Growth-ration Relationship and Conversion Efficiency of Juvenile *Hemibagrus nemurus*

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ABSTRACT

To investigate the growth-ration relationship and feed conversion efficiency of a bagrid catfish *Hemibagrus nemurus*, an 8-week experiment was conducted in 12 indoor tanks. Juvenile *H.nemurus* with a mean weight of 1.83g were fed a 40% protein and 3% lipid diet at 4 different ration levels (2, 3, 4 and 5% of initial body weight) per day. Water temperature was approximately 26.6°C throughout the experiment. The average final weight, specific growth rate and feed conversion efficiency were directly measured. At the end of the experiment, significant differences were found in growth parameters, average final body weight and specific growth rate among the four groups of fish receiving different rations ($p<0.05$). The relationship between specific growth rate in wet weight (SGRw, percentage per day) and ration level (RL, percentage per day) was an asymptotic curve described as $SGRw = -0.2072RL^2+2.0054RL-0.9959$ ($R^2=0.9778$; $p<0.01$). Feed conversion efficiency decreased significantly with increasing ration levels. Based on the above results, it may be concluded that a ration size of 4% of body weight per day is optimal for good growth and feed conversion efficiency of juvenile *H.nemurus* (from initial weight of 1.8g to final weight of 16g).

Keywords: bagrid catfish, *Hemibagrus nemurus*, feeding rate, growth

INTRODUCTION

Ration is an important factor affecting the growth of fish and a growth–ration relationship has been established for several species. The typical relationships are both a decelerating curve (Cui &Wootton, 1988; Jobling, 1994; Sun *et al*. 2006; Desai and Singh, 2009), and linear (Niimi& Beamish, 1974; Yoshida & Sakurai, 1984; Klaoudatos & Apostolopoulos, 1986; Cui *et al*.,1994). A great deal of past research has focused on determining the optimum ration level of various finfish species (Khan & Abidi, 2010). There are, however, differences among species. The optimum ration level for better growth, conversion efficiencies and body composition of fingerling *Heteropneustes fossilis* was found to be in the range of 5.9–6.8% body weight per day

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(Khan & Abidi, 2010). A ration size of 6% of body weight per day is optimal for good growth of *Cyprinus carpio* fry (Desai & Singh, 2009). Ahmed (2007) observed that a ration size of 6.5–7.0% body weight per day is optimal for growth and efficient utilization in *Labeo rohita*. Among the different rations tried, 2% body weight per day showed highest growth in juvenile grass carp, *Ctenopharyngodon idella* (Zhen-Yu *et al*., 2006). A feeding ration of 5 to 5.5% is optimal for growth of *Cirrhinus cirrhosus* (Khan *et al*., 2004).

Two factors which determine the economic viability of aquaculture are the growth and feed utilization efficiency of the cultured species, and both are influenced by feeding rate (Hung & Lutes 1987; Hung *et al*., 1993). Knowledge about optimum feeding rates is important not only for promoting good growth and feed efficiency, but also for preventing water quality deterioration as a result of excess feeding (Ng *et al*., 2000). It is well known that an inappropriate feeding strategy in aquaculture may lead to overfeeding which results in feed waste, whilst insufficient feeding leads to poor growth (Eroldogan *et al*., 2006) as growth depression has been induced by complete or partial food deprivation (Ali *et al*., 2003).

The tropical bagrid catfish, *Hemibagrus nemurus* (synonym *Mystus nemurus*), is indigenous to Southeast Asia. It is the most abundant bagrid catfishes found in Thailand and constitutes a substantial part of the inland fishery. *H. nemurus* is a popular food fish and fetches a premium price at local markets. There is a growing interest in the commercial culture of *H. nemurus*. Currently, the recommended feeding rate of *H. nemurus* (from an initial weight of 12 to a final weight of 35g) fed a diet containing 36.2% protein, is 2.5% body weight per day (Ng *et al*., 2000). However, feed consumption in relation to body weight decreases as weight increases (NRC, 1993). Therefore small *H. nemurus* would require higher feeding rates than large fish under similar culture conditions. For example, daily feeding allowances for the commercial production of channel catfish, *Ictalurus punctatus*, vary from 25% BW/day for swim-up fry to about 1% BW/day for fish of 500g or larger (NRC, 1993). However, until now, no information of growth-ration relationship for *H. nemurus* has been published. In addition, optimum feed ration for this species, particularly during the early nursing stage (from an initial weight of approximately 2g) will be useful for fish farmers. Consequently, a commercial pellet feed containing 40% crude protein and 3% crude lipid, which is available and always used for fish nursing in Thailand and neighboring countries was selected in the experiment in order to facilitate adoption of the results. Therefore, the objective of the present study was to determine optimum ration level, growth-ration relationship and feed conversion efficiency of the bagrid catfish, *Hemibagrus nemurus*.

MATERIALS AND METHODS

Juvenile *Hemibagrus nemurus* were obtained from a local private fish farm and held in 500-l fiberglass tanks upon arrival at the laboratory. The fish were acclimatized to laboratory conditions for 3 weeks during which they were fed a commercial pellet feed (small particle size) containing 40% crude protein and 3% crude lipid (manufacturer's specification; Chareon Pokpand Ltd). Thereafter, this diet was used to feed the fish throughout the experiment. The experiment was carried out in an indoor tank culture system consisting of 12 concrete tanks (1.45 × 1.4 × 1 m, water volume 1 m^3). Well water was used to fill all tanks throughout the experiment. Aeration in each tank was provided continuously except during feeding, with one diffuser stone of 3 cm diameter placed at a mid-depth level. About 30% of water in each tank was drained, and then replaced by well-aerated water every day.

At the start of the experiment, 50 catfish of approximately equal size (1.83g) were stocked into each tank. Feed was provided at increasing rations to randomly assign triplicate groups of fish, the four rations being 2, 3, 4, and 5% of body weight per day (BW/day). Fish were given their daily rations divided into two equal meals per day at 0900 and 1600 h. The fish were batch-weighed (per tank) at biweekly intervals and the daily ration adjusted accordingly. During the biweekly weighing, the walls of each tank were scrubbed and washed before refilling with water and replacing the fish. The feeding experiment was carried out for 8 weeks.

At the end of the 8 week experiment, all fish from each tank were individually weighed and their total length (TL) measured to calculate the condition factor [CF = 100 x BW in g/(TL in cm)^3]. Growth and feed utilization efficiency were also determined based on final fish weight, weight gain (expressed as the percent of initial body weight at the end of the experiment), specific growth rate (ln final – ln initial fish weight/time,expressed as % per day), feed conversion ratio (total dry diet feed/wet weight gain), feed conversion efficiency (wet weight gain/total dry dietfed) and protein efficiency ratio (wet weight gain/total protein fed).

Water quality parameters in the experimental tanks were measured weekly throughout the experiment, namely dissolved oxygen (using YSI mode 52), temperature and pH (using pH meter, Consort C533).

Statistical tests were performed using SPSS statistical software. A one-way ANOVA followed by a multiple range test (Duncan New Multiple Range test) was used for the fourration levels to examine significant differences ($p<0.05$) among various treatments. Least square regression was performed to evaluate the relationships between specific growth as well as the feed conversion efficiency and ration, and judged by the coefficient of determination (R^2). Data are expressed as mean±standard error.

RESULTS

Water quality parameters i.e. dissolved oxygen (5.9 ± 0.3 mg/L to 7.4 ± 0.5 mg/L), pH (7.7 ± 0.2 to 7.9 ± 0.2) and temperature (26.6 ± 0.1 °C to 26.9 ± 0.1 °C) during experimental period were not different among the treatments.

Table 1 shows the growth performance of juvenile *Hemibagrus nemurus* that were fed at different ration levels. There was no significant difference in the initial body weight of fish among treatments. Mean values of final weight among fish groups were significantly different ($p<0.05$); the fish fed at 2% ration level had the lowest value. Mean values of specific growth rate at different ration levels were significantly different ($p<0.05$). The specific growth rate for fish fed at 2% ration was 2.17%/day and this increased to 3.66%/day for fish fed at 4% ration, then slightly further increased to 3.87%/day for fish fed at 5% ration. No significant difference was observed in specific growth rate among fish fed at 4 and 5% ration levels. The relationship between specific growth rate in wet weight (SGRw) and ration size (RL) was an asymptotic curve (Fig. 1; $R^2=0.9778$, n=12, $p<0.01$). Survival rates of fish fed at all ration levels were not significantly different ($p>0.05$), whilst feed conversion efficiency was significantly different among fish groups ($p<0.05$), and tended todecrease as ration level increased (Fig. 2; $R^2=0.9752$, n=12, $p<0.05$). No significant difference was observed in feed conversion ratio among fish fed at 2 and 3% ration levels. Protein efficiency ratio was significantly different among fish groups ($p<0.05$), and tended to decrease as ration level increased. Mean values of condition factor among fish groups were significantly different ($p<0.05$). No significant difference was observed in fish fed at lower ration (2 or 3%), and higher ration (4 or 5%).

Table 1. Growth performance and feed utilization efficiency of *Hemibagrus nemurus* fed at different ration levels for 8 weeks.

Ration level (%/day)	**Initial weight (g)**	**Final weight (g)**	**Survival rate (%)**	**Specific growth rate (%/day)**	**Feed conversion efficiency**	**Feed conversion ratio**	**Protein efficiency ratio**	**Condition factor**
2	1.84±0.03	6.20±0.14^{a}	98±1.1	2.17±0.04^{a}	1.19±0.09^{d}	0.84±0.00^{a}	2.98±0.02^{d}	0.84±0.08^{a}
3	1.88±0.00	11.34±0.22^{b}	99±0.7	3.20±0.03^{b}	1.02±0.01^{c}	0.98±0.01^{a}	2.55±0.02^{c}	0.74±0.11^{a}
4	1.76±0.10	13.72±1.23^{bc}	97±2.4	3.66±0.06^{c}	0.81±0.03^{b}	1.18±0.09^{b}	2.03±0.08^{b}	1.04±0.03^{ab}
5	1.85±0.02	16.17±1.51^{c}	99±0.7	3.87±0.10^{c}	0.64±0.03^{a}	1.56±0.07^{c}	1.61±0.07^{a}	1.18±0.06^{b}

Values that are denoted with the same superscript are not significantly different from each other (ANOVA, $p<0.05$).

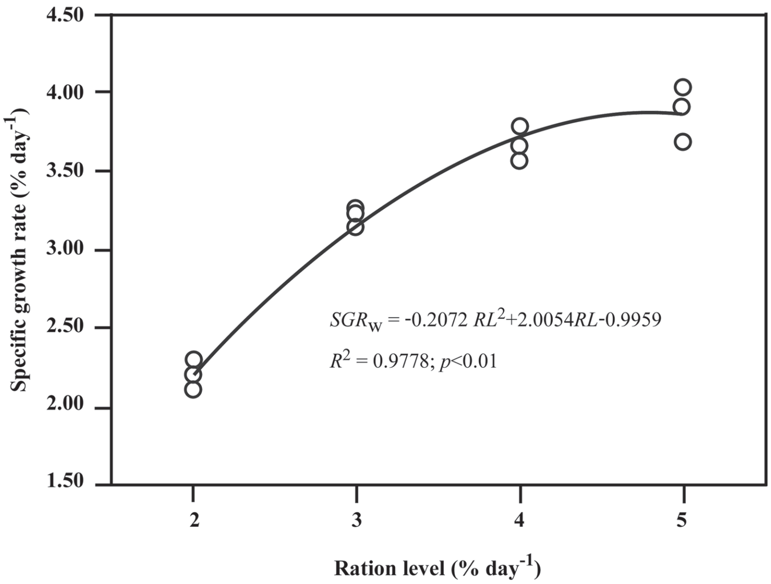

Figure 1. Relationship between specific growth rate in wet weight (*SGRw*) and ration level (*RL*) for *Hemibagrus nemurus* (initial weight 1.83g) fed a commercial diet containing 40% proteinand 3% lipid twice daily for 8 weeks.

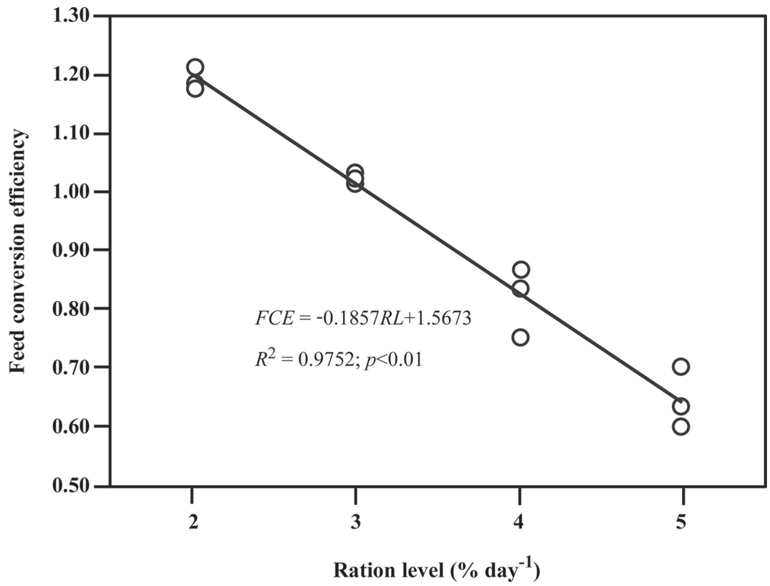

Figure 2. Relationship between feed conversion efficiency (*FCE*) and ration level (*RL*) for *Hemibagrus nemurus* (initial weight 1.83g) fed a commercial diet containing 40% protein and 3% lipid twice daily for 8 weeks.

DISCUSSION

The water parameters (dissolved oxygen concentration, pH and temperature) during the experimental period were within the ranges recommended for aquaculture (Boyd & Tucker, 1992).

The significant differences in final weight and specific growth rate among the different fish groups at the end of the study period indicated that ration level had an effect on the growth of fish. The specific growth rate for fish fed during this period ranged from 2.17 to 3.87%/day and were similar to the observations reported for *Cyprinus carpio* by Desai & Singh (2009), whilst being higher than those for *Sparus aurata* (Eroldogan *et al*., 2006), *Oreochromis niloticus* (Xie *et al*., 1997) and *Pangasius bocourti* (Jiwyam, 2010). The fact that the relationship between the specific growth rates in wet weight (SGRw, percentage per day) and ration levels (RL, percentage per day) of the fish was an asymptotic curve and that the specific growth rates of fish receiving feed at rations of 4 and 5% of initial body weight were not significantly different, coupled with the previously mentioned knowledge that increases in growth tend towards maximum when the ration level approaches the satiation level (Xie *et al*., 1997), indicate that the ration level of 4% was close to the satiation level for juvenile *H. nemurus*. Meanwhile, feed conversion efficiency (FCE) decreased with increasing rations, similar to the study in Nile tilapia (Xie *et al*., 1997) and *Pangasius bocourti* (Jiwyam, 2010), in which feed conversion efficiency decreased with increasing rations. This was also reported in the study of juvenile cobia (about 10g), for which feed conversion efficiency in wet weight peaked at the 9%/day ration, and then decreased at the ad libitum ration, 12.87 %/day (Sun *et al*., 2006). In the present study, the lowest feed conversion efficiency in wet weight was achieved in fish receiving the 5% ration level. The results of this present study indicate that an optimum feed conversion efficiency can be achieved at the lower 2% ration and that it decreases with increased feeding rations, similar to the observations reported in *C. carpio* (Desai & Singh 2009), *Ctenopharyngodon idella* (Zhen-Yu *et al*., 2006) and *H. nemurus* (Ng *et al*., 2000). However, the highest growth was not achieved at this ration. When the feed conversion efficiencies between 4 and 5% rations were compared, the fish receiving the 4% ration level showed a higher feed conversion efficiency than those receiving 5% ration level ($p<0.05$), although feed conversion efficiency was significantly higher in fish fed 5% ration ($p<0.05$). On the other hand, the fish receiving 5% ration level tended to have a higher specific growth rate than those of 4% even if it was not significantly different. Second order polynomial regression analysis (Fig. 1) predicted that maximum SGRw response point (Y max; 3.86) occurred at 4.84% ration level (Xmax). This indicated that the maximum ration level of *H. nemurusis* approximately 5%,which is similar to a study of Nile tilapia which also had a decelerating growth–ration pattern and a feed conversion efficiency that were not maximized at the same ration level (Xie *et al*., 1997). The results indicated that the 4% ration level is a sub-maximum level, due to the fact that for the fish which have a decelerating growth–ration pattern, the feed efficiency will decline at the maximum ration level (Xie *et al*., 1997). In this case, the optimum feeding strategy would be to feed thefish at an intermediate, not maximum, ration level to obtain both rapid growth and high feed conversion efficiency (Sun *et al*., 2006). The lack of difference in the condition factor between fish fed 4 and 5% ration levels suggested that the fish were adequately fed at 4% ration level. Therefore, a sub-maximum ration of 4%/day is proposed as the optimum ration level at this growth stage of the fish fed a commercial pellet feed containing 40% crude protein and 3% crude lipid.

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