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EFFECTS OF DUCKWEED (*Lemna minor*) AS SUPPLEMENTARY FEED ON MONOCULTURE OF GIFT STRAIN OF TILAPIA (*Oreochromis niloticus*)

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ABSTRACT

An experiment was conducted for a period of 135 days on the effect of duckweed (*Lemna minor*) as supplementary feed on monoculture of GIFT strain of tilapia (*Oreochromis niloticus*). The experiment had two treatments, each with three replications. In treatment-1 ponds were supplied with duckweed as supplementary fish feed and in treatment-2 ponds were kept as control (without supply of duckweed). Ponds were stocked at a stocking density of 150 fingerlings per decimal. The ponds were fertilized fortnightly with poultry dropping at the rate of 5 kg/decimal, urea 60g/decimal and TSP 90g/decimal. Duckweeds were supplied to the ponds (treatment-1) at the rate of 60% of the total body weight (wet weight basis) of the fish. During the experimental period, the ranges of physico-chemical parameters viz, water temperature, transparency, dissolved oxygen, pH, total alkalinity, free CO_2, PO_4-P, and NO_3-N were within the productive limit and more or less similar in all the ponds under treatments 1 and 2. There were 24 genera of phytoplankton under 5 major groups and 10 genera of zooplankton under 3 major groups were found in the experimental ponds. Mean survival rates in treatments 1 and 2 were 85.34% and 83.68% respectively. Specific growth rate (SGR, % per day) of the fish in treatments 1 and 2 were 1.90% and 1.60% respectively. Calculated net production of the fish in treatment-1 was 5.03 ton/ha/yr and in treatment-2 was 3.11 ton/ha/yr. By t test it was found that the net production of fish in treatment-1 was significantly ($p<0.05$) higher than that of treatment-2.

Key Words : Duckweed, Supplementary feed, Monoculture, GIFT

INTRODUCTION

Aquaculture in Bangladesh has rapidly progressed in recent years with a contribution of 44% to the annual fish production (DoF, 2005). Among different techniques of aquaculture, monoculture is one of the most important techniques. Monoculture is mainly practiced in seasonal ponds to get maximum production within short period (4-6 months). Bangladesh has numerous seasonal water bodies in the form of shallow ponds, ditches, road side canals, pits in rice fields which retain water for 4-6 months. In seasonal ponds and ditches GIFT (*Oreochromis niloticus*) can be a promising species for aquaculture because it attains marketable size within a short period of time. The natural environment

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of Bangladesh is suitable for growing this as it is an omnivorous fish and it can be cultured in both shallow seasonal ponds and deeper perennial ponds.

Supplementary feed is one of the key inputs in fish culture to get higher production. Duckweeds are small floating aquatic plants which are widely available in Bangladesh and consist of four genera viz, *Lemna*, *Spirodela*, *Wolfia* and *Wolfiella* among which about 40 species have been identified (Journey *et al.*, 1991; Skillikorn *et al.*, 1993). Duckweed can easily grow abundantly with minimum cost and can be made available as much cheaper feed than other alternative plant protein sources. Recently duckweed has been accepted as protein rich (40-45% of the dry weight) feed for fish (Leng *et al.*, 1995; Saha *et al.*, 1999). In Bangladesh few research works have been carried out on the biology and application of duckweed. Duckweed protein has higher concentration of essential amino acids, lysine and methionine than most plant proteins and more closely resembles animal protein in that respect (Journey *et al.*, 1991). Considering all these factors duckweed (*Lemna minor*) was selected as supplementary feed for fish in monoculture of GIFT strain of tilapia, *Oreochromis niloticus*.

MATERIALS AND METHODS

The experiment was conducted for a period of 135 days from July to November 2005 in the earthen ponds each measuring 40 m^2 (1 decimal) area at the south-east corner of the Faculty of Fisheries Building, Bangladesh Agricultural University, Mymensingh. Before fish stocking water of the experimental ponds were drained out to eradicate all the undesirable fishes and renovated. Liming was done in all the ponds at the rate of 1 kg/decimal. The ponds were then filled up with deep tubewell water and fertilized with poultry dropping, urea and TSP at the rate of 10 kg/decimal, 100 g/decimal and 100 g/decimal respectively.

The experiment had two treatments each with three replications. In treatment 1 ponds were supplied with duckweed as supplementary fish feed and in treatment 2 ponds were kept as control (without duckweed). Ponds were stocked at a stocking density of 150 fingerlings of Gift tilapia per decimal. The initial average length and weight of tilapia were 4 cm and 5 g respectively. The ponds were fertilized fortnightly at the rate of 5 kg, 60g and 90g/decimal of poultry dropping, urea and TSP respectively. Duckweeds were supplied every day to the ponds of treatment 1 at the rate of 60% of the total body weight (wet weight basis) of the fish.

Water quality parameters

Various physical, chemical and biological parameters of water quality of pond waters such as water temperature (^oC), transparency (cm), dissolved oxygen (mg/l), pH, free CO_2 (mg/l), total alkalinity (mg/l), PO_4-P (mg/l), NO_3-N (mg/l), phytoplankton density (cells/l), and zooplankton density (cells/l) were recorded and estimated fortnightly. Water temperature was recorded with a Celsius thermometer and transparency was measured with a secchi disc of 30-cm diameter. Dissolved oxygen was measured directly with a DO meter (Lutron, DO-5509) and a digital pH meter (CORNING pH meter 445) was used to measure pH. Free CO_2 and total alkalinity were determined by titrimetric method (APHA, 1981). PO_4-P (mg/l) and NO_3-N (mg/l) were determined by a Hach Kit (DR/2010, a direct reading Spectrophotometer). The counting of both phytoplankton and zooplankton was done with the help of Sedgwick-Rafter Counting Cell (S-R cell) under a compound binocular microscope. The plankton population was determined by using the formula of Rahman (1992). Identification of planktons up to generic level were made according to Needham and Needham (1963); Belcher and Swale (1978).

Survival, growth and production of fish

Fish samples were collected monthly with a cast net to estimate the growth in length (cm) and in weight (g) and to check up the health condition of fish. At the end of the experiment, all fish were harvested through repeated netting by seine net.

The survival rate was estimated by using the following formula:

$$\text{Survival rate (\%)} = \frac{\text{Total No. of harvested fishes}}{\text{Initial no. of fishes}} \times 100$$

Specific growth rate (SGR, % per day) was estimated by the following formula :

$$\text{SGR (\% per day)} = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{T_2 - T_1} \times 100 \text{ (after Brown, 1957)}$$

Where, W_1 = Initial live body weight (g) at time T_1 (day)
W_2 = Final live body weight (g) at time T_2 (day)

$$\text{Calculated gross production (ton/ha/yr)} = \frac{\text{Gross weight (kg) of fish/decimal/month} \times 250 \times 12}{1000}$$

$$\text{Calculated net production (ton/ha/yr)} = \frac{\text{Net weight (kg) of fish/decimal/month} \times 250 \times 12}{1000}$$

Statistical analysis

T-test of net fish production of the ponds under treatment 1 and treatment 2 was done by a computer using SPSS package programme.

RESULTS AND DISCUSSION

Water quality parameters

Throughout the study period, a number of physical, chemical and biological water quality parameters of the ponds such as water temperature (°C), transparency (cm), dissolved oxygen (mg/l), pH, free CO_2 (mg/l), total alkalinity (mg/l), PO_4-P (mg/l), NO_3-N (mg/l), phytoplankton density (cells/l), and zooplankton density (cells/l) were determined (Table 1). All physical and chemical parameters of the ponds water were found to be within the acceptable ranges for the fish culture and there was no abrupt change in any parameter of the pond water during the tenure of experiment. The results were more or less similar to the findings of Wahab *et al.* (1995); Kohinoor *et al.* (1998). The generic distribution of phytoplankton and zooplankton found during the tenure of experiment are shown in Table 2. Plankton (phytoplankton and zooplankton) population in number and genera were more or less similar to the findings of Tasneem (1998); Rashid (1999); Israfil (2000).

Table 1. Water quality parameters of the experimental ponds during the experimental period

Parameters	Treatment-1 (Mean ± SD)	Treatment-2 (Mean ± SD)
Temperature (°C)	30.26 ± 1.85	30.46 ± 1.68
Transparency (cm)	31.63 ± 1.85	36.50 ± 1.69
Dissolved oxygen (mg/l)	6.53 ± 0.79	6.48 ± 0.74
pH	7.35 ± 0.19	7.31 ± 0.29
Free CO_2 (mg/l)	3.09 ± 0.46	3.25 ± 0.42
Alkalinity (mg/l)	89.38 ± 16.35	81.69 ± 14.81
Phosphate-phosphorous (mg/l)	0.89 ± 0.13	0.98 ± 0.11
Nitrate-nitrogen (mg/l)	1.76 ± 0.16	1.88 ± 0.26
Phytoplankton ($x10^3$ cells/l)	53.16 ± 5.48	44.10 ± 4.92
Zooplankton ($x10^3$ cells/l)	9.55 ± 1.12	8.10 ± 1.55

Table 2. Generic status of phytoplankton and zooplankton found in the experimental ponds

Phytoplankton		Zooplankton
Bacillariophyceae	**Cyanophyceae**	**Crustacea**
Asterionella	*Anabaena*	**Cladocera**
Cyclotella	*Aphanocapsa*	*Daphnia*
Diatoma	*Chroococcus*	*Diaphanosoma*
Fragilaria	*Gomphospaeria*	
Navicula	*Microcystis*	**Copepoda**
Synedra	*Oscillatoria*	*Cyclops*
Tabellaria		*Diaptomus*
Chlorophyceae	**Dinophyceae**	
Actinastrum	*Ceratium*	**Rotifera**
Chlorella	**Euglenophyceae**	*Asplanchna*
Closterium	*Euglena*	*Brachionus*
Gloeocystis	*Phacus*	*Filinia*
Oocystis		*Keratella*
Pediastrum		*Polyarthra*
Scenedesmus		*Trichocerca*
Ulothrix		
Volvox		

Survival, growth and production of fish

The details of survival rate, growth and production of fish are presented in Table 3. The survival rate of *Oreochromis niloticus* in treatment 1 and treatment 2 were 85.34% and 83.68% respectively. In treatment-1 SGR value recorded was 1.90% and in treatment-2 SGR value recorded was 1.60%. SGR value in treatment-1 was little higher than that in treatment-2. SGR values obtained in the present study are similar to that obtained by Hossain *et al.* (1997). It can be said that the higher specific growth rate in treatment-1 was due to use of duckweed as a supplementary feed for tilapia (*O. niloticus*). The gross and net productions of fish of the ponds under treatment-1 were 5.53 ton/ha/yr and 5.03 ton/ha/yr and those of the ponds under treatment-2 were 3.61 ton/ha/yr and 3.11 ton/ha/yr respectively. Percent increase of net production of fish of treatment-1 over treatment-2 was 161.74%. Kohinoor *et al.* (1999) observed the effectiveness of duckweed as low cost supplementary feed through 6 months production trial of Thai sharpunti. Bornali (2004) found 4.99 ton/ha/yr net production of tilapia (*O. niloticus*) where fresh duckweed was supplemental feed and the production was significantly higher in pond with supply of duckweed than that of the ponds without supply of duckweed.

Table 3. Survival rate, growth and production (gross and net) of fish under treatment-1 and treatment-2

Treatments	Survival rate (%)	Total initial weight (kg/dec.)	Total final weight (kg/dec.)	Specific growth rate (SGR % per day)	Production (kg/dec/yr)		Production (ton/ha/yr)		Percent increase of net production of treatment-1 over treatment-2*
					Gross	Net	Gross	Net	
1	85.34	0.75	22.11	1.90	22.11	20.11	5.53	5.03	161.74%
2	83.68	0.75	14.44	1.60	14.44	12.44	3.61	3.11	

*Treatment-2 was taken for 100%

Most of the water quality parameters of the ponds under treatment 1 and treatment 2 were more or less similar but the higher production of fish was recorded in treatment 1. The reason behind the higher production in treatment 1 was due to supply of duckweed as supplementary feed. T test of net productions shows that difference between treatment 1 and treatment 2 are statistically significant ($p<5\%$) i. e. influence of duckweed on production of fish is positively significant. Finally, it can be concluded that duckweed might be used as one of the most preferable supplementary feed items for GIFT tilapia (*O. niloticus*).

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