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Duckweed (*Lemna minor*) as Supplementary Feed in Monoculture of Nile Tilapia, *Oreochromis niloticus*

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Abstract: An experiment on duckweed (*Lemna minor*) as supplementary feed in monoculture of nile tilapia (*Oreochromis niloticus*) was conducted for a period of 90 days. 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 80 fingerlings per decimal. The ponds were fertilized fortnightly with poultry dropping at the rate of 5 kg decimal^{-1}, urea 60 g decimal^{-1} and TSP 90 g decimal^{-1}. 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 27 genera of phytoplankton under five major groups and 11 genera of zooplankton under three major groups were found in the experimental ponds. Mean survival rates in treatments 1 and 2 were 94.37 and 93.75%, respectively. Specific growth rate (SGR, % per day) of the fish in treatments 1 and 2 were 1.16 and 0.80%, respectively. Calculated net production of the fish in treatment-1 was 16.28 kg decimal^{-1} year^{-1} and in treatment-2 was 8.92 kg decimal^{-1} year^{-1}. 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, nile tilapia, *Oreochromis niloticus*

INTRODUCTION

Aquaculture in Bangladesh has rapidly progressed in recent years with a contribution of 44% to the annual fish production (Anonymous, 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 nile tilapia (*Oreochromis niloticus*) can be a promising species for aquaculture because it attains marketable size within a short period of time. The natural environment 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.

The present study of use of duckweed as supplementary feed in monoculture of nile tilapia was undertaken to evaluate the efficacy of duckweed (*Lemna minor*) as a low cost supplementary feed.

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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 (Landolt and Kandeler, 1987; Leng *et al*., 1995; Saha *et al*., 1999). According to Porath and Agami (1977), the weight of grass carp could be tripled (from 100 to 300 g) within 50 days when feeding a mixture of *Lemna gibba* and *Lemna minor*. In Bangladesh few research works have been carried out on the biology and application of duckweed (Zaher *et al*., 1995; Hossain *et al*., 1997). 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 nile tilapia, *Oreochromis niloticus*.

MATERIALS AND METHODS

The experiment was conducted for a period of 90 days from July to October 2004 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, renovated and liming was done in all the ponds at the rate of 1 kg $decimal^{-1}$. Ponds were filled up with DTW water and fertilized at the rate of poultry dropping 10 kg $decimal^{-1}$, urea 100 g $decimal^{-1}$ and TSP 100 g $decimal^{-1}$ as initial doses.

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 80 fingerlings of tilapia per decimal. The initial average length and weight of tilapia were 10 cm and 30 g, respectively. The ponds were fertilized fortnightly with poultry dropping at the rate of 5 kg $decimal^{-1}$, urea 60 g $decimal^{-1}$ and TSP 90 g $decimal^{-1}$. Duckweeds were supplied to the fish culture ponds (treatment-1) at the rate of 60% of the total body weight (wet weight basis) of the fish every day.

Water Quality Parameters

Various physical, chemical and biological water quality parameters of ponds water such as water temperature (°C), transparency (cm), dissolved oxygen (mg L^{-1}), pH, free CO_2 (mg L^{-1}), total alkalinity (mg L^{-1}), PO_4-P (mg L^{-1}), NO_3-N (mg L^{-1}), phytoplankton density (cells L^{-1}) and zooplankton density (cells L^{-1}) were 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^{-1}) and NO_3 N (mg L^{-1}) were determined by a Hach Kit (DR/2010, a direct reading Spectrophotometer). The counting of plankton (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 plankton (phytoplankton and zooplankton) up to generic level were made according to Needham and Needham (1963) and Belcher and Swale (1978).

Survival, Growth and Production of Fish

Fish samples were collected with a cast net monthly 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 the following formula:

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

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

$$\text{SGR (\% per day)} = \frac{\text{Loge } W_2 - \text{Loge } W_1}{T_2 - T_1} \times 100$$

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)

Statistical Analysis

T-test of net fish production of the ponds under T_1 and T_2 was done by a computer using SPSS package programme.

RESULTS

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^{-1}), pH, free CO_2 (mg L^{-1}), total alkalinity (mg L^{-1}), PO_4-P (mg L^{-1}), NO_3-N (mg L^{-1}), phytoplankton density (cells L^{-1}) and zooplankton density (cells L^{-1}) were determined. The results of water quality parameters are shown in Table 1. All physical and chemical parameters of the ponds water were found to be within the acceptable ranges for the fish culture. The generic status of phytoplankton and zooplankton found during the tenure of experiment are shown in Table 2.

Table 1: Water quality parameters (X±SD) of the experimental ponds during the experimental period

	Treatments			
	Treatment-1		Treatment-2	
Parameters	Mean	SD	Mean	SD
Temperature (°C)	28.30	2.45	28.59	2.51
Transparency (cm)	28.66	1.66	34.50	3.22
Dissolved oxygen (mg L^{-1})	7.64	1.53	7.29	0.83
pH	7.53	0.33	7.58	0.52
Free CO_2 (mg L^{-1})	3.25	1.03	3.33	0.87
Alkalinity (mg L^{-1})	59.75	8.41	64.58	10.34
Phosphate-phosphorous (mg L^{-1})	1.18	0.27	1.15	0.26
Nitrate-nitrogen (mg L^{-1})	1.94	0.31	1.89	0.41
Phytoplankton (×10^3 cells L^{-1})	49.88	3.96	40.24	4.42
Zooplankton (×10^3 cells L^{-1})	7.92	0.40	5.17	0.58

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

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

Table 3: Survival rate, growth and production (gross and net) of fish under T_1 and T_2

Treatments	Survival rate (%)	Total initial weight (kg dec.$^{-1}$)	Total final weight (kg dec.$^{-1}$)	Specific growth rate (SGR% per day)	Production (kg dec.$^{-1}$ year^{-1}) Gross	Net	Percent increase of net production of T1 over T2*
1	94.37	2.40	25.88	1.16	25.88	16.28	182.51%
2	93.75	2.40	18.52	0.80	18.52	8.92	

*: Treatment-2 was taken for 100%

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 T_1 and T_2 were 94.37 and 93.75%, respectively. In T1 SGR value recorded was 1.16% and in T2 SGR value recorded was 0.80%. The gross and net productions of fish of the ponds under treatment-1 were 25.88 and 16.28 kg dec.$^{-1}$ year^{-1} and those of the ponds under treatment-2 were 18.52 and 8.92 kg dec.$^{-1}$ year^{-1}, respectively.

DISCUSSION

Water Quality Parameters

The physical and chemical water quality parameters of the ponds such as water temperature (°C), transparency (cm), dissolved oxygen (mg L^{-1}), pH, free CO_2 (mg L^{-1}), total alkalinity (mg L^{-1}), PO_4-P (mg L^{-1}) and NO_3-N (mg L^{-1}) of the ponds water were found to be within the acceptable ranges for fish culture and there was no abrupt change in any parameter of the pond water during the tenure of experiment (Table 1). The results were more or less similar to the findings of Wahab *et al*. (1995) and Kohinoor *et al*. (1998). Plankton (phytoplankton and zooplankton) population in number and genera were more or less similar to the findings of Tasneem (1998), Rashid (1999) and Israfil (2000).

Survival, Growth and Production of Fish

The survival rate of *Oreochromis niloticus* in T1 and T2 were 94.37 and 93.75%, respectively (Table 3). The survival rate was high because the initial length of fish was about 10 cm and tilapia can tolerate even a bad environmental condition. Kohinoor *et al*. (1993) obtained a survival rate of 86 to 94% in the monoculture of Thai sharpunti. In T1 SGR value recorded was 1.16% and in T2 SGR value recorded was 0.80% (Table 3). SGR value in T1 was higher than that in T2. 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 T1 was due to use of duckweed as a supplementary feed for nile tilapia (*O. niloticus*). The gross and net productions of fish of the ponds under T1 were 25.88 and 16.28 kg $dec.^{-1}$ $year^{-1}$ and those of the ponds under T2 were 18.52 and 8.92 kg $dec.^{-1}$ $year^{-1}$, respectively (Table 3). Percent increase of net production of fish of T1 over T2 was 182.51%. 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/year 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.

Most of the water quality parameters of the ponds under T1 and T2 were more or less similar but the higher production of fish was recorded in T1. The reason behind the higher production in T1 was due to supply of duckweed as supplementary feed. T-test of net productions shows that difference between T1 and T2 is 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 nile tilapia (*O. niloticus*).

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