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# Milkfish Production and Ecology of Brackishwater Ponds Treated with Organic Versus Inorganic Fertilizers in Cochin, India

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The paper deals with a comparative study of growth, survival and yield of milkfish as well as the ecological characteristics of two brackish water culture ponds (0.042 ha each), one treated with organic fertilizer (cowdung) and the other with inorganic fertilizers (superphosphate and urea). Milkfish, *Chanos chanos* of 6 g average weight were stocked at a rate of 4500 fingerlings $ha^{-1}$ in both the ponds. Remarkably better growth of fish (238 g), 86% of survival and gross and net productions of 852 and 825 kg $ha^{-1}$ respectively, were obtained after 120 days of culture from the pond treated with cowdung, than from the pond treated with inorganic fertilizers which showed a growth of only 63 g, survival of 82% and gross and net productions of 226 and 199 kg $ha^{-1}$, respectively during the same period. The operational economics of milk fish production from the ponds has been compared. The rate of return on operational costs works out to be 298% in the pond treated with cowdung and 3% in the pond treated with chemical fertilizers.

Although the milkfish, *Chanos chanos* is one of the most important commercially cultured brackishwater fishes in several South East Asian countries, its culture in India has not yet gained a commercial status. Milkfish seed resource have been already located throughout the coasts of peninsular India and there is obviously a great potential for its commercial culture in South India.

Experimental work on milkfish culture in India includes that of Tampi (1960), Nair *et al.* (1974), Dwivedi *et al.* (1980) Marichamy & Rajapakiam (1982), Mohanraj *et al.* (1982), Ramakrishna *et al.* (1982) Shanmugham & Bensam (1982), Mohan (1983a, b), Santhanam *et al.* (1983), James *et al.* (1984), Anon (1985) and Jose *et al.* (1987). An exhaustive bibliography and abstracts on milkfish including its culture has been compiled by the staff of the Brackishwater Aquaculture Information System (BRAIS, 1988), Iloilo, Philippines. Although ecology of brackishwater fields in India has been studied by Pillay (1954), Datta & Sarangi (1980) Bandyopadhyay & Datta (1987) and Nair *et al.* (1988), such studies in controlled brackishwater fish ponds are scanty.

Production and maintenance of natural feed organisms for milkfish in the culture ponds has been widely reported as one of the main factors contributing to the success of milkfish production. The present work aims at a comparative evaluation of the application of organic manure and chemical fertilizers of equivalent $P_2O_5$ and $N_2$ values, in order to enhance the availability of natural feed in the culture ponds, entailing in better milkfish production.

## Materials and Methods

Two uniformly sized brackishwater ponds connected to the Cochin backwaters, each having an area of 0.042 ha and an average water depth of 50 cm were used

for milkfish culture for 120 days. Prior to stocking, the ponds were dewatered to a level of 10 cm and treated with mahua oil cake at a rate of 250 kg $ha^{-1}$ in order to eradicate predatory and weed fishes. Thereafter, lime and bleaching powder were applied at a rate of 500 and 50 kg $ha^{-1}$, respectively for enhancing mineralisation and also for eliminating harmful invertebrates at the pond bottom. The ponds were filled with tidal water through a net screen. Pond A was treated with cowdung at a rate of 500 kg $ha^{-1}$ $week^{-1}$ and pond B with fortnightly application of superphosphate and urea at a rate of 11 and 10 kg $ha^{-1}$, respectively, equivalent to the $P_2O_5$ and $N_2$ values of the cowdung applied in pond A.

The details of milkfish stocking are summarised in Table 1. Supplementary feeding and water exchange were not done. Growth rate of the fishes was assessed fortnightly by carefully taking the total length and weight measurements of the live fishes and returning them to the ponds. Duplicate samples for physico-chemical and biological parameters were collected fortnightly. Primary production was measured by the light and dark bottle method (Strickland & Parsons, 1972). Samples for zooplankton analyses were collected by sieving 50 litres of the pond water through a conical plankton net made of bolting silk No. 25 (53 µm mesh size). The wet weight of copepods and nauplii was measured by the formula applied by Klekowski & Shushkina as detailed in Edmondson & Winberg (1971). The wet weight of rotifers was calculated on the basis of volume and specific gravity (1.0) measurements (Edmondson & Winberg, 1971). Their volume was determined using Andrassy's formula, $a^2b/1.7$, where 'a' is the maximum body diameter and 'b' the body length of rotifers (Andrassy, 1956).

Table 1. *Details of stocking, growth rate and harvesting of Chanos chanos*

| Particulars | Pond A (Treated with cowdung) | Pond B (Treated with super phosphate and urea) |
|---|---|---|
| Area of the ponds, ha | 0.042 | 0.042 |
| Stocking density, nos. $ha^{-1}$ | 4500 | 4500 |
| Fingerlings stocked in the ponds, nos. | 189 | 189 |
| Size at stocking, mm(g) | 86 (6) | 86 (6) |
| Date of stocking | August, 1986 | August 1986 |
| Daily growth increment $fish^{-1}$, mm (g) | 24 (1.82) | 17 (0.51) |
| Monthly growth rate, mm (g) | 79.5 (59.4) | 51 (15.75) |
| Date of harvesting | December, 1986 | December, 1986 |
| Size at harvesting, mm (g) | 318.20 (238) | 204 (63) |
| Percentage survival | 86 | 82 |
| Yield from the ponds, kg | 35.8 | 9.5 |

Sediment samples for macrobenthos were collected from the ponds using a van Veen grab with a biting area of 625 $cm^2$. These samples were preserved with 5% formalin and were sieved through a standard test sieve of 500 µm mesh for further extraction of the fauna manually. Sediment samples for meiofauna were collected by inserting a graduated hard PVC core tube of 2.2 cm inner diameter and 30 cm length into the contents of van Veen grab to a depth of 4 cm and pulling it up after tightly closing it at the top using a rubber bung (Uhlig *et al.*, 1973). The core samples were preserved with 5% formalin. The meiofauna were concentrated from the formalin preserved samples by first sieving the sediment through a 53 µm mesh standard test sieve and then by elutriating the contents of the sieve (Uhlig *et al.*, 1973). The wet weight of nematodes was also determined on the basis of volume (using Andrassy's

formula) and specific gravity of 1.13 as determined by Wieser (1960).

The physico-chemical parameters namely, temperature, Secchi-disc reading, water depth, salinity, dissolved oxygen and pH were measured by using standard methods (Strickland & Parsons, 1972). Particle size analysis of the pond sediment was done on the days of stocking and harvesting using Pipette analysis (Krumbein & Pettijohn, 1938).

$P_2O_5$ and $N_2$ content of cowdung were determined by following Shankaram (1966).

## Results and Discussion

The details of harvesting of *C. chanos* after 120 days of culture are given in Table 1. Gross production obtained from pond A was 35.8kg and from pond B, 9.5 kg. The estimated production works out to 852 and 226 kg $ha^{-1}$, respectively for 120 days.

The growth pattern for the first two fortnights in both the ponds was almost similar. But, subsequent growth in pond A was remarkably better than in pond B. In pond A, the fishes almost doubled in weight during the first three fortnights, but in pond B, this trend was limited to the first two fortnights. The pattern of fortnightly growth increment in Pond A was mostly in an ascending order whereas in pond B, it was mostly in a descending order.

The operational economics of the experiment as given in Table 2 reveals that the rate of return on operational costs works out to be 298% in the pond treated with cowdung as against 3% in the pond treated with chemical fertilizers.

Data on the fortnightly primary production (net and gross) are represented graphically in Fig. 1. It is clear that the net and gross primary production values in pond A were remarkably higher than in pond B. Highest values were observed at the end of 90 days in both the ponds and coincided with the calm postmonsoon conditions that prevailed in November. The lowest gross and net primary production synchronised with the October rains.

Table 2. *Operational economics of the experiment**

| Particulars | Pond A Rs. Ps. | Pond B Rs. Ps. |
|---|---|---|
| Input costs (A) | | |
| *Chanos chanos* fingerlings 189 nos. @ Rs. 30 100 $nos^{-1}$ | 57.00 | 57.00 |
| Mahua oil cake 10.5 kg; @ Rs. 1.65 $kg^{-1}$ | 17.00 | 17.00 |
| Lime 21 kg. @ Rs. 0.50 $kg^{-1}$ | 10.00 | 10.00 |
| Bleaching powder 2 kg, @ Rs. 10.50 $kg^{-1}$ | 21.00 | 21.00 |
| Cowdung 336 kg, @ Rs. 0.75 10$kg^{-1}$ | 25.00 | - |
| Fertilizers | | |
| superphosphate 3.7 kg, @ Rs. 0.90 $kg^{-1}$ | - | |
| urea 3.4 kg @ Rs. 1.8 $kg^{-1}$ | - | 10.00 |
| Dewatering and labour charges | 50.00 | 50.00 |
| Total | 180.00 | 165.00 |
| Output (B) | | |
| Sale price of *C. chanos* 35.8 kg @ Rs. 20 $kg^{-1}$ | 716.00 | - |
| Sale price of *C. chanos* 9.5 kg @ Rs. 18 $kg^{-1}$ | - | 170.00 |
| Total | 716.00 | 170.00 |
| Profit (B-A) | 536.00 | 5.00 |
| % return on investment | 298 | 3 |
| Estimated net income $ha^{-1}$ 120$days^{-1}$ | 12,762.00 | 119.00 |

* Worked out on the basis of costs in 1986

Fortnightly abundance of zooplankton groups, and total zooplankton biomass in the two ponds are detailed in Table 3. The groups represented in the zooplankton were rotifers, copepods and nauplii with fortnightly variations in both the ponds. In pond A the zooplankton biomass was relatively higher than in pond B except at

the end of 15 days which was due to a sudden decline of rotifers. In pond B, there was an unusual rise in the rotifers at that time. In general, the weekly application of cowdung enhanced the zooplankton production also.

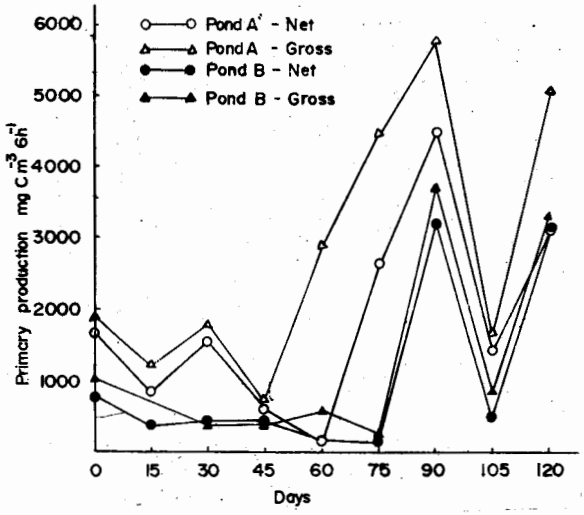


Fig. 1. Primary production (gross and net) in ponds A & B during the culture period

Abundance of meiofauna in the two ponds are summarised in Table 4. The meiofauna was mainly constituted by two groups namely free-living nematodes and copepods. Up to the end of 60 days, the total meiofauna biomass was much higher in pond A than in pond B. Subsequently, pond A showed an unpredictable variation of meiofauna biomass which was less than in pond B except at the end of 105 days. The frequency of free-living nematodes was 100% in both the ponds and for copepods it was 88.9% in pond A and 100% in pond B.

The fortnightly abundance of macrofauna of the two ponds are furnished in Table 5. The macrofauna groups namely amphipods, tanaids and polychaets were common in both the ponds. In addition, chironomid larvae and the bivalve *Nuculana* sp. were present in pond A. The black clam, *Villorita cyprinoides* var. *cochinensis* was very dominant at pond B contributing a wet weight as high as 7200g $m^{-2}$ which could be observed half way through the culture period. This bivalve was completely absent from pond A.

Data on temperature, Secchi disc reading, salinity, dissolved oxygen and pH are graphically represented in Fig. 2. In both the ponds the percentage composition of sand, silt and clay were 89, 3 and 8%, respectively.

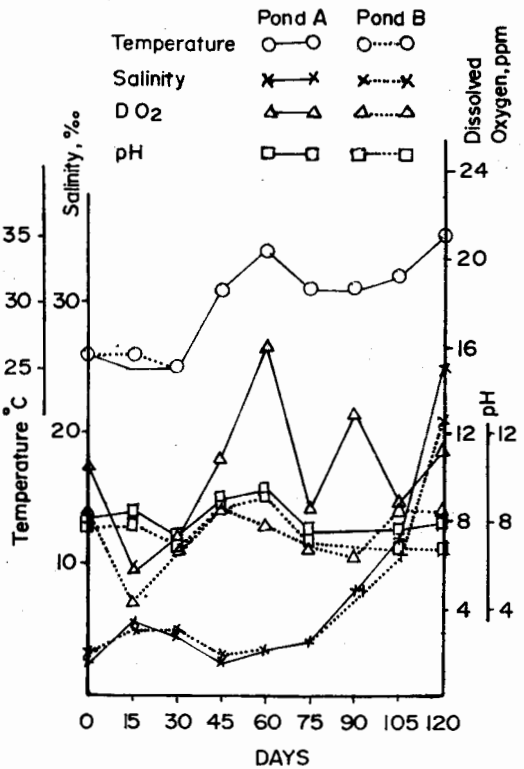


Fig. 2. Physico-chemical parameters of the pond A (treated with organic manure) and pond B (treated with inorganic fertilizers) during the culture period

The results clearly show that the pond treated with cowdung yielded better growth, survival and production of

Table 3. *Fortnightly abundance (wet weight in mg $m^{-3}$) of zooplankton groups and total biomass in the experimental ponds*

| Days | Rotifers | | Copepods | | Nauplii | | Total zooplankton biomass | |
|---|---|---|---|---|---|---|---|---|
| | Pond A | Pond B | Pond A | Pond B | Pond A | Pond B | Pond A | Pond B |
| 0 | 394.8 | 13.5 | 9.6 | 7.2 | 12.4 | 0.7 | 416.9 | 21.5 |
| 15 | 14.7 | 360.4 | 7.2 | - | 0.4 | 0.3 | 22.4 | 360.7 |
| 30 | 24.6 | 3.7 | 168.0 | 12.0 | 2.9 | 0.6 | 195.5 | 16.3 |
| 45 | - | 7.4 | 40.8 | 16.8 | 0.6 | 0.7 | 41.4 | 24.9 |
| 60 | 13.5 | - | 16.8 | 4.8 | 0.6 | 0.3 | 30.9 | 5.1 |
| 75 | 275.5 | 3.7 | 16.8 | 4.8 | - | - | 292.3 | 8.5 |
| 90 | 405.9 | 6.2 | 72.0 | 12.0 | - | 0.4 | 477.9 | 18.6 |
| 105 | 94.7 | 22.1 | - | - | 1.3 | 1.6 | 96.0 | 23.7 |
| 120 | 1.2 | 18.5 | 31.0 | 7.2 | 0.3 | 0.3 | 32.7 | 25.9 |

Table 4. *Fortnightly abundance (wet weight in μg per 10 $cm^{-2}$) of meiofauna groups and total meiofauna biomass in the experimental ponds*

| Days | Nematodes | | Harpacticoid copepods | | Total meiofauna biomass | |
|---|---|---|---|---|---|---|
| | Pond A | Pond B | Pond A | Pond B | Pond A | Pond B |
| 0 | 93.7 | 17.4 | 122.3 | 53.5 | 216.1 | 71.0 |
| 15 | 137.3 | 30.5 | 263.8 | 107.0 | 401.1 | 137.5 |
| 30 | 651.8 | 85.0 | 217.9 | 22.9 | 869.7 | 108.0 |
| 45 | 368.4 | 89.4 | 233.2 | 279.1 | 601.6 | 368.5 |
| 60 | 1722.2 | 1510.7 | - | 45.9 | 1722.2 | 1556.6 |
| 75 | 119.9 | 93.7 | 22.9 | 122.3 | 142.8 | 216.1 |
| 90 | 13.1 | 21.8 | 22.9 | 61.2 | 36.0 | 83.0 |
| 105 | 1815.4 | 209.3 | 512.3 | 519.9 | 2327.7 | 729.2 |
| 120 | 318.3 | 248.5 | 15.3 | 195.0 | 333.6 | 443.5 |

Table 5. *Fortnightly abundance (wet weight in g $m^{-2}$) of macrofauna in the experimental ponds*

| Days | Amphipods | | Tanaids | | Polychaetes | | Chironomids | *Nuculana* sp. | *Villorita* sp. | Total macrofauna biomass excluding *Villorita* sp. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pond A | Pond B | Pond A | Pond B | Pond A | Pond B | Pond A | Pond A | Pond B | Pond A | Pond B |
| 0 | - | - | - | - | - | - | 4.5 | - | - | 4.5 | - |
| 15 | - | - | - | - | - | - | 9.0 | - | 160 | 9.0 | - |
| 30 | - | 0.8 | - | 1.4 | - | 1.6 | 9.9 | - | 704 | 9.9 | 3.8 |
| 45 | 7.6 | - | 2.0 | - | 0.5 | - | - | - | 1200 | 10.0 | - |
| 60 | 0.9 | - | - | - | - | - | - | - | 7200 | 0.9 | - |
| 75 | 1.1 | - | - | - | - | - | - | - | 3520 | 1.1 | - |
| 90 | - | 1.1 | - | 0.7 | - | 0.7 | - | - | 2592 | - | 2.4 |
| 105 | 2.6 | 0.6 | 6.0 | - | 23.2 | - | - | 49.6 | 4640 | 81.4 | 0.6 |
| 120 | 3.2 | - | 0.9 | - | 0.2 | - | - | - | 5600 | 4.3 | - |

*C. chanos* than the pond treated with superphosphate and urea. The gross production obtained from that pond is perhaps, the highest production, obtained in India from short-term monoculture of *C. chanos* without any supplementary feeding, but merely by manuring the pond with cowung at a rate of 500 kg $ha^{-1}$ $week^{-1}$.

The application of chemical fertilizers namely, superphosphate and urea although equating the $P_2O_5$ and $N_2$ values of the cowdung, did not seem to provide as much natural food for the cultured milkfish as did the application of cowdung. This is evident from the fact that the primary production, zooplankton, macrofauna (excluding *V. cyprinoides*) and meiofauna biomass were generally lesser in the inorganic fertilizer treated pond. As suggested by Schroeder (1978), the sources of decomposing organic matter in the cowdung might have favoured the growth of bacteria which in turn might have formed a nutritional source for the milkfish as well as for fish food organisms in the pond.

Mohanraj *et al.* (1982) reported gross milkfish yield of 852 kg $ha^{-1}$ obtained from monoculture for a period of 10 months conducted at Mandapam, Tamil Nadu. Fingerlings (weight 13 g) were stocked at a rate of 4000 nos $ha^{-1}$ and were fed with a mixture of ricebran, groundnut oilcake, tapioca powder and fish meal in equal proportion, at 5-10% of body weight. The conversion ratio for the feed obtained by them was 9.95:1. Fertilizers were not applied to the pond in that experiment. A conversion of 9.7 kg cowdung to 1 kg *C. chanos* which is better than that reported on application of costly feed ingredients by the afore mentioned authors, was obtained in the present study. Moreover, the period taken to obtain 852 kg $ha^{-1}$ was also relatively much shorter in the present study i.e., nearly 4 months instead of 10 months.

Jose *et al.* (1987) reported net production of 1138-1565 kg $ha^{-1}$ $yr^{-1}$ in the monoculture experiment of milkfish conducted at Vyttila, Kerala. The ponds were treated with cowdung at 5000 kg $ha^{-1}$ $yr^{-1}$ and mussooriphos at 600 kg $ha^{-1}$ $yr^{-1}$ every month and no supplementary feeding was done. Comparatively higher rate (24,000 kg $ha^{-1}$ $yr^{-1}$) and more frequent (weekly) application of cowdung in the present study might have contributed to better yield of milkfish than that reported by them. Experiments carried out in the Philippines by Parreno (1987) on six different treatments using cow manure only, chicken manure only, cow manure plus NPK (16-12-0), chicken manure plus NPK (16-12-0), NPK only and with no fertilization, demonstrated that, of all the fertilizers used, cow manure was the most effective in enhancing milkfish production.

Assuming 3 crops a year, it is possible to obtain a yield of about 2500 kg $ha^{-1}$ by adopting the suggested management practice. The milkfish seed may be stocked when they are seasonally abundant and kept stunted for round the year culture. The operational economics of the experiments from this pond also reveals that short term milkfish culture of 120 days is economically feasible in our country.

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