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A Preliminary Study on Nile Tilapia (*Oreochromis niloticus*) Polyculture with Common Carp (*Cyprinus carpio*) Fed with Duckweed (*Spirodela*) in Nepal

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Abstract

Mixed-sex Nile tilapia (*Oreochromis niloticus*) and common carp (*Cyprinus carpio*) were cultured in four cement ponds of 72 m^2 at 1:1 ratio with a stocking density of 1 fish•m^{-2} during summer in subtropical Nepal. Fish were fed with locally collected duckweed (*Spirodela* sp.) during 108 days of experimental period. Nile tilapia grew from 39.6±3.7 g at stocking to 145±5.2 g at harvesting with a survival rate of 90±4 %. Common carp grew from an initial 2.8±0.6 g to final 63.2±2.4 g with 97±1 % survival rate. The ex-trapolated annual yield of stocked fish ranged from 2.3 - 2.9 t•ha^{-1} with a mean of 2.5 ±0.1 t•ha^{-1}. Tilapia offsprings produced during the experimental period was 1690±261 fish per pond with an average size of 7.2±1.6 g. Weight of tilapia recruits obtained was two times more than that of the net yield of originally stocked fish. The common carp did not control tilapia recruitments.

Introduction

The major aquaculture practice in Nepal involves polyculture of warm water fishes, including native carps, rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*) and catla (*Catla catla*) and exotic carps, common (*Cyprinus carpio*), silver (*Hypophthalmichthys molitrix*), bighead (*Aristichthys nobilis*), and grass (*Ctenopharyngodon idella*). Present productivity of carp culture in ponds is estimated to be 1.93 $t \cdot ha^{-1} \cdot yr^{-1}$ (ASD 1996).

Nile tilapia (*Oreochromis niloticus*) was introduced from Thailand to Nepal in 1985 (Pullin 1986; Pantha 1993; Singh 1995) and kept at various Government farms for research purposes (Singh 1995). It has not been made available to farmers nor any effort has been made to evaluate its performance in Nepal, probably due to its bad image as a pest exhibiting uncontrollable breeding resulting to stunted and unattractive fish (Pullin 1984). This paper describes the result of a preliminary study conducted to evaluate the performance of mixed-sex Nile tilapia in polyculture with common carp in subtropical climate of Nepal during summer and discuss its potential in pond culture for the resource-poor in Nepal.

Materials and Methods

An experiment was conducted in rectangular cement ponds of 72 m^2 at the Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan, Nepal from 9 June to 25 September 1996. Four ponds were filled with tap water to about 1 m and new water was added weekly to compensate for evaporative losses. Thirty six mixed-sex Nile tilapia fingerlings of 39.6±3.7g (mean ± SE) collected from the tilapia ponds of IAAS farm, were stocked in each pond at a density of 0.5 $fish \cdot m^{-2}$. Common carp fries of average weight 2.8±0.6 g, obtained from IAAS fish farm, were also stocked at the same stocking density as the Nile tilapia. Giant duckweeds (*Spirodela* sp.) were collected daily from the wet land area of the IAAS Campus and fed to fish at *ad libitum*. Feed conversion ratio (FCR) was calculated based on fresh duckweeds and fresh net fish yield. Pond water temperature, dissolved oxygen (DO) and pH were measured *in situ* weekly at 0600 h with a DO meter (YSI meter model 50 B) and pH meter (WTW pH 91). Weekly Secchi disk visibility was monitored at 1100 h.

Results

Results on fish growth, survival, and net yield of Nile tilapia and common carp are presented in Table 1. The extrapolated mean net yield of tilapia and common carp in polyculture was 2.5±0.1 $t \cdot ha^{-1} \cdot yr^{-1}$ with a range of 2.3 - 2.9 $t \cdot ha^{-1} \cdot yr^{-1}$ (Table 1). Tilapia reproduction in ponds ranged from 1159 to 2353 individuals with a mean of 1690±261 individuals per pond which contributed to a total net yield twice that of the original stock (Table 1). Mean FCR values of fresh duckweeds to Nile tilapia and tilapia plus common carp were 34.4± 3.0 and 20.1± 0.9 with a range of 27.5 - 42.2 and 17.7 - 22.8 respectively. However, FCR range was 5.2-9.9 with a mean of 6.7± 1.1 when recruits were also included (Table 1). Moisture content of fresh duckweeds was 90.1±1.4%.

Temperature, dissolved oxygen and pH of pond water measured at 0600 h ranged from 30.3 - 32.3 °C, 3.3 - 12.1 $mg \cdot L^{-1}$ and 7.6 - 9.9, respectively. Secchi disk visibility decreased gradually from an initial 90±1 to 30±3 cm during the experimental period.

Discussion

Nile tilapia is commonly cultured in semi-intensive ponds with the addition of organic and/or inorganic nutrients (Oláh et al. 1986; Siddique et al.

1989; Knud-Hansen et al. 1993). Use of duckweeds as feed to produce tilapia culture was also reported (Gaigher et al. 1984; Hassan 1986; Santos 1987; Hassan and Edwards 1992). In this study, daily weight gain (DWG) of mixed-sex Nile tilapia (1.0 $g \cdot fish^{-1} \cdot day^{-1}$) polycultured with common carp was higher than the DWG (0.2 $g \cdot fish^{-1} \cdot day^{-1}$) of sex-reversed male Nile tilapia monocultured at a stocking density of 2 $fish \cdot m^{-2}$ in outdoor tanks (5 m^2) fed with the same type of duckweeds (*Spirodela* sp.) at 2.5 - 7.5% feeding rates (Hassan and Edwards (1992). DWG of Nile tilapia in the present study was comparable with the results obtained by Santos (1987) who fed the fish with *Lemna* in outdoor concrete tanks. The author reported the daily growth of mono-sex tilapia at 0.49, 0.93, and 1.33 $g \cdot fish^{-1} \cdot day^{-1}$ when fed at 2, 4, and 6% of fish biomass based on dry duckweeds and fresh fish biomass. It indicated that there was a positive relationship between the feeding rate and the growth rate of tilapia. In the same study, higher feeding rates (>4% of biomass), however, resulted in the death of all the fish in the tanks after about two months due to bad water quality especially poorly dissolved oxygen

Table 1. Growth and production of Nile tilapia and common carp in polyculture fed with duckweeds in cement pond (72 m^2) and cultured for 108 days.

	Pond				
	1	2	3	4	Mean ± SE
Nile tilapia					
Initial weight (g)	44.4	47.2	33.3	33.3	39.6 ± 3.7
Final weight (g)	148.1	152.1	129.7	150.7	145.2 ± 5.2
Weight gain ($g \cdot fish^{-1} \cdot day^{-1}$)	1.0	1.0	0.9	1.1	1.0 ± 0.0
Survival (%)	94.4	77.8	94.4	94.4	90.0 ± 4.2
Common carp					
Initial weight (g)	1.9	1.7	3.3	4.4	2.8 ± 0.6
Final weight (g)	58.2	65.9	60.3	68.5	63.2 ± 2.4
Weight gain ($g \cdot fish^{-1} \cdot day^{-1}$)	0.5	0.6	0.5	0.6	0.6 ± 0.0
Survival (%)	97.2	100.0	97.2	94.4	97.2 ± 1.1
Net fish yield ($g \cdot m^{-2} \cdot day^{-1}$)					
Nile tilapia	0.44	0.33	0.41	0.50	0.42 ± 0.04
Common carp	0.25	0.30	0.26	0.28	0.27 ± 0.01
Total	0.69	0.63	0.67	0.78	0.69 ± 0.03
Extrapolated yield ($t \cdot ha^{-1} \cdot yr^{-1}$)	***2.5***	***2.3***	***2.4***	***2.9***	***2.5 ± 0.1***
Tilapia recruits					
Number per pond	1159	1418	1831	2353	1690 ± 261
Weight (kg per pond)	5.5	15.6	15.6	10.9	11.9 ± 2.4
Mean weight (g)	4.8	11.0	8.5	4.6	7.2 ± 1.6
Feed conversion ratio (FCR)[1]					
Nile tilaia	34.4	42.2	33.6	27.5	34.4 ± 3.0
Nile tilapia+Common carp	20.0	22.0	20.8	17.7	20.1 ± 0.9
Nile tilapia+Common carp +tilapia recruits	9.9	5.3	5.2	6.4	6.7 ± 1.1

[1]FCR values are based on the fresh weight of duckweed and fresh net fish yield. Moisture content of fresh duckweed was 90.1 ± 1.4%.

concentration in the morning. Similar growth rate of Nile tilapia ranging from 0.52 - 1.25 $g \cdot fish^{-1} \cdot day^{-1}$ has been reported in a fertilized system in Thailand and the Philippines (Fortes et al. 1986; Shrestha and Knud-Hansen 1990; Shrestha and Knud-Hansen 1994; Diana et al. 1996). Growth rate of 3.1 $g \cdot fish^{-1} \cdot day^{-1}$ has been reported by Diana et al. (1996) with supplemental feeding with formulated pellets. Daily weight gain of common carp (0.6 $g \cdot fish^{-1} \cdot day^{-1}$) in this study was comparable to the growth rates (ranged 0.4 - 0.7 $g \cdot fish^{-1} \cdot day^{-1}$) reported by Siddiqui et al. (1993).

Despite *ad libitum* feeding in this study, mean FCR value (i.e. 3.4) of duckweeds (on dry-weight basis) to Nile tilapia only was comparable with the value (3.1) for low feeding rate (2.5% biomass on duckweed dry-weight basis) reported by Hassan and Edwards (1992) in outdoor tanks (5 m^2). Higher FCR values (5.9 and 9.4) were reported in the same study with feeding rates of 5.0% and 7.5% biomass. The present study, therefore, indicates that duckweeds utilization might be better in mixed-sex tilapia culture and/or polycutured with common carp than in all-male tilapia monoculture. However, competition for food may occur among stocked tilapia, tilapia recruits and common carp at low feeding rates of duckweed and higher stocking density of tilapia and/or common carp. Further investigation, therefore, is necessary to optimize the rates of duckweed feeding and fish stocking.

Tilapias are considered to be unique in their capacity to breed naturally in the cultured system without any artificial inducement (Macintosh and Little 1995). Recruitment constituted about 50% to 61% of the net fish pro duction when fry were collected 3 to 6 times daily from the pond (Little 1989). Similar results (57% and 61% tilapia recruits) were obtained when Nile tilapia was cultured with bighead carp at the end of the experimental period (154 days) but the recruit production was significantly lower (14%) when common carp was included in the two fish polyculture system in fertilized earthen pond (Edirisinghe 1990). In contrast, based on the present study, recruitment weight constituted about 70% of the total net fish production.

As seed supply is the major constraint in the development of aquaculture in Nepal (Pradhan 1994), the recruits could be a free source for pond stocking. In the present study 7 ± 1 $fry \cdot m^{-2} \cdot month^{-1}$ were obtained at the end of the experiment. However, more fry could be produced (> 120 $fry \cdot m^{-2} \cdot month^{-1}$), if they were frequently collected with scoop nets from pond edges which is still the most widely used method for tilapia seed production in many countries (Macintosh and Little 1995).

Over-population of tilapia from uncontrolled reproduction in the cultured system resulting in stunted fish growth due to shortage of food has been well recognized as a problem in tilapia culture. Various methods of population control, such as, culture in cages, culture with predators, intermittent harvesting, hybridization, induction of sterility, hormonal sex-inversion, and production of super male (YY-male) have been described (Mair and Little 1991). Since there is no possibility of producing monosex fry at present in Nepal, culture of mixed sex young-of-the-year population could be one of the suitable ways that could give quick returns (3-6 months) and 2-3 crops a year (Hepher and Pruginin 1992).

Although aquaculture development in Nepal has been considered as "pointers for success" (Pullin 1986), the present annual productivity of pond is only 1.93 $t \cdot ha^{-1}$ (ASD 1996). Several constraints have been pointed out and feed is one of them (Pradhan 1994). Tilapias might be one of the suitable species for the resource poor farmers of the country as they performed well when fed with duckweeds and grew well in enhanced natural food obtained by simply adding either inorganic fertilizers such as urea and triple superphosphate or organic manures such as chicken manure (PD/A CRSP 1996), buffalo manure, goat manure, crop residues, and kitchen wastes. However, there is a risk of negative impacts on the indigenous fish species from the tilapia which could escape from ponds if introduced. This can be prevented by providing tilapia seed to farmers whose ponds have well controlled water supply and drainage system. Moreover, tilapia can be an excellent species for the resource poor farmers utilizing the seasonal rain-fed ponds which can hold water for about 4-5 months only. Nevertheless, tilapias do not survive at low temperature (e.g. 10° or 11°C, Popma and Lovshin 1996). Temperature in most of the rivers of Nepal falls below 10°C during winter season and remains less than 20°C for about 6 months during the year (Shrestha 1992). It is at this temperature when tilapia stops to reproduce (Popma and Lovshin, 1996). Tilapia, therefore, may not be a threat for native fishes. As low temperatures i.e. <29°C for growth and <25°C for reproduction are harmful (Popma and Lovshin 1996), an investigation is needed in order to evaluate the growth and reproductive performances of tilapia during winter season.

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