

**GROWTH AND YIELD OF MONOSEX TILAPIA OREOCHROMIS NILOTICUS IN  
FLOATING CAGES FED COMMERCIAL DIET SUPPLEMENTED WITH  
PROBIOTICS IN FRESHWATER POND, SYLHET**

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**Abstract:** The effect of probiotics mixed with floating feed on the growth and production of tilapia *Oreochromis niloticus* over a period of 120 days was evaluated. Four treatments were T<sub>1</sub> (super biotic probiotics), T<sub>2</sub> (biozyme probiotics), T<sub>3</sub> (zymetin probiotics) and T<sub>4</sub> (control) with three replicates. Higher growth of tilapia was found in T<sub>3</sub> (272.78 g) followed by T<sub>2</sub> (242.56 g), T<sub>1</sub> (222.76 g) and T<sub>4</sub> (199.35 g). The highest gross yield (8.82 kg m<sup>-3</sup>) was achieved in T<sub>3</sub> compared to T<sub>2</sub> (7.78 kg m<sup>-3</sup>), T<sub>1</sub> (7.23 kg m<sup>-3</sup>) and T<sub>4</sub> (6.35 kg m<sup>-3</sup>), which is manifolds higher than the earthen pond yield of tilapia in Bangladesh. The highest net profit (TK. 401.0 m<sup>-3</sup>) was obtained in T<sub>3</sub> and the lowest (TK. 119.0 m<sup>-3</sup>) was in control (T<sub>4</sub>). Results suggest that probiotics can be used in feed to increase fish production.

**Key words:** Feed, probiotics, yield, tilapia, Bangladesh

### INTRODUCTION

Tilapia *Oreochromis niloticus* are being used in commercial farm in more than 100 countries of the world from extensive to super-intensive and one of the important fishes in aquaculture industry in this century. Tilapia is the second most cultured fish worldwide after the carps and even though they are easily cultured in a wide variety of environment and are relatively resistant to aquaculture stressors compared to other cultured fin fishes (Hussain 2004). Tilapia is randomly cultured in brackishwater environment though it is a freshwater fish. This fish is palatable and hardy can survive in very low depth of water (15 cm). Tilapia culture in rural areas of Bangladesh is increasingly becoming popular. The rural Bangladesh is 20,60,408 mt in closed waterbodies production of tilapia contributed 1,52,884 mt in 2014-2015 but it was 1,38,000 mt of 18, 59,808 mt in 2012-2013 (DoF 2016). Carps are easily affected by bacterial and fungal diseases but tilapia suffers less although tilapia lake virus disease has been reported in some tropical country including Bangladesh. As a result, farmers have been found reluctant to stock carps in their small ponds and seasonal water bodies. To protect diseases and for getting quick return,

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most of the farmers shifted their culture practice into tilapia production in their seasonal ponds. Tilapia in different countries is farmed with fertilization and/or supplementary feeding. Supplemental feeds are given to increase yield above produced with fertilization alone. In fish farming practices, stocking density is considered to be one of the important factors that affect fish growth and survival, feed utilization and yield (Liu and Chang 1992). Furthermore, it has been reported that stocking density is a key factor in determining the productivity and profitability of commercial fish farms (Ellis *et al.* 1952). Feed is the highest cost oriented input in aquaculture. Thus the higher the effective feed the less will be the cost of production.

Monosex tilapia *O. niloticus* does not breed/multiply, which makes it easy for fish farmers to avoid uncontrolled breeding in their farms. They grow fast and attain market size within a short period in pond, cage and pen than other tilapia forms. Monosex tilapia become marketable size (100-150 g) within 2-3 months. Size of tilapia is entirely dependent on the size of pond/cage/pen, natural productivity of water, feed quality, frequent of feeding, stocking density, size of fry/fingerlings and management. Among different forms of tilapia, monosex is more suitable for cage culture because tilapia does not jump. This fish is currently considered to be the most important and commonly cultured species around the world and constitutes over 70% of cultured tilapia (Fitzsimmons 2004) which represent approximately 6% of total farmed fish production (FAO 2004).

Probiotics are feed additives defined as live microbes that may serve as dietary supplements to improve the host intestinal microbial balance and growth performance (Gatesoupe 1999). The probiotics in aquaculture have been shown to have several modes of action: competitive exclusion of pathogenic bacteria through the production of inhibitory compounds, improvement of water quality, enhancement of immune response of host species and enhancement of nutrition of host through the production of inhibitory of supplemental digestive enzymes (Carnevali and Cresci 2006). Thus the use of probiotic in aquaculture has received some attention (Abdel *et al.* 2002).

Use of probiotics as farm animal feed supplements dates back to the 1970s. They were originally incorporated into the feed to increase the animal's growth and improve its health by increasing its resistance to disease (Fuller 1992). Today, probiotics are quite common place in health promoting "functional foods" for humans, as well as therapeutic, prophylactic and growth supplements in animal production and human health (Geovanny *et al.* 2007). Most studies on probiotics in aquaculture have been used in *in vitro* models of specific bacteria as antagonists of pathogens. The use of probiotics in aquaculture has been

accompanied by an increase in nutrient utilization through providing enzymes capable of converting certain components of the diet into more digestible nutrients for the host. With increasing demand for environment friendly aquaculture, the use of probiotics in aquaculture is now widely accepted (Gatesoupe 1999 and Moriarty 1998). Though several types of probiotics (Aqua photo, Aqua mazic, Ammonil, Safegut, Probio-Aqua, Super biotic, Super P S) in powder or liquid forms are found in the markets, most of the farmers do not know the techniques of use and impact of these probiotics. A few work have been done on probiotics in shrimp culture in brackishwater to determine the mode of application of *Bacillus* probiotics (Islam *et al.* 2008). Very few studies related to the usage of probiotics in aquaculture are available in Bangladesh. Therefore, there is a need to understand the effects of probiotics in artificial diet of tilapia cage culture. The objectives of this study were to determine the effects of dietary supplementation of commercial probiotics on growth and production performance of tilapia in the freshwater cage in the pond.

#### **MATERIAL AND METHODS**

*Experimental animal and conditioning:* Tilapia fry were purchased from a private hatchery and were transported in oxygenated polythene bags from the hatchery to University campus. Before stocking, fry were acclimatized to the pond water for one hour period. Initial weight and length of 25 fish were recorded before stocking in the cages. The study was undertaken in 12 nylon net cages installed in a pond of Sylhet Agricultural University (SAU) campus, Sylhet over 120 days from 15 July to 12 November 2015.

*Experimental system:* Twelve newly constructed cages (1.5 × 1 × 1 m) were used as culture system. Frame of cage was made of bamboo split. Plastic drums were used as cage float. Net cages were made of plastic or knot-less polyethylene net (mesh 1.0 cm). Cages were hanged with cage frame. Bamboo made platform was set up over the cages and all cages were fixed with the poles of the platform. Cages were installed at both sides of the platform for easily feed supply and intensive observation.

*Experimental design:* This study was a one factorial in which types of probiotics were the only experimental variable such as T<sub>1</sub> (super biotic), T<sub>2</sub> (biozyme), T<sub>3</sub> (zymetin) and T<sub>4</sub> (control) with three replicates. Pond selected for setting the cages was cleaned manually and limed with CaO @ 250 kg ha<sup>-1</sup>. After that the ponds were fertilized with urea and TSP @ 25 and 37.5 kg ha<sup>-1</sup>, respectively. After 6 days of fertilization, cages were stocked with required quantity of fry of male Nile tilapia *O. niloticus* at a density of 35 m<sup>-3</sup> with 3.0 ± 0.11 g size in each cage.

*Proximate composition of the feed ingredients:* The commercial mega feed fed tilapia was analyzed to determine moisture, crude protein, crude lipid, ash, crude fibre and carbohydrate following AOAC methods (2000). Moisture, crude protein, crude lipid, ash, crude fibre and carbohydrate of the feed were 24.19, 10.11, 7.85, 22.65, 6.04 and 29.16%, respectively.

*Culture of tilapia:* After liming and fertilization, water colour of the pond turned into green. Then cages were stocked with all male tilapia fry. Artificially manufactured probiotics (beneficial bacteria) was mixed with commercial feed before application @ 0.5 g kg<sup>-1</sup> feed following the instruction of the manufacturer. Stocked fry of tilapia were fed commercial floating diet at the decreasing rate of 10 - 5% of body weight thrice daily until the previous day of harvest.

Super biotic (*Bacillus* sp. recommended by manufacturer at strength of 10<sup>7</sup> CFU g<sup>-1</sup>), biozyme (*Bacillus subtilis* - 7 × 10<sup>9</sup> CFU g<sup>-1</sup> and *Saccharomyces cerevisiae* - 3 × 10<sup>12</sup> cells) and zymetin (*Bacillus mesentericus*, *Streptococcus faecalis* and *Clostridium butyricum*) were used with feed to assess their role on growth and yield of tilapia.

*Sampling:* Fish was sampled fortnightly to determine the growth and to adjust the feed rations. Body weight (g) was measured with a digital balance (CAMRY digital electrical balance Model EK 3052, Bangladesh). Behavior of tilapia was regularly observed especially after feeding in the morning and in the evening to determine their conditions such as movement, infection, colorations and diseases. Sampling was continued until harvest.

*Water quality variables:* Water quality variables *viz.* temperature, transparency, dissolved oxygen (DO) concentration, pH, total alkalinity, nitrate and ammonia were measured fortnightly intervals between 09 and 10 a.m. at the time of fingerling sampling. Surface water temperature was measured *in situ* by using a standard centigrade thermometer. Transparency was recorded by using a Secchi disc. Dissolved oxygen was measured by using a portable DO meter (YSI digital DO meter, Model 58, HANNA Company, USA). Pond water pH was monitored by using a hand held pH meter (Digital pH meter, Model HI 98107 HANNA Company, USA). Total alkalinity was measured by titrimetric method (APHA 2000). Nitrate and ammonia were measured by using nitrate and ammonia test kit, respectively (Biosol, A.A. Biotech PVT LTD., Fishtech BD LTD).

*Harvest:* Tilapia was harvested after 120 days of culture. All fish were caught from each cage at the same day by scooping. After harvest, all tilapia of the cages were counted and weighed individually to determine the survival rate, growth and yield. Survival rate (%), specific growth rate (SGR), food conversion ratio (FCR) and protein efficiency ratio (PER) were calculated following the

equation as cited by Pechsiri and Yakupitiyage (2005). The equations are as follows:

Survival rate (%):  $(\text{Number of fish harvested} \div \text{Number of fish stocked}) \times 100$

SGR ( $\% \text{ day}^{-1}$ ):  $\{\text{Ln (final body weight)} - \text{Ln (initial body weight)}\} \times 100 / \text{cultured period (day)}$ .

Feed conversion ratio (FCR):  $\text{Feed consumed (g dry weight)} / \text{Live weight gain (g wet weight) of fish}$ .

Protein efficiency ratio (PER):  $\text{Weight gain (g)} / \text{protein consumed (g)}$ .

Yield:  $\text{No. of fish caught} \times \text{average final weight of fish}$ .

Net profit margin:  $(\text{Net profit} / \text{Sales}) \times 100$ .

*Data analysis:* Survival and growth rate were transformed into square root before analysis. Mean were compared by using 1-way followed by Tukey's HSD post hoc for multiple comparisons. Level of significance considered in this study was  $p < 0.05$  by using SPSS (Statistical Package for Social Science) version 20.0.

## RESULTS AND DISCUSSION

*Survival rate and growth rate:* Survival rate of tilapia ranged from 89.52 to 91.43% (Table 1). In a previous study, survival rate of caged tilapia had been found to range from 95.76 to 97.54% (Ahmed *et al.* 2014) and 95.39 to 95.87% (Kunda *et al.* 2015), which are similar to the findings of present study.

Significantly higher final weight of tilapia was found in T<sub>3</sub> (275.88 g) than those of T<sub>4</sub> (202.45 g), T<sub>1</sub> (225.88 g) and T<sub>2</sub> (245.68 g), respectively (Fig. 1 and Table 1). The highest growth obtained in T<sub>3</sub> might be due to probiotics zymetin, which is very fine and attractive smell, and having three beneficial bacteria. Final weight of tilapia obtained in the present study is in agreement with the findings of Ahmed *et al.* (2014), who found final weight of tilapia as 207.90 - 271.48 g at 50m<sup>-3</sup> densities over 120 days rearing in suspended cages fed commercial diet supplemented with probiotics at Dakatia river, Chandpur. Kunda *et al.* (2015) has demonstrated that final weight of tilapia attained from 167.15 to 189.67 g for a 99 days period reared in net cages given floating feed without probiotics in a pond of Sylhet Agricultural University (SAU). Daily weight gain of tilapia varied from 1.69-2.30 g (Table 1) which is in agreement with the findings of Ahmed *et al.* (2014) who obtained daily weight gain 1.45 - 1.98 g by applying commercial floated feed with probiotics in cages. Ahmed *et al.* (2013) has also found daily weight gain 1.56 g by applying prepared feed and 1.78 g by using commercial feed for tilapia reared for 70 days period.

The highest SGR was found in T<sub>3</sub> (4.67%) while the lowest in the control group (Table 1). SGR found in other two treatments were also significantly different.

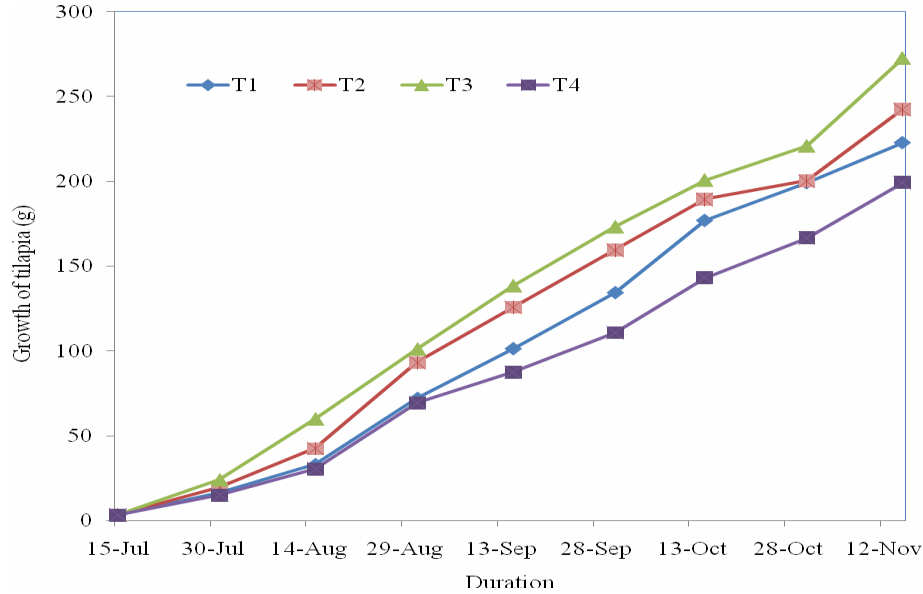


Fig. 1. Growth of tilapia measured in different treatments over 120 days culture duration.

**Table 1. Survival rate, growth and yield performance (mean  $\pm$  Sd) of male tilapia found in four treatments over 120 days culture**

Variables	Treatments			
	T <sub>1</sub> (Super biotic)	T <sub>2</sub> (Biozyme)	T <sub>3</sub> (Zymetin)	T <sub>4</sub> (Control)
Stocking density (nos. m <sup>-3</sup> )	35	35	35	35
Survival rate (%)	91.42 $\pm$ 2.86	90.48 $\pm$ 1.65	91.43 $\pm$ 2.86	89.52 $\pm$ 4.37
Average initial weight (g)	3.0 $\pm$ 0.11	3.0 $\pm$ 0.11	3.0 $\pm$ 0.11	3.0 $\pm$ 0.11
Average final weight (g)	225.88 $\pm$ 5.95 <sup>bc</sup>	245.68 $\pm$ 13.88 <sup>ab</sup>	275.88 $\pm$ 13.6 <sup>a</sup>	202.45 $\pm$ 14.71 <sup>c</sup>
Net final weight gain (g)	222.78 $\pm$ 5.95 <sup>c</sup>	242.56 $\pm$ 13.88 <sup>bc</sup>	272.78 $\pm$ 13.6 <sup>a</sup>	199.35 $\pm$ 14.71 <sup>c</sup>
Daily weight gain (g)	1.88 $\pm$ 0.05 <sup>bc</sup>	2.04 $\pm$ 0.12 <sup>ab</sup>	2.30 $\pm$ 0.12 <sup>a</sup>	1.69 $\pm$ 0.12 <sup>c</sup>
Specific growth rate (% day <sup>-1</sup> )	4.48 $\pm$ 0.03 <sup>bc</sup>	4.55 $\pm$ 0.06 <sup>b</sup>	4.67 $\pm$ 0.05 <sup>a</sup>	4.37 $\pm$ 0.07 <sup>c</sup>
FCR	1.23 $\pm$ 0.04 <sup>b</sup>	1.14 $\pm$ 0.07 <sup>bc</sup>	1.01 $\pm$ 0.05 <sup>c</sup>	1.38 $\pm$ 0.1 <sup>a</sup>
PER	2.53 $\pm$ 0.07 <sup>a</sup>	2.76 $\pm$ 0.16 <sup>a</sup>	3.1 $\pm$ 0.16 <sup>b</sup>	2.26 $\pm$ 0.17 <sup>a</sup>
Gross yield (kg m <sup>-3</sup> )	7.23 $\pm$ 0.41 <sup>bc</sup>	7.78 $\pm$ 0.31 <sup>ab</sup>	8.82 $\pm$ 0.36 <sup>a</sup>	6.35 $\pm$ 0.74 <sup>c</sup>
Net yield (kg m <sup>-3</sup> )	7.13 $\pm$ 0.41 <sup>bc</sup>	7.68 $\pm$ 0.31 <sup>ab</sup>	8.72 $\pm$ 0.32 <sup>a</sup>	6.25 $\pm$ 0.73 <sup>c</sup>

Mean values in the same row with same superscript letters are not significantly different ( $p < 0.05$ ).

SGR values observed in the present study is in agreement with the SGR value (4.60 - 4.72%) reported by Kunda *et al.* (2015). However, SGR value of this study was comparatively higher than the values of 2.97 - 3.09 and 3.10%, respectively demonstrated by Ahmed *et al.* (2013) and Diana *et al.* (1996).

*Fish yield:* The gross yield of tilapia obtained from all treatments ranged from 6.35 to 8.82 kg m<sup>-3</sup> with the highest yield (8.82 kg m<sup>-3</sup>) in T<sub>3</sub> and the lowest yield (6.35 kg m<sup>-3</sup>) in T<sub>4</sub> (Table 1). Ahmed *et al.* (2014) obtained 9.93-11.63 kg m<sup>-3</sup> of tilapia in cages at 50 m<sup>-3</sup> densities, which is slightly higher than the yield of the present study. The fish yield of the present study is almost similar to the yield (7.7 - 9.4 kg m<sup>-3</sup>) reported by Alam *et al.* (2014).

Food conversion ratio (FCR) of tilapia in this investigation was 1.01 - 1.38 (Table 1). However, FCR of tilapia in this study is similar to the findings of Kunda *et al.* (2015) and Ahmed *et al.* (2014), who found FCR of tilapia 1.18-1.25 and 1.11-1.41, respectively.

Protein efficiency ratio (PER) for tilapia yield in the present study varied from 3.1 - 2.26, which coincided with the finding of Saha and Khatun (2014), who found PER 2.81 - 3.97 at 5 m<sup>-3</sup> density for 105 days culture period by applying floating feed supplemented with probiotics.

*Water quality variables:* Water quality variables were presented in Table 2.

**Table 2. Water quality variables (mean ± Sd) recorded from the cages under different treatments during the study period of July-November 2015**

Water variables	Treatments			
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>
Temperature (°C)	28.6 ± 1.8	28.7 ± 1.9	28.6 ± 1.8	28.7 ± 1.9
Transparency (cm)	36.33 ± 1.48	35.62 ± 1.25	34.35 ± 1.52	35.28 ± 1.31
Dissolved Oxygen (mg/l)	4.92 ± 0.81	4.93 ± 0.79	4.91 ± 0.80	4.92 ± 0.75
pH	7.4 (7.0—7.5)	7.3 (7.0—7.4)	7.3 (7.0—7.4)	7.2 (7.0—7.4)
Total alkalinity (mg/l)	82.10 ± 2.62	83.11 ± 2.70	82.20 ± 2.60	82.15 ± 2.58
NO <sub>3</sub> -N (mg/l)	0.11 ± 0.03	0.10 ± 0.02	0.12 ± 0.03	0.10 ± 0.01
NH <sub>3</sub> -N (mg/l)	0.012 ± 0.002	0.012 ± 0.001	0.010 ± 0.002	0.013 ± 0.003

*Profit:* Profit of tilapia farming as obtained in the present study was highest (TK. 401.00 ± 83.35 m<sup>-3</sup>) in T<sub>3</sub> followed by T<sub>2</sub> (TK. 282.00 ± 73.33 m<sup>-3</sup>) and T<sub>1</sub> (TK. 212.00 ± 70.3 m<sup>-3</sup>). The lowest profit (TK. 119.00 ± 65.8 m<sup>-3</sup>) was found in controlled treatment (without probiotics, T<sub>4</sub>) (Fig. 2). Benefit cost ratio (BCR) was also highest in T<sub>3</sub> (1.61) followed by T<sub>2</sub> (1.43), T<sub>1</sub> (1.32) and T<sub>4</sub> (1.19) indicating that highest benefit was obtained from the treatment of zymetin probiotics (T<sub>3</sub>) which may be due to the three beneficial bacteria and efficient utilization of the

supplied feed. Production cost of zymetin probiotics treatment was more or less same as did the other treatments.

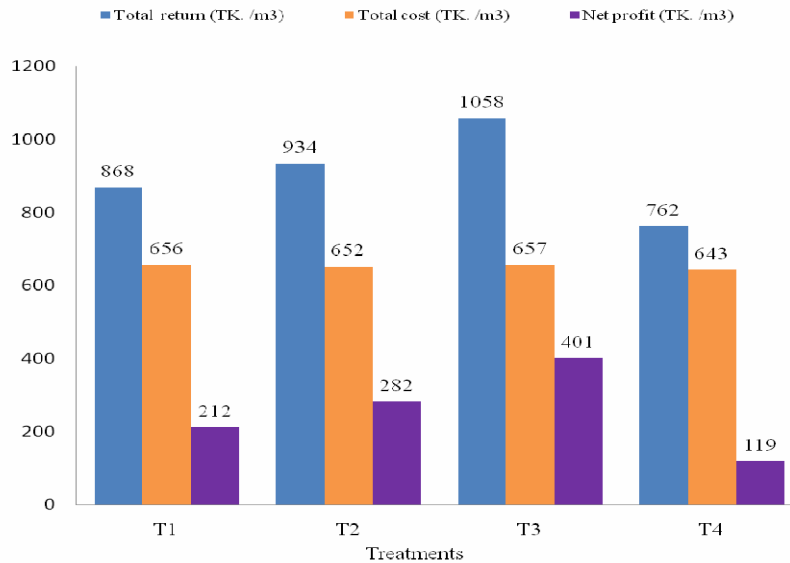


Fig. 2. Economic analysis of tilapia production in different treatments.

Results of the study demonstrated that zymetin probiotics treatment was better among the four in respect of survival rate, growth and fish yield. Therefore, it may be suggested to apply probiotics in tilapia cage culture system in the open/perennial waterbodies for increasing fish production with a satisfactory profit.

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