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Efficacy of Biofertilizer Enriched Flower Waste Vermicompost on Production and Growth of Primary Producers and Freshwater Aquarium Fishes

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Abstract: An experiment was conducted in glass jars for seven weeks to assess the efficacy of vermicompost and vermicompost enriched with biofertilizers on the production and growth of primary producers and aquarium fishes. Water quality parameters were found to be within the optimum level of aquarium fish culture in all the experiments. Five groups of phytoplankton (Bacillariophyceae, Chlorophyceae, Cyanophyceae, Charophyceae and Euglenophyceae) and two groups of Zooplanktons (Protozoans and Rotifers) were identified. The result shows that E2 enhances high plankton production than others and recommended for primary production in aquaculture. The growth rate of Aquarium fish Silver Tetra (*Ctenobrycon spilurus*) and Platy (*Xiphophorus maculatus*) were analyzed by feeding with the plankton (T1); aquarium feed (T2) and combination of both (T3). A high level of weight gained, Percentage weight gained (%) and Specific growth rate (SGR) was recorded in combination feeding group (T3).

Key words: Experiment · Fish · Feed · Plankton · Primary Producers · Vermicompost

INTRODUCTION

In India, freshwater aquaculture has made a significant contribution towards total fish production involving different types and levels of inputs [1]. The manures are either directly utilized by the fishes or they enrich the aquatic ecosystem with autotrophic (plankton) and heterotrophic microbial communities [2]. Fertilization is far the useful technique to make up the essential needed nutrients to enhance the natural productivity through the production of aquatic biota, that serve either directly or indirectly as food for fishes [3]. Fertilizer application is to increase the primary productivity of the fish pond and both organic and inorganic fertilizers are used. Inorganic fertilizers mainly increase the quantity of primary producers. But the organic fertilizers such as dung of cattle, pig, poultry, biogas slurry and live stock wastes for stimulate abundant growth of zooplanktons and insect larvae and other forms of fish food organisms [4].

Phytoplankton and zooplankton are a rich source of protein often containing 40-60% protein on a dry matter basis and is sufficient to support excellent fish growth [5]. Diatoms are important primary producers in aquatic ecosystems and represent an important source of food for aquatic grazing organisms [6]. Rotifers are the most important live food organisms for use as starter food for rearing small fish larvae [7]. Both the qualitative and quantitative abundance of plankton in a fish pond are of great importance in managing the successful aquaculture operations.

Of all the organic manures, raw cattle dung has the widest application over decades in India, South-east Asia and other countries [8]. Among the decomposed manures, vermicompost is rich in all types of major and minor nutrients, vitamins, enzymes, antibiotics, growth promoters, etc. [9]. Sulochana *et al*. [10] observed higher manorial value of the vermicompost as compared to raw cow dung and poultry droppings in terms of its effect on hydrobiology of water. Even if vermicompost dries up,

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there is no harm to its microflora hence; it is referred to as potential biological manure or biofertilizer [11]. Vermicompost is found to be more nutritious than cow dung/farmyard manure in terms of more carbon and phosphorus, less potassium and comparable nitrogen [12]. Vermicompost is hazard free organic manure, which improves quality of pond base and overlying water as well as provides organically produced aqua crops [13].

In recent decades, the market for ornamental fish has grown steadily. The annual global trade value has been estimated to amount to US $ 9 billion [14]. The present study was designed to analyze the effect of vermicompost and vermicompost enriched with biofertilizers and chemical fertilizer (DAP) on plankton abundance and density. The growth of Aquarium fishes [Silver Tetra (*Ctenobrycon spilurus*) and Platy (*Xiphophorus maculatus*)] were analyzed by feeding with the planktons and aquarium pellet feed.

MATERIALS AND METHODS

Experimental Design: Fresh water plankton was collected using 200µ and 300µ mesh from River Cauvery in Velur, Namakkal Dt. The collected plankton was subjected to mass culture in 5 l glass jars at a rate of 50 cells/ ml. The culture set up was as follows (A control and six experiments with triplicate).

Fresh Water Alone:

E1- Fresh water + Vermicompost.
E2-Fresh water + Vermicompost enriched with Azospirillum.
E3- Fresh water + Vermicompost enriched with PSB (Phosphate solublising bacteria).
E4- Fresh water + Vermicompost enriched with BGA (Blue green algae).
E5- Fresh water + Vermicompost enriched with Rhizobium.
E6- Fresh water + Inorganic fertilizer (DAP).

All the culture jars were aerated till the end of the experiment (45 days). Water quality such as temperature, dissolved oxygen, pH were measured at fortnightly intervals by following the standard methods and nutrient analysis were determined by APHA [15] and Tandon [16].

Plankton samples were collected on a weekly basis from each experimental jar. The samples were fixed with 2 ml of Lugol's iodine (1:1000) for sedimentation and preservation of planktons. After 2 to 3 days the supernatant was carefully siphoned out and the volume was made up to 50 ml. The concentrated preserved plankton samples were analyzed on a Sedgewick-Rafter counting cell (SR-cell) under a compound microscope. For each sample, 1ml of sub sample was transferred to the cell. From 10 randomly selected squares of the cell, the planktonic organisms were enumerated. The planktons were further identified up to genus level following the guidelines of Bellinger [17]. The cultured planktons were given as feed for aquarium fishes [Silver Tetra (*C. spilurus*) and Platy (*X. maculatus*)]. The growth rate of these aquarium fishes were tested by giving planktonic feed and commercial aquarium pellet feed. The fish culture setup was as follows;

T1- Plankton alone
T2- Commercial Aquarium pellet feed
T3- Combination of both (50:50)

Data Analysis: The growth rate of aquarium fishes was analyzed at the end of the 30th day. Fish growth (n = 20) was assessed by measuring body length and weight at fortnight intervals. Data was analyzed for following parameters;

Weight gain (g) = Final body weight (g) - Initial body weight (g)

$$\text{Percentage weight gain (\%)} = \frac{\text{Final body weight (g) - Initial body weight (g)}}{\text{Initial body weight (g)}} \times 100$$

The Specific Growth Rate (SGR) was calculated as: SGR = 100 [(Wt – Wo)/t];

where Wo and Wt are the initial and final live weight of the fish (g), respectively and (t) is culture period in days [18].

All the Data were analyzed using the SPSS statistical package. Differences among different experimental parameters were calculated by using one way ANOVA ($p \leq 0.05$) and Duncan's multiple range test (DMRT), regression analysis was performed for fish growth parameters.

RESULTS AND DISCUSSION

The statistical analysis (One way ANOVA) of water samples showed no significance among all water parameters ($p<0.05$) presented in Table 1. The physicochemical parameters pH varied from 7.1 to 7.37, while the temperature ranged between 32 to 34.5°C,

Table 1: Physicochemical parameters of plankton culture water samples

	pH	Temp. °C	DO_2 (mg/l)	N (%)	P (%)	K (%)
C	7.13±0.11[a]	32.17±0.65[b]	3.58±0.95[a]	1.92±0.52[b]	0.86±0.06[a]	1.24±0.24[b]
E1	7.37±0.15[a]	34.5±1.32[a]	3.76±0.86[a]	2.03±0.97[ab]	0.94±0.14[a]	1.48±0.2[b]
E2	7.30±0.1[a]	34.33±1.08[ab]	3.54±0.7[a]	2.29±0.91[ab]	0.98±0.13[a]	1.93±0.04[b]
E3	7.10±0.17[a]	34.00±1[ab]	3.78±0.65[a]	2.20±1.0[a]	1.02±0.12[a]	1.83±0.1[b]
E4	7.10±0.17[a]	34.33±1.52[ab]	3.77±0.86[a]	2.25±0.85[ab]	0.96±0.02[a]	1.84±0.1[b]
E5	7.17±0.15[a]	34.33±0.57[ab]	4.14±0.86[a]	2.29±1.19[ab]	0.98±0.1[a]	2.12±0.12[b]
E6	7.33±0.15[a]	33.67±1.15[ab]	2.70±0.24[a]	0.80 ± 0.04[c]	0.88 ± 0.25[a]	Nil

DO_2, Dissolved Oxygen; N, Nitrogen, P, Phosphate; K, Potassium

Values with different superscripts in a row differ significantly ($p \leq 0.05$)

Table 2: Generic status of phytoplankton and zooplankton available in the experimental culture during the study

Plankton	Class	Genus
Phytoplankton	Bacillariophyceae	*Amphora, Asterionella, Aulocoseira, Cyclotella, Fragillaria, Melosira, Navicula, Nitszia, Stephanodiscus, Synedra.*
	Chlorophyceae	*Coleasterum,Dictyosporangium, Odagonium, Pediasterum, Scenedesmus.*
	Cyanophyceae	*Aphanizomenon, Chorococcus disperses, C.turgidus, Homoeothrix, Lynghya, Merismopedia, Microcystis aeruginosa, M. flosaquae, Oscillatoria.*
	Euglenophyceae	*Euglena, Strombomonas.*
	Charophyceae	*Spirogyra, Chara.*
Zooplankton	Protozoa	*Actinosphaerium, Paramecium.*
	Rotifera	*Branchionus, Philodina.*

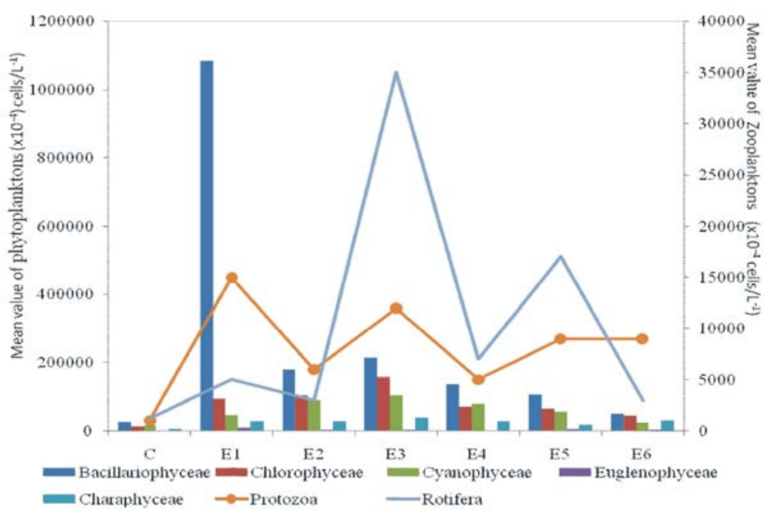

Fig. 1: Abundance of phytoplankton and zooplankton during the study period

it was recorded in the control and experimental groups. Maximum dissolved oxygen was recorded in E5 and minimum dissolved oxygen was recorded in E6 during the experimental period. Among the nutrients, maximum N was recorded in E2 and E5, minimum in E6, whereas highest available P in E3 and lowest in C. Potassium level was nil in E6 and higher was recorded in E5.

Plankton Analysis: Phytoplankton composition was represented by five diverse groups, namely Bacillariophyceae, Chlorophyceae, Cyanophyceae, Charophyceae and Euglenophyceae in all the experiments. Among the phytoplanktons Bacillariophyceae showed the highest percentage composition (43.62%), Euglenophyceae was presented the lowest (1.14%) in all the experiment and control (Table 2 & Fig. 1). The phytoplankton population was found in increasing order in the experimental samples than the control. Almost similar order of dominance in different groups of phytoplankton has been reported by Wahab *et al*. [19] and Ahmed *et al*. [20]. Among phytoplankton genera, *Fragillaria, Navicula, Synedra, Stephanodiscus, Nitzschia, Cyclotella, Coleastrum, Pediastrum, Scenedesmus, Merismopedia, Microcystis*, were persistently present in all experimental and control jars (Table 2 & Fig. 1). Even though the phytoplankton groups

Table 3: Comparison of growth performance of [Silver Tetra (*Ctenobrycon spilurus*) and Platy (*Xiphophorus maculatus*)] in different feed treatments

Growth parameters / Feeding groups	Silver Tetra (*Ctenobrycon spilurus*) T1	T2	T3	Platy (*Xiphophorus maculatus*) T1	T2	T3
No of fishes introduced	20	20	20	20	20	20
Average Initial weight (g)	$3±0.22^{e}$	$3±0.48^{e}$	$5±0.49^{d}$	$3.6±0.02^{e}$	$4.1±0.16^{d}$	$4.8±0.16^{c}$
Average Final weight (g)	$9±0.31^{b}$	$6.87±0.32^{c}$	$17±0.36^{a}$	$7.65±0.19^{b}$	$7.28±0.18^{b}$	$14±0.66^{a}$
Average weight gain (g)	6	3.87	12	4.05	5.3	9.2
Average Initial length (cm)	$1.16±0.23^{c}$	$1.2±0.15^{c}$	$1.18±0.6^{c}$	$1.44±0.02^{d}$	$1.5±0.02^{d}$	$1.46±0.04^{d}$
Average Final length (cm)	$2.38±0.3^{b}$	$1.68±0.32^{a}$	$3.08±0.3^{a}$	$2.5±0.03^{b}$	$2.3±0.04^{c}$	$3.06±0.18^{a}$
Average length gain (cm)	1.22	0.48	1.9	1.06	0.8	1.6
Percentage weight gain (%)	200	129	240	112.5	77.56	126.21
Specific growth rate (% wt gain/day)	2.71	1.07	4.22	2.36	1.78	3.56
Survival rate (%)	86	55	94	82	68	88

Values with different superscripts in a row differ significantly ($p \leq 0.05$)

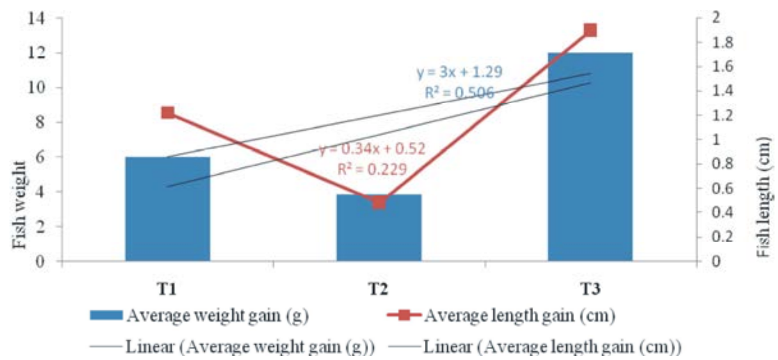

Fig. 2: Length and weight relationship of (*Ctenobrycon spilurus*) Silver Tetra fish

are more or less common in order to their abundance in the vicinity of the present study, the generic representation differs either in quality or in quantity [20].

Among the zooplankton composition rotifera accounted (71.5%) and protozoa (28.5%) were observed in the present study. Highest zooplankton composition were recorded in E3 (70.21%) and least number in C (3.44%). The amount of available phosphate was high in the (E3) treatment indicating better manorial for improvement in zooplankton production [21]. Vermicompost treated samples E3, E5 and E1 shows a significantly higher zooplankton production, both in total number and in group-wise variation. Though rotifers have been reported as common and dominant zooplankton group in all experiments, rotifers may also occur as equally abundant in manure treated ponds [22]. Also, the overall observation revealed an increasing trend of phytoplankton population in various sampling days of the experimental period in all the treatments. Significant differences were also found between vermicompost and compost treatments.

Fish Growth: Survival of silver tetra fish (94%) and platy (88%) in T3 followed by T2 and T1 were observed in all experiments. There was a steady increase in the length and weight of fish in all the experimental tanks. As compared to T2, significantly higher growth of the fish was recorded in T3 and T1 (Table 3). The specific growth rate was quite high, in silver tetra (4.22) and platy (3.56) in treatment T3 and lowest value was observed in treatment T2. Maximum fish growth parameters were observed in T3, which can be attributed to higher availability of natural food organisms with high nutritional value. The average growth of individual fish among the treatment was significant ($p < 0.05$) and stepwise multiple regression analysis was presented in the (Table 3 & Figs. 2 and 3). There was a direct relationship between combination feed with length, weight gain by silver tetra fish growth ($r=0.229$; $r = 0.506$) and platy ($r=0.437$; $r = 0.918$). It might be that the weight gain is more directly related to differences in food concentrations, although zooplankton density and water quality were closely related to each other [23]. The microorganisms present in the vermicompost samples play a greater role in liberating the nutrients for phytoplankton growth. Vermicompost samples served as fertilizer for autotrophic and for heterotrophic production of natural fish food organisms [2]. Moreover fishes even feed on the undigested fractions of the vermicompost samples directly, which may be low in nutrient value, but the microorganisms

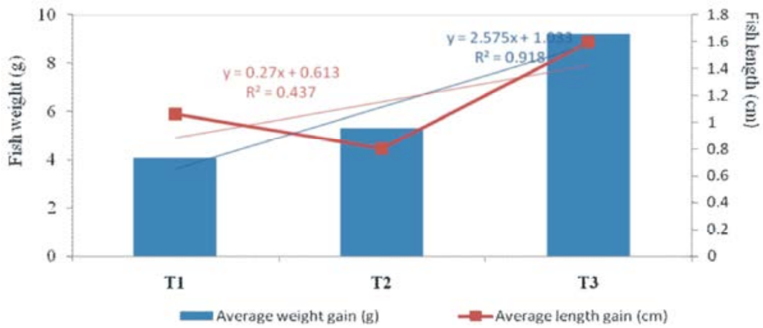

Fig. 3: Length and weight relationship of (*Xiphophorus maculatus*) platy fish

adhering to them are of high protein value which contribute higher yield [13, 21, 24]. The present study shows the utilization of vermicompost enriched with biofertilizers which serve the double role as a direct feed to growing fishes and as direct manures for autotrophic and heterotrophic production of natural fish food organisms.

CONCLUSION

From this present study it is concluded that water quality parameters were found within the optimum limit for aquarium fish culture in all the experiments. The highest plankton composition (phytoplankton and zooplanktons) was observed in E3 and lowest value recorded in the control. Maximum fish growth parameters were observed in treatment T3 may be attributed to higher availability of natural food organisms with high nutritional value. We strongly recommended vermicompost enriched with biofertilizers as successful organic manure for fish growth and an ecofriendly product for aquaculture practices.

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