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EFFECT OF PROBIOTICS ON GROWTH AND YIELD OF NILE TILAPIA UNDER CAGE CULTURE AT DEKAR HAOR IN SUNAMGANJ

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Abstract

Probiotics effect with dietary supplemental feed on growth and yield of male tilapia (*Oreochromis niloticus*) in floating cages placed at Dekar haor of Sunamganj for 120 days was assessed. Four treatments *viz* T_1 (Safegut), T_2 (Biogen), T_3 (Super biotic) and T_4 (control) each with three replicates were used in the experiment. Tilapia were stocked in cages at a density of 40 no. m^{-3} with the average initial weight of 14.23-16.44 g and they were fed with commercial floating feed at a decreasing rate of 10-5% of total biomass thrice daily. Feed was supplemented mixed with probiotics at a rate of 0.5 g kg^{-1}. Higher growth (289.56±14.14g), survival rate (96.91%), yield (10.67±1.7 kg m^{-3}), net profit (BDT 845.25±86.8 m^{-3}) and lower food conversion ratio (1.13) were obtained in T_1 than those of other treatments, which were 4-5 times higher than the earthen pond production of tilapia in Bangladesh. The lowest growth, survival, production and higher FCR were found in control treatment where no probiotics was supplied. Therefore, results of the study suggest that probiotics may be applied to supplementary feed to boost up fish production.

***Keywords*:** Socioeconomic characteristics, production cost, return, factors, problems.

Introduction

Aquaculture is one of the fastest growing food production activities in the world rapidly during the last decade. It has been predictable as a growth area of economic importance in countries and has attracted the courtesy of both public and private sectors (FAO, 2012). 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). Male tilapia grow significantly faster than female and they are also larger in size than females (Ponzoni *et al*., 2005). This species is currently considered to be the most important and commonly cultured species around the world and constitutes over 70% of cultured tilapia (Fitzsimmons, 2004).

Cage farming is a rising technology to accelerate fish production. A widespread and profitable culture of fish and prawns in cages has already been developed successfully in Asia, Europe and America (Beveridge, 1987). This practice in South-East Asia first started from late 1800s, since then, many countries are practicing cage culture in freshwater and marine environments including ponds, rivers, haors, beels, open sea, estuaries, lakes, reservoirs, etc (Balcazar *et al*., 2006). Cage culture in open waterbodies like haor area could provide a prospect for increasing fish production, uplift of livelihood of rural fish farmers and mitigating protein demand in the nation.

Probiotics are referred as microorganisms promoting the growth of other microorganisms (Lilly and Stillwell, 1965). Probiotics are beneficial microorganisms or their products with the benefit effects to the hosts, have been used in aquaculture in order to control disease, as supplements for improving growth and in some cases as a mean of replacing antimicrobial compounds (Gatesoupe, 1999 and Irianto and Austin, 2002). Probiotics of live microbes have shown their effectiveness to mitigate the effects of stress, resulting in a greater production of Nile tilapia (Ghazalah *et al*., 2010). Olvera *et al*. (2001) and Salah *et al*. (2008) opined that yeast have a positive effect on fish performance when are cultured under stress condition of lowering dietary protein, leading to improving growth and feed efficiency.

Feed quality and feeding methods therefore need to be thoroughly considered in order to improve growth performance and feed efficiency of the cultured animals. Several earlier reports have suggested that probiotics supplementation can reduce disease outbreaks by enhancing the immune system of fish and shrimp, and can decrease culture costs by improving the growth and feed efficacy of fish (Pieters *et al*., 2008; Fernandez *et al*., 2011 and Peterson *et al*., 2012).

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Different brands of probiotics (Rapid grow, Biogen, Biozyme, Zymetin, Aqua photo, Aqua mazic, Ammonil, Safegut, Probio-Aqua, Super biotic, Super P S) in powder or liquid forms are found in markets. Most of the farmers of this country do not know the techniques of use and effect of these probiotics. A few works have been conducted on probiotics in shrimp culture in coastal region of Bangladesh to determine the mode of application of *Bacillus* probiotics (Islam *et al*., 2008). Few studies related to the usage of probiotics in aquaculture are available in Bangladesh (Ahmed *et al*., 2014 and Begum *et al*., 2017). But work related to use of probiotics in haor environment at floating cage farming is not available in Bangladesh. So it is needed to know the effect of probiotics mixed with supplementary feed on tilapia cage culture in haor condition. Considering these facts, the present research was undertaken aimed to evaluate the effect of probiotics on growth, survival and yield of monosex tilapia (*O. niloticus*) in cages.

Materials and Methods

The study was performed in the Dekar haor one of the most important and largest haor of Bangladesh. Dekar haor lies between latitude 24°46´N to 24°57´N and longitude 91°20´E to 91°31´E (Fig. 1). It is situated by the side of Sylhet-Sunamganj high way and close to Sunamganj district town. The study was conducted for a period of four months from July 1 to October 29, 2018.

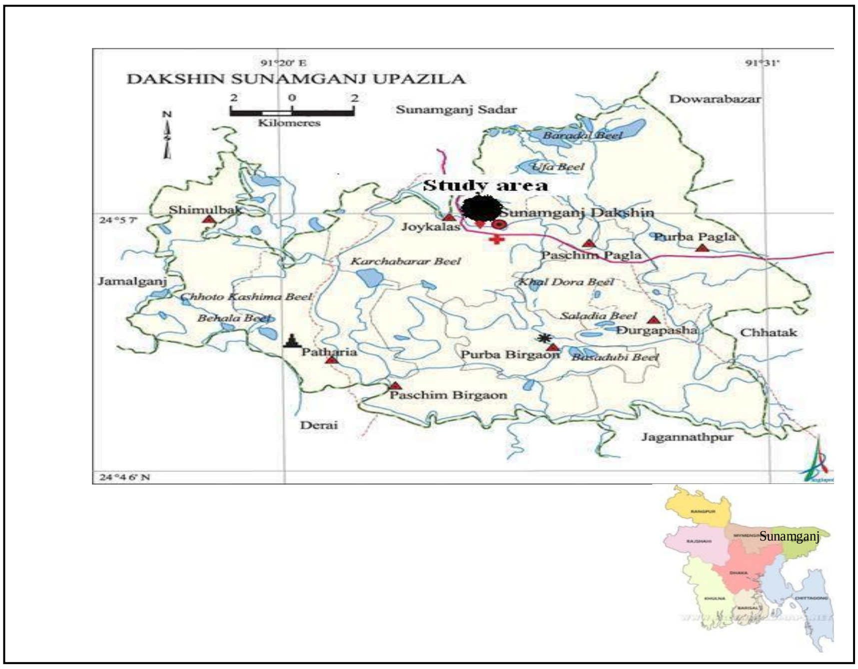

Fig. 1. Large black mark showing the study area in Dakshin Sunamganj upazilla

Twelve nylon net cages (1.5 × 3 × 3 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. Open part of each cage was covered with another piece of net (mesh 7.0-7.5 cm) to avoid escaping of fish and predation by bird. This study was a one factorial in which probiotics were the only experimental variable as T_1 (Safegut), T_2 (Biogen), T_3 (Super biotic) and T_4 (control) each with three replicates.

The place selected for setting the cages was cleaned manually and selected place was limed with agricultural lime ($CaCO_3$) at a rate of 250 kg ha^{-1}. After six days of liming, all cages were stocked with required quantity of fry of male tilapia (*O. niloticus*) at a density of 40 no. m^{-3} with the average initial weight of 14.23-16.44 g. Monosex tilapia fry were purchased from Pirojpur private fish hatchery, Sylhet sadar, Sylhet and was transported in oxygenated polythene bags from hatchery to experimental area. Before stocking, fry were acclimatized to the cage water for one and half hour period. Initial weight and length of 10% fishes were recorded before stocking in cages. Stocked fry of tilapia were fed with commercial mega floating feed at a decreasing rate of 10-5% of body weight thrice daily until the previous day of harvest. Proximate compositions as moisture, crude protein, crude lipid, ash, crude fiber, carbohydrate of supplemented feed were respectively 11, 30, 7, 15, 8 and 29%. Probiotics namely Safegut, Biogen and Super biotic were mixed with commercial feed at a rate of 0.5 g kg^{-1} of feed following the instruction of the manufacturer to assess their role on growth and yield of monosex tilapia (Table 1). Total daily feed ration was divided into three equal portions and was applied in the morning between 8.00-9.00 am, at noon 12.00-1.00 pm and in evening 5.00-6.00 pm. Feeding amount was adjusted every 15-day intervals depending on the body weight of stocked tilapia. Net of the cages were cleaned and checked every 7-day intervals. Behavior of tilapia was regularly observed specially after providing feed in the morning and in the evening to determine their conditions as movement, feeding intensity, body colour and diseases.

Table 1. Name of beneficial bacteria of experimental probiotics

Brand name of probiotics	Name of beneficial bacteria	No. of treatment	Dose of probiotics
Safegut	*Bacillus subtilies*, *B. licheniformis*, *Saccharomyces boulardii*, *S. cerevisiae*, *Aspergillus oryzae*, *A. niger* and *Lactobacillus sporangos*	T_1	$0.5\ g\ kg^{-1}$ of feed
Biogen	*B. subtilis* and *L. rhamnosus*	T_2	
Super biotic	*Bacillus* sp.	T_3	
---	-----	T_4	without probiotics

Water quality parameters like surface temperature, transparency, dissolved oxygen (DO) concentration, pH, total alkalinity and ammonia were determined at fortnightly intervals between 9.00-10.00 am at the time of fingerlings sampling. Surface water temperature was measured on the spot using a standard centigrade thermometer. Transparency was recorded using Secchi disc. Dissolved oxygen was determined using a portable DO meter (YSI digital DO meter, Model 58, HANNA Company, America). pH of cage water was recorded using pH meter (HANNA Company, America). Total alkalinity was measured by titrimetric method (APHA, 2000). Ammonia nitrogen was measured using ammonia test kit (Biosol, A.A. Biotech PVT LTD., Fishtech BD Ltd).

Fortnightly sampling was done to determine growth of tilapia fry and to adjust the feed rations. Growth was measured regarding weight (g) with digital balance and length by measuring scale. Tilapia were totally harvested after 120 days of culture. They were caught using hand scoop net and lifting all cages from water on the same day. After harvest, all tilapia of cages were counted and weighed individually to determine growth, survival rate and yield. Specific growth rates (SGR), food conversion ratio (FCR) and survival rate (%) were calculated following the equation as cited by Pechsiri and Yakupitiyage (2005). The equations are as follows:

Weight gain = Mean final weight – mean initial weight
Survival rate (%) = (Number of fish harvested ÷ total number of fish stocked) × 100
SGR (% /day) = {Ln (final body weight) – Ln (initial body weight) × 100}/cultured period.
Feed conversion ratio (FCR) = Feed consumed (g dry weight)/live weight gain (g wet weight) of fish
Yield of fish = No. of fish caught × (average final weight of fish–average initial weight fish)

Economic analyses of tilapia cage farming under different treatments was calculated on the basis of purchasing prices of tilapia fry, feed, fertilizers, lime, transport cost, cage materials and revenue from the sale of harvested tilapia. At the end of the study, all fish were sold at local market. Tilapia was sold at a rate of Tk. 120.00 kg^{-1}. Net profit and cost-benefit ratio (BCR) were calculated using the following formula:

Net profit = Total return – total cost and BCR = Total return ÷ total cost

Survival rate, growth and yield variables were analyzed using one way analysis of variance (ANOVA) to compare the treatments means. If the main effect showed significant, the ANOVA was followed by Duncan's Multiple Range Test. All ANOVA were tested at 5% level of significance using SPSS (Statistical Package for Social Science) version 20.

Results and Discussion

Water quality variables

Fortnightly water quality parameters like water temperature, transparency, dissolved oxygen, pH, alkalinity and ammonia of this study were determined. Values of surface water temperature in the present study were 26.9-30.8ºC (Fig. 2a). Begum *et al.* (2017), Islam and Hossain (2017) and Dev (2015) recorded the temperature of tilapia cage water in SAU campus and in haor village ponds as 26.8-30.9, 27.0-30.5 and 28.5ºC, respectively which are similar to the result of the present work.

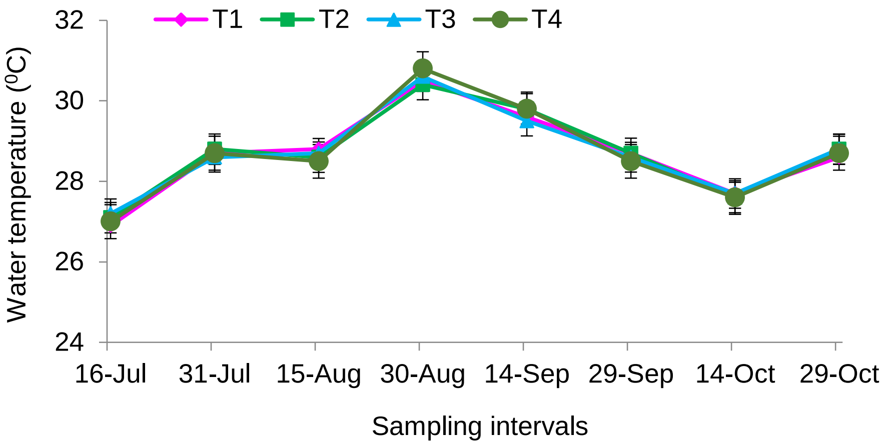

Fig. 2a. Variation of water temperature in four different treatments in the haor

Water transparency in this study ranged from 29.5 to 41.0 which is resemblance with the result of Begum *et al.* (2017), who recorded transparency as 30.0 to 40.9 cm, respectively. Dissolved oxygen (DO) concentration of the study was 5.1 to 6.5 mg l^{-1} (Fig. 2b), which is consistent with the results of Begum *et al.* (2017) and Dev (2015), who recorded DO as 4.5-6.1 mg l^{-1} and 5.25 mg l^{-1}, respectively at SAU pond.

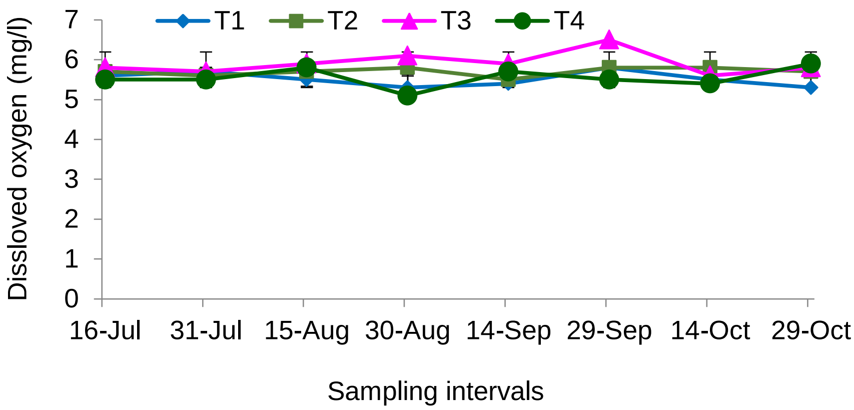

Fig. 2b. Variation of dissolved oxygen in four different treatments in the haor

Water pH of this study varied within 6.9 to 7.6 (Fig. 2c), which is little bit higher than the pH values of 6.5-7.0 obtained by Begum *et al.* (2017). But result of this study is coincided with the result demonstrated by Islam and Hossain (2017), who recorded pH of water in ponds as 7.0-7.7. Values of total alkalinity were in the range of 122.10-128.10 mg l^{-1} in all cages. Begum *et al*. (2017) recorded total alkalinity was ranging from 80.0-85.7 mg l^{-1} in cages, which is comparatively lower than the result of the present experiment. Concentrations of ammonia nitrogen in all treatments varied between 0.010 and 0.012 mg l^{-1}. This finding has the resemblance with the results of Begum *et al.* (2017), who recorded 0.010-0.013 mg l^{-1} ammonia concentration in the SAU research pond.

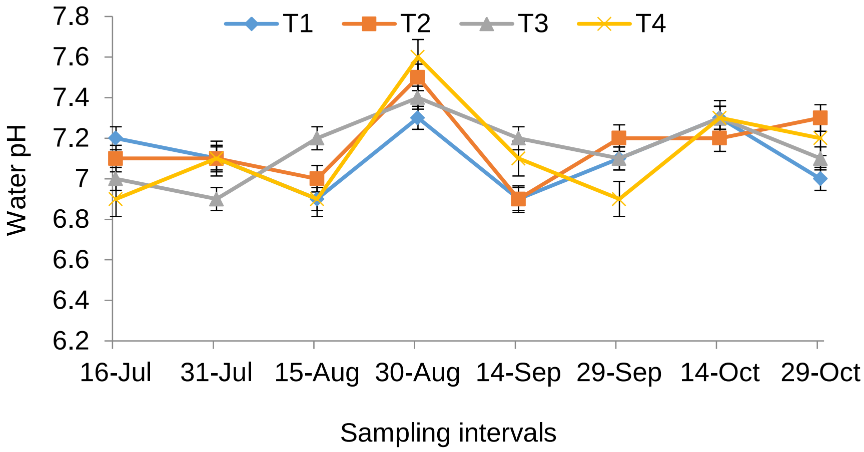

Fig. 2c. Variation of water pH in four different treatments in the haor

Growth and yield of male tilapia

Final weight of tilapia was the highest in T_1 (289.56±14.14 g) followed by T_2 (219.42±16.22 g), T_3 (204.67±13.44 g) and T_4 (169.33±14.24 g), respectively (Table 2 and Fig. 3). Begum *et al.* (2017) recorded final weight of tilapia attained from 202.45-275.88 g at 35 no. m^{-3} densities for 120 days reared in net cages supplied floating feed with probiotics in a pond of Sylhet Agricultural University (SAU), Bangladesh. Ahmed *et al.* (2014) demonstrated final weight of tilapia as 207.90-271.48 g at 50 no. m^{-3} densities over 120 days rearing in suspended cages fed commercial diet supplemented with probiotics in Dakatia river, Chandpur, Bangladesh. These results are in agreement with the findings of the present research.

Table 2. Growth, survival rate and yield (mean±Sd) of *Oreochromis niloticus* in four treatments during study period of 120 days

Parameter	Treatments			
	T_1 (Safegut)	T_2 (Biogen)	T_3 (Super biotic)	T_4 (Control)
Stocking density (no. m^{-3})	40	40	40	40
Average initial weight (g)	14.23±2.14	15.0±2.87	15.25±3.1	16.44±3.07
Average final weight (g)	289.56^{a}±14.14	219.42^{b}±16.22	204.67^{c}±13.44	169.33^{d}±14.24
Daily weight gain (g)	2.29	1.70	1.58	1.27
Survival rate (%)	96.91	95.31	91.48	91.29
Specific growth rate (% day^{-1})	2.51	2.24	2.17	1.94
FCR	1.13	1.20	1.45	1.70
PER	2.85	2.72	2.51	2.10
Yield (kg m^{-3})	10.67^{a}±1.70	7.79^{b}±1.14	6.94^{c}±1.80	5.58^{d}±1.24

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

Daily weight gain of male tilapia in the present work varied from 1.27-2.29 g over 120 days culture periods with supplied floating feed, which is similar to the findings of Ahmed *et al.* (2014) and Begum *et al.* (2017), who recoded daily weight gain of *O. niloticus* as 1.45 to 1.98 g and 1.69 to 2.30 g, respectively in net cages supplied floating feed mixed with probiotics.

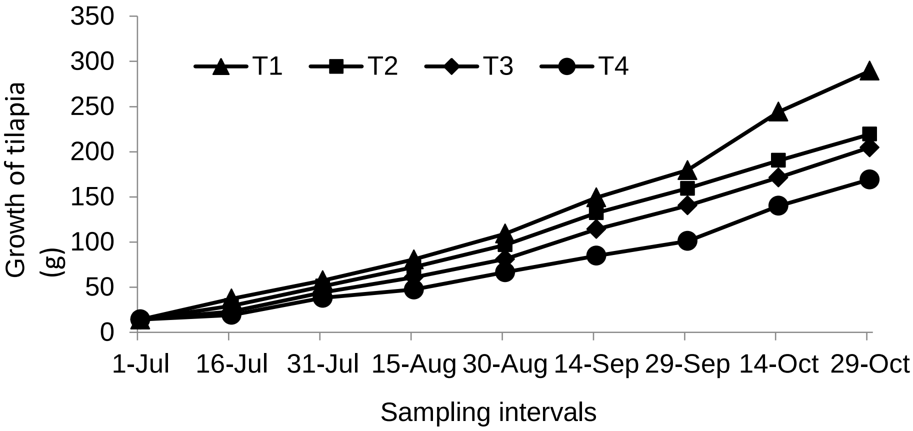

Fig. 3. Growth rate of tilapia reared in four treatments at haor conditions

Survival rate of male tilapia in the present investigation was 91.29-96.91% (Table 2). Higher survival of tilapia was found in T_1 (96.91%) followed by T_2 (95.31%), T_3 (91.48%) and T_4 (91.29%). Survival rate of cage reared tilapia varied from 95.76-97.54% (Ahmed *et al.*, 2014) and from 95.39-95.87% (Dev, 2015), which are supported to that of present study. Begum *et al.* (2017) obtained the survival rate of tilapia in cage culture at closed waterbody as 89.52-91.43%, which is slightly lower than the present findings.

Specific growth rate (SGR) of tilapia ranged within 1.94-2.51%. SGR was comparatively higher in T_1 (2.51%) and lower in T_4 (1.94%) (Table 2). The observed SGR values of the present work were higher than the findings made by Ahmed *et al.* (2014), who recorded 1.52-1.74% in Dakatia river. Diana *et al.* (1996) reported SGR of *O. niloticus* as 3.10% using feed and fertilizers in earthen pond of Thailand. Ahmed *et al.* (2013) obtained SGR of monosex tilapia as 3.09% using prepared feed (55.24% protein) and Begum *et al.* (2017) recorded SGR of cage reared tilapia in perennial freshwater pond as 4.37-4.67%, which are higher than the present research due to initial size of stocked tilapia recorded by the above researchers was lower than this work. Food conversion ratio (FCR) of tilapia in the present study varied from 1.13-1.70 (Table 2). The findings of the present study are coincided with the findings of Dev (2015), Ahmed *et al.* (2014) and Begum *et al.* (2017), who recorded FCR of tilapia in cage culture as 1.18 to 1.25, 1.11 to 1.41 and 1.01 to 1.38, respectively. Protein efficiency ratio (PER) of tilapia was significantly higher in T_1 (2.85) than those of T_2 (2.72), T_3 (2.51) and T_4 (2.10), respectively. Begum *et al.* (2017) reported PER as 2.26-3.10 in cage culture, which is comparable to the findings of this study.

Yield of tilapia recorded from all treatments ranged from 5.58-10.67 kg m^{-3} with the highest yield (10.67 kg m^{-3}) in T_1 and the lowest yield (5.58 kg m^{-3}) in T_4 (Table 2). The finding of the present study is slightly lower than the finding of Moniruzzaman *et al.* (2015), who reported tilapia production from cages as 12.4 kg m^{-3} at 50 m^{-3} densities in Kaptai Lake. But the result of this study of tilapia cage farming in Dekar haor condition was higher than the finding of Begum *et al.* (2017), who recorded yield of tilapia as 6.35-8.82 kg m^{-3} in freshwater pond of SAU.

In the present study, net profit of tilapia farming in cages was the highest (BDT 845.25±86.80 m^{-3}) in T_1 followed by T_2 (BDT 522.35±88.11 m^{-3}), T_3 (BDT 442.30±82.23 m^{-3}) and T_4 (BDT 315.27±91.60 m^{-3}) (Fig. 4). Benefit cost ratio (BCR) was also highest in T_1 (2.94) followed by T_2 (2.26), T_3 (2.13) and T_4 (1.89) indicating that highest profit was found from the treatment of safegut probiotics (T_1). The reason behind that was the strong positive role of using safegut with supplemented feed owing to this probiotics contains more than four beneficial bacteria and supplemented feed was efficiently utilized. From the above discussion it may conclude that safegut probiotics is better than other two types of probiotics. So it can be used with supplementary feed in tilapia cage culture for getting higher yield and profit. It is proven that more beneficial bacteria mean more production and more benefit, which is supported by many researchers (Moriarty, 1996a; El-Haroun *et al*., 2006 and Verma and Gupta, 2015).

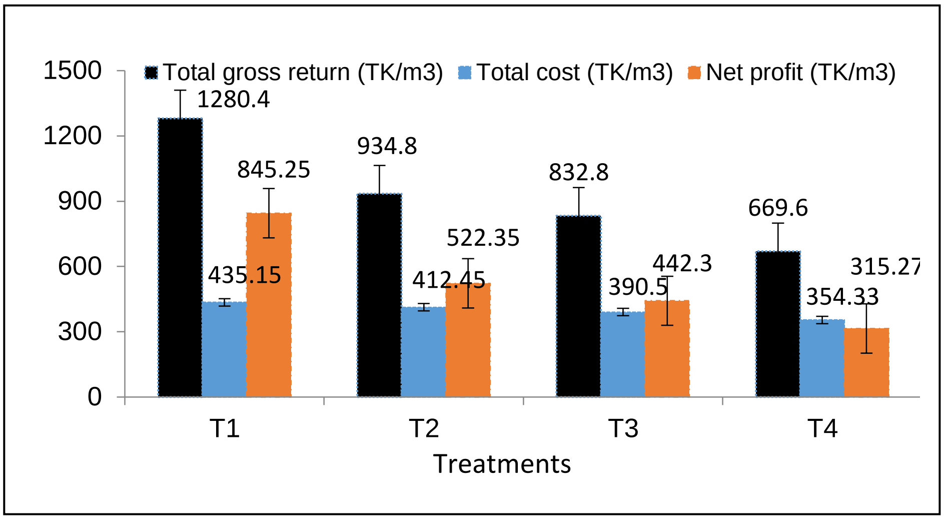

Fig. 4. Cost and profit of tilapia farming under different treatments in haor condition

In Bangladesh, most of the open waterbodies remain fallow round the year due to useful guidelines have yet not been formulated to manage the floodplain/wetland resources. But these are most valuable. These valuable resources may easily bring under modern cage culture practices in planned way for increasing fish production and consumption of fish in the country. Findings of the study indicate that safegut probiotics is better than other two probiotics in the context of growth, production and profit. If fry of monosex tilapia and other inputs can be made available to the farmers in time with fair price, production of tilapia would be increased, which help to accelerate of the farmers' income as well as national nutritional status.

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