ISSN: 2224-0616
Int. J. Agril. Res. Innov. Tech. 9(1): 73-83, June 2019
DOI: https://doi.org/10.3329/ijarit.v9i1.42952

Available online at http://www.ijarit.webs.com
https://www.banglajol.info/index.php/IJARIT

EFFECT OF USE OF DUCKWEED POWDER AS A FISH FEED ON MONOCULTURE OF SILVER CARP (*Hypophthalmichthys molitrix*)

K. Hasan[2*], M.S. Rahman[1], S. Sultana[1] and M. Shahjahan[1]

Received 25 April 2019, Revised 15 June 2019, Accepted 24 June 2019, Published online 30 June 2019

Abstract

An experiment on the use of duckweed powder as a fish feed on monoculture of silver carp (*Hypophthalmichthys molitrix)* was conducted in 6 ponds for a period of 75 days. The area of the each pond was one decimal. The experiment was carried out under two treatments, each with 3 replications. A combination of duckweed powder and rice bran at the ratio of 3:1 was supplied at the rate of 4% of total body weight in the ponds under treatment-I. On the other hand, the ponds under treatment-II were without supplying of feed. Each of the ponds under both treatments were stocked with 45 fingerlings of silver carp (*H. molitrix)*. The average initial length and weight of the fingerlings were 14.60 cm and 33.48 g, respectively. The ponds were fertilized fortnightly with poultry droppings at the rate of 2 kg, urea 60 g and TSP 90 g decimal^{-1}. During the experimental period the ranges of physico-chemical parameters viz. water depth (0.82 to 0.90 m), water temperature (17.80 to 26.7 °C), air temperature (19.11 to 28.29 °C), transparency (28.00 to 34.00 cm), dissolved oxygen (6.70 to 8.20 mg L^{-1}), pH (6.70 to 8.00), total alkalinity (170 to 210 mg L^{-1}), free CO_2 (0.0 to 3.50 mg L^{-1}), phosphate-phosphorus (1.2 to 2.9 mg L^{-1}), and nitrate-nitrogen (3.1 to 4.5 mg L^{-1}) were within the productive limit and more or less similar in all the ponds under treatments I and II. There were 25 genera of phytoplankton under four major groups and 10 genera of zooplankton under three major groups in the experimental ponds. Mean survival rates under treatment-I and treatment-II were 97.78% and 95.56%, respectively. The specific growth rates (SGR % per day) of the fish found under treatment-I and treatment-II were 0.98% and 0.49%. The calculated net production of the ponds under treatment-I was 1.87 ton ha^{-1} yr^{-1} and that of the ponds under treatment-II, was 0.74 ton ha^{-1} yr^{-1}. By 't' test, it was found that the net fish production of treatment-I was significantly ($p<0.01$) higher than that of treatment-II, and cost return relationship was found that the net profit of treatment-I and treatment-II were more or less similar. Finally, it can be concluded that duckweed powder as an ingredient of fish feed had significant impacts on production of silver carp, which do not consume duckweed as fresh and raw condition. Thus, duckweed powder can be used as feed for most fishes.

Keywords: Duckweed Powder, Monoculture, Fish Feed, Fish Production, Water Quality

[1]Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.
[2]Senior Upazila Fisheries Officer, Department of Fisheries, Ministry of Fisheries and Livestock, Government of the People's Republic of Bangladesh.

*Corresponding author's email: kamrulbau211@gmail.com (K. Hasan)

Cite this article as: Hasan, K., Rahman, M.S., Sultana, S. & Shahjahan, M. (2019).Effect of use of duckweed powder as a fish feed on monoculture of silver carp (*Hypophthalmichthys molitrix*). *Int. J. Agril. Res. Innov. Tech.* 9(1): 73-83

Introduction

The inland water fisheries resources play significant roles in providing nutrition, employment opportunities, food supply, poverty alleviation, foreign exchange earnings and especially socio-economic stability among rural people. In the world, Bangladesh has emerged as one of the leading nations in fresh water aquaculture production in recent years. The contribution of fisheries sector is about 3.61% to the total GDP, 24.41% to the total agricultural production and 1.51% to the total export earnings (DoF, 2018). It contributes about 60% of animal protein to our daily diet (DoF, 2018). The per capita annual fish consumption is 21.90 kg against the minimum requirement of about 21.90 kg (DoF, 2018). Therefore, it is high time to take immediate steps to maximize the fish production with minimum production cost in order to fulfill the ever-increasing domestic consumption of the increased population as well as to increase export for strengthening the national economy of the country.

It is necessary to provide costly artificial feed to fish in order to obtain higher fish production in many culture techniques. Therefore, it is difficult to bear feed cost, which in most cases cover 70-80% of the total expenditure of aquaculture in many modern culture techniques to provide costly artificial feed to fish in order to obtain higher production. To allow a real development of fish production among the poor people of this country, alternative sources of feed or a sustainable production technique should be sought to reduce the burden on the household budget. In this circumstance, duckweed-based fish culture may offer an improved new technique of fish culture based on natural production could be a solution.

Silver carp (*H. molitrix*) has long been an important cultured species because it is herbivorous and low in the food chain; feeds and fertilizers are therefore easily available at low cost, it can be poly cultured with some other species, due to its specific habitat, seeds are readily available from artificial breeding and production management is simpler and the rearing period is shorter than for other carp species.

Duckweeds are small floating aquatic plants belonging to the family Lemnaceae, which are widely available in Bangladesh. The nutritive value of duckweed is often higher than other plants

Although there are some studies on the production and use of duckweed as feed for fishes in mono and polyculture but a very few research works have been done on duckweed powder-based aquaculture in Bangladesh. Considering the great potentialities of the use of duckweed in aquaculture the present research work was undertaken.

Materials and Methods

The ponds under the study

There were a series of six earthen ponds for this experiment and each having an area of 1 decimal (40 m^2) and an average depth of 0.86 m. All the experimental ponds were arbitrarily numbered as pond no. 1 (P_1), pond no. 2 (P_2), pond no. 3 (P_3), pond no. 4 (P_4), Pond no. 5 (P_5) and Pond no. 6 (P_6) for the convenience of the research.

Experimental layout

The experimental layout has been given in the table below (Table 1).

Table.1. The layout of the experiment.

Treatment	Pond No.	Replication	Stocking of fingerlings	Description
T-I (with supply of duckweed powder and rice bran)	P_1,P_4,P_6	3	45 fingerlings per decimal (40 m^2)	Monoculture of the fish, *Hypophthalmichthysmolitrix,* with daily supply of duckweed powder and rice bran
T-II (without feeding)	P_2,P_3,P_5	3	45 fingerlings per decimal (40 m^2)	Monoculture of the fish, *H. molitrix,* without feeding

Pond preparation: Prior to the starting of the experiment, the ponds were renovated, dried and cleaned of aquatic vegetation manually. Liming (CaO) was done in all the ponds at the rate of 1 kg $decimal^{-1}$ before 7 days of fertilization. After 7 days of liming urea and triple super phosphate (TSP) were applied at the rate of 100 g and 200 g $decimal^{-1}$, respectively as initial doses.

Supply of feed: The duckweed was collected from the nearby water bodies and was sun dried to make it powder form earlier of starting of the experiment. The rice bran was collected from Market. Both duckweed and rice bran were packaged in polythene bags at the ratio of 3:1 and then supplied daily to the ponds of treatment-I. The amount of feed had to be increased by assuming the 10% increase of the body weight of the fish per week. At the time of providing the feed, the feeds were wetted and made into balls and then the balls were thrown on the pond surface by hand once every day.

Study of water quality parameters

Various water quality parameters were estimated and recorded fortnightly throughout the experimental period. Water quality measurements and sample collections were made between 8.30 am to 10.00 am.

Water depth of the experimental ponds were measured with the help of a graduated wooden depth meter. Transparency of water of the experimental ponds were measured by a Secchi-disc (30 cm diameter). Air and water temperatures were recorded by a mercury celsius thermometer (1 div. = 0.1°C).

Dissolved oxygen of water was measured by a portable digital dissolved oxygen (DO) meter (Lutron, DO-5509). pH of water was determined by a portable digital pH meter (Hanna Instruments HI 8424). For determining free carbon dioxide of water phenolphthalein indicator method was used (APHA, 1981).To determine total alkalinity titrimetric method was

used by using methyl orange indicator. Phosphate-phosphorurs (PO_4-P) was determined by a digital phosphate meter (model HI 93717, Hanna Instruments). Nitrate-nitrogen (NO_3-N) was determined by a digital nitrate meter (model HI 93728, Hanna Instruments).

Methods for study of biological parameters

Collection and preservation of plankton

For qualitative and quantitative study of phytoplankton and zooplankton of water, ten liters of water sample were randomly collected from five different locations of each of the ponds and passed through a plankton net (mesh size 55 µm) and finally concentrated to 85 ml. Then concentrated samples were preserved in small plastic bottles in 50% ethanol.

Counting of plankton

Counting of both phytoplankton and zooplankton were done with the help of Sedgwick-Rafter Counting Cell (S-R cell). The S-R cell is 50 mm long and 20 mm wide and 1 mm deep. The volume of the chamber is equally divided into 1000 fields of 0.001 ml each. From the concentrated plankton samples, 1 ml was taken by a dropper and then put in the S-R cell. The counting chamber was covered with a cover slip in order to eliminate the air bubbles and left to stand for about 10 minutes to allow the plankton settle down and then it was studied under a compound microscope and planktons were counted in 10 squares of the cell chosen randomly.

Identification of plankton

Identification of plankton (phytoplankton and zooplankton) up to generic level were made according to Ward and Whipple (1959), Smith (1950), Pennak (1953), Needham and Needham (1963), Prescott (1962), Belcher and Swale (1978).

Calculation

The plankton population was determined by using the following formula (Rahman, 1992).

$$N = \frac{A \times 1000 \times C}{V \times F \times L}$$

Where,
N= No. of plankton cells per liter of original water
A= total no. of plankton counted
C= Volume of final concentrated sample in ml
V= Volume of a field = 1 mm^3
F= No. of fields counted
L= Volume of original water in liter.
The number of phytoplankton and zooplankton were expressed as cells L^{-1}.

Harvesting of fish

At the end of the experiment the water of the ponds were pumped out and all the fishes were harvested. Then the final growth gained by the fishes was recorded by measuring the length (cm) and weight (g) of the recovered fishes by using a measuring scale and a balance, respectively.

Estimation of survival rate, growth and production of fish

(i) The survival rate was estimated by the following formula:

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

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

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

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)

(iii) Calculated Gross Production (ton ha^{-1} yr^{-1})

$$= \frac{\text{Gross weight (kg) of fish per decimal per 2.5 months} \times 250 \times 12}{1000 \times 2.5}$$

(iv) Calculated Net Production (ton ha^{-1} yr^{-1})

$$= \frac{\text{Net weight (kg) of fish per decimal per 2.5 months} \times 250 \times 12}{1000 \times 2.5}$$

Cost-benefit analysis

The purpose of this section is to identify the items of inputs used in pond fish production and output for performing cost-benefit analysis. Purchased inputs involved direct expenses. To determine the profitability, it is therefore, necessary to determine cost of all items and deduction of those from the value of the output.

$$\text{Cost-benefit ratio (\%)} = \frac{\text{Net return}}{\text{Total cost}} \times 100$$

Statistical analysis

T-test of net fish productions of the ponds under treatment-I and treatment-II was done by a computer using SPSS package programme.

Results

Water quality parameters

A number of physico-chemical and biological parameters of water of all the experimental ponds such as water depth, transparency, water temperature, air temperature, dissolved oxygen, free CO_2, pH, total alkalinity, phosphate-phosphorus, nitrate-nitrogen and cell densities and qualities of phytoplankton and zooplankton were determined to find out suitability and fluctuations of the parameters. Fortnightly variations and descriptions of all the water quality parameters of the ponds in both treatments have been given below:

Physical parameters

The results of the physical parameters of the experimental ponds have been presented in the Figs. 1, 2, 3 and 4.

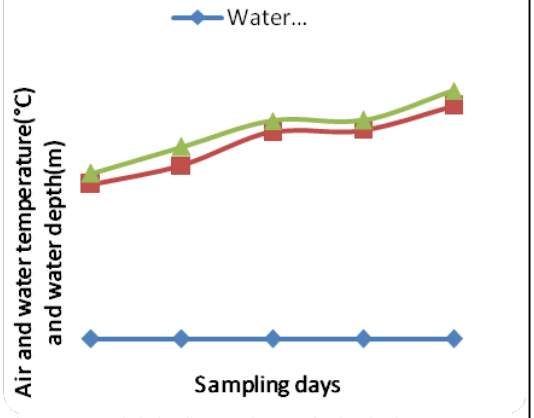

Fig. 1. Fortnightly fluctuations of Physical parameters (air temperature, water temperature and water depth) of the ponds under treatment-I during the experimental period.

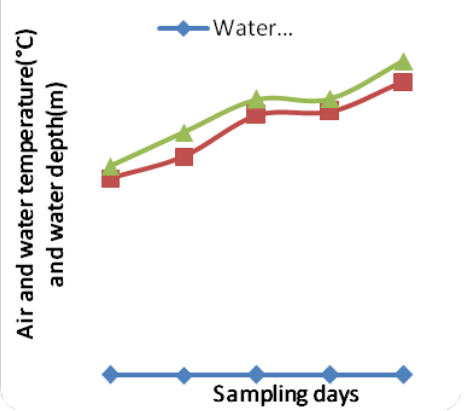

Fig. 2. Fortnightly fluctuations of Physical parameters (air temperature, water temperature and water depth) of the ponds under treatment-II during the experimental period.

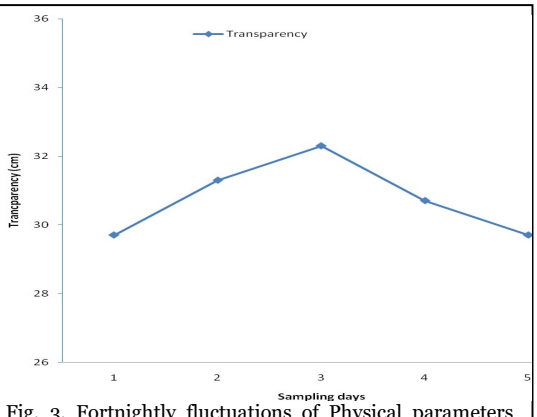

Fig. 3. Fortnightly fluctuations of Physical parameters (transparency) of the ponds under treatment-I during the experimental period.

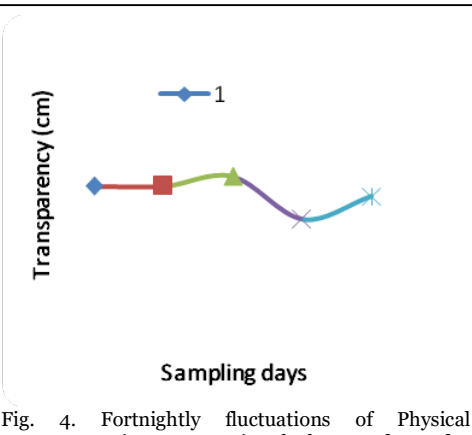

Fig. 4. Fortnightly fluctuations of Physical parameters (transparency) of the ponds under treatment-II during the experimental period.

Chemical parameters

The results of the chemical parameters of the experimental ponds recorded during the experimental period have been presented in the Tables 2 and 3.

Table 2. Fortnightly fluctuations of chemical parameters of the ponds under treatment-1 (with supply of duckweed powder and rice bran) during the experimental period.

Parameters	Pond No.	No. of fortnightly sampling days					Mean ±S.D.
		1	2	3	4	5	
Dissolved oxygen (mg L^{-1})	P_1	7.50	7.20	7.80	7.60	7.40	7.50±0.22
	P_4	7.10	6.70	7.60	7.50	7.70	7.30±0.41
	P_6	6.90	6.80	7.40	6.90	7.50	7.10±0.32
	Mean	7.20	6.90	7.60	7.30	7.10	7.30 ±0.26
Free CO_2 (mg L^{-1})	P_1	0.00	1.20	0.50	2.00	3.50	1.44±1.38
	P_4	2.00	1.80	2.50	2.20	3.00	2.30±0.47
	P_6	2.00	2.20	1.50	2.50	2.80	2.20 ±0.49
	Mean	1.33	1.73	1.50	2.23	3.10	1.98±0.71
pH	P_1	7.20	7.40	6.80	7.50	7.70	7.30±0.34
	P_4	7.50	7.80	7.40	7.30	6.90	7.40±0.33
	P_6	7.40	7.00	7.50	7.80	8.00	7.50±0.38
	Mean	7.40	7.40	7.20	7.50	7.50	7.40±0.12
Total Alkalinity (mg L^{-1})	P_1	202.00	196.00	208.00	186.00	191.00	196.60±8.71
	P_4	186.00	170.00	200.00	180.00	185.00	184.20±10.87
	P_6	182.00	185.00	175.00	192.00	200.00	186.80±9.58
	Mean	190.00	183.70	194.30	186.00	192.00	189.20±4.33
PO_4-P (mg L^{-1})	P_1	2.30	2.10	2.50	1.90	2.30	2.20±0.23
	P_4	2.30	2.40	2.20	2.30	2.10	2.30±0.11
	P_6	1.90	2.20	2.40	2.10	2.40	2.20±0.21
	Mean	2.20	2.20	2.40	2.10	2.30	2.20±0.13
NO_3-N (mg L^{-1})	P_1	3.50	3.70	4.30	4.10	3.90	3.90±0.32
	P_4	3.30	3.90	3.70	3.50	4.10	3.70±0.32
	P_6	4.40	4.10	3.80	4.00	3.40	3.90±0.37
	Mean	3.70	3.90	3.90	3.90	3.80	3.80±0.09

Table 3. Fortnightly fluctuations of chemical parameters of the ponds under treatment-2 (without feeding) during the experimental period.

Parameters	Pond No.	No. of fortnightly sampling days					Mean ±S.D.
		1	2	3	4	5	
Dissolved oxygen (mg L^{-1})	P_2	7.30	7.50	6.80	7.50	7.20	7.30±0.29
	P_3	7.20	6.90	7.30	8.20	7.40	7.40±0.48
	P_5	6.80	7.10	7.20	7.50	7.00	7.20±0.26
	Mean	7.10	7.20	7.10	7.70	7.20	7.30±0.25
Free CO_2 (mg L^{-1})	P_2	2.00	2.50	2.20	3.00	2.80	2.50±0.41
	P_3	0.00	1.80	2.00	2.80	1.70	1.66±1.02
	P_5	0.00	1.40	1.60	2.40	2.50	1.58±1.01
	Mean	0.67	1.90	1.93	2.73	2.33	1.91±0.65
pH	P_2	7.10	7.50	6.70	7.20	6.80	7.06±0.32
	P_{43}	7.30	6.80	7.50	6.90	7.40	7.20 ±0.31
	P_5	7.10	7.60	6.50	7.30	7.80	7.30±0.50
	Mean	7.20	7.30	6.90	7.10	7.30	7.20 ±0.17
Total Alkalinity (mg L^{-1})	P_2	186.00	190.00	185.00	182.00	210.00	190.60±11.22
	P_3	192.00	178.00	198.00	200.00	196.00	192.80±8.79
	P_5	186.00	202.00	192.00	184.00	176.00	188.00±9.69
	Mean	188.00	190.00	191.67	188.67	194.00	190.47±2.42
PO_4-P (mg L^{-1})	P_2	2.40	2.30	1.20	2.20	2.70	2.20±0.57
	P_3	2.80	1.50	2.30	2.90	1.60	2.20±0.65
	P_5	2.10	2.80	2.10	2.00	2.50	2.30±0.34
	Mean	2.40	2.20	1.90	2.40	2.30	2.20±0.21
NO_3-N (mg L^{-1})	P_2	3.10	3.80	4.20	4.10	3.60	3.80±0.44
	P_3	3.60	3.90	3.70	4.30	4.10	3.90±0.29
	P_5	4.50	3.80	3.60	3.90	4.20	4.00±0.35
	Mean	3.70	3.80	3.80	4.10	3.90	3.90±0.15

Biological parameters

The results of different biological parameters such as phytoplankton and zooplankton cell density (cells L^{-1}), generic status of phytoplankton and zooplankton have been presented in Tables 4 and 5.

Phytoplankton: Throughout the experimental period a total of 25 genera of phytoplankton belonging to 4 different groups of Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae were found in the experimental ponds (Table 5).

Zooplankton: Different zooplankton belonging to three groups of Rotifera (3 genera), Cladocera (5 genera) and Copepoda (2 genera) were found in the experimental ponds during the experimental period (Table 5).

Table 4. Fortnightly fluctuations of the cell densities of phytoplankton and zooplankton of the experimental ponds during the experimental period.

Parameters	Treatment	Pond No.	No. of fortnightly sampling days					Mean ±S.D.
			1	2	3	4	5	
Phytoplankton(x10^3, cells L^{-1})	T-I	P_1	57.20	53.90	55.50	51.05	48.67	53.26±3.42
		P_4	54.30	56.05	53.90	52.16	49.94	53.27±2.32
		P_6	52.60	54.40	58.20	48.94	55.98	54.02±3.51
		Mean	54.70	54.78	55.87	50.72	51.53	53.52±2.25
	T-II	P_2	54.60	51.70	52.20	50.10	52.50	52.22±1.62
		P_3	57.50	48.90	49.50	49.74	53.94	51.92±3.71
		P_5	50.80	52.30	53.80	54.51	51.16	52.51±1.62
		Mean	54.30	50.97	51.83	51.44	52.53	50.21±1.29
Zooplankton (x10^3, cells L^{-1})	T-I	P_1	6.80	6.40	6.60	7.35	6.56	6.74±0.37
		P_4	5.10	5.70	6.20	6.65	6.30	5.99±0.60
		P_6	6.50	7.15	5.90	7.80	6.80	6.83±0.71
		Mean	6.13	6.42	6.23	7.27	6.55	6.52±0.45
	T-II	P_2	5.85	6.75	5.48	6.10	7.20	6.28±0.69
		P_3	5.98	6.50	7.30	6.25	6.20	6.44±0.51
		P_5	6.50	7.20	6.80	5.85	6.75	6.62±0.49
		Mean	6.11	6.82	6.53	6.07	6.72	6.45±0.35

Table 5. Generic status of phytoplankton and zooplankton found in the experimental ponds.

Phytoplankton		Zooplankton
Bacillariophyceae 1. *Fragilaria* 2. *Navicula* 3. *Nitzschia* 4. *Cyclotella* 5. *Surirella* 6. *Asterionella* 7. *Tabellaria* Chlorophyceae 1. *Volvox* 2. *Spirogyra* 3. *Ulothrix* 4. *Pediastrum* 5. *Scenedesmus* 6. *Actinastrum* 7. *Ankistrodesmus* 8. *Pleurococcus* 9. *Chlorella* 10. *Stichococcus*	Cyanophyceae 1. *Anabaena* 2. *Spirulina* 3. *Microcystis* 4. *Aphanizomenon* 5. *Gomphosphaeria* 6. *Coelastrum* Euglenophyceae 1. *Euglena* 2. *Phacus*	Rotifera 1. *Brachionus* 2. *Keratella* 3. *Polyarthra* Crustacea Cladocera 1. *Daphnia* 2. *Diaphanosoma* 3. *Moina* 4. *Sida* 5. Nauplius (Crustacean larva) Copepoda 1. *Cyclops* 2. *Diaptomus*

Survival rate, growth and production of fish

Survival rate: The mean survival rate in treatment-I was 97.78 % and in treatment-II was 95.56 %. The survival rate in treatment-I was slightly higher than that in treatment-II (Table 6).

Specific growth rate (SGR% per day): The specific growth rate (SGR % per day) of the fish, *H. molitrix*, varied in different treatments. In treatment-I mean SGR value recorded was 0.98 % per day and in treatment-II mean SGR value recorded was 0.49% per day. SGR value in treatment-I was higher than that in treatment-II (Table 6).

Production of fish: The productions of the fish, *H. molitrix,* were different in different treatments. The gross and net productions of the fish of the ponds under treatment-I and treatment-II have been presented in the Tables 6 and Figs. 5 and 6.

Table 6. Total survival rate, growth and production (gross and net) of the fish, *H. molitrix*, under treatment-I and treatment –II.

Treatment	Total survival rate (%)	Total final weight (Kg deci^{-1} yr^{-1})	Total initial weight (Kg deci^{-1})	Specific growth rate (SGR % day^{-1})	Production (Kg deci^{-1} yr^{-1})		Production (Ton ha^{-1} yr^{-1})		Percent increase of net production of treatment-I over treatment -II
					Gross	Net	Gross	Net	
I (with feeding)	97.78	14.72	1.51	0.98	14.72	7.47	3.68	1.87	*152.7%
II (without feeding)	95.56	10.15	1.51	0.49	10.15	2.90	2.54	0.74	

**Net production of treatment-II has been taken for 100*

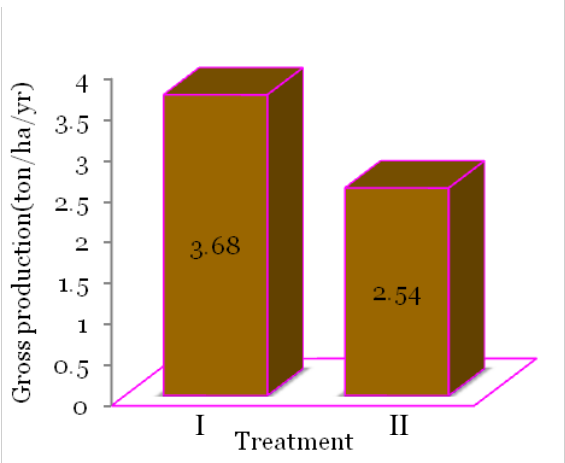

Fig. 5. Gross production of the fish (*H. molitrix*)

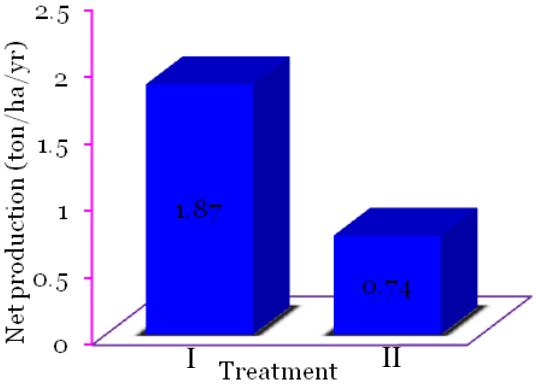

Fig. 6. Net productions of the fish (*H. molitrix*)

Cost-return relationship:

Production cost

Only the cost of the items like material inputs such as feed, fertilizer, organic fertilizer and fingerlings were included in the cost of silver carp production. Uses of land and interest on operating capital have been omitted here as they are provided by the Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh.

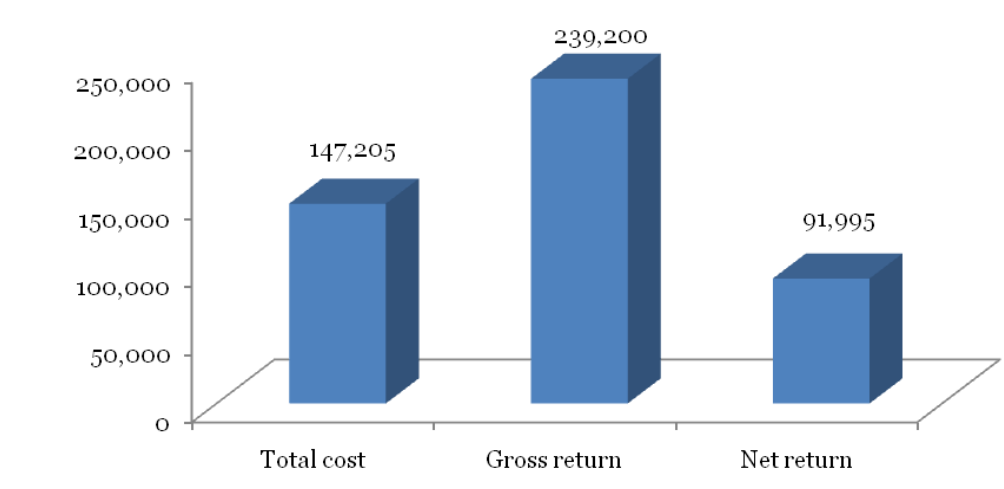

Fig. 7. Total cost, gross return and net return (profit) per hectare per year in Taka under treatment-I.

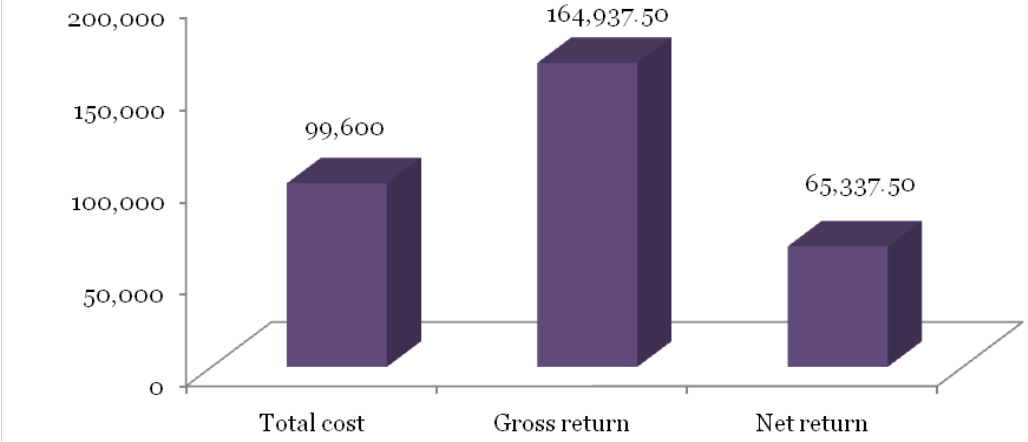

Fig. 8. Total cost, gross return and net return (profit) per hectare per year in Taka under treatment-II.

Statistical analysis

Net productions of treatment-I and treatment-II

Treatment	Net Productions (kg deci^{-1} 2.5 months^{-1})		
	Replication 1	Replication 2	Replication 3
I	1.69	1.39	1.59
II	0.76	0.59	0.46

T-test between net productions of the fish, *H. molitrix,* of the ponds under treatment-I and treatment-II were significant at 1% level.

Paired samples test

	Mean	S.D.	S.E.	df	t
Treatment-I Treatment-I	0.953	0.166	0.096	2	9.927**

** *Significant at 1% level*

Discussion

All the results of the present study such as water quality parameters, growth and production of fish along with cost-return relationship have been discussed below:

The primary productivity of water body is dependent on physical and chemical factors of water in relation to the environmental factors (Rahman *et al.,* 1982).Various physical parameters such as water depth, water temperature, air temperature and transparency have great influence on the survival and growth of fish. Throughout the experimental period, the ranges of physical parameters recorded were within the acceptable limits for fish culture. During the experimental period, fortnightly fluctuations of water depth ranged from 0.82 to 0.90 m. Rahman (1992) stated that pond should not be shallower than 1 m and deeper than 5 m and optimum depth should be 2 m. During the present experimental period, the transparency

values of the ponds varied from 28 to 34 cm. The mean values of water transparency of the ponds under treatment-I and treatment-II were 30.7 ± 1.12 cm and 30.8 ± 0.49 cm, respectively. Rahman (1992) stated that the transparency of productive water bodies should be 40 cm or less (turbidity resulting from plankton). Temperature is the most important physical factor in the aquatic life. For 1°C rise of temperature metabolic rate of fish increases 10%. Paul (1998) recorded temperature ranged from 26.7 to 33.7°C in the ponds of BAU campus. Rahman et al. (1982) found water temperature of ponds 26.06 to 31.97°C, which was within the suitable range for fish culture. In the present experiment water temperature was favorable for fish culture.

Chemical parameters

Chemical parameters are also responsible for the survival and growth of fishes. All the chemical parameters such as dissolved oxygen, freeCO_2, pH, alkalinity, phosphate-phosphorus, nitrate-nitrogen studied during the present experimental period were found within the acceptable range for fish culture, which have been discussed below:

The gases, which are found in dissolved condition in natural waters, are oxygen, nitrogen, carbon dioxide, hydrogen sulphide, ammonia, methane, sulfur dioxide and carbon monoxide. Among these the most important and critical one is oxygen. Regular supply of dissolved oxygen is required by all the aquatic organisms except anaerobic bacteria. During the present experimental period, dissolved oxygen content of the ponds was found between 6.70 to 8.20 mg L^{-1}. According to Rahman (1992) dissolved oxygen content of a productive pond should be 5 ppm or more. Ellis *et al.* (1946) reported that the dissolved oxygen content at levels of 3 ppm or below should be regarded as hazardous to lethal and 5 ppm or more dissolved oxygen is suitable for fish production. Carbon dioxide is the basis of all life on the earth although sometimes it may be considered as a troublesome substance. Without free carbon dioxide, the basic food production by plants through photosynthesis is not possible. In the present experiment fortnightly fluctuations of free carbon dioxide during the experimental period ranged from 0.00 to 3.00 mg L^{-1}. According to Lagler (1972), free CO_2 more than 20 mg L^{-1} may be harmful to fishes and even lower concentrations may be equally harmful when dissolved oxygen content is less than 3 mg L^{-1}. pH is considered as an important chemical factor in fish culture. Most water bodies have pH within the range of 6.5 to 8.5. The circum-neutral pH values during the experimental period under treatment-I and treatment-II ranged from 6.80 to 8.00 and 6.70 to 7.80, respectively. The mean values of pH under treatment-I and treatment-II were 7.40 ± 0.12 and 7.20 ± 0.17, respectively. According to Swingle (1967), pH 6.5 to 9.0 is suitable for pond fish culture and pH more than 9.5 is unsuitable because free CO_2 is not available in this situation. According to Boyd (1982) the acidic and alkaline death points for fish are pH 4 and 11, respectively. In alkaline waters, essential nutrients are found in higher quantities and this is the most important reason for the higher biological productivity in alkaline waters than in acidic waters. However, highly alkaline condition is not favourable for biological production. Fortnightly fluctuations of total alkalinity in the present experimental ponds ranged from 170.00 to 208.00 mg L^{-1}. According to Boyd (1982) total alkalinity of productive ponds should be 20 ppm or more and fish production increases with the increase of total alkalinity. According to Rahman (1992), total alkalinity of productive ponds should be 20 ppm or more**.** Variations of phosphate-phosphorus in the experimental ponds ranged from 1.9 to 2.5 mg L^{-1}. In the present experiment, phosphate-phosphorus contents were closely near to the suitable range. Nitrate is extremely important as a nutrient in supplying nitrogen for protein synthesis. Nitrate-nitrogen usually occurs in relatively small concentrations in unpolluted fresh water. The observed range of nitrate-nitrogen in the present experiment was from 3.3 to 4.4 mg L^{-1}, which is sufficient for algal production. According to Alikunhi (1957), good pond water for fish culture should have a concentration of 0.06 ppm of nitrate

Biological parameters

The abundance of phytoplankton in nature is regulated by different environmental factors such as temperature, light, dissolved oxygen, pH and nutrient concentration. Phytoplankton population indicates the productive status of water body because these are the direct and basic sources of food for most of the organisms in aquatic habitat. In the present experiment, the mean values of phytoplankton cell densities of the experimental ponds under treatment-I and treatment-II were 53.52±2.25 ($x10^3$) and 50.21±1.29 ($x10^3$) cells L^{-1}, respectively. The higher abundance of phytoplankton in the present experiment might be due to higher availability of nutrients as the ponds were regularly fertilized fortnightly.

Zooplankton is the most important source of food for the fishes. During the present experiment the mean values of zooplankton in the experimental ponds under treatment-I and under treatment-II) were 6.52±0.45 and 6.45±0.35 ($x10^3$) cells L^{-1}, respectively. Ten genera of zooplankton belonging to the groups of Rotifera, Cladocera and Copepoda were found in the ponds during the present experiment.

Survival rate, growth and production of fish

Survival rate (%)

During the present study, the survival rates were more or less similar in different ponds. The mean survival rates (%) in treatment-I and treatment-II were 97.78±1.28 and 95.56±1.28. The survival rate was high because the initial length of the fish was 14.60cm and ponds were prepared effectively with appropriate doses of lime, urea, TSP and poultry droppings.

Specific growth rate (SGR % per day)

In the present experiment the specific growth rates of silver carp, *H. molitrix*, (SGR % per day) under treatment-I and treatment-II varied from 0.39 to 1.07%. SGR of fish fed on high protein and energy diet shows higher value but fish fed on supplemental feeds made on-farm could show SGR value between 3-4% per day (De Silva and Davy, 1992).

Production of fish

In the present experiment, gross and net productions of fish of the ponds under treatment-I (with supply of duckweed powder and rice bran) were 3.68 ton ha^{-1} yr^{-1} and 1.87 ton ha^{-1} yr^{-1} and those of the ponds under treatment-II (without feeding) were 2.54 ton ha^{-1} yr^{-1} and 0.74 ton ha^{-1} yr^{-1}, respectively. Net production of fish of treatment-I increased than that of treatment-II and it was 152.7% in comparison to treatment-II where net production was taken for 100%. Haque (1996) found 4.85 ton ha^{-1} yr^{-1} net production of Thai sharpunti (*P. gonionotus*) in ponds where duckweed was used as supplemental feed and the production was higher in ponds with supply of duckweed than in ponds without supply of duckweed. Most of the physico-chemical parameters of the ponds under treatment-I and treatment-II were more or less similar but the production of fish recorded was higher in treatment-I than that of treatment-II. The higher production in treatment-I was due to supply of dried duckweed powder mixed with rice bran at the ratio of 3:1. On the other hand, the production was lower in treatment-II due to no supply of feed.

Conclusion

The experiment was conducted to evaluate the impacts of duckweed powder as an ingredient of low cost supplementary feed on the survival and growth of silver carp in monoculture and to compare the growth and production of silver carp under two different treatments. According to the findings of the present experiment, it may be concluded that due to the availability and cost-effectiveness of duckweed powder it has significant effect as feed ingredient on the basis of economic aspect for monoculture of silver carp, *H. molitrix*. Duckweed can be easily collected and dried from the surrounding water bodies such as ditch, canals and beels, etc. So, this technology can be easily adopted by poor farmers. The growth rate of duckweed is very high (approximately double within two to three days under culture condition) that make it possible to produce duckweed easily. It may be concluded that this duckweed powder-based technology might play a vital role in pond fish culture to increase production of fish with minimum cost because silver carp takes duckweed powder mixed with rice bran as their feed. By adopting this method, production cost of fish culture can be minimized considerably. So, duckweed powder-based silver carp culture technology may be recommended for the resource-poor rural fish farmers of the country because this technology can be used as an economically highly viable and sustainable technology.

References

Alikunhi, K.H. 1957. Fish culture in India. *F.M. Bull. Indian Coun. Agric. Res.* 20: 144.

APHA (American Public Health Association). 1981. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington D.C. pp. 1-50

Belcher, H. and Swale, E. 1978. A Beginner's Guide to Freshwater Algae. Institute of Terrestrial Ecology, Natural Environment Research Council, London. 47 p.

Boyed, C.E. 1982.Water Quality Management for Pond Fish Culture.Elsevier Science Publishers, Amsterdam, The Netherlands. 318 p.

Brown, M.E. (ed.). 1957. Environmental studies on growth. In: The Physiology of Fishes. Academic Press, New York. 1: 361-400.

De Silva, S.S. and Davy, F.B. 1992. Fish nutrition research for semi-intensive culture system in Asia. *Asian Fish. Sci.* 5: 129-144.

DoF. 2018. Matshaw Pakkhaw Sankalon. Department of Fisheries, Ministry of Fisheries and Livestock. Government of the People's Republic of Bangladesh, Matsya Bhaban, Ramna, Dhaka. pp. 150-151.

Ellis, M.M., Westfall, B.A. and Ellis, M.D. 1946. Determination of water quality. Fish and Wildlife Service, U.S. Dept. Interior, Res. Rept. 9, 122 p.

Haque, M.S. 1996. Use of duckweed (*Lemna minor*) as supplementary feed in monoculture Sharpunti (Puntius gonionotus). M.S. Thesis, Dept. of Fisheries Management, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, Bangladesh. 86 p.

Lagler, K.F. 1972. Freshwater Fishery Biology. 2nd ed. W.M.C. Brown Company, Publishers, Dubuque, IOWA. 421 p.

Needham, J.G. and Needham, P.R. 1963. A guide to study of Freshwater Biology, 5th ed. Holden-day, Inc. San Francisco. 106p.

Paul, S. 1998. Comparison between carp polyculture system with silver carp, *Hypophthalmicthys molitrix*, and with small indigenous fish mola, *Amblypharyngodon mola*. M.S. Thesis, Dept. of Fisheries Management, BAU, Mymensingh. 85 p.

Pennak, R.W. 1953. Fresh water Invertebrates of the United States. The Ronald, Press Company, New York. 769 p.

Prescott, G.W. 1962. Algae of the Western Great Lakes Area. Wm. C. Brown Co. Dubuque, IOWA. 946 p.

Rahman, M.S. 1992. Water Quality Management in Aquaculture, BRAC Prokashana, 66, Mohakhali, Dhaka - 1212, Bangladesh, 84 p.

Rahman, M.S., Chowdhury, M.Y., Aminul Haque, A.K.M. and Haq, M.S. 1982.Limnological studies of four ponds. *Bangladesh J. Fish*. 25 (1-2): 25-35.

Smith, G.M. 1950. The Fresh water Algae of the United States. 2nd ed. McGraw Hill Book Company, New York. 719 p.

Swingle, H.S. 1967. Standardization of chemical analyses for water and pond's muds. *FAO Fish. Rep*. 4(44): 397-421.

Ward, H.B. and Whipple, G.C. 1959. Freshwater Biology. 2nd ed. John Wiley and Sons. Inc. USA. 1248p.