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Effect of stocking density and source of animal protein on growth and survival of rainbow trout fingerlings in flow-through system at Nuwakot, Nepal

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ABSTRACT

An experiment was conducted in outdoor nursing raceways with flow-through system (2.7 m^2) at the Fisheries Research Station, Trishuli, Nuwakot Nepal for 249 days to evaluate the effect of stocking density and sources of animal protein on growth and survival of rainbow trout fingerlings production. The experiment was conducted in 2 × 2 factorial completely randomized design having two stocking densities, (density-1: 10 kg/m^2 and density-2: 12.5 kg/m^2) and two diets (diet-1: shrimp meal based diet and diet-2: 5% bovine blood meal mixed diet). All treatments were replicated thrice. Water from the Trishuli river was used and 50 cm water depth was maintained in all treatments. Initial feeding rate of 10% of the body weight was gradually reduced to 8, 7, 6, 5, 4 and 3% was maintained for the subsequent months. Feeding was done 5 times a day throughout the study period. Results showed that the mean total harvest weight in diet-1 (30.17 ± 1.34 kg) was significantly higher than in diet-2 (22.77 ± 1.34 kg); however, no significance difference was observed at stocking density levels. Mean survival of fish in diet-1 (60.30 ± 2.08%) was significantly higher than diet-2 (47.78 ± 2.08%). Similarly, survivability of fish in density-1 (63.45 ± 2.08%) was significantly higher than in density-2 (44.63 ± 2.08%). The mean dissolve oxygen at density-2 (8.89 ± 0.02 mg/L) was significantly lower to that of density-1 (8.94 ± 0.02 mg/L) and B:C ratio was high with shrimp meal based diet and high stocking density (T_3). In the present study, the treatment with shrimp meal based diet and high stocking density (T_3) was superior with high mean total harvest weight, gross fish yield, low FCR and high B: C ratio than other treatment combinations. The present study demonstrated that growth, production and survival performances of rainbow trout in the present experimental condition were not satisfactory by substituting a part of shrimp meal by blood meal.

1. Introduction

Rainbow trout is a globally important cold water species for aquaculture with annual global production of around 814 thousand tons (Singh et al., 2016). Intensive farming of rainbow trout in flow-through systems is a common practice in cold water aquaculture of Nepal. Despite the surge in trout productions (0.045 mt in 1997/98; 16.095 mt in 2004/05, 228 mt in 2013/14–300 mt in 2015/16), we still have lower level of production within the country (DoFD, 2016). One of the major challenges for wider adoption of trout aquaculture throughout the country is to supply quality fingerling in adequate quantity to growing areas. Regarding quality fingerling production, proper stocking density and feed quality determine its growth, survival and economic of production.

Optimum stocking density for the rainbow trout in a flow-through aquaculture system is necessary in terms of maintaining a positive correlation between density and growth rate. It is necessary to find balance between the maximum profit and the minimum incidence of physiological and behavioral disorders (Ayyat et al., 2011). In Nepal, the commonly practiced stocking density of rainbow trout on weight basis is 10 kg/m^2 (Nepal et al., 1998) while on stocking number basis is 50–100 fish/m^2 (Rai et al., 2008). This stocking density is the least in comparison to practices available worldwide. With advancement with feed quality, feeding practices and rearing techniques, the stocking

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density needs to be updated.

Feed, the other limiting factor for growth performance is sole dependent on shrimp meal imported from India. However, seasonal variation in quality, decreasing shrimp meal supply relative to demand and increasing costs threaten the sustainability and growth of the trout industry. Presently, feed manufacturers are faced with limited shrimp meal supply and increasing prices of almost all imported feedstuff (Bista et al., 2008). Understanding the potent alternative animal protein source for rainbow trout fingerlings in relation to its rearing density may lead to the coping with low fingerling survivability enhancing their growth and production. Moreover, assessing the cost-effective alternative animal protein sources and its effect at different stocking densities is of particular interest. Ingredient choice should be based not only on nutrient level, digestibility, and cost, but also upon other criteria such as sustainability and environmental impact of production, and fish-in fish-out ratio (Jackson, 2010; Kaushik and Troell, 2010). The possible potential alternatives include different agriculture by-products, oil crop by-products (Hardy, 2010); fisheries by-products (Hernández et al., 2004) and animal protein sources such as meat meal, bone meal, blood meal and hydrolyzed feather meal (Tantikitti, 2013). Despite their good amino acid profile, soybean meal has competitive uses for human consumption and other livestock and poultry feeds. Similarly, meat and bone meal cannot be incorporated in the feed as a result of implementation of the ban by European Union on their use in any animal production (Chadd et al., 2004), while blood meal, easily available animal by-products find some application in fish feed formulation owing to their high nutritive value and low cost (Biswas, 2003) with restrictions of 1–8% in rainbow trout feed (Tacon et al., 2011). Earlier study with rainbow trout in Nepal on potent alternative protein source mainly focused on soya bean (FRCT, 2003, 2004; Roy, 2006) and Silk worm (Dheke and Gubhaju, 2013). However, use of animal rendered products like blood meal is overlooked. Statistical Information on Nepalese Agriculture states that there is a huge consumption of pork and buffalo meat in Kathmandu valley and its vicinity. The by-product of the slaughter house included blood is wasted or unused. The blood meal can be used in fish feed as a source of animal protein (Pillay, 1990). To address these issues, the present study was conducted to evaluate the effect of stocking density and addition of blood meal in feed on growth, survival and economics of rainbow trout fingerlings production.

2. Materials and methods

2.1. Experimental design

This experiment was conducted in 12 outdoor cemented raceway tanks with flow-through system having surface area of 2.7 m^2 (each dimensions 2.5 × 1.06 m^2) at the Fisheries Research Station, Trishuli, Nuwakot, Nepal for 249 days. The experiment was conducted in a 2 × 2 factorial completely randomized design (CRD) having two stocking densities, density-1(10 kg/m^2) and density-2 (12.5 kg/m^2) and two diets, diet-1 (shrimp meal based) and diet-2 (5% blood meal mixed). Altogether there were four treatments replicated thrice. The treatments were T_1: Density-1 Diet-1; T_2: Density-1 Diet-2; T_3: Density-2 Diet-1 and T_4: Density-2 Diet-2.

2.2. Research set-up

Rainbow trout fries of 0.21 ± 0.01 g average size obtained from the Fisheries Research Station, Trishuli were used for the experiment. The fish were stocked in 2.7 m^2 raceways at densities of 10 and 12.5 kg/m^2. The raceways were supplied with the water from Trishuli river with backup reservoir passing through desiltation tank at ambient temperature. In all raceways, water depth was maintained at 50 cm. The inflow rates within raceways were monitored regularly and adjusted about 10 L/sec.

The external stand pipe of each raceway was removed daily for approximately 10 s to flush away the accumulated uneaten food and fecal matter on the drainage screens to reduce the risk of blockage. The floor and sides of the raceway were scrubbed to clean, following the removal of fish during monthly sampling. Biomass in each unit raceway was estimated from the mean mass obtained from monthly sampling.

2.3. Preparation of experimental diets

Fresh bovine blood was collected from the abattoir located near the study area and transported to the research station for processing. The coagulated blood was pre-cooked in boiling water and subjected to dehydration air oven at a temperature of 65 ± 2 °C for 36 h (Cavalheiro et al., 2012) with continuous stirring to prevent burning and allow even cooking. The brownish lumps were cut into smaller pieces to allow easy and faster drying. The proximate composition of blood meal was: 97.55% dry matter, 65.0% crude protein, 3.19% ether extract, 1.69% crude fiber, 8.19% total ash and 4890 Kcal/kg gross energy.

Two diets with same levels of dietary protein (37.0%) were formulated, shrimp meal based diet and 5% replacement of shrimp meal with blood meal. To prepare formulated pellet diet, all ingredients (Table 1), including vitamin and mineral premixes, were ground thoroughly and sieved to pass through 0.5 mm mesh size, mixed together and then put into the electric pellet machine.

2.4. Feeding

Fish were hand fed with pellet feed at the rate of 10% of the body weight during the first month. The feeding rate was then gradually reduced to 8, 7, 6, 5, 4 and 3% of the total body weight for the subsequent months. The total daily feed ration was divided into five equal portions and delivered at 8:00 am, 10:00 am, 12:00 pm, 2:00 pm and 4:00 pm under ambient lighting.

2.5. Fish growth and production

Monthly sampling of fish was done of each raceway by seining. About 10% fish were randomly weighed (± 0.1 g, Phoenix instrument electronic balance Model SN-014739), measured (total length ± 1 mm, ordinary scale attached wooden measuring board) and growth

Table 1
Ingredients and per cent composition of the experimental diets. Additional methionine and lysine were added in total composition.

Ingredient	Diet-1	Diet-2
Blood meal	0	5
Shrimp meal	35	30
Soya full roasted	30	30
Soya cake	5	5
Wheat	15	15
Mustard oil cake	3	3
Rice bran	8	8
Vitamin premix[a]	1	1
Mineral mix[b]	1	1
Yeast	1	1
Salt	1	1
Additional amino acids		
Methionine	0.7	0.7
Lysine	0.2	0.2

[a] Vitamin mixture/kg premix contained 33000 IU vitamin A, 3300 IU vitamin D3, 410 IU vitamin E, 2660 mg Vitamin BI, 133 mg vitamin B2, 580 mg vitamin B6, 41 mg vitamin B12, 50 mg biotin, 9330 mg choline chloride, 4000 mg vitamin C, 2660 mg Inositol, 330 mg *para*-amino benzoic acid, 9330 mg niacin and 26.60 mg pantothenic acid.

[b] Mineral mixture/kg premix contained 325 mg Manganese, 200 mg Iron, 25 mg Copper, 5 mg Iodine and 5 mg Cobalt.

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