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Effect of Feeding Frequency and Feeding Rate on the Growth and Feed Efficiency of Milkfish, *Chanos chanos* Forsskal, Juveniles

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Abstract

The effect of feeding frequency on the growth and feed efficiency of milkfish was investigated at two feeding rates (5% and 9% of body weight) in a 2 x 2 factorial experiment. The study was conducted in sixteen conical fiberglass tanks provided with aerated recirculating water, with four replicate tanks for each treatment. Fish averaging 0.60 g, were fed either four times over a period of six hours or eight times over a period of 14 hours using practical diets for six weeks. The percentage weight gain ranged from 57% to 167%. Regardless of feeding rate, increasing feeding frequency from four to eight times a day significantly increased ($P \leq 0.05$) growth and feed efficiency by about 20%. The results suggest that more frequent feeding over a wider spread of time would be a more efficient strategy for feeding milkfish in ponds.

Introduction

As the culture of milkfish (*Chanos chanos* Forsskal) becomes more intensive, strategies for supplementary feeding will have to be assessed to reap maximum economic returns. Feeding frequency is one important consideration as it can affect growth and the efficiency of feed utilization. Feeding at the optimum frequency can result in tremendous savings in feeding costs. Different species of fish have been shown to have different optimum feeding frequencies (Shelbourn et al. 1973; Andrews and Page 1975; Chua and Teng 1978; Charles et al. 1984; De Silva et al. 1986).

Chiu et al. (1986) have shown that providing supplementary feeds in the early morning and late afternoon can result in a shift of the feeding pattern from a sharp noon peak to a lower peak of longer duration in milkfish, provided dissolved oxygen is adequate. This study was conducted to determine whether the sharp noon peak or a broader but lower peak is a more efficient strategy of feeding milkfish. The different feeding duration was simulated by feeding four or eight times a day with an interval of two hours between each feeding. The study was conducted at two feeding rates to determine whether this parameter would affect the result.

Materials and Methods

The experiment was conducted in 90-l conical fiberglass tanks supplied with aerated water which was recirculated after passing through a settling tank and a sand filter. Water flowed at 1.8 l min^{-1}. Temperature and salinity ranges were 26.8-29.0°C and 30-43 ppt, respectively. Milkfish fry were reared to fingerling size in brackishwater ponds, allowed to acclimate for a week and reared for six weeks in the tanks. The fish were fed practical diets (Table 1).

Table 1. Composition of experimental diets for milkfish.

Ingredient	Proportion (%)
Fishmeal	25
Shrimphead meal	22
Soybean meal	20
Rice bran	16
Wheat flour	6.6
Cod liver oil	3
Vegetable oil	3
Mineral/Vitamin Mix[1]	4
Ascorbic acid	0.2
$AlK(SO_4)_2.12H_2O$	0.002
$CoCl_2.6H_2O$	0.002
$NaSeO_3$	0.0012
Inositol	0.2

[1]Robichem (Robichem Lab., Pasig, Metro Manila). This premix supplied the following in g/100 g premix: Vitamins - Vit. A, 0.6333; Vit. D_3, 0.1; Vit. E, 0.5333; Vit. B_1, 0.0267; Vit. B_2, 0.1067; Vit. B_6, 0.0267; Vit. B_{12}, 0.0005; Vit. K_3, 0.04; Ca-D-Pantothenate, 0.2167; Niacin, 0.5267; Choline chloride, 8.3333; Amino Acid - DL Methionine, 1.3333; Minerals - Mn, 1.3333; Fe, 0.5333. Cu, 0.0833; Zn, 0.4; I, 0.0083; BHT, 0.4; Zinc Bacitracin, 0.1333; Furazolidone, 0.6667, 3-Nitro 100, 1.2000.

Fish were weighed every two weeks and feeding rates were adjusted after every sampling.

To simulate and evaluate the long and short feeding duration for milkfish reared in ponds, juveniles averaging 0.60 g were either fed four times over a period of six hours (1000, 1200, 1400 and 1600 hours) or eight times over a period of fourteen hours (0600, 0800, 1000, 1200, 1400, 1600, 1800, and 2000 hours). Two feeding rates (5% and 9% of body weight) were used in a 2 x 2 factorial experiment using four replicate tanks with 45 fish per tank for each treatment.

Data on growth, survival and feed efficiency were analyzed through a microcomputer using the analysis of variance of the multivariate general linear hypothesis (MGLH) module of the System for Statistics (Systat., Inc. Il. USA).

Results and Discussion

Feeding eight times a day instead of four reduces the ration for each feeding period by half. Growth and efficiency of feed utilization significantly decreased ($P \leq 0.05$) by about 20% with the lower feeding frequency when fish were fed at both 5% and 9% of the body weight. Increasing feeding rate from 5% to 9% of body weight significantly ($P \leq 0.01$) increased growth by about 130%. It resulted in a small and insignificant ($P > 0.05$) decrease in feed efficiency (Table 2). No interaction effect ($P > 0.05$) between feeding rate and frequency was observed. In all cases the food was consumed within five minutes after feeding. Survival averages ranged from 84.0 to 97.2% and did not vary among treatments ($P > 0.05$).

Teshima et al. (1984) showed that milkfish fingerlings, fed various artificial diets, grew significantly faster when fed twice each day than when fed once each day, although rate of feeding and type of

Table 2. Response of milkfish juveniles to feeding at different rates and frequency.

Treatment no.	Feeding rate (% of body weight)	Feeding frequency (times/day)	Average wt. gain[1] (g)	Feed efficiency[1] (gain/feed x 100)	Survival[1] (%)
1	5	8	0.44 ± 0.03^{b}	30.5 ± 1.8^{b}	94.4 ± 2.3^{a}
2	5	4	0.34 ± 0.02^{a}	25.2 ± 1.6^{a}	95.0 ± 3.7^{a}
3	9	8	1.00 ± 0.04^{d}	27.2 ± 1.5^{b}	84.0 ± 5.2^{a}
4	9	4	0.81 ± 0.03^{c}	24.7 ± 0.9^{a}	97.2 ± 0.5^{a}

[1]Values represent the means ± SEM in each treatment. Means with the same supercript are not significantly different ($P > 0.05$).

diet were more important factors affecting fingerling growth. The present results also show that feeding rate was the more important variable in determining weight gain.

In the brackishwater pond environment, when natural food is abundant, the feeding pattern would be short and comparable to feeding four times a day over six hours in this study (Chiu et al. 1986). The feeding peak coincides with the peak photosynthetic activity, temperature and dissolved oxygen levels in the pond (Chiu and Benitez 1981; Chiu et al. 1986). This study indicates poorer growth and efficiency of feed use with this feeding pattern compared to feeding the same quantity over a long duration. Weight gain increased by about 20%, and the absolute gain in weight increased at higher feeding rates, when milkfish were fed over a longer duration ($P > 0.05$).

Shelbourn et al. (1973) observed faster growth when young salmon were fed continuously for 15 hours per day compared to feeding to satiation thrice daily. In contrast, growth and feed efficiency in channel catfish was highest when they were fed twice a day (Andrews and Page 1975) and in common carp when fed three times a day (Charles et al. 1984) compared to more feeding when fish were fed *ad libitum*. In the estuarine grouper, Chua and Teng (1978) observed that feeding once every two days resulted in optimum growth while weight gains were substantially reduced in groups fed to satiation with one feeding every 5, 4 or 3 days and were not enhanced when the feeding frequencies were increased to two and three feedings daily.

Milkfish exhibit continuous browsing when feeding and its gut morphology is characterized by the absence of dentition, presence of fine gill rakers, and long intestine (Juliano 1985). Continuous or more frequent feeding observed in milkfish appears to be more efficient and results in a relatively full gut when next feeding commences. This condition contrasts with the observation of Chua and Teng (1978), who found 48-hour feeding intervals with food deprivation time of about 36 hours to be optimum for grouper.

The differences in growth and feed efficiency when different species of fish are fed at varying frequencies underscore the importance of considering different feeding schemes for the various fish cultured so that feed costs can be minimized. The rate of feeding and size of fish need to be considered because optimum feeding frequency may differ with these parameters as observed by De Silva et al. (1986) in *Oreochromis niloticus*.

Chiu et al. (1986) observed that the duration of feeding of milkfish can be prolonged by providing artificial feeds early morning and late afternoon, and that natural food is preferred during the day when photosynthetic activity peaks. The present study suggests that in practice, when supplementary feed is provided for milkfish in brackishwater ponds that have some amount of natural food, feeding early morning and late afternoon to prolong feeding activity would improve growth and feed efficiency.

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