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The Effect of Mixed Feeding Schedules of Varying Dietary Protein Content on the Growth Performance of *Channa striata* Fry

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Abstract

A feeding trial was carried out over 7 weeks to determine the effect of mixed feeding schedules on the growth performance of *Channa striata* fry (initial weight 0.58-0.95 g). The fry were fed three control diets of low (30%; A), intermediate (35%; B) and high (40%; C) protein levels and three mixed feeding schedules of 1 day of low followed by 1 day of high protein diet (1A/1C), 1 day of low and 2 days of high protein diet (1A/2C) and 2 days of low followed by 2 days of high protein diet (2A/2C). The highest specific growth rate was obtained for fry maintained on Diet B with the mixed feeding schedule of 1A/1C ranking third after Diet A. The feed conversion ratio, protein efficiency ratio and protein retention values were better for fry fed control diets only, but among the mixed feeding schedules, schedule 1A/2C performed best. The overall ranking was highest for Diet B with the mixed feeding schedule of 1A/2C ranking third. A 13.9% protein saving relative to Diet B was obtained for feeding schedule 1A/2C.

Introduction

The snakehead (*Channa striata*) is a popular freshwater fish in Malaysia and is consumed particularly as a traditional medicine for post operational healing purposes (Mohsin and Ambak 1983). The snakehead is carnivorous and therefore requires relatively high protein levels (40-50%) in its diets for optimal growth. In practical diets, the protein component is often provided by fishmeal. A general problem associated with the culture of carnivorous fish is the high feed costs and this has been addressed by studies on the use of cheaper ingredients as protein sources (Shiau et al. 1987; De Silva et al. 1988).

Another approach to reduce feed costs is to develop appropriate feeding management strategies and other improvements in husbandry (Singh and Srivastava 1984, 1985). The significance of feed utilization in relation to digestive processes in some fish has been highlighted recently. De Silva and Perera (1983, 1984) reported a daily variation in protein digestibility in *Etroplus suratensis* and *Sarotherodon niloticus*, which led to the strategy of mixed feeding schedules for

better protein utilization of feeds (De Silva 1985). Furthermore, information on the different responses of digestive enzyme activity to feeds in *Anguilla japonica* (Takii et al. 1985), *Cyprinus carpio* (Onishi et al. 1976) and *Clarias gariepinus* (Uys et al. 1987) have improved the feeding strategies of these cultured species.

The applicability of the mixed feeding schedule to carnivorous fish has not been investigated. This paper presents the results of a preliminary study on the response of snakehead fry to a mixed feeding schedule that alternates the presentation of high and low protein diets.

Materials and Methods

C. striata fry were collected from a nearby ricefield and acclimated to laboratory conditions until ready for use. The initial weight range of fry was 0.58-0.95 g. The experiment was carried out in fiberglass tanks, 90-cm diameter and height 75 cm, with a stocking density of 20 fry per tank. The fry were further acclimated to conditions in the fiberglass tanks for an additional week and were maintained on trash fish. Each experimental tank was supplied with a flow through water system of 1.5 $l \cdot min^{-1}$, continuous aeration and a 12 hour:12 hour light dark photoperiod. The water quality throughout the experiment did not vary significantly among the tanks and was as follows: pH 7.3-7.5; temperature 28.4-29.2°C and DO 6.00-6.50 $mg \cdot l^{-1}$.

Three practical diets containing 30% (low), 35% (intermediate) and 40% (high) protein levels were used. Although the intermediate protein diet (35%) was not used in the mixed feeding schedule, this diet was used in this trial to compare its effect on growth of the fry with the mixed feeding schedules. The moisture content of the diets, which were determined using an AND Infrared Moisture Determination Balance, and the proximate analyses of the diets were carried out according to Lovell (1981) and are shown in Table 1. The feeding schedules used for each experimental group is summarized in Table 2. All experiments were carried out in duplicate. The fry were fed three times daily at 0800, 1300 and 1800 hours to satiation.

The fish were weighed individually biweekly in water to monitor weight gain. At the end of the feeding trial, the tanks were drained and all fish were weighed individually and survival determined. The fish muscle were also sampled for carcass analysis. The data were analyzed using ANOVA and Duncan's Multiple Range test to determine differences in means.

Results

The biweekly weight of *C. striata* fry over 7 weeks and growth response are shown in Fig. 1 and Table 3, respectively. Generally, best performance was observed when fry were maintained on feeding schedules with constant protein content. The highest specific growth rate was observed for fry maintained on Diet B (35% protein) followed by fry fed Diet A and feeding schedule 1A/1C. However, the differences in specific growth rate for all the treatments were not

Table 1. Composition and proximate analysis of experimental diets ($g \cdot 100\ g^{-1}$).

Ingredients (g)	Diet A	B	C
Fishmeal	46.94	49.24	52.13
Soybean meal	27.85	32.87	31.81
CLO	3.06	4.05	2.08
Ulva	5.00	5.00	5.00
Flour	5.00	5.00	5.00
Vit/min mix[1]	2.00	2.00	2.00
Cellulose	10.15	1.84	1.98
Proximate analysis (% dry weight)			
Protein	33.54	35.04	46.70
Lipid	11.72	8.66	11.47
Ash	19.08	16.75	16.94
Fiber	16.51	17.42	14.31
NFE[2]	19.15	22.13	10.58
Gross energy ($kcal \cdot 100\ g^{-1}$)[3]	378.77	370.55	415.63

[1]Wee (1986)
[2]NFE = 100 - (Protein + Lipid + Ash + Fiber)
[3]Calculated on an estimated 5.65 $kcal \cdot g^{-1}$ protein, 9.45 $kcal \cdot g^{-1}$ lipid, 4.10 $kcal \cdot g^{-1}$ carbohydrate.

Table 2. Feeding schedule used during the feed trial.

Feeding schedule	Remarks
Diet A (30% protein)	Control
Diet B (35% protein)	Control
Diet C (40% protein)	Control
1A/1C	Alternate days of Diets A and C
1A/2C	1 day of A followed by 2 consecutive days of C
2A/2C	Alternate every 2 consecutive days of Diets A and C.

Table 3. Growth performance of *Channa striata* maintained on varying feeding schedules after 7 weeks.

Feeding schedule	A	B	C	1A/1C	1A/2C	2A/2C
Initial weight (g)	0.69^{b}	0.97^{c}	0.90^{c}	0.58^{a}	0.89^{c}	0.68^{b}
Final weight (g)	4.26^{a}	6.82^{c}	4.52^{b}	3.55^{a}	5.18^{b}	3.78^{a}
Weight gain (g)	3.57^{a}	5.84^{c}	3.61^{a}	2.97^{a}	4.28^{b}	3.10^{a}
Food taken (g)	8.80^{a}	10.25^{a}	9.10^{a}	9.80^{a}	8.68^{a}	9.25^{a}
Specific growth (%)[1]	3.72^{a}	3.95^{a}	3.26^{a}	3.72^{a}	3.58^{a}	3.52^{a}
FCR[2]	2.05^{b}	1.80^{a}	2.67^{b}	3.41^{c}	2.05^{b}	2.99^{b}
PER[3]	1.24^{b}	1.62^{c}	1.01^{c}	0.82^{a}	1.41^{b}	0.95^{a}
Protein retention[4]	8.53^{b}	11.59^{c}	7.15^{ab}	5.72^{a}	9.85^{bc}	6.56^{a}
Survival (%)	77.5^{b}	62.5^{a}	65.0^{b}	55.0^{a}	65.0^{b}	50.0^{a}

Mean values within a row with the same superscript are not significantly different.
[1](ln final weight - ln initial weight)/49 days x 100
[2]Dry food given/wet weight gain of fish
[3]Wet weight gain of fish/dry weight of protein given
[4](Final total weight of carcass protein - initial total carcass protein)/total dry weight of protein fed

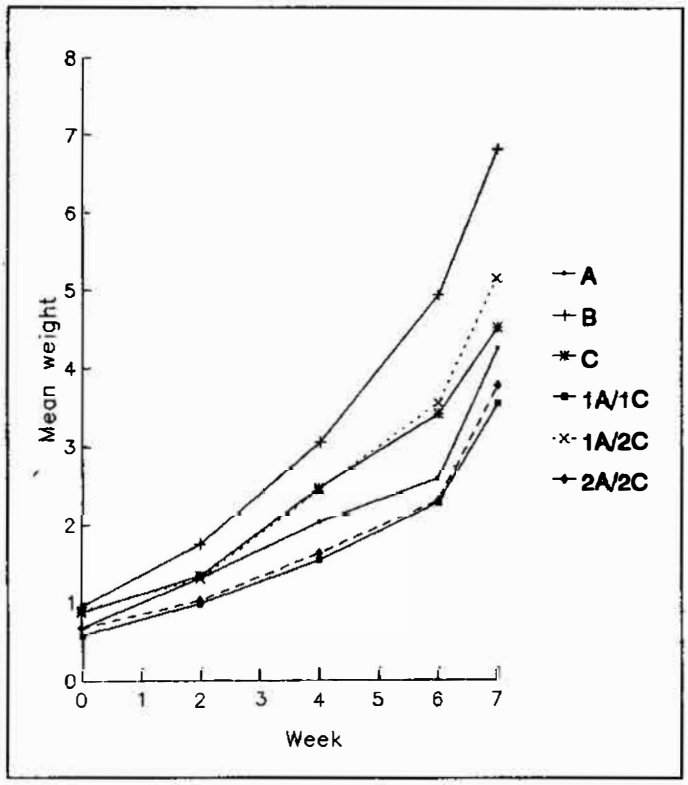

Fig. 1. Biweekly weight of *Channa striata* fry maintained on varying feeding schedules.

significantly different at $P<0.05$. A similar trend was observed for the feed conversion ratio (FCR), protein efficiency ratio (PER) and protein retention values. In terms of feed utilization, a comparison among the mixed feeding schedules showed that those fed the 1A/2C schedule resulted in better FCR, PER and protein retention values.

Fig. 2. shows the frequency of weight distribution of the fry at the end of the feeding trial. The weight distribution frequency was mainly 5-6 g for fry fed wholly Diets B and C, and 5-8 g for those maintained on the 1A/2C schedule.

No significant differences in carcass composition among the feeding schedules were observed. Carcass analysis of the fry (Table 4) showed highest protein content in fry maintained on Diet B alone followed by those maintained on the 1A/2C feeding schedule. However, fat deposition was significantly highest ($P<0.05$) for schedule 1A/2C with no significant differences observed in the ash content.

The rank order for the different growth parameters for each feeding schedule is presented in Table 5. A maximum score of 6 was awarded for best performance in each growth parameter. The total score for each feeding schedule is shown in Table 6; the highest total score of 24 was obtained for feeding schedule B. A 13.9% protein savings relative to Diet B was obtained for fry maintained on the 1A/2C feeding schedule (Table 7).

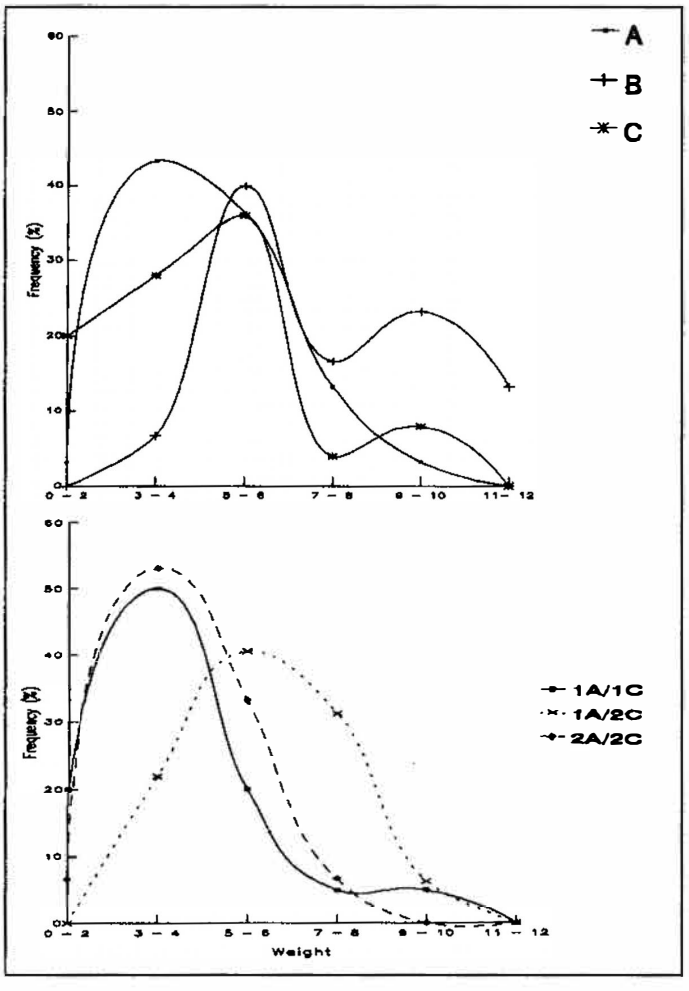

Fig. 2. Frequency of final weight distribution of Group I *Channa striata* fry fed varying feeding schedules after 7 weeks.

Table 4. Carcass composition of *Channa striata* fry maintained under varying feeding schedules after 7 weeks.

	Initial	A	B	C	1A/1C	1A/2C	2A/2C
Moisture	85.76[a]	79.06[a]	83.79[a]	79.31[a]	82.11[a]	78.92[a]	79.54[a]
Protein	68.23[a]	68.90[a]	71.00[a]	70.24[a]	69.64[a]	69.67[a]	68.98[a]
Lipid	7.51[ab]	6.38[a]	9.50[b]	6.34[a]	7.88[ab]	8.18[b]	5.86[a]
Ash	9.33[a]	9.30[a]	9.15[a]	9.92[a]	8.29[a]	7.70[a]	8.00[a]

Table 5. Ranking for each dietary feeding schedule based on growth performance of *Channa striata* fry.

Rank order	% gain day^{-1}	FCR	PER	Protein retention
1	B	B	B	B
2	A 1A/1C	A 1A/2C	1A/2C	1A/2C
3	-	-	A	A
4	1A/2C	C	C	C
5	2A/2C	2A/2C	2A/2C	2A/2C
6	C	1A/1C	1A/1C	1A/1C

Table 6. The total score obtained for each feeding schedule for *Channa striata* fry. The maximum possible score for a feeding schedule is 24.

Feeding schedule	Group I
A	18
B	24
C	10
1A/1C	12
1A/2C	15
2A/2C	6

Discussion

Channa spp. is known to require high protein levels for optimal growth. *C. striata* juveniles are reported to require 45.8% protein (Wee 1986) whereas *C. micropeltes* can utilize as high as 60% protein (Wee 1982). Since the culture of fish requiring high protein levels tends to be costly leading to increased production costs, the introduction of cost-effective feeding strategies is deemed necessary. De Silva and Perera have shown that the Asian cichlid, *Etroplus suratensis* (1983), and *Tilapia nilotica* (1985) exhibit daily variations in protein digestibility, although this is not well-defined. Based on these findings, De Silva (1985) then suggested alternating the presentation of a high protein diet with one of low protein as a possible solution to reducing feed and production costs.

In this experiment, best growth performance was observed only in fry (mean initial weight < 1 g) maintained on a diet containing 35.04% protein (Diet B). Alternating protein levels did not appear to improve any of the growth parameters monitored as evident by the maximum score of 24 points obtained for Diet B (Table 6) compared with the score of 15 for the mixed feeding schedule of 1A/2C which ranked third. A study by De Silva (1985) showed that growth performance of two different sizes of *O. niloticus* was affected by its feeding schedule with the best performance obtained when fry were fed 2 days on a low protein diet alternated with 3 days of high protein diet. In common carp, for example, Srikanth et al. (1989) found that a feeding schedule of 1 day low protein followed by 3 days high protein resulted in growth similar to the high protein diet. However, a comparison between these studies on the suitability of a particular mixed feeding schedule over another is not possible due to the different quality of the diets and the experimental conditions.

Table 7. Protein saving for the mixed feeding schedule, 1A/2C relative to Diet B for a culture period of 7 weeks.

		Schedule	
		B	1A/2C
No. of days of presentation	A	-	17
	B	49	-
	C	-	32
Amount of fishmeal (g)[1]		5.05	4.35
Protein saving over 7 weeks (% of Diet B)		13.9	

[1]Protein content in fishmeal = 49.7%.

From the above study, the responses to the different feeding schedules may be due to differences in the development stage of the snakehead's digestive system. Although it appears that fry of less than 1 g do not respond as well to a mixed feeding schedule compared with the 35% protein diet, the lack of significant differences in specific growth rate and the relative 13.9% protein saving obtained for the 1A/2C feeding schedule suggests that this feeding schedule may still be used to reduce feed costs.

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