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Fish pond mechanization to enhance fish productivity

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Abstract
From September to December 2019 at DoAR, Parwanipur, an experiment was conducted to identify the effects of a paddle wheel aerator and feed dispenser on the productivity of carp in a completely randomized design (CRD) having four treatments: No Aeration + No Feed Dispenser (T_1), No Aeration + Feed Dispenser (T_2), Aeration + No Feed Dispenser (T_3) and Aeration + Feed Dispenser (T_4) with three replications each. For grass carp, Dubo grass (Cynodon dactylon) and floating pellets at 3% of total body weight were also given to the fish every day. T_4 had the largest extrapolated gross fish yield, followed by T_3, T_2, and T_1, which were significantly different ($p<0.05$). The aggregate net fish yield was highest in T4, which had a statistically significant difference from T_1 ($p<0.05$), whereas T_2 and T_3 were statistically not different to T_1 and T_4 ($p> 0.05$). Similar to this, it was discovered that T4 had the highest overall final yield, followed by T_3, T_2, and T_1, which were all statistically different ($p<0.05$). The feed conversion ratio was found the least in T_4 followed by T_2, T_3 and T_1. These findings imply that aeration and feed dispensers may be a feasible method for aquaculture to increase the dissolved oxygen content in pond water as well as productivity.

Keywords: Feed dispenser, paddle wheel aerator, feed conversion ratio

1. Introduction
Aquaculture is the fastest-growing animal-based food-producing sector, particularly in developing countries like Nepal and its production contributes to livelihoods, and employment and also fulfils the nutritional demand of millions of people (FAO, 2016) [5]. Polyculture is the practice of culturing more than one species of aquatic organisms in the same pond. Combinations of three Chinese carps: bighead carp (*Hypophthalmichthys nobilis*), silver carp (*Hypophthalmichthys molitrix*) and grass carp (*Ctenopharyngodon idella*), and the common carp are most common in polyculture. Therefore, to fulfil the animal protein demand for the teeming population in Nepal productivity of pond aquaculture should be increased.

Since for high productivity ponds are heavily stocked with fish as well as with high feed supply and in these artificially fed fish ponds, many problems like organic pollution, deficiency of oxygen, increased level of free carbon dioxide and a total increase in ammonia-nitrogen, nitrite-nitrogen ratio are frequently occurring. However, the problem of oxygen depletion in the rearing of freshwater fish species is a major threat and main limiting factor in intensive aquaculture because it leads to hypoxia which affects fish growth, food conversion levels and feeding efficiency etc. (Mallya, 2007) [7] and fish always show high feed efficiency when they are fed at required DO in water (Boyd, 1998). Fish feed alone consists of 60% of production cost and the protein component is the most expensive in overall feed cost (Erondu *et al*., 2006) [4]. Feeding the fish with a suitable type of feeding device and feed type is of prime importance in the polyculture system. Much of the mash feeds are remained uneaten by fish, which results in feed wastage and increased organic loading that eventually leads to poor water quality (Munguti, 2014) [8].

Therefore, in the present study, a paddle wheel aerator and feed dispenser have been used for oxygen supply and feeding fish in aquaculture ponds to determine the effect of aeration on growth, production and different water quality parameters, respectively.

2. Materials and methods

2.1 Site and design of the experiment

The experiment was conducted in a completely randomized design (CRD) in four 750 m^2 earthen ponds of 1-meter depth over the course of three months, from September 20 to December 20 (90 days) having four treatments: No Aeration + No Feed Dispenser (T_1), No Aeration + Feed Dispenser (T_2), Aeration + No Feed Dispenser (T_3) and Aeration + Feed Dispenser (T_4) with three sample replications each. After pond preparation, a two-paddle wheel aerator (1 HP) and automatic feed dispenser were installed for aeration and to feed the fish twice daily. Aerators are typically used for three hours each time, from three in the morning to six in the morning and from nine in the morning to twelve in the afternoon, when oxygen depletion occurs.

2.2 Pond preparation

Calcium carbonate was applied to ponds @ of 5 kg/100 m^2 (Gupta & Rai, 2011) [5] and allowed to sun dry for a week. Screening the water inlets prohibited the exit of pond fish and the introduction of wild fish. Before a week of fish stocking, ponds were fertilised with inorganic fertilisers such as urea and Di-ammonium phosphate (DAP) at 0.4 g N/m^2/day and 0.1g P/m^2/day and repeated biweekly (Shrestha and Pandit, 2007) [9].

2.3 Stocking of fingerlings

At the time of stocking, all treatments included equal amounts of silver carp, bighead carp, grass carp, common carp, and rohu, with a total stocking density of 750 fingerlings per pond.

2.4 Water quality parameters

Temperature, dissolved oxygen (DO), and pH were measured weekly using an Orion-1230 DO metre and a HANNA-HI-96107 pH meter. In a similar manner, biweekly measurements of nitrate (NO_3), nitrate (NO_2), and ammonia (NH_3) were made using the Digital water testing accurate Eco-Check kit #486798-k.

2.5 Fish growth measurement

Each experimental unit had a dragnet used to randomly collect around 15% of the population of each fish species for monthly sampling. These fish were then weighed individually and in batches using an electronic balance, and then they were returned to the appropriate experimental units. At the time of harvest, growth indicators including total weight (kg/750 m2), gross fish yield (GFY), net fish yield (NFY), and feed conversion ratio (FCR) were calculated.

2.6 Statistical analysis

Using SPSS, experimental data were examined (version 21). The significance test was run using a one-way ANOVA with a 0.05 alpha level ($p<0.05$). DMRT was used to compare the means ($p<0.05$). The data tabulation and figure preparation were done on a computer using the Microsoft Excel application. Every mean was provided with a standard error (SE).

3. Results and Discussion

3.1 Water quality parameter

Table 1 shows the average values of the weekly and biweekly water quality metrics measured during the experimental period. There was no significant difference among the treatments ($p>0.05$)

Table 1: Temperature, dissolved oxygen, pH, ammonia, nitrite, and nitrate in various treatments over the course of the experiment (Mean ±SE).

Parameters	Treatments Mean			
	T_1	T_2	T_3	T_4
Temperature (°C)	**27.05±0.04**	**27.08±0.05**	**27.12±0.05**	**27.03±0.05**
DO (mg/L)	6.32±0.13	6.56±0.07	6.70±0.05	6.68±0.02
pH	7.70±0.07	7.79±0.04	7.60±0.07	7.60±0.07
NH_3 (mg/L)	0.09±0.02	0.03±0.02	0.06±0.02	0.01±0.02
NO_2 (mg/L)	0.01±0.01	0.03±0.01	0.17±0.01	0.06±0.01
NO_3 (mg/L)	1.91±0.09	1.28±0.09	1.68±0.11	1.12±0.11

3.2 Fish Growth Measurement

Silver carp, bighead carp, common carp, and rohu's, initial mean weight (g) and final mean weight (g) did not differ significantly among treatments ($p>0.05$) as shown in Table 2. The final mean weight of silver carp was found the highest in T_4 and the least in T_1 which were significantly different ($p<0.05$) while T_2, T_3 and T_4 were *statistically at par* ($p>0.05$). In the case of grass carp, the final mean weight was the highest in T_2 among all treatments which were significantly different from T_1, T_3 and T4 ($p<0.05$) while T_1 and T_2 were statistically at par ($p>0.05$).

Table 2: Initial mean weight (g), final mean weight (g) of silver carp, bighead carp, grass carp, common carp and rohu

Parameters	Treatments			
	T_1	T_2	T_3	T_4
Silver carp				
Initial mean weight (g/fish)	5±0.001	5±0.001	5±0.001	5±0.001
Final mean weight (g/fish)	125±0.05^b	225±0.05^a	225±0.05^a	229±0.05^a
Bighead carp				
Initial mean weight (g/fish)	6±0.001	5±0.001	5±0.001	3±0.001
Final mean weight (g/fish)	152±0.07	155±0.07	171±0.07	155±0.07
Grass carp				
Initial mean weight (g/fish)	7±0.001	8±0.001	`10±0.001	8±0.001
Final mean weight (g/fish)	153±0.01^b	194±0.01^a	118±0.01^c	110±0.01^c
Common carp				
Initial mean weight (g/fish)	8±0.001	28±0.001	45±0.001	19±0.001
Final mean weight (g/fish)	267±0.01	310±0.01`	275±0.01	305±0.01
Rohu				
Initial mean weight (g/fish)	21±0.001	12±0.001	28±0.001	22±0.001
Final mean weight (g/fish)	134±0.01	151±0.01	164±0.01	167±0.01

Mean values with different superscripts in the same row are significantly different ($p<0.05$)

The final mean weight of silver carp and grass carp was found the highest in the ponds having installed with an aerator and feed dispenser and least on ponds without mechanization. It was found that the aerator and feed dispenser was effective in increasing fish production (Sultana *et al.*, 2017) [10].

Extrapolated gross fish yield (GFY) was found the highest ($p<0.05$) in T_4 followed by T_3, T_2 and T_1 which were significantly different ($p<0.05$) (Table 3). Extrapolated net fish yield (NFY) was found the highest in T_4 which was significantly different ($p<0.05$) from T1 while T_2 and T_3 *were statistically at par* ($p>0.05$) and not significantly different from T1 and T4 ($p>0.05$). Similarly, total yield was found the highest ($p<0.05$) in T4 followed by T3, T2 and T1 which were significantly ($p>0.05$) different. According to Craig *et al*., 2017 [3] fish can develop to an acceptable size when fed floating feed, but different species require different types of food. Even though common carp are bottom feeders, they also ingest items that are afloat, which may account for the increased production of common carp (Bauer, 2014). According to the findings of (Sultana *et al*., 2017) [10], the reduced FCR seen in aerators-installed ponds may be the result of correct feeding, controlled conditions, and changes in DO concentration caused by aeration facilities.

Table 3: Extrapolated GFY, NFY, total yield and FCR in different treatments (Mean ± S.E.).

Parameters	Treatments			
	T_1	T_2	T_3	T_4
Extrapolated GFY (kg/ha/day)	12.15 ± 0.031^d	15.89 ± 0.03^c	18.66 ± 0.03^b	19.82 ± 0.03^a
Extrapolated NFY (kg/ha/day)	9.38 ± 1.54^b	13.93 ± 1.54^{ab}	13.56 ± 1.54^{ab}	18.35 ± 1.54^a
Total yield (kg/pond)	76.57 ± 0.19^d	100.11 ± 0.19^c	117.55 ± 0.19^b	124.85 ± 0.19^a
FCR	2.83±0.4	2.05±0.4	2.39±0.4	`1.76±04

Mean values with different superscripts in the same row are significantly different ($p<0.05$)

4. Conclusion

Overall, aeration and feed dispensers boosted yield and improved the dissolved oxygen concentration in feed-based pond aquaculture As a result, it can be inferred that aeration and feed dispensers are a promising aquaculture strategy for promoting fish development and productivity. For farmers to become aware of aeration, feed dispensers, and their effects on pond productivity, more action research is needed at the field level.

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