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Research Article

Assessment of Water Temperature on Growth Performance and Protein Profile of Rainbow trout Oncorhynchus my kiss (Walbaum, 1792)

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ABSTRACT

Thermoregulation in poikilothermic animals is influenced by thermal variations. It is known that fish ectotherms are highly influenced by thermal variability during development, which leads to important modifications at several metabolic levels such as growth and its physiology. Thus, the aim of this study was to investigate the effect of varied water temperature on growth performance and protein profiles of rainbow trout Oncorhynchus my kiss [1]. Altogether six varied temperatures as T1(8-10 o C), T2 (10-12 o C), T3 (12-14 o C), T4 (14-16 o C) , T5 (16-18 o C) and T6 (18-20 ° C) were fixed with the help of aquarium heater in 18 aquaria (three replicates) considered as six treatments and normal feeding (45% protein) were done at the rate of 3% of bodyweight twice daily for 90 days. At the end of the feeding trial cent per cent survival rate was recorded in T4 temperature treated group of fish while in other the survival rate was 99.6, 97.3, 96.4, 95.7 and 93.13% respectively. Mean weight gain (2 times) and specific growth rate (SGR) were significantly (P<0.05) high in T4 temperature treated group as compared to control, while FCR showed decreasing trend at T4 and as the temperature increased, increasing FCR were observed in T5 and T6 temperature treated group. The total protein was significantly (P<0.05) higher 176.29 % in liver and 180.12 in kidney in T4 temperature treated group. It was concluded that water temperature ranging from 12-14°C seemed to be the most effective for rearing of juvenile rainbow trout and higher temperature (>18°C) results in slow growth, reduce protein level and increase mortality level.

Keywords: temperature, rainbow trout, growth, FCR, protein, albumin, liver, kidney

INTRODUCTION

Rainbow trout Oncorhynchus mykiss [2] is an exotic carnivorous sport fish was first introduced in Nepal in the late 1960s and early 1970s from the United Kingdom, Japan and India, and was re-introduced from Japan in 1988. Now the breeding and culture technology of rainbow trout in Nepal is well developed. Rainbow trout culture requires a permanent supply of water with a temperature range from 0 to 20°C so rearing of trout is common in Himalayan region. The optimum temperature for growth of trout is between 16 and 18°C, but the suitable water temperature range for feeding and growth is 13-18°C [3], and 9-14°C for the spawning and hatching of eggs [4]. The consistency of environmental conditions regarding water temperature, volume and quality is very important for trout culture.

Temperature is one of the environmental factors with greatest influence on the growth performance of animals. Being cold-blooded animal, fish is affected by the temperature of the surrounding water which influences the body temperature, growth rate, food consumption, feed conversion and other body functions [5]. Therefore, water temperature is a driving force in the fish life because its effects are more than any other single factor. Growth and livability of fish are optimum within a defined temperature range [6]. Although short-term changes, such as weather conditions, may influence a fish for a day or two, but temperature has more predictable and seasonal effect.

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Like other ectothermic animals, fish are affected by the ambient water temperature, which can influence their appetite, food consumption rate, conversion efficiency [7], growth rate [8] and over-all physiological status (Azevedo et al., [9].

Temperature variations diversely affect fish species, and while information is growing regarding the effects of thermal variation on aquatic systems, limited knowledge is available on impacts to the metabolic and physiological traits of fish. Thermal change is the strongest influencing force for ectothermic organisms such as fish, which, in contrast to endotherms, cannot maintain a constant body temperature via homeostatic mechanisms [10]. In aquatic systems, fish are exposed to spatial and temporal variations in temperature that significantly affect individual physiological traits (i.e., growth and metabolic condition), genetic structure [11], and/or survival [12]. Indeed, species-specific thermal tolerances are a primary driver establishing the environments in which fish live [13].

Increased water temperature also influences fish survival indirectly by controlling metabolic function, resulting in the sensitivity of growth to temperature [14]. The physiological mechanisms causing death at high temperatures are not entirely understood but appear to be related to underlying factors such as the increase in oxygen consumption by fishes and corresponding decrease in dissolved oxygen solubility at high temperatures, and the decreased capacity to sustain vital energy reserves and electrolyte concentrations. Ultimately, death at high temperatures is caused by osmoregulatory failure [15].

Water temperature and ration size are two of the most important factors influencing the growth of fish [16]. The metabolic rate, growth, energy expenditure and feed intake of fish are highly influenced by water temperature. When temperature is low, growth rates, feeding rates, and metabolic rates are suppressed; whereas elevated temperatures correlate with an increase in growth up to an optimum point above which thermal stress occurs [17], hence to determine the optimal feeding rate at specific water temperature is prerequisite to the success of aquaculture production [18]. Therefore, it is important to investigate growth of benni in relation to temperature and ration so to provide useful knowledge for relevant farmers.

Several studies indicate that temperature fluctuations can enhance growth of some organisms, such as zooplankton [19], fish [20] and shrimp. Therefore, water temperature is a driving force in the fish life because its effects are more than any other single factor. Increasing water temperatures may influence the persistence of trout populations by affecting their distribution, survival, and growth. Water temperature affects the geographic distribution of fishes with increasing temperatures leading to a shift toward warm water adapted species replacing those species adapted to cold water in lower elevations. Because most fish lack a means of maintaining an independent body temperature, increased water temperatures can be lethal, and sub lethal temperatures can alter metabolism, growth, and competitive interactions. Thus, the aim of this study was to evaluate the effects of different temperature range for growth and protein profiles of rainbow trout, Oncorhynchus mykiss cultured at Nuwakot of Trishuli, Nepal.

Material and Methods

Experimental fish

Rainbow trout *Oncorhynchus mykiss* (31.88 ± 0.37g) from Sosod Trout Hatchery in Ranipowa-4 (3,353′), Nuwakot (27° 54′ 59.99″ N, 85° 14′ 60.00″ E) were transported to the Aquaculture Research Unit of Amrit Campus, Tribhuvan University, Nepal, ten days prior to start of the experiment. Trout were distributed randomly among six stocking tanks (1.96 × 1.02 × 0.61m, 1200L in size and capacity). Each tank was supplied with running raceways water and the trout (30 fish/tank) were fed the same pellet die used in the hatchery.

Experimental diets

Using *WinFeed 2.8* with the standard calculation, altogether six practical diets were prepared equally for each treatment (Table 1). Fish meal was dried well, ground in a grinder and sieved (mesh size: 500µ) to get fine powder. Then powdered fish meal was mixed and lukewarm water was added in required amount. Cod liver oil was added, mixed well so that all the ingredients were spread homogeneously. The dough was prepared and passed through a feed maker using 1 mm die. The threads formed were dried and further chopped into small pieces of required sizes of pellets through a blender and then passed through a sieve to obtain equal sized particles. Diet was kept in plastic containers and stored at 4°C until used.

Ingredients	Experimental diets (% inclusion)					
	T1	T2	T3	T4	T5	T6
Fish Meal†	29.31	29.31	29.31	29.31	29.31	29.31
Soya meal‡	14.52	14.52	14.52	14.52	14.52	14.52
Ground nut oil cake†	9.17	9.17	9.17	9.17	9.17	9.17
Rice Powder †	14.16	14.16	14.16	14.16	14.16	14.16
Wheat Flour†	14.43	14.43	14.43	14.43	14.43	14.43
Corn flour†	11.37	11.37	11.37	11.37	11.37	11.37
Sunflower oil†	3	3	3	3	3	3
Cod liver oil†	2	2	2	2	2	2

Vitamin & Mineral Premix§	1	1	1	1	1	1
Betain Hydroc hloride††	0.02	0.02	0.02	0.02	0.02	0.02
BHT(Butylated hydroxytoluene) ††	0.02	0.02	0.02	0.02	0.02	0.02
CMC (Carboxymethyl cellulose) ††	1	1	1	1	1	1
Total	100	100	100	100	100	100
Proximate composition						
Dry Matter (DM)	97.15	97.43	97.59	97.71	96.93	97.14
Moisture	2.85	2.57	2.41	2.29	3.07	2.86
Crude Protein (CP)	31.16	31.07	31.32	31.14	31.22	31.39
Ether Extract (EE)	6.56	6.37	6.11	6.98	6.55	6.55
Crude Fibre	8.32	8.32	8.43	8.79	8.45	8.97
Ash	9.23	8.73	9.53	7.69	7.84	7.58
NFE‡	44.73	45.51	44.61	45.4	45.34	45.51

Table 1: Ingredients and proximate composition of experimental diets(%).

Proximate analysis

For proximate analysis dry matter, crude protein, crude lipid, and ash were analyzed for experimental diets. Dry matter was analyzed by drying the samples to constant weight at 105 °C. Crude protein was determined using the Kjeldahl method (AOAC, 2000) and estimated by multiplying nitrogen by 6.25. Crude lipid was measured by ether extraction using Soxhlet method. Ash was examined by combustion in a muffle furnace at 550 °C for 6 h. Triple analyses were conducted for each sample. The analysis was carried out in the laboratory of Department of Zoology at Amrit Campus, Kathmandu, Nepal.

Experimental design

The experiment was conducted during mid-October to mid-January and in controlled temperature conditions ranges between 8-20 °C. Hence, to make the temperature constant, chillers were used and thus altogether 18 circular plastic tanks of 1meter diameter selected for this experiment were divided into 6 treatment groups (T1, T2, T3, T4, T5 and T6) with 3 replicate in each. Water temperatures were fixed with the help of water heater. In the beginning 8 °C was fixed in tank T1 and then after a month it was changed to 9 °C followed by 10 °C in the following month. This tank was considered as control having T1 (8-10 °C). Similar temperature variations were applied in other treated tanks in which after a month in each tank 1°C temperature was increased using aquarium heater manually. Hence, experimental rearing system were designed as T1 (8-10 °C), T2 (10-12 °C), T3 (12-14°C), T4 (14-16 °C), T5 (16-18 °C) and T6 (18-20 °C) for this experiment (Figure 1). Recirculation system of water was managed independently in treatment wise to control the temperature system of tanks.

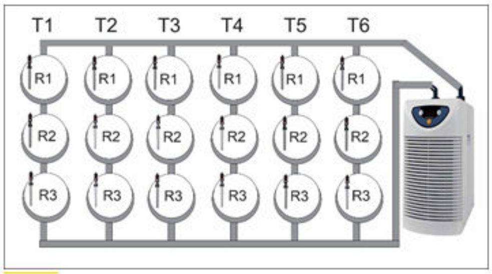

Figure 1: Experiment designed and set up using cooling system.

Sampling and examination procedure

At the end of experiment fish were starved for 24 h prior to sampling, and then anesthetized using 5 mg/l MS 222 (Sigma Chemical Co. St. Louis, MO, USA) for 2-3 minutes. All fish were measured for final body weight (FBW) and 5 fish per tank were sacrificed to collect liver and kidney tissues for the analysis of protein profiles. Weight gain rate (WGR), Specific growth rate (SGR) and Feed conversion ratio (FCR) were calculated using standard formulae;

Weight gain rate (WGR)=100 × [(final weight - initial weight)/ initial weight].

Specific growth rate (SGR =(Ln final weight - Ln initial weight) × 100 days.

Feed conversion ratio (FCR)=amount of feed given (g) weight gain(g).

Protein profiles were measured from the liver and anterior kidney of trout. Total protein was determined by Bradford (1976). Albumin was determined by BCG method using kit. Globulin was calculated by the deduction of albumin from total protein while albumin-globulin ratio was calculated by dividing albumin values to that of globulin values.

Results and Discussion

Rainbow trout is a globally important coldwater species for aquaculture with annual global production of around 814 thousand tons. 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 (0.045mt in 1997/98; 16.095mt in 2004/05, 228mt in 2013/14-300mt in 2015/16), we still have lower level of production within the country. 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.

CONCLUSION

The results from the present study provide important information for commercial rearing of rainbow trout. The weight gain rate and feed conversion ratio (FCR) was found comparatively better in T4 temperature (14-16°C) treated than other groups. High temperature indicates slow growth due to slow in physiological activities. Total Protein concentrations in liver and head kidney indicate better results in T4 treated group and similar results were observed in albumin and globulin. Thus, it has been proved that water temperature ranging from 14-16°C seemed to be the most effective and much better for rearing of rainbow trout Oncorhynchus mykiss at high altitude and proved for better growth and healthy production. Moreover, in the laboratory experiment only a batch of fish was used, and the fish were held at low density in laboratory conditions, which made it uncertain whether the results can be generalized to the context of aquaculture. Aquafarmers can be benefitted by using this technique.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

Ethical statement

This article does not contain any study with human life, thus it was required no animal ethic statement.

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