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Growth Performance and Production of Organically Cultured Grass Carp *Ctenopharyngodon idella* (Val.) Under Mid-Hill Conditions of Meghalaya; North Eastern India

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Abstract

The aquatic fern Azolla (*Azolla caroliniana*) can be easily grown organically in North Eastern India due to favorable climatic conditions. This fern was fed to the grass carp, *Ctenopharyngodon idella* (Val.) as a step towards producing organic fish. In the study, *Azolla was* found to be a preferred feed by the grass carp and mean daily growth increment was recorded. The statistically paired *t*-test indicated that the final weight gain of grass carp in *Azolla* fed ponds were significantly higher (t_{cal}=4.85***; df=13) than that of the control pond. The net profit for production of organic grass carp was calculated as 0.12 \$/m^2. It was concluded that the utilization of organic *Azolla* through grass carp is one of the best options for production of fish biomass from the aquatic habitat. This would also pave way for producing organic fish and help in bridging the gap between production and demand of organic fish in the country.

Key words: Organic fish, Grass carp, *Ctenopharyngodon idella*, Azolla, growth performance, North Eastern India.

Introduction

In recent years, organic aquaculture has been gaining considerable importance. Many farmers have begun shifting from traditional method to organic cultivation as means of producing safe foodstuff and respecting environment. The concept of sustainable farming has caught increasing momentum in India during recent years. Organic farming favours lower input costs, conserve nonrenewable resources, high value markets and boost farm income, besides improving quality of the product. Organic fish farming system rely on practices such as cultural and biological disease management and virtually prohibit utilization of synthetic chemicals in fish production. The North Eastern Hill Region of India has been identified as the potential zone for production of organic foods including fish due to thin population density (151 person/km^2) and negligible use of inorganic inputs. Aquaculture is one of the important enterprises in the state of Meghalaya and many rural farmers in valley areas have at least one or two ponds within their farm area for fish culture (Bujarbaruah *et al*., 1996). This part of the country receives rainfall during most part of the year, thus giving ample scope to fish culture throughout the year. In North Eastern Hill Region of India in general and Meghalaya in particular, grass carp, *Ctenopharyngodon idella* (Val.) is a widely preferred species by the farmers as they are cold tolerant and found to perform very well, attaining about 1.0 to 1.2 kg in a year (Majhi, 2005). In addition, there is a good market demand for this species, varying between \$1.28 and \$1.70 per kg when grown in polyculture system. However, increasing price up to \$2.13 can be expected when the fish is produced with organic standards. The preference for grass carp among the local people of the region is good, as the flesh of this fish is firm and flaky having a good flavour.

Since grass carp is a suitable species for the hills, some of the terrestrial and aquatic weeds grown organically can be utilized as feed for this fish. Earlier attempts to use terrestrial grass as feed for grass carp by Venkatesh and Shetty (1978); Devaraj *et al*. (1986) and Suresh and Mandal (2000) have shown encouraging result under ordinary culture system. Sivakumar and Solaimalai (2003) have reported that feeding fresh and dried *Azolla* to Tilapia (*Oreochromis niloticus*) in integrated rice-fish culture system was beneficial. However, no reports were found on acceptability, growth performance and production of grass carp through feeding organically produced aquatic weeds.

The present study therefore is focused on utilization of the organically produced aquatic fern *Azolla* as feed for the grass carp grown in organic pond and its contribution in growth performance and total fish production.

Materials and Methods

Three ponds of 1,000 m^2 each were used for the study. The fish in two ponds were fed with organically produced *Azolla* and the third pond was kept as control, where no feed was given to the fish. The ponds were located at 950 m above the MSL between 21° 50′ - 29°.50′ N latitude and 85° 5′ -97° 5′ E longitude, inside the campus of ICAR Research Complex, Meghalaya. The climatic condition of the region is cold to warm pre-humid with annual rainfall

of above 2,000 mm.The air and water temperature varies between 11 - 26ºC and 10 - 24ºC, respectively. Before the experiment was conducted, the ponds were kept fallow for over three years as recession period. After that, the ponds were dried and the bottom soil was exposed to sun for one week for eradication of unwanted microorganisms and wild fish. Organic manure in the form of well decomposed Farm Yard Manure (FYM) was applied at the rate of 1 kg/m^2 to fertilize the ponds. Auto-filling of water was performed in each pond through underground seepage, which took one week to reach a water table of 1.0 m. The pond was kept without stocking of fish for 14 days for production of plankton. The experiment lasted for 150 days.

Healthy grass carp fingerlings of 23.50±5.0 g, 5.0±3.0 cm (produced following organic standards i.e. no synthetic inputs were used) were procured from Rural Resource and Training Centre (RRTC), Umran, Meghalaya. A total number of 750 fingerlings were stocked as 0.75 fish/m^2 in each ponds including control pond. Before releasing the fingerlings to the experimental ponds, the fish were kept for 12 hours fasting for complete defecation.

The fingerlings in treated ponds were fed with finely chopped aquatic fern *Azolla caroliniana* placed over a feeding basket. The *Azolla* was procured from Division of Agronomy, Indian Council of Agricultural Research (ICAR) Complex, Barapani, Meghalaya, which was grown organically. For manuring of *Azolla* pond, FYM 10 t/ha along with 40 kg phosphorus in the form of Mussorie Rock Phosphate (MRP) were well mixed and allowed for microbial decomposition for one month. This phosphorus enriched FYM was used for fertilizing the *Azolla*. Phosphorus is essential for better growth and multiplication of cyanobacterium, *Anabaena azollae*, which lives in the dorsal cavity of *Azolla* and fixes atmospheric nitrogen, in symbiotic association with aquatic fern *Azolla*. No other synthetic chemicals were used for protection and production. The fish were fed everyday at 9.30 am at the rate of 10% of kg biomass. The nutrient content of *Azolla* was analyzed by following the procedures described by Prasad (1998). The NPK content of *Azolla* on dry weight basis was 1.68%, 0.47% and 1.16%, respectively. It also contained a considerable amount of Ca^+ (0.5%), Mg^+ (0.5%) and Fe^+ (0.21%)**.** In addition to macro and micronutrients, it is also a rich source of amino acids and vitamins (Sardana, 1997).

The water quality parameters (variations in water temperature, pH, dissolved oxygen and total alkalinity) of the experimental ponds were monitored monthly and the samples were analyzed following the standard methods (APHA, 1998). The acceptability of *Azolla* by grass carp and their growth were calculated.

The mean values of weight gain in *Azolla* treated grass carp fingerlings were compared with mean values of weight gain in control by *t*-test (paired two samples for mean).

Results

The variations in water temperature, pH, dissolved oxygen and total alkalinity during the experiment were 20 - 22ºC, 7.5 – 8.2, 7.0 – 7.8 mg/l and 40 to 45 ppm, respectively.

It was clearly observed that grass carp were well accepting the *Azolla* as feed. The weight gain and the average growth of fish fed with *Azolla* are presented in Table 1. The highest and the lowest individual wet weight gains were recorded as 900±50 g and 250±25 g, respectively. Absolute growth for *Azolla* fed grass carp (247.68 g) was 297% higher than that of control group. The *Azolla* fed grass carp also exhibited higher growth increment (1.65 g/fish/day) than that of control (0.42 g/fish/day). Similarly, Specific growth rate (1.65%) and relative growth rate (7.29%) was also found to be higher for *Azolla* fed grass carp. The total production of grass carp at the end of 150 days culture period was 0.19 kg/m^2 in *Azolla* fed pond and 0.05 kg/m^2 in control pond. The paired *t*-test for mean indicates that the final weight gain of grass carp in *Azolla* treated ponds was significantly different (*t*cal = 4.85^{***}; df= 13) from that of control pond. Survival was not influenced by treatments as there were 100% survival both in treated and control ponds. Survival and biomass increments of grass carp fed with *Azolla* are presented in Table 2.

Economic evaluation of grass carp production with *Azolla* feeding (Table 3) revealed that a net profit of \$118.00 (\$0.12/m^2) was obtained from 1000 m^2 pond with an investment of \$314.

Discussions

In recent years, worldwide increasing attention has been given on organic foodstuffs including fish. European Union (EU) directives suggest that fish captured or harvested from the wild cannot be labeled as “organic”. It should be produced in under specific conditions (Alderman *et al*., 1998). The organic fish farming is a holistic management system, which promotes and enhances agro-ecosystem health including biodiversity, biological cycle and soil biological activity (Bjorklund *et al*., 1990). Organic production systems are based on specific and precise standard of production, which aim at achieving optimal agro-ecosystem, and which are socially, ecologically and economically sustainable.

In the present study, IFOAM (International Federation of Organic Agriculture Movement) standards were followed to conduct the experiment (Bernward *et al*., 2002). However, as the experiment was conducted in outdoor system, some of the physical parameters like rainfalls and hailstones were not controllable.

The *Azolla* used in the experiment is otherwise well known as biofertilizer. It fixes atmospheric nitrogen in symbiotic association with cyanobacterium, *Anabaena azollae.* The higher

Table 1. Effect of *Azolla* feeding on growth performance of grass carp

Treatments	Initial Weight (g/fish)	Final Weight (g/fish)	*Azolla* fed (g/fish/day)	Total Wight Gain (g/fish)	Absolute Growth (g)	Growth Increment (g/fish/day)	SGR (%)	RGR (%)
Azolla[*]	22.66	270.34	14.6	10.94	247.68	1.65	1.65	7.29
Control	24.25	86.67	-	2.58	62.42	0.42	1.27	1.72
t value	0.184 [NS]	4.85 [***]	-	-	-	-	-	-

SGR: Specific Growth Rate, RGR: Relative Growth Rate, TWG: Total Weight Gain (TWG=Final weight -Initial weight / Initial weight)
[*]Data presented are means of duplicate [NS:] Not Significant [***]: Significant at 1%

Table 2. Effect of *Azolla* feeding on survival and biomass of grass carp

Treatment	Pond Area (m^2)	Initial biomass (kg)	Final biomass (kg)	Survival (%)
Azolla[*]	1000	17.00	202.76	100
Control	1000	18.19	65.02	100

[*]Data presented are means of duplicate

Table 3. Economic evaluation of organic grass carp production with *Azolla*

Break down of costs	Amount (US $)	
Variable Costs		
Supplies		72.84
Feed	35.6	
Fingerlings	15.96	
Manure (FYM, MRP)	21.28	
Electric/fuel		00
Labor		36
Miscellaneous		14.47
Maintenance costs	10.64	
Marketing	3.83	
Total variable costs (TVC)		123.31
Fixed Costs		
Pond construction		180.86
Depreciation		9.58
Pond	4.26	
Equipment	5.32	
Interest		0.00
Total fixed costs		190.44
Total annual costs		314.00
Value of production		431.88
Production (kg)	202.8	
Market value ($/kg)	2.13	
Net profit		118.00

1 US $ = Rupees 47.00 (During November 2005)

content of nutrient and availability of amino acids and vitamins make the aquatic fern ideal to meet the nutritional requirement of grass carp. From the study, it has been observed that *Azolla* fed fish attain a daily growth increment of 1.65 g/fish/day, whereas in control, the growth increment was 0.42 g/fish/day. In contrast, Vinod *et al.* (2004) reported that the growth increment of grass carp fed with four different terrestrial weeds was *Ageratum conyzoides* (0.0646 g/ day), *Biden pilosa* (0.0354 g/day), *Galinsoga perviflora* (0.2476 g/day) and *Crassocephalum. crepidioides* (0.166 g/day). Thus, from the present study, it is well evident that feding grass carp with organically grown *Azolla* will give better returns (Table 3) in comparison to that of other terrestrial weeds. In addition, the higher growth increment in *Azolla* fed fish may be due to high FCR, which is attributed to high daily feed consumption. According to Grygierek (1973), the large quantity of faeces produced by the grass carp due to high feed consumption may also serve as feed for the bottom feeders in a polyculture system.

Azad (1996) found that the grass carp fingerlings showed a better growth performance (0.071 g/day) when fed with *Ageratum conyzoides* when compared to the aquatic weed *Azolla* and *Lemna*. On the contrary, in the present study, growth of grass carp fed with *Azolla* was remarkably high

(1.65 g/fish/day) and the total production of fish was 185.76 kg in a culture period of 150 days. A small unit of pond in the backyard is the common scenario in every rural household in Meghalaya. Thus, training the farmers to culture the *Azolla* organically would definitely add a momentum in production of organic grass carp in the region.

Conclusion

The utilization of aquatic fern *Azolla* as fish feed in organic fish farming would be one of the cheapest way to increase the fish production from the aquatic habitat. This would also pave way for producing organic fish and narrow the wide gap between the production and demand of organic fish in the country. Above all, organic fish production would also increase the farm income and living standard of low income farmers of the region.

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