitrate (NO_3-N), 8.15±0.016 pH, and 6.0±0.058 oxygen. The water temperature was maintained at 27±1°C.

Measurements and calculations. At the end of the experiment, growth performance, body composition, and food utilization were calculated as follows: avg daily growth (ADG%) = 100 [W_t - W_i/W_i x T]; specific growth rate (SGR,%/day) = ([lnW_t - lnW_i]/T) x 100; daily growth index (DGI) = 100 x [$(W_t)^{1/3}$ - $(W_i)^{1/3}$]/T; feed efficiency (FE) = wt gain/feed fed; protein efficiency ratio (PER) = (W_t - W_i)/crude protein fed; feed conversion ratio (FCR) = (C x T)/(W_t - W_i); and condition factor (K) = 100 x (wt/length^3), where W = weight, W_i = initial weight of fish, W_t = final weight of fish, C = daily food intake, and T = duration.

Statistical analysis. Data were analyzed by analysis of variance (ANOVA) with the SAS package. Duncan's multiple-range test was used to compare differences among individual means. Treatment effects were considered significant at $p<0.05$. Percentage and ratio data were transformed to arcsine values prior to analysis (Zar, 1984).

Table 1. Composition and proximate analysis of experimental diets (% of raw material).

	Diet (% protein)			
	Diet 1 (30)	*Diet 2 (35)*	*Diet 3 (40)*	*Diet 4 (44)*
Ingredient				
Soybean oil cake	40	40	40	40
Fishmeal (anchovy)	12.5	20.5	28.5	35
Wheat	12.5	12.5	12.5	10.5
Cornstarch	20.5	12.5	4.5	-
Wheat bran	5	5	5	5
Gelatin	5	5	5	5
Bentonite	3	3	3	3
Salt	0.5	0.5	0.5	0.5
Vitamin mix[1]	0.5	0.5	0.5	0.5
Mineral mix[2]	0.5	0.5	0.5	0.5
Proximate analysis				
Crude protein	29.86	35.22	39.45	43.43
Lipid	1.88	2.41	3.01	2.77
Ash	6.16	6.86	5.76	9.74
Dry matter (% of air-dry wt)	92.37	92.37	92.87	92.47
Digestible energy (DE; Kcal/g diet)[3]	2.78	2.76	2.75	2.76
Protein:DE (mg protein/kcal)	107.41	127.61	143.46	157.36

[1] Rovimix 123-T 25 K (per 2.5 kg): Vitamin A 12,000,000 UI; vitamin D_3 2,000,000 UI; vitamin E 35,000 mg; vitamin K_3 4,000 mg; vitamin B_1 3,000 mg; vitamin B_2 7,000 mg; vitamin B_6 5,000 mg; vitamin B_{12} 15 mg; vitamin C 50,000 mg; niacin 20,000 mg; folic acid 1,000 mg; calcium D-pantothenate 10,000 mg; biotin 45 mg; choline chloride 125,000 mg.
[2] Remineral S 25K (per kg): Fe 60,000 mg; Cu 5000 mg; Mn 80,000 mg; Co 200 mg; Zn 60,000 mg; I 1,000 mg; Se 150 mg.
[3] Based on estimated values of diet ingredients according to NRC (1983, 1993).

Results

The final average weight, mean weight gain, ADG, SGR, PER, DGI, and FE of fish fed diet 3 were significantly higher than those of fish fed diets 1 and 2 but did not significantly differ from those of fish fed diet 4 (Table 2). The feed conversion ratio (FCR) of fish fed diet 3 was significantly lower than that of fish fed diets 1 and 2 but not significantly different from that of fish fed diet 4. The mean initial and final condition factors (K) did not significantly differ among groups. Survival was high for all treatments.

Table 2. Growth performance, feed conversion, and protein efficiency of European catfish (*Silurus glanis*) fingerlings fed diets containing different protein levels for 16 weeks.

	Diet (% protein)			
	Diet 1 (30)	*Diet 2 (35)*	*Diet 3 (40)*	*Diet 4 (44)*
Mean initial wt (g)	46.38±0.907[a]	46.44±1.192[a]	46.41±1.266[a]	46.37±1.348[a]
Mean final wt (g)	76.42±2.699[b]	82.37±2.568[b]	106.35±2.465[a]	102.52±3.742[a]
Mean wt gain (g)	30.04±3.650[b]	35.93±0.648[b]	59.94±0.042[a]	56.15±0.343[a]
Mean wt gain (%)[1]	64.8	77.4	129.2	121.1
Mean initial length (mm)	20.87±0.156[a]	20.75±0.181[a]	20.72±0.195[a]	20.68±0.203[a]
Mean final length (mm)	24.92±0.320[b]	25.64±0.304[b]	28.01±0.237[a]	27.30±0.336[a]
Mean initial condition factor (K)	0.51±0.006[a]	0.52±0.005[a]	0.52±0.005[a]	0.52±0.008[a]
Mean final condition factor (K)	0.49±0.005[a]	0.49±0.005[a]	0.48±0.004[a]	0.50±0.011[a]
Food consumed (g)[2]	548.36±3.41[b]	546.78±6.06[b]	579.03±6.64[a]	566.89±6.75[ab]
Avg daily growth (ADG; g/fish/day)	0.57±0.067[b]	0.69±0.015[b]	1.14±0.004[a]	1.07±0.008[a]
Specific growth rate (SGR; %/day)	0.45±0.041[b]	0.51±0.009[b]	0.74±0.002[a]	0.71±0.004[a]
Food conversion ratio (FCR)[1]	1.85±0.214[a]	1.52±0.011[a]	0.97±0.010[b]	1.01±0.018[b]
Protein efficiency rate (PER)[1]	1.83±0.212[b]	1.87±0.013[b]	2.62±0.028[a]	2.28±0.041[a]
Daily growth index (DGI)	1.24±0.126[b]	1.44±0.025[b]	2.18±0.0042[a]	2.07±0.011[a]
Feed efficiency (FE)[1]	0.55±0.063[b]	0.66±0.005[b]	1.04±0.011[a]	0.99±0.018[a]
Survival (%)	100	100	100	100

Values with different superscripts differ significantly ($p<0.05$).

[1] Expressed as the percent of the initial body weight after 16 weeks.

[2] Moisture-free basis.

Discussion

Data from the present study indicate that fish fed diets containing 30% (diet 1) and 35% (diet 2) protein had lower growth performance than those fed diets with 40% (diet 3) and 44% (diet 4) protein. Our weight gain results concur with those found by Soon et al. (2001) who reported that weight gains of 7.6 g bagrid catfish, fed 10 weeks, were 49.3%, 62.9%, 97.6%, 86.6%, 134.7%, 120.6%, and 96.3% with feeds containing 20.2%, 24.4%, 29.5%, 36.8%, 41.0%, 47.1%, and 53.1% protein respectively. Li and Robinson (1998) found that *I. punctatus* fed diets containing 24% crude protein gained less weight than those fed 32% or 28%. Li and Lovell (1992a) showed that dressing percentage increased as dietary protein increased from 24 to 36% and decreased as dietary protein increased from 36 to 40% in second-year channel catfish (*I. punctatus*). Similar results were obtained by Li and Lovell (1992b); when the percentage of dietary protein increased from 26 to 32%, the dressing protein percentage increased and when the percentage of dietary protein increased from 32 to 38%, the dressing protein percentage decreased in channel catish grown from 60 g to market size.

In our study, growth declined in fish fed the diet containing more than 40% protein. This result is consistent with findings in salmonids (Arzel et al., 1995) and American eel (Tibbetts et al., 2000), explained by the assumption that dietary protein is not utilized beyond a certain level for metabolic functions such as tissue growth and is, therefore, superfluous.

Our PER, mean weight gain, and SGR values increased as protein levels rose to 40% but decreased beyond that level, in agreement with findings in hybrid *Clarias* catfish (Giri et al., 2003) and black catfish (Salhi et al., 2004). Lower protein levels resulted in decreased PER values in *C. batrachus* fry (Chuapoehuk, 1987) and *C. gariepinus* fingerlings (Degani et al., 1989).

The present study indicates that the best results were obtained with the diet containing 40% protein, similar to results for other catfish species: 35%-40% for hybrid catfish (*C. batrachus* x *C. gariepinus*) postlarvae (Giri et al., 2003), 37% and 40% respectively for *C. gariepinus* and *C. isheriensis* fingerlings (Hoffman et al., 1997), 40% for *C. batrachus* (Erfanullah and Jafri, 1998), 37% for black catfish fry (Salhi et al., 2004) and 42% for bagrid catfish fingerlings (Kim and Lee, 2005).

References

Adamek Z., Fasaie K. and M.A. Siddiqui, 1999. Prey selectivity in wels (*Silurus glanis*) and African catfish (*Clarias gariepinus*). *Ribarstvo*, 57(2):47-60.

Anon., 2005. *Fishery Statistics 2003*. State Institute of Statistics, Prime Ministry, Republic of Turkey, publ. no. 2937, Ankara.

AOAC, 1997. *Official Methods of Analysis*, 16th ed. Association of Official Analytical Chemists, VA.

APHA, 1980. *Standards Methods for the Examination of Water and Wastewater*. 15th ed. American Public Health Association, Washington DC.

Arzel J., Metailler R., Kerleguer C., Delliou L.H. and J. Guillaume, 1995. The protein requirement of brown trout (*Salmo trutta*) fry. *Aquaculture*, 130:67-78.

Boujard T., 1995. Diel rhythms of feeding activity in the European catfish, *Silurus glanis*. *Physiol. Behavior*, 58(4):641-645.

Chuapoehuk W., 1987. Protein requirements of walking catfish, *Clarias batrachus* (Linnaeus), fry. *Aquaculture*, 63:215-219.

Degani G., Ben-Zvi Y. and D. Levanon, 1989. The effect of different protein levels and temperatures on feed utilization, growth and body composition of *Clarias gariepinus* (Burchell 1822). *Aquaculture*, 76:293-301.

Erfanullah and A.K. Jafri, 1998. Effect of dietary carbohydrate-to-lipid ratio on growth and body composition of walking catfish (*Clarias batrachus*). *Aquaculture*, 161:159-168.

Giri S.S., Sahoo S.K., Sahu A.K. and P.K. Meher, 2003. Effect of dietary protein level on growth, survival, feed utilisation and body composition of hybrid *Clarias* catfish (*Clarias batrachus* x *Clarias gariepinus*). *Anim. Feed Sci. Technol.*, 104:169-178.

Hoffman L.C., Prinsloo J.F. and G. Rukan,

1997. Partial replacement of fish meal with either soybean meal, brewers yeast or tomato meal in the diets of African sharptooth catfish *Clarias gariepinus*. *Water SA*, 23(29):181-186.

Kim L.O. and S.M. Lee, 2005. Effects of the dietary protein and lipid levels on growth and body composition of bagrid catfish, *Pseudobagrus fulvidraco*. *Aquaculture*, 243: 323-329.

Li M. and R.T. Lovell, 1992a. Growth, feed efficiency and body composition of second- and third-year channel catfish fed various concentrations of dietary protein to satiety in production ponds. *Aquaculture*, 103:153-163.

Li M. and R.T. Lovell, 1992b. Comparison of satiate feeding and restricted feeding of channel catfish with various concentrations of dietary protein in production ponds. *Aquaculture*, 103:165-175.

Li M.H. and E.H. Robinson, 1998. Effects of supplemental lysine and methionine in low protein diets on weight gain and body composition of young channel catfish *Ictalurus punctatus*. *Aquaculture*, 163:297-307.

Linhart O., Stech L., Svarc J., Rodina M., Audebert J.P., Grecu J. and R. Billard, 2002. The culture of the European catfish, *Silurus glanis*, in the Czech Republic and in France. *Aquat. Living Resour*., 15:139-144.

NRC, 1983. *Nutrient Requirements of Warmwater Fishes and Shellfishes*, revised ed. National Research Council, National Academy Press, Washington DC.

NRC, 1993. *Nutrient Requirements of Fish*. National Research Council, National Academy Press, Washington DC.

Rakocy J.E., Bailey D.S., Shultz R.C. and E.S. Thoman, 2004. Update on tilapia and vegetable production in the UVI Aquaponic System. pp. 676-691. In: *ISTA 6th Int. Symp. Tilapia in Aquaculture*, Vol. 2. Sep. 12-16, 2004, Philippines.

Salhi M., Bessonart M., Chediak G., Bellagamba M. and D. Camevia, 2004. Growth, feed utilization and body composition of black catfish, *Rhamdia quelen*, fry fed diets containing different protein and energy levels. *Aquaculture*, 231:435-444.

Soon S.C. and R. Hashim, 2001. The dietary protein requirement of a bagrid catfish, *Mystus nemurus* (Cuvier & Valenciennes), determined using semipurified diets of varying protein level. *Aquacult. Nutr.*, 7:45-51.

Tibbetts S.M., Lall S.P. and D.M. Anderson, 2000. Dietary protein requirement of juvenile American eel (*Anguilla rostrata*) fed practical diets. *Aquaculture*, 186:145-155.

Zar J.H., 1984. *Biostatistical Analysis*, 2nd ed. Prentice Hall, Englewood Cliffs, NJ. 718 pp.