Dietary protein requirements for discus (Symphysodon spp.)

Article *in* Aquaculture Nutrition · October 2008

DOI: 10.1046/j.1365-2095.2000.00151.x

Aquaculture Nutrition **2000 6;** 275–278

Short Communication

Dietary protein requirements for discus (*Symphysodon* spp.)

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Abstract

Discus (*Symphysodon* spp.), a valuable ornamental species (mean initial weight 4.40–4.65 g) were fed five isoenergetic (gross energy: 200–209 kJ g^{-1}), semipurified diets (casein, gelatine and Danish fish meal as protein sources) twice a day to satiation for 12 weeks. Five levels of protein were evaluated (350, 400, 450, 500 and 550 g kg^{-1} diet) and each fed to four replicates. Growth rate increased significantly with protein level up to 500 g kg^{-1} diet and then decreased. Feed conversion rates (FCRs) ranged from 2.2 to 3.8, varying inversely with observed growth rate. A similar trend was also observed in the efficiency of protein utilization (PER). Analysis of dose (protein level)-response (growth rate) with second order polynomial regression suggested a requirement of 449–501 g kg^{-1}.

KEY WORDS: discus, semipurified, ornamental, protein requirement, second order polynomial

Received 19 February 1999, accepted 27 March 2000

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Discus (*Symphysodon aequifasciata*), a freshwater cichlid, is one of the most valuable aquarium species (Axelrod *et al.* 1986). Chapman *et al.* (1997) indicated a higher average price for an imported discus (US$ 4.42) than for goldfish (US$1.06) or swordtail (US$0.33). Nutritional studies for aquarium fish are sparse in comparison with those of food fish (Shim & Chua 1986; Shim & Ng 1988). There is no published information till date on the nutritional requirements of discus. Large-scale discus breeders rely mostly on live food such as *Tubifex*, blood worm and *Artemia nauplii*. The present study aimed to determine the dietary protein requirement of young discus reared under controlled experimental conditions.

Five isocaloric semipurified diets with gross energy ranging from 202.9 to 211.3 kJ g^{-1} at varying protein levels were formulated (Table 1). Danish fish meal, casein and gelatin (4:2:1) were used as protein sources with the latter two to provide a balanced dietary amino acid profile whilst fish meal ensured adequate feed palatability. As the digestible energy values for feed ingredients have not yet been determined in discus, gross energy values were used; 23.85 kJ g^{-1} for protein, 39.75 kJ g^{-1} for lipid and 16.74 kJ g^{-1} for carbohydrate.

Diets were prepared in a Hobart food mixer and meat grinder to 1-mm pellet size. Proximate analyses were carried out for moisture, crude protein, lipid, ash and fibre determination for major ingredients and each formulated diet. Protein was determined by Kjeldahl method, lipid by ether extraction, ash by combustion at 600 °C for 16 h and fibre by acid–alkaline digestion (AOAC 1980).

Domesticated hybrid discus (*S. aequifasciata* hybrid) purchased from a local breeder were prophylatically treated with a potassium permanganate bath and acclimatized by feeding frozen bloodworms (Hikari®) twice a day. Each experimental diet was evaluated using four replicates with eight fishes (mean weight 4.45–4.65) in each experimental tank (600 cm × 30 cm × 30 cm). The experiment was conducted in a static system with aeration. The fishes were fed to satiation twice a day (1000 and 1500 h) for 6 days per week for 12 weeks. Weighing was performed individually at the beginning and end of the trial while batch weighing was conducted at weekly intervals. After weighing, fishes were immersed in a mixture of NaCl (15 g L^{-1}) and acriflavine solution (1 mg L^{-1}) for 30 min for the purpose of disinfection from ectoparasites.

Growth performance of discus fed with the varying protein diets was evaluated by calculating mean weight gain (MWG), specific growth rate (SGR), feed conversion rate (FCR), protein efficiency ratio (PER) and coefficient of variance (CV).

Differences in parameters between treatments were analysed with Tukey's HSD using SPSS®. All percentage values

Table 1 Ingredients (g kg^{-1}) and proximate analysis results for all experimental diets

	Diet (g kg^{-1} P)				
	35	40	45	50	55
Ingredients					
Danish fish meal[1]	233.90	272.93	311.95	350.98	390.00
Casein[2]	126.80	144.92	163.05	181.17	199.30
Gelatin[3]	58.60	66.98	75.35	83.73	92.10
Cod liver oil	70.00	66.87	63.75	60.62	57.50
Dextrin	300.00	225.00	150.00	75.00	0.00
Vitamin mix[4]	20.00	20.00	20.00	20.00	20.00
Mineral mix[5]	20.00	20.00	20.00	20.00	20.00
Choline chloride	1.50	1.50	1.50	1.50	1.50
Carboxymethyl cellulose	169.20	181.80	194.40	207	219.60
Proximate analysis (g kg^{-1} of dry matter)[6]					
Crude protein (CP)	350.40	390.50	445.50	501.10	549.70
Crude lipid (CL)	85.00	83.70	82.50	82.90	84.10
Ash	43.20	48.30	49.40	51.20	55.20
Fibre	13.70	14.40	15.20	17.20	19.50
NFE (by difference)	504.00	450.90	407.40	344.60	291.50
Gross energy (kJ g^{-1})	20.25	20.42	20.71	21.84	25.02
P:E[7]	17.30	19.12	21.49	22.94	21.97

[1] Source: (Moisture 42.3 g kg^{-1}, CP 706.80 g kg^{-1}, CL 74.70 g kg^{-1}, ash 92.50 g kg^{-1} and fibre 1.60 g kg^{-1}).
[2] Source: Fluka.
[3] Source: Sigma Chemical co. St. Louis, MO.
[4] FISH 2112®; As per kg: vitamin A 5.0×10^6 IU; vitamin D_3 1.0×10^6 IU; vitamin E 50 000 IU; vitamin K_3 5000 mg, vitamin B_1 15 000 mg; vitamin B_2 15 000 mg; vitamin B_6 12 000 mg; vitamin B_{12} 25 mg; niacin 50 000 mg; folic acid 2500 mg; vitamin C 300 000 mg; inositol 100 000 mg.
[5] ELEMENT 88®; As per kg: N 200 mg; Ca 18 600 mg; Mg 5200 mg; Fe 9400 mg; Co 25 mg; Mn 650 mg; Zn 500 mg; other elements included C, H, S, Po, K, Na, Cl, Cu, Ni, Mb, Sel, Cr, I, Fl, Zn, Vn, Ar.
[6] Moisture of diets (6.8–7.3 g kg^{-1}); mean values from three replicates; gross energy calculated based on 523.85 kJ g^{-1} for protein, 39.75 kJ g^{-1} for lipid and 16.74 kJ g^{-1} for carbohydrate.
[7] Protein to Energy ratio in mg kJ^{-1}

were transformed to arcsine values prior to analysis. A second order polynomial regression model between SGR and protein level was used for determination of protein level required for maximum growth (Zeitoun *et al.* 1976).

No mortality occurred during any of the treatments throughout the experimental period reflecting the effectiveness of the post-treatment handling. Coefficient of variance ranged from 11 to 28% with tanks fed with lower protein levels generally having higher CV values (Table 2). The heterogeneity of fish size was probably owing to the territorial behaviour exhibited by this species. Based on weekly samplings, weight increase among the five different treatments began to differ by the 5th week. At the end of the experiment, Tukey's HSD analysis showed a linear relationship between protein level and growth up to 450 g kg^{-1} protein, beyond which SGR did not differ significantly (Table 2). Numerous studies reported growth depression in response to protein levels higher than the optimum (Siddiqui *et al.* 1988; Khan *et al.* 1993), possibly owing to the energy costs of deaminating excess amino acids (Jauncey 1982).

Table 2 Growth performance of young discus after 12 weeks of feeding with diets at different protein levels[1,2]

Diet (g kg^{-1} P)	Initial weight (g ± SE)	Final weight (g ± SE)	MWG (g ± SE)	SGR (% ±SE)	Food consumed (% body weight per day)	FCR ± SE	PER ± SE	CV[3] (% ±SE)
35	4.60 ± 0.08	14.42 ± 0.32	9.82 ± 0.32[a]	1.36 ± 0.04[a]	10.47 ± 0.57[c]	3.84 ± 0.98[b]	0.75 ± 0.64[a]	28.3 ± 4.5[b]
40	4.65 ± 0.08	18.74 ± 0.74	14.09 ± 0.69[b]	1.66 ± 0.03[b]	10.03 ± 0.45[b,c]	2.98 ± 0.54[a,b]	0.83 ± 0.57[a]	22.4 ± 5.8[b]
45	4.63 ± 0.23	20.39 ± 0.42	15.76 ± 0.40[b,c]	1.79 ± 0.06[b,c]	9.21 ± 0.16[b]	2.17 ± 0.48[a]	1.02 ± 0.69[a]	17.7 ± 4.3[a,b]
50	4.48 ± 0.10	20.99 ± 0.41	16.52 ± 0.38[c]	1.84 ± 0.02[c]	9.26 ± 0.45[b]	2.26 ± 0.58[a,b]	0.88 ± 0.74[a]	19.0 ± 5.4[a,b]
55	4.56 ± 0.12	21.15 ± 0.49	16.60 ± 0.47[c]	1.83 ± 0.03[c]	8.34 ± 0.13[a]	3.22 ± 0.61[a,b]	0.57 ± 0.54[a]	11.6 ± 3.6[a]

[1] Values from the mean of four replicates.
[2] Mean with the same superscript within the same column are not significantly different (Tukey's HSD test, $P > 0.05$).

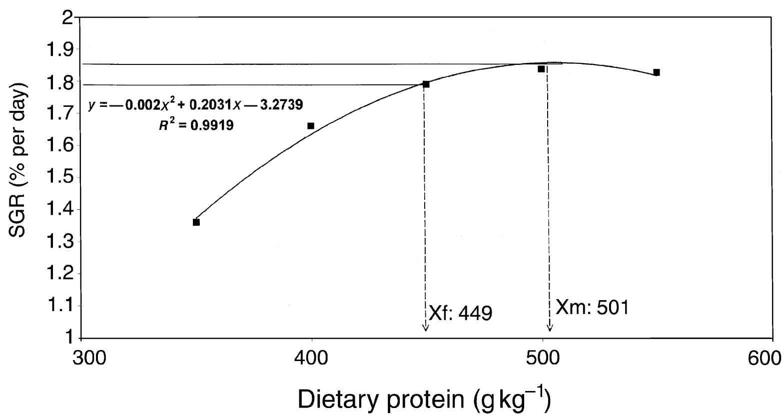

Figure 1 Second order polynomial regression analysis between SGR and dietary protein level (%) for young discus [Xm: (level for maximum growth), Xf (best FCR, Fiogbe *et al.* 1996)].

Analysis derived from the second order polynomial regression curve ($r^2 = 0.99$) indicated that the protein level needed for maximum SGR (1.87%) was 501 g kg^{-1} (Fig. 1). This curve was also able to yield additional 'requirement' level of 449 g kg^{-1} which corresponds to the lowest FCR of 2.17. (Fiogbe *et al.* 1996). Table 1 also showed the corresponding protein-energy ratio for this optimum requirement range to be at 21.5–22.9 mg kJ^{-1}.

Protein requirements estimated here are relatively higher than for juveniles of other species such as grass carp (*Ctenopharyngodon idella*) of 410–430 g kg^{-1} (Dabrowski 1977), silver barb (*Puntius gonionotus*) of 350 g kg^{-1} (Wee & Ngamsnae 1987) and bighead carp (*Aristichthys nobilis*) of 300 g kg^{-1} (Santiago & Reyes 1991). Discus would also appear to have higher protein requirements than other ornamental species such as goldfish, 29 g kg^{-1} (Lochmann & Phillips 1994), dwarf gourami, 250 g kg^{-1} (Shim *et al.* 1989) and tin foil barb, 417 g kg^{-1} (Elangovan & Shim 1997). This could be owing to the very carnivorous habit of discus, with aquatic insects being a large part of their natural diets. Optimum protein requirements for carnivorous species reported elsewhere for comparison are for brown trout fry (*Salmo trutta*), 480–530 g kg^{-1} (Arzel *et al.* 1995) and snakehead (*Channa micropeltes*) 520 g kg^{-1} (Wee & Tacon 1982).

Feeding rate, when expressed as the percentage body weight of fishes per day, was inversely related to protein levels (Table 2). Studies have shown a decrease in protein requirement when feeding level is increased (Ogino 1980; Martinez-Palacios *et al.* 1996). If discus were to be fed a restricted ration below the 8% recorded in this study, then the protein requirement might be expected to increase. The efficiency of feed conversion generally showed an increase with higher protein levels. A similar trend was also observed in the utilization of protein (PER).

Future studies should investigate the effects of protein quality (digestibility and amino acid requirements) and protein to energy ratio of the protein requirements of this species.

Acknowledgements

Our appreciation goes to A. Mohd. Nor for technical assistance, E.H. Khor for supply of fishes and advice on discus maintenance and the Malaysian Ministry of Science for scholarship for ASC Chong's Ph.D. program.

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