Survey on the use of natural food and supplemental feed in commercial milkfish farms on Panay, Philippines

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Abstract

This study evaluated the feed intake of the milkfish (*Chanos chanos* Forsskål) in commercial brackishwater ponds under different management regimes. Feed intake and growth were compared between a rather intensive culture management in a fish farm of 1 ha pond size and a semi-intensive one, with a total pond area of 30 ha. The data suggested a direct consumption of only 12 % of the supplemental feed in the intensive farm, leading to a wastage of high quality fish feed and a significantly lower specific and metabolic growth rate ($P < 0.001$) than in the semi-intensive system without any supplementation and only relying on abundant natural food through fertilization. These results suggest that a heavy reduction in, or even the abandonment of the use of, supplemental feed for milkfish culture would be more cost-effective.

Keywords: milkfish (Chanos chanos), semi-intensive aquaculture, commercial fish ponds, feed intake

Introduction

The milkfish (*Chanos chanos* Forsskål) is the most important cultured fish species in the Philippines. It makes up over 60 % of the total aquaculture production (excluding seaweeds) of the country. In 1998, more than 156,000 t were produced here (Bagarinao, 2000), over 91 % of this in brackishwater ponds. A significant part of this production is achieved semi-intensively in commercial fish farms of 1-30 ha total pond area. These are usually located in the tidal area of rivers and streams or in former mangrove swamps. Milkfish are produced throughout the year during both the wet and dry seasons, so that 2-3 harvests are possible.

A culturing system is defined as semi-intensive if the growth of natural food from the pond is enhanced by fertilization and/or supplemental feed is given. Researchers from the Philippines (Sumagaysay, 1995) suggest daily rates of supplemental feeding of up to 4 % BME (body mass equivalent). However, investigations on the intake of supplemental feed and natural food by milkfish in experimental ponds (Kühlmann, 1998) showed that only a part of the supplemental feed was taken in directly by the fish. A previous study in a commercial milkfish farm on Panay Island, Philippines (Lückstädt et al., 1998) suggested, that this incomplete intake of supplemental feed takes place in commercial milkfish culture as well.

The present study was aimed at finding out the utilization of natural food and supplemental feed in commercial milkfish ponds using different management systems. Feed intake was also estimated using a mathematical model.

Materials and methods

Several pond monitorings were conducted on Panay Island, Philippines in two commercial milkfish farms using different culture methods, between October 1996 and August 1998. The individual size of the ponds ranged between 1.0 ha and 9.0 ha. Pond depth varied from 0.3 m to 0.7 m.

Intensive production system

The earthen pond in Dumangas (1.0 ha pond area) was supplied and drained by a small primary creek running straight into the sea around 300 m away. Pond water was changed every spring tide. Additional water supply was possible through a diesel powered water pump. A pond depth of 0.7 m was maintained during the whole culture period. No manure, fertilizer or agricultural lime was applied to the pond before the pond bottom was flooded. Milkfish juveniles, caught in the wild, were stocked on July 4th, 1996 at a density of 4,000 ha^{-1}. The average initial stocking weight was 120 g. For the first 48 days, only natural food ("*lumot*" - local term for filamentous green algae) made up the diet of the fish. After that, the fish were fed three times a day at 9:00 am, 1:00 pm and 5:00 pm at an increasing rate. During the monitorings, the feeding level was maintained at 3.75 % BME. Fish were harvested on October 23rd, 1996 after 112 days of culture.

Following a preliminary monitoring on October 1st, samples of up to 5 fishes were caught with a cast net at 5-hour intervals over a period of 5 days during the main sampling one week later, thus covering all hours of the day. This sampling regime minimized the disturbance to the fish in the pond. Only 82 fish were caught overall, since 5 fish could not be caught during some night hours. After collection, fish were measured, weighed and the stomach removed and preserved.

The different growth parameters of fish, like condition factor (Richter et al., 2000), weight gain, specific growth rate SGR (Steffens, 1985), as well as metabolic growth rate MGR (Kühlmann, 1998) were calculated.

Semi-intensive production system

The fish farm in Banate used a method involving the regular transfer of fish (every 8 weeks) to larger ponds with a well-developed natural food supply, as well as the stocking of fish of different sizes (15, 30 and 45 g). The total pond area of the farm was 30 ha, while the ponds ranged between 1.0 and 9.0 ha. The mean pond depth was 0.3 m. All ponds were drained and flooded by the tide, requiring no additional pumping. Fertilizer was used prior to stocking the fish to enhance the growth of natural food. About 2,000 kg ha^{-1} chicken manure and 2,000 kg ha^{-1} pig manure were applied per production cycle (two cycles per year). This was followed by an application of 1,000 kg ha^{-1} rice bran. No agricultural lime was used during pond preparation. Supplemental feed was not given to the fish. During the monitorings, the stocking density varied between 2,300 ha^{-1} and 2,500 ha^{-1} due to partial harvests. Fish were stocked on April 15th 1998. Ponds were monitored regularly every 6 weeks. The culture period was terminated after 107 days at the end of July.

Catching and handling the fish followed the same procedure as described above. This time only 3 fishes were caught every other hour, so each monitoring run was finished after 48 hours, covering all hours of the day. Since three fish were again not available every hour, the total number of fish collceted sometimes fell short of the desired figure of 72.

Water parameters like temperature, oxygen and salinity were measured regularly at the same time as the fish were sampled. Temperature ranged from 27°C to 35°C in Dumangas and from 28°C to 40°C in Banate. Salinity was stable at 20 ppt and at 65 ppt in Dumangas and Banate respectively. Oxygen fluctuated in both farms over the daily cycle from < 1 mg/l to > 10 mg/l, with critical values recorded early in the morning. Additional water parameters (pH, nitrite and ammonia) were analysed at the Central Analytical Lab at SEAFDEC Main Station with the aid of bottled samples. They did not, at any time, reach critical values for the fish.

Calculation of daily ration

Stomach samples of fish from both sampling areas were preserved in 70 % ethanol. The daily feed intake was estimated by microscopic and gravimetric analyses of stomach contents followed by the mathematical modelling of the change in the level of stomach fullness over time (Elliott & Persson, 1978). For this analysis, the stomach contents were converted to percent body mass equivalent (% BME, dry matter basis) and then related to the metabolic body mass of the respective fish to get comparable results. For the Elliott-Persson model, knowledge of the rate of stomach evacuation is required. This rate was calculated from a preliminary experiment by non-linear regression with the aid of the fish feeding model MAXIMS (Jarre et al., 1991) and was applied to both data sets, the justification being that those factors mainly affecting this rate (fish size and pond water temperature) were comparable.

Statistical analysis

The data on fish condition, specific and metabolic growth rates and contribution of different food components towards total stomach content composition were tested for differences between the two management systems, using the t-test (STATISTICA, version 4.5, StatSoft Inc.). The significance of observed differences were tested at levels of $P < 0.001$, $P < 0.01$ and $P < 0.05$. Results are given as means ± S.D.

Results

During the monitored period (98 days) the milkfish increased their body weight 2.8 times in the intensive system in Dumangas (Table 1), while the increase in body weight in the semi-intensive system in Banate was 5.2 times within 78 days (Table 2).

Table 1: Growth of milkfish during a culture period in Dumangas, August-October 1996

Culture period [days]	Number of fish [n]	Body mass [g] ± S.D.	Condition ± S.D.$^{+}$
stocking (0)	-	120.0^{++}	n.d.$^{+++}$
89	5	316.1 ± 31.8	21.0 ± 1.1
98	82	334.7 ± 81.9	20.6 ± 1.1

$^{+}$ Condition factor calculated as (100 * mass) / (total length * height^2)
$^{++}$ stocking information from the pond owner
$^{+++}$ not determined

Table 2: Growth of milkfish during a culture period in Banate, March-June 1998

Culture period [days]	Number of fish [n]	Body mass [g] ± S.D.	Condition ± S.D.
stocking (0)	72	44.5 ± 27.4	20.0 ± 1.9
78	50	232.8 ± 88.0	19.8 ± 1.0

Over the whole culture cycle, milkfish reached in Dumangas a weight gain of 214.7 g, however during the monitored culture period in Banate a weight gain of 188.3 g was recorded. In both management systems a slight decrease in fish condition was observed, but at the end of the culture period fish in Dumangas had significantly higher condition factors than the fish in Banate ($P < 0.001$).

Table 3: Growth parameters for both culture systems

	Dumangas (intensive)	Banate (semi-intensive)
Condition factor	$20.6^a \pm 1.1$	$19.8^b \pm 1.1$
weight gain [g]	214.7	188.3
growth rate [g/d]	2.2	2.4
SGR*	$1.04^b \pm 0.15$	$2.04^a \pm 0.39$
MGR**	$7.26^b \pm 1.09$	$11.76^a \pm 2.25$

* Specific growth rate (%) calculated as (ln final mass - ln initial mass) / days of culture * 100
** Metabolic growth rate (g $kg^{-0.8}$ d^{-1}) calculated as:
(mass gain / [(initial $mass^{0.8}$ + final $mass^{0.8}$) / 2]) / days of culture
Values in each row with different small superscripts differ significantly ($P < 0.001$)

Specific growth rates were significantly higher ($P < 0.001$) in the semi-intensive production system in Banate (Table 3). Here, fish reached a growth rate of 2.4 g/d compared to 2.2 g/d in the intensive system in Dumangas. The metabolic growth rate also differed significantly ($P < 0.001$); again it was higher in Banate. A total of 132 fish were analysed for stomach content composition. 82 stomachs from Dumangas were examined, of which 71 had at least some contents. In Banate 50 stomach were analysed (36 with contents). The stomach content in the intensive system consisted mainly of supplemental feed (45%), detritus (35%) and *Diatoma* (11%). *Chlorophyta* (5%), crustacea (2%) and *Cyanophyta* (1%) and other categories (a mix of snails, eggs and parts of higher plants; 1%) were also found. On the other hand, detritus (48%) was the major part of the stomach content in the semi-intensive system. *Cyanophyta* (19%), other categories (17%) and *Diatoma* (11%) made up nearly half of the diet. *Chlorophyta* (3%) and crustacea (2%) were also found. When analysed on a % BME basis, only differences between algae and other categories were found to be significant ($P < 0.05$ and $P < 0.01$ respectively),(Table 4).

Table 4: Contribution of different food components in the stomach (dry matter) in % BME

	Dumangas (intensive)	Banate (semi-intensive)	Level of significance
Supplemental feed	0.0168 ± 0.0217	-	
Algae	0.0057 ± 0.0086	0.0123 ± 0.0099	*
Crustacea	0.0011 ± 0.0022	0.0009 ± 0.0017	
Diatoma	0.0045 ± 0.0052	0.0053 ± 0.0061	
Others	0.0002 ± 0.0003	0.0049 ± 0.0055	**
Detritus	0.0360 ± 0.0490	0.0240 ± 0.0160	

Values in each row with one star (*) differ significantly at $P < 0.05$
Values in each row with two stars (**) differ significantly at $P < 0.01$

Based on the supplementation rate of fish in Dumangas, the total diet intake should exceed 3.75 % BME. However, the results of the Elliott-Persson analysis showed that the calculated daily ration was only 1.02 % of fish body mass (equivalent to 8.19 g $kg^{-0.8}$ d^{-1}).

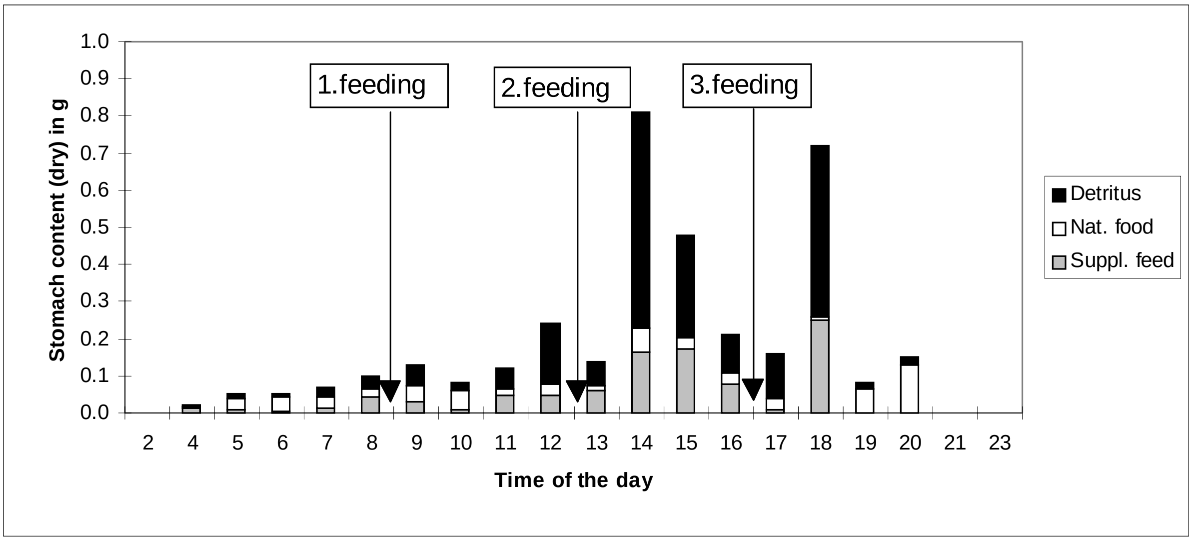

Figure 1: Diurnal stomach content distribution in milkfish, Dumangas, October 1996

Therefore, the Elliott-Persson analysis suggests that only 12 % of the feed given was taken in directly by the fish. Furthermore, feed intake peaked only between 11:00 am and 2:50 pm in the morning and between 4:40 pm and 6:00 pm in the evening, so almost no feed was consumed immediately following the first feeding (Fig. 1).

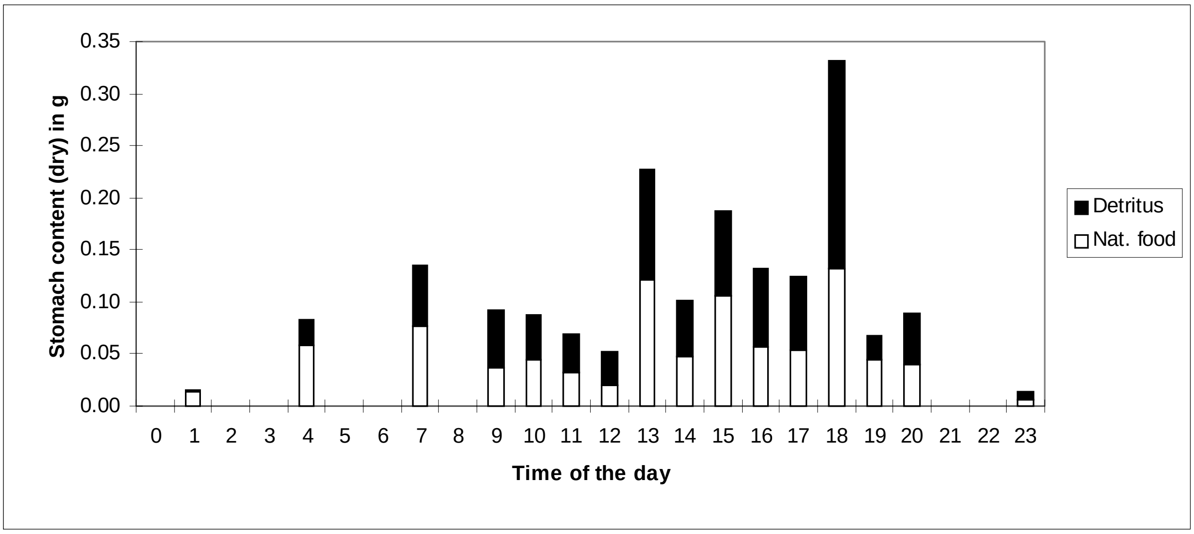

Figure 2: Diurnal stomach content distribution in milkfish, Banate, June 1998

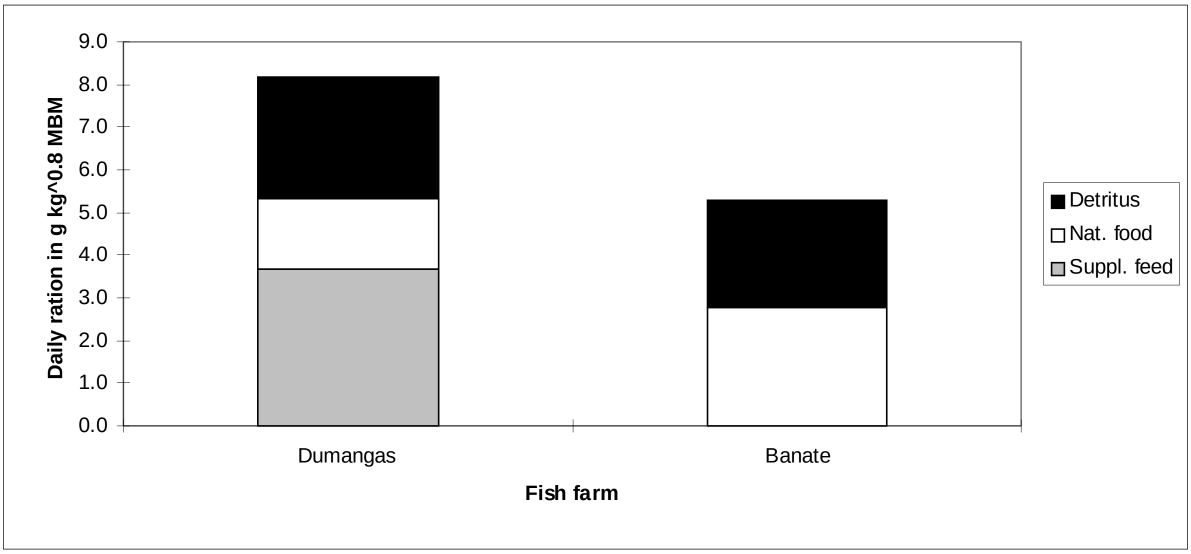

Figure 3: Calculated daily ration (Elliott-Persson) in Dumangas, 1996 and Banate, 1998

In Banate, natural food was mainly consumed during the day, with peaks at 1:00 pm and 6:00 pm (Fig. 2). The analysis with the Elliott-Persson model gave a daily ration of 0.71 % BME, equivalent to 5.31 g $kg^{-0.8}$ d^{-1} (Fig. 3).

Discussion

A positive effect of the semi-intensive management in milkfish culture was observed. Fish grew significantly faster in that type of system as compared to the intensive one. Sumagaysay (1995) described a semi-intensive feeding system in brackishwater ponds with a supplementation rate of 4%. Here, the SGR was determined to be 2.1 %. On the other hand, fish observed in the semi-intensive system in Banate reached an SGR of 2.04 %. This fast growth rate can be attributed to a well maintained natural food through fertilization. The milkfish already reached a marketable size after around 80 days, despite the harsh El Niño conditions as shown by the high salinity (65 ppt), while in the intensive system, feed utilization was poor. The direct intake of the feed given at 3.75 % BME was low (total diet intake 1.02 % BME) and reached only around 12 %. This utilization level is even lower than that determined by Kühlmann (1998) in small experimental ponds (30 %) at 3-4 % BME supplementation rates. This was confirmed by the presence of unused feed in the water column. Furthermore, the first feeding in the intensive system did not result in a higher feed consumption, probably due to low oxygen levels in the pond. Chiu et al. (1986) found that milkfish cease feeding at oxygen levels below 1.5 mg/l. These results strongly suggest the heavy reduction and optimization, or even the abandonment of the use of supplemental feed for milkfish culture, since comparable growth rates can be achieved without any pelleted diets. The unused supplemental feed can lower the economic costs of milkfish production and may be used to feed other animals instead. Finally, the complex interactions taking place in milkfish pond farming demand further investigations into alternative culture strategies which should take into account the low supplemental feed utilization observed in these systems.

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