Efficacy of fermented cereal flours and decomposed kitchen waste in augmenting production of aquatic microbial and zooplankton populations

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ABSTRACT

The present investigation was carried out for a period of 50 days in cement cisterns to evaluate the efficacies of fermented rice (T1), maize (T2), wheat flour (T3) as well as decomposed kitchen waste (T4) in the production of microbial and zooplankton population. These were added @ 10 mg l⁻¹. The effect of different treatments on the bacterial and zooplankton population was quite significant. The average total bacterial population in 7 weeks duration was found to be highest (1817 No./ml) in T4, followed by T3 (1278 No./ml), T1 (1234 No./ml), and control (662 No./ml). Highest zooplankton population of 5553 No./l was obtained from T4 followed by T2 (4910 No./l), T3 (4357 No./l), T1 (3220 No./l) and control (2113 No./l). The results indicated highest efficacy of decomposed kitchen waste under the existing environmental conditions. The coefficient of correlation between the average total bacterial population and average total zooplankton population was found significant.

Introduction

Phytoplankton, zooplankton and other microorganisms play an important role in fish culture. Phytoplankton is the primary producer which provides food and oxygen for other organisms present in the fish pond. Zooplankton comprising of four major groups, viz., cladocerans, copepods, rotifers and their nauplii are the preferred food material for the cultured fish species. Apart from the presence of phytoplankton and zooplankton, there are number of microbial organisms in the fish pond. These microbial populations act upon the organic matters and decompose them so as to make available easily assimilable food for the growth of other organisms including fish.

The zooplankton and fish thrive well on the microbes developed on the organic waste present in the fish pond. Fermentation of various feed materials enhances the microbial activity which can be utilized by other organisms such as zooplankton and fish for their growth (Schroeder, 1978; Ayyappan et al., 1990; Malik, 1992; Kumar 1994; Kishan, 2000; Skrede et al., 2002). The present study was carried out to find out the efficacy of some selected fermented cereal flours viz., rice, maize, wheat and decomposed kitchen waste.

Materials and methods

The experiment was conducted at the Department of Aquaculture, College of Fisheries, MPUAT, Udaipur. Fifteen cement cisterns of 150 l capacity were cleaned and filled with filtered well water. Each cistern was inoculated with 50 ml zooplankton collected from the natural water body.
The results for microbial population was expressed in nos./ml, whereas for zooplankton as nos./l.

The experimental materials were analyzed for proximate composition following AOAC (1984). Analysis of variance, coefficient of correlation and Duncan’s Multiple Range Test (DMRT) were done as per Steel and Torrie (1960).

**Results and discussion**

*Physico-chemistry of water*

The results of the water quality parameters such as temperature, pH, DO, O-PO₄ and NO₃-N are presented in Table 1. The temperature, pH and DO remained congenial for fish culture throughout the experimental period, whereas fluctuation in the nutrient contents i.e., O-PO₄ and NO₃-N was observed. The O-PO₄ content became negligible after 3rd week and NO₃-N concentration showing a decrease in the 1st week, increased thereafter up to the 5th week. The concentration dropped sharply in the 6th week and remained almost stationary except in T₂. The results of the water quality thus indicate no significant effect of the fermented cereal flours and the decomposed kitchen waste.

**Bacterial population**

Weekly and average total bacterial populations of different treatments are given in Fig. 1. The bacterial population increased from the initial population of 11 No./ml to 48, 43, 42, 36 and 29 in T₁, T₂, T₃, T₄ and control respectively during 1st week. The population of bacteria continued to increase up to the 5th week and decreased sharply in the 6th week. This decrease could be attributed to the reason that during this week the doses were suspended in all the treatments. This was done to see the effect of different doses on the microbial population.

### Table 1. Range and average of water quality parameters (the figures in parentheses indicate average values)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Treatment</th>
<th>T₁</th>
<th>T₂</th>
<th>T₃</th>
<th>T₄</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water temperature (°C)</td>
<td></td>
<td>23.93-32.90</td>
<td>22.20-33.03</td>
<td>22.60-32.93</td>
<td>22.13-33.50</td>
<td>22.00-33.73</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(8.28)</td>
<td>(8.53)</td>
<td>(8.62)</td>
<td>(8.64)</td>
<td>(8.25)</td>
</tr>
<tr>
<td>Dissolved oxygen (mg/l)</td>
<td></td>
<td>6.93-20.23</td>
<td>6.10-19.93</td>
<td>5.80-21.00</td>
<td>7.90-21.53</td>
<td>9.50-20.03</td>
</tr>
<tr>
<td>Orthophosphate (mg/l)</td>
<td></td>
<td>0.00-0.076</td>
<td>0.00-0.110</td>
<td>0.00-0.082</td>
<td>0.00-0.090</td>
<td>0.00-0.074</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0116)</td>
<td>(0.0136)</td>
<td>(0.0174)</td>
<td>(0.0130)</td>
<td>(0.0130)</td>
</tr>
<tr>
<td>Nitrate-nitrogen (mg/l)</td>
<td></td>
<td>0.066-0.252</td>
<td>0.077-0.234</td>
<td>0.104-0.602</td>
<td>0.052-0.192</td>
<td>0.039-0.402</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.167)</td>
<td>(0.150)</td>
<td>(0.230)</td>
<td>(0.119)</td>
<td>(0.150)</td>
</tr>
</tbody>
</table>

The population again increased in the 7th week when the doses were restarted. This indicates that the application of different doses of the experimental materials had an impact on the microbial population. The average total bacterial population for seven weeks duration was found to be highest in T₄, T₁, T₂ and control with 1817, 1278, 1234, 1097 and 662 nos./ml respectively. The percentage increase in the bacterial population was also highest in T₄ (16421%) followed by T₁ (11521%), T₂ (11115%), T₃ (9876%) and control (5555%) (Fig. 2).

Statistically, the analysis of variance was found to be significant at 5% level (p<0.05). ANOVA-I indicates highly significant production of bacteria in treated cisterns as compared to control. An increase in microbial population in T₁, T₂ and T₃ was expected because of yeast used for fermentation. A high population of bacteria in T₄ (decomposed kitchen waste) could be attributed to the natural decomposing bacterial activity. This activity was significantly high as compared to other treatments.
Zooplankton population

Total zooplankton population fluctuated irregularly in all the treatments (Fig. 3). The average total zooplankton population however was found to be highest in T4 followed by T2, T3, T1 and control. Like bacterial population, the zooplankton population was also highest in T4 but in other treatments, different trend was observed. The percentage increase in the zooplankton population for seven weeks duration was also maximum in T4 followed by T2, T3, T1 and control (Fig. 4).

Results of the present investigation revealed significant effect of fermented cereal flours and decomposed kitchen waste on both the bacterial biomass as well as zooplankton biomass as compared to control. A high population of bacteria and zooplankton at the end of the experiment as against the initial populations in control could be assigned to the nutrient materials already present in the experimental waters.

ANOVA-II also indicates that the zooplankton production was highly significant in all the treatments. The treatments when compared with control showed significant zooplankton production. The coefficient of correlation between the average total bacterial population and average total zooplankton population was significant $[r = 0.826, t_{cal} = 2.285$ and $t_{tab} = 2.132$ at 5% level of significance].

The microbial population not only helps in the processing of organic waste, but also act as feed materials for some zooplankton and fish. Pullin (1987) and Srinivasan (1987) have suggested use of microbial communities for processing organic waste and production of single cell proteins (SCP) as well as silage additives for improving fish production. Sharma et al. (1986) have also reported the significance of microbial population on fish growth with camel dung. A high bacterial activity in the kitchen waste treated cisterns also supports the above views.

Edwards et al. (1995) reported that the microbial degradation of aquatic macrophytes can play an important part in making suitable pelleted diet for fish. They also reported that the microbial flora itself could provide nutritious and easily assimilable food source for the fish.

Ayyappan et al. (1990) mentioned that fermentation of bran cake mixture improved the quality of feed. Results of the present investigation also show an improvement in the crude protein levels of the fermented cereal flours as well as decomposed kitchen waste (Fig. 5).

Importance of microbial population in relation to zooplankton production has been emphasized by Malik (1992). Shimeno et al. (1993) observed a high fish growth rate and feed efficiency with fermented soybean meal diet and contributed this to the increased digestibility of the fermented feed. Umesh et al. (1999) reported higher production of fish due to bacterial biofilm promoted on the substrate with cattle dung and urea.

Skrede et al. (2002) found an improved digestibility of starch and fat of the fermented cereals (wheat and barley meal flours). Several other researchers have also reported significant impact of microbial communities on the growth performance of fish (Kumar, 1994; Sharma and Kumar, 1998; Kumar and Sharma, 1999; Kishan, 2000).
Fig. 5. Proximate composition of experimental materials
Galindo (2004) found that *Lactobacillus plantarum* 44a have potential for probiotic application in the fish feed. The findings of the present investigation thus reveal the significance of microbial population as well as zooplankton population in fish culture. The bacteria being very small in size can be consumed by zooplankton and other benthic organisms, which in turn are used by fish as feed. The fermented feed materials not only provide easily digestible and assimilable food for fish but also keep the water quality congenial for fish culture as also reported by Berard et al. (1995). In the present investigation, no fish was taken and hence the effect of fermented material on their growth could not be evaluated.

From the results of the present investigation, it could be concluded that under the local environmental conditions of southern Rajasthan, a dose of decomposed kitchen waste @ 10 mg/l could be considered better for the production of bacterial and zooplankton population. The use of other fermented cereal flours however, could not be ignored. Further research work with fermented/decomposed materials is recommended to work out the optimum dose for microbial and zooplankton production as well as fish growth depending on the local environmental conditions.

**References**


