Asian Fisheries Science 3(1990): 251-256.
Asian Fisheries Society, Manila, Philippines
https://doi.org/10.33997/j.afs.1990.3.2.007

Increasing Milkfish *(Chanos chanos)* Yields in Brackishwater Ponds through Increased Stocking Rates and Supplementary Feeding

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Abetract - Brackishwater milkfish culture in the Philippines is normally practiced at fish stocking rates of 2,000-3,000 ha^{-1} with fertilizers as the sole nutrient input. Supplementary feeding is not common. We stocked two 1-ha ponds with 6,000 fish and another two 1-ha ponds with 9,000 fish with an average weight of 2 g. The fish at each stocking rate were given diets with two different energy levels (2,950 and 3,265 $kcal^{-}kg$-1) at 3% body weight, on the second and third month of culture. An average of 0.69 and 1.04 t were produced at 6,000 and 9,000 ha^{-1}, respectively. Low temperature and dissolved oxygen levels appeared to limit the growth of milkfish masking the effect of dietary energy. The results suggest that supplementan- feeding can have a marked effect on milkfish yield when stocking rates are 6,000 ha^{-1} or above.

More than 90% of the total brackishwater pond area in the Philippines is used for milkfish *(Chanos chanos)* production. The yield of milkfish is limited by the food supply, which can be augmented by fertilization and/or addition of supplementary feed. Both organic and inorganic fertilizers are used but supplementary feeding is not common.

Fish yield is a function of growth rate and stocking density. The natural food produced through fertilization can normally support fish densities of 1,500-3,000 ha^{-1}. In order to maintain the potential growth rate for a stocking density beyond the critical standing crop for fertilizer inputs, supplementary feeding is necessary. However, an earlier study with fish stocked at 4,000$\cdot ha^{-1}$ suggested that supplementary feeding had no effect on yield (Otubusin and Lim 1985).

More intensive methods, by stocking as high as 25,000 fish$\cdot ha^{-1}$ using pelletized diets containing 24-29% protein, and provision of artificial aeration, have been successfully practiced in Taiwan. Farmers in the Philippines are hesitant to intensify culture practices because of the relatively low price of milkfish and high cost of production involved. It would require a demonstration of the economic benefit and packaging of a new technology suitable under the Philippine economic setting to convince farmers to stock at higher densities and provide supplemental feeds.

In this study, it was hypothesized that energy limits the yields of milkfish from brackishwater ponds, so that using cheap agricultural products as supplementary feeds will increase yields. The hypothesis was tested here using two diets that differ by more than 300 $kcal\cdot kg^{-1}$ with milkfish stocked at 6,000 and 9,000 ha^{-1}.

Four 1-ha earthen ponds at the University of the Philippines in the Visayas, Brackishwater Aquaculture Center in Leganes, Iloilo, were used in this study. The experiment tested the effect of two energy levels in supplementary diets (Table 1). The analysis of the ingredients and preparation of the pellets were done by Vitarich Corporation (Manila, Philippines).

Before stocking, natural food was grown by draining and drying the ponds and then applying 2 t of chicken manure, 0.5 t rice bran and 0.5 t agricultural lime. After flooding, N-P-K fertilizer (16-20-0) was applied at 12 $kg\cdot ha^{-1}\cdot week^{-1}$.

The fish (average weight 2 g) were stocked on 19 September and feeding commenced a month later. The pond water depth was gradually increased with increasing size of the fish and was maintained between 50 and 70 cm. Primary productivity and various water quality parameters were measured two weeks after stocking and two weeks prior to the termination of the experiment. Gross primary productivity was estimated using the seven-point dissolved oxygen (D.O.) method of Olah et al. (1978). Dissolved oxygen, temperature and salinity were measured biweekly at about 0600 and

Table 1. Composition and proximate analysis of experimental diets.

	Diet I (lower energy)	Diet II (higher energy)
Ingredients ($g \cdot 100\ g^{-1}$)		
Copra meal	35.0	35.0
Rice bran	15.0	30.0
Wheat pollard	22.5	-
Soybean meal	20.0	23.5
Fishmeal	5.0	5.0
Coconut oil	-	4.0
Tricalcium phosphate	2.0	2.0
Vitamin supplement	0.5	0.5
Nutrients (%)[a]		
Crude protein	25.0	24.7
Crude fiber	7.3	6.4
Crude fat	7.7	12.7
Ash	8.2	8.3
Nitrogen-free extract	51.8	47.9
Metabolize energy ($kcal \cdot kg^{-1}$)[b]	2,950	3,265
Gross energy ($kcal \cdot kg^{-1}$)[b]	4,264	4,560
Protein: Metabolizable Energy (%)	33.9	30.3

[a]Calculated values based on the proximate analysis of feed ingredients.
[b]Calculations were based on the following energy values: carbohydrate, 2.5 and 4.10; protein, 4.0 and 5.65; fat, 8.5 and 9.45 kcal/g, for metabolizable and gross energy, respectively.

1400 hours using a YSI model 57 D.O. meter and an Atago S/Mill refractometer, respectively. Total carbon dioxide, un-ionized ammonia and reactive nitrite were determined using methods described by Strickland and Parsons (1972).

Fish production did not appear to vary much with dietary treatment but was greatly increased when fish were stocked at a higher rate (Table 2). Ponds stocked at 6,000 fish yielded an average of 688 kg while those stocked at 9,000 fish yielded 1,042 kg. The final mean fish weight was between 125 and 143 g in all four ponds. The efficiency of feed conversion based on the growth of fish during the feeding period appeared to be poorer at the higher stocking density. Fig. 1 shows that the growth rate was not adversely affected by higher stocking density. The slowing of growth rate in the last month of culture appeared to be caused by the decreasing water temperature (Fig. 1). Also, D.O. levels of less than 1 ppm were observed

Table 2. Milkfish production in brackishwater ponds exposed to the different experimental treatments.

	Pond No.			
	D-3	D-4	D-5	D-6
Stocking rate (fish·ha^{-1})	6,000	6,000	9,000	9,000
Dietary treatment	lower energy	higher energy	lower energy	higher energy
Average final weight (g)	143	125	125	143
% Recovery	81	91	88	85
Total production (kg)	695	682	990	1,094
Feed consumed (kg)	784	784	1,156	1,160
Apparent feed conversion[a]	1.14	1.15	1.16	1.06
Actual feed conversion[a]	1.6	1.6	2.2	1.8

[a]Apparent feed conversion is based on the weight gained during the whole culture period while actual feed conversion is based on the weight gained since the feed was given.

occasionally in ponds D-4, D-5 and D-6 at the latter part of the culture period and fish kills of less than 50 fish would follow. Studies on different species of fish showed that diel fluctuations of dissolved oxygen with the low level below the critical concentration depress growth and that resulting reduction in growth is greater than when the fish are maintained at the mean dissolved oxygen level (Brett 1979).

Gross primary productivity decreased as biomass increased (14.7-23.2 to 5.2-12.0 mg $O_2 \cdot l^{-1} \cdot day^{-1}$). Ranges of total carbon dioxide (0.34-0.64 to 1.22-1.33 ppm) and reactive nitrite (1.0 to 22.6-39.6 ppb) increased as biomass increased. Water pH ranged from 7.09 to 8.9 and un-ionized ammonia was found to be rather low (0.1 to 16.0 ppb). Salinity ranged from 22 to 32 ppt during the experiment.

Otubusin and Lim (1985) did not observe any effect of supplementary feeding on milkfish yields in brackishwater ponds. They attributed this to the adequacy of natural food resulting from pond fertilization. However, their stocking rate was much lower, 4,000·ha^{-1} and their experiment was carried out in warmer months (March-May) when photosynthesis would be higher. Natural food could have been adequate at that stocking level and thus masked any effect of supplementary feeding.

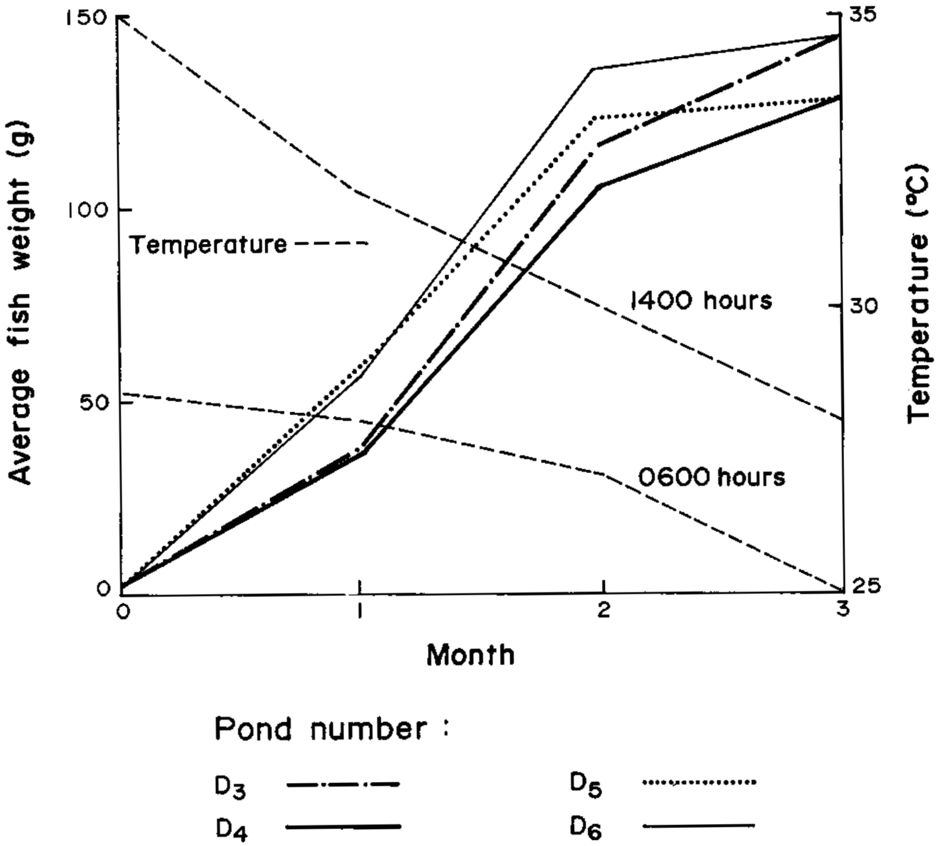

Fig. 1. Growth of milkfish in earthen ponds at two stocking densities and two levels of supplementary dietary energy. Solid lines are weight of fish in the four ponds D_3-D_6; broken lines represent water temperature. D_3 - 6,000 fish · ha^{-1}, lower energy; D_4 - 6,000 fish · ha^{-1}, higher energy; D_5 - 9,000 fish · ha^{-1}, lower energy; D_6 - 9,000 fish · ha^{-1}, higher energy.

The significant increase in production without any effect on growth rate in our experiment, when stocking rates were increased from 6,000 to 9,000 ha^{-1}, suggests the importance of food availability.

Our results although preliminary, seem to suggest that the dietary energy levels in supplementary feeds provided had no effect on milkfish production, with growth slowing down as a function of temperature towards the end of the experiment. Marquez (1987) demonstrated that the protein content of supplemental feed for milkfish that would result in maximum increase in profit is close to 27.4% with gross energy content of 3,959 kcal·kg^{-1}. The gross energy content of diets in the present study was higher (4,264-4,580 kcal

kg^{-1}). From the practical point of view, it may be possible to formulate a cheaper supplementary diet of low energy and produce the same yields. Milkfish growth is slowest during the cold months, December-February (Juliano 1985), and it appears that the best way to increase yields and profits is by increasing stocking rates and by providing supplementary feeds when natural food is limiting. Moreover, the effectiveness of supplementary feeding may be dependent on the season and studies should be conducted at different seasons. Further, it is evident that as culture intensity increases, provisions for pumping or aeration will be necessary to prevent critical oxygen levels.

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Manuscript received 1 June 1987; accepted 21 September 1989