Maintenance Energy Requirement of Five Popular Species of Ornamental Fish[1]

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EXPANDED ABSTRACT

Indexing Key Words:

• *ornamental fish* • *maintenance energy requirement*

Ornamental fish live, eat and excrete their waste in the relatively small environmental space of an aquarium where both soluble (i.e., H_2S, NH_3, NO_2^-, NO_3^-, PO_4^-, CO_2) and solid waste are either chronically or acutely toxic to them. It is therefore not surprising that poor food utilization and overfeeding are the two main causes of pollution in the aquarium. Poor food utilization can be avoided by feeding ornamental fish with a balanced diet (Pannevis 1993). To avoid overfeeding, the energy requirement of ornamental fish needs to be addressed. Feeding levels for ornamental fish, however, should not be below maintenance requirement. There do not appear to be any reports on the energy requirement of ornamental fish. The nutrient and energy requirement of fish has been extensively reported for aquaculture food fish species [National Research Council (NRC) 1981, NRC 1983]. These studies have indicated that in general the maintenance energy requirement [J digestible energy (DE)/$kg^{0.75}$] of fish is <10% of the maintenance energy required by birds or mammals (Smith 1989). The low maintenance energy requirement is partly due to the poikilothermic nature of fish. Fish also exert less energy on posture and have an energetic advantage over mammals in their nitrogenous waste management as they excrete mainly ammonia instead of urea or uric acid, thus losing less energy in protein catabolism and excretion of nitrogenous waste (NRC 1983). The purpose of this study was to measure the food and energy intake of five species of ornamental fish species.

TABLE 1

Gross analysis of experimental diet (1) (goldfish) and diet (2) (tropical fish)

Nutrient	Diet (1)	Diet (2)
Moisture	4.1	4.8
Protein	33.5	39.0
Fat	10.9	12.7
Ash	11.4	13.3
Carbohydrate	40.0	30.0
Gross energy, *kJ/100 g*	1938	1966
Digestible energy, *kJ/100 g*	1665	1783

Material and methods. *Fish.* Five species of ornamental fish were used in this study. One cold water specie, the goldfish (*Carassius auratus*), was used in four different size groups: 3.59 ± 0.06 (mean ± SD) g (n = 15 per tank; two tanks per feeding level), 4.78 ± 0.09 g (n = 10; one tank per feeding level), 8.06 ± 0.31 g (n = 10; one tank per feeding level) and 11.66 ± 0.20 g (n = 10; one tank per feeding level). Four tropical freshwater ornamental species were used: neon tetra's (*Paracheirodon innesi*) of 0.18 ± 0.01 g (n = 25 per tank; two tanks per feeding level), zebra danio's (*Brachydanio rerio*) of 0.30 ± 0.02 g (n = 13 per tank; three tanks per feeding level), kribensis (*Pelvicachromis pulcher*) of 1.02 ± 0.08 g (n = 10 per tank; three tanks per feeding level) and moonlight gouramies (*Trichogaster microlepis*) of 1.87 ± 0.08 g (n = 15 per tank; two tanks per feeding level).

Husbandry. The fish were kept in 50-l tanks that were part of two recirculation systems: one at 20°C

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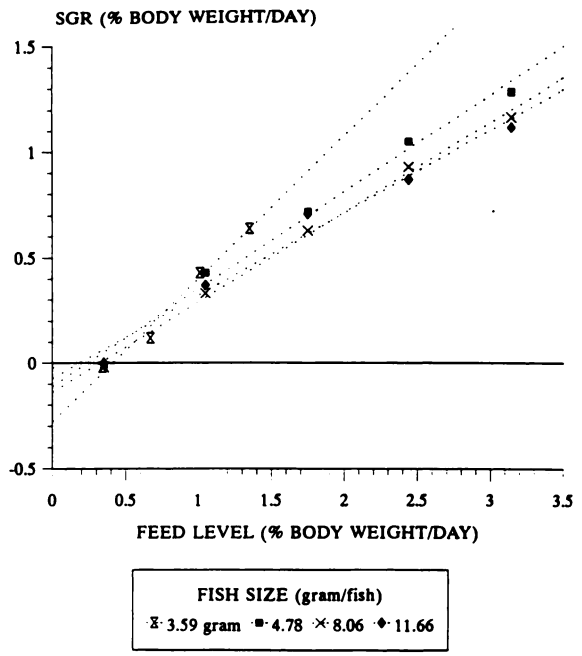

FIGURE 1 Relation between feed level (%body weight fed/d) and specific growth rate (%body weight growth/d) for four size groups of goldfish [3.59 ± 0.06 (means ± SD) g/fish, n = 30; 4.78 ± 0.09 g/fish, n = 10; 8.06 ± 0.31 g/fish, n = 10; 11.66 ± 0.20, n = 10] at 20°C.

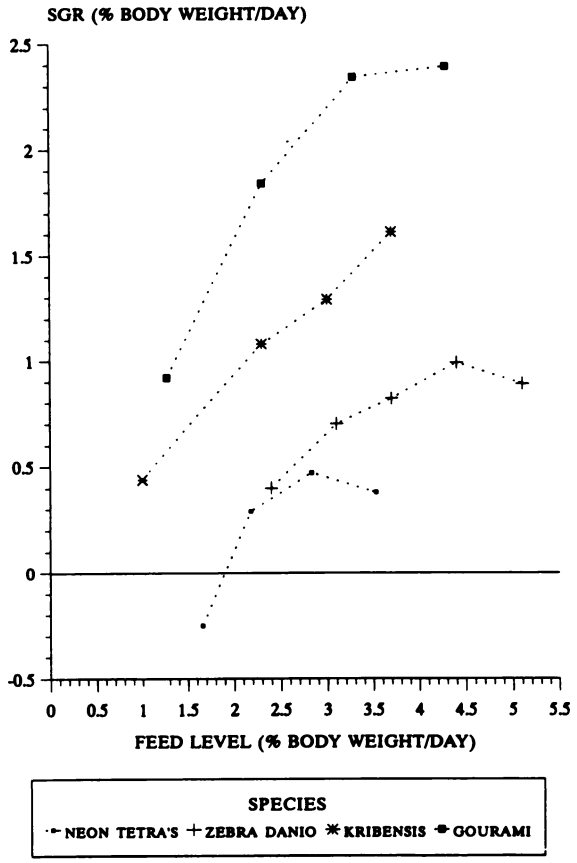

FIGURE 2 Relation between feeding level (%body weight fed/d) and specific growth rate (%body weight growth/d) for neon tetra [0.18 ± 0.01 (means ± SD) g/fish, n = 50], zebra danio (0.30 ± 0.02 g/fish, n = 39), kribensis (1.02 ± 0.08 g/fish, n = 30) and moonlight gourami (1.87 ± 0.08 g/fish, n = 30) at 26°C.

for the goldfish and the other at 26°C for all four tropical fish species. The fish were fed two experimental diets. The composition of the goldfish diet (1) and of the diet for tropical fish (2) is shown in **Table 1.** The feeding levels were given as a set percentage of the fish's body weight (**Figs. 1** and **2**) and maintained for 3–9 wk. The fish were weighed individually at the beginning and end of the trial and as a group every 3 wk to adjust feeding levels. Fish were weighed while in a beaker of water on an analytical scale (Sartorius, Goettingen, Germany).

Growth was expressed as Specific Growth Rate (SGR, % body weight growth/d) = 100 × (ln (W_2) − ln (W_1))/days$_{(W2-W1)}$. DE value for goldfish experimental diet (1) was determined in a study with 40 goldfish and found to be 0.859 GE (Gross Energy). The DE content of diet (2) was 0.898GE (n = 30 moonlight gourami, *T. microlepis*). The maintenance feeding re-

TABLE 2

Maintenance feeding requirement of five popular species of ornamental fish

Fish species	Initial (W_1) fish size[1]	Maintenance feeding requirement	Maintenance feeding requirement	Maintenance energy requirement	Maintenance feeding requirement
	g/fish	*% BW food/d*	*mg food/(fish · d)*	*J DE/(fish · d)*	*flakes/(fish · d)*
Goldfish	3.59 ± 0.06	0.40	14.36	239	2.4
	4.78 ± 0.09	0.24	11.47	191	1.9
	8.06 ± 0.31	0.32	25.79	429	4.4
	11.66 ± 0.20	0.16	18.33	306	3.1
Neon tetra	0.18 ± 0.01	1.9	3.8	68	0.6
Leopard danio	0.30 ± 0.02	<2.4	<7.2	<128	<1.2
Kribensis	1.02 ± 0.08	<1.0	<10.2	<182	<1.7
Moonlight gourami	1.87 ± 0.08	<1.5	<28.5	<508	<4.9

[1] Values are means ± SD.
BW = body weight; DE = digestible energy.

quirement is defined as the feeding level at which the SGR is zero after linear regression of feeding level against specific growth rate for each group of goldfish (Fig. 1). The maintenance feeding level for the tropical ornamental species could only be assessed for the 0.18 g neon tetra (Fig. 2).

Results and conclusions. The maintenance feeding level of diet (1) is 14.4 mg flake/d [239 J DE/(fish/day)] for a 3.6-g goldfish up to 18.3 mg flake/d [306 J DE/(fish/day)] for a 11.7-g goldfish per day (Fig. 1). The maintenance feeding requirement of diet (2) of the 0.18-g neon tetra is 3.8 mg diet/d [68 J DE/(fish/day)]. The maintenance feeding level of diet (2) for a 0.30-g leopard danio is <7.2 mg diet/d [<128 J DE/(fish/day)].

The maintenance feeding level of diet (2) for a 1.02-g kribensis is <10.2 mg diet/d [<182 J DE/(fish/day)]. The maintenance feeding level of diet (2) for a 1.87-g moonlight gouramies is <28.5 mg diet per fish per day [<508 J DE/(fish/day)]. The maintenance feeding requirement of the species in this study is as low as 60% of a single flake (5.9 mg/flake) for a neon tetra up to 4.4 flakes per day for a 8.06-g goldfish (**Table 2**).

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