Bhutan Journal of Animal Science (BJAS)
Volume 5, Issue 1, Page 103-107, 2021

ON-FARM GROWTH PERFORMANCE OF RAINBOW TROUT FRY IN BHUTAN

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ABSTRACT: This study was conducted to evaluate the growth performance, survival rate and the feed conversion ratio of the Rainbow trout frys fed with fish feed imported from Kolkata, India. A total of 70,000 eyed ova Rainbow trout (*Onchorhynchus mykiss*) was evaluated for the period of nine months at National Research and Development Centre for Riverine and Lake Fisheries, Haa. The measurement was taken at the interval of 21 days after incubation. The fishes were fed @ 5% of body weight and were fed thrice in an hour till the stock attained weight of 9.50g and length of 9.72cm, followed by thrice a day feeding. The fish growth parameters were recorded monthly through random sampling of 20 fishes. The initial and final average weight and length of fishes were recorded 0.10g, 48.80g and 27.5 mm, 156 mm, respectively. The specific growth rate of 1.47% and FCR of 3.5:1 was recorded. The survival rate of 2.69% is considered extremely low highlighting urgent need to invest in feed quality improvement and associated management practices.

Keywords: Feed conversion ratio**;** dissolve oxygen; trout fry**.**

1. INTRODUCTION

Rainbow trout (*Oncorhynchus mykiss*) is a cold-water carnivorous fish species native to North America (FAO 2011). Due to its aggressive feeding behavior, it is one of the most sought-after sport fish in the world. Rainbow trout were first artificially propagated in California, Alaska, Asia, and Europe in the 19th century (Gurung 2008). They are ideal cold-water fish to culture due to their relatively faster growth rate and high-quality meat than its congeners. As a result, more than 82 countries have adopted rainbow trout farming (FAO 2011). Rainbow trout requires high-quality protein feed and well-oxygenated water. While it can survive temperatures ranging from 0-25°C, the best-growing temperatures range between 10-20°C. Under optimum condition and quality feeding regime, the species attains a commercial size of 200-300gm within 14-20 months (Gurung 2008).

In Bhutan, aquaculture was introduced in the late 1970s in the form of carp culture, which was exclusively limited to the southern belts**.** Opportunities for raising fish remained relatively unexplored in the northern regions of Bhutan (Wangchuk 2015) until recently. In 2007 some 20,000 eyed rainbow trout embryos were sourced from India and reared at the trout farm in the erstwhile National Cold Water Fishery Centre, Haa (National Strategy Document [NSD] 2013). The goal of introducing trout aquaculture was to provide high-quality fish protein to people in the northern region. Poor survival marred those initial fish stocks, which did not survive due to the lack of technical know-how and poor-quality fish feed (Tshering 2019). Subsequent batches of rainbow trout were imported between 2012 and 2017, each with increasing success in survivability, indicating gradual progress in the technical know-how on its management aspects. However, despite numerous pilot trials, a proper assessment of growth performance of rainbow trout in Bhutan has not yet been carried out. Now that rainbow trout is gaining popularity among the

Bhutanese populace and market demand for domestic fish products is growing, such studies are critical. These studies will generate understanding of current management practices, identify issues and explore opportunities for improvement. There are currently two semi-commercial trout farms in Bhutan, and there is potential to develop more in the future. Thus, assessing growth parameters will provide a blueprint for private farmers to emulate and serve as a foundational baseline for current and future production efforts to draw comparisons. In this manuscript, we provide the first growth performance of rainbow trout, fed with feed imported from India, and raised in the temperate region of Bhutan (Ha).

2. MATERIALS AND METHODS

2.1 Study area

The study was carried out at the Trout Breeding Centre (TBC) under National Research and Development Centre for Riverine & Lake Fisheries (NRDCR&LF), Haa. It is located at latitude 27º22'30 N and longitude 89º 17' 15' E. The region lies at an elevation of 2700 meters above sea level and is at the north western border of Bhutan. It experiences temperate climatic conditions with cool summers and cold winters and frequent snow falls (Atlas of Bhutan 2016).

2.2 Fish sample

The rearing facility has an access to natural spring water that is clean and flows at a relatively constant rate and temperature. Fishes are typically reared in hatching troughs from the time they are newly hatched (alevin) to swim up frys. After that the fish are transferred to a rearing tank (circular/square), where they are reared until they attain advance fingerling size (5-9 g). Finally, the fingerlings are stocked in larger tanks (raceways) where they are reared till table size (250 g). All rearing units (trough, tank and raceways) are supplied with running water to ensure proper exchange.

The trout (rainbow) used for the experiment was acquired from the Troutex Ap, Denmark. The fishes were maintained in hatching trays and rearing tanks. Water temperature was maintained at 11 ± 1 °C. Fish were hand fed to apparent satiation change as per standard feeding regime. For this study, 50,000 Rainbow trout frys of 0.1g (weight) were reared for a period of nine months (October 2018 to June 2019) during which, data on important growth parameters such as weight (in g), length (in mm), and feed conservation ratio (in ratio) were collected. In addition, the study also assessed total survivability of the stock. Data were collected on a monthly basis each from randomized samples of 20 individuals.

2.3 Feeding management

Fry were fed with commercially formulated feed (in powder) with crude protein (CP) content of 31.82 %, 89.31% dry matter, 10.69% total ash, 9% crude fibre, 6 % crude fat, 42.49% nitrogen free extract and 10.69% moisture.

Feeding rate and frequency varied depending on the stage of development. Initially fish were fed at a frequency of once every 15 minutes (@ 5% total body weight) until they attained a size of 5.7g. The rate and frequency were recalibrated to three times a day and 5% per body weight (feeding rate) till fish attained weight of (48.8g). Details of the feeding regime are provided in Table 1.

Table 1: Stage wise feeding interval

Stage	Feeding Rate	Frequency	Total/day
Eyed ova-Alevin	No feeding	No feeding	No feeding
Swim-up fry- Fry	5% b.w.t	three times/hour	Nine hours
Advanced fry (Fingerling)	5%	three times/ day	three times/ day

The frys were reared in troughs at a stocking density of 2500 nos/trough until fry weighed more than 2g each. Stocking density rate was adapted with modification from FAO. The details of the stocking density are provided in Table 2.

Table 2: Stocking density as used in the study

Stage	Stocking Rate	Remarks
Eyed-ova	5000/ tray	Till Yolk sac or Swim-up fry (0.1g)
Swim-up fry	2500/ tray	Till fry stage (2.0g)
Fingerling	10 Kg/m^3	Till table size stage (250 g)

The fish weight and length were measured using an electronic compact scale SF-400A (0.2-500g) and a standard ruler scale (300mm) respectively. Water temperature was recorded using a standard mercury thermometer; Dissolved Oxygen (DO) and pH were measured using the HANNA water testing kit. The following equations were used to evaluate the growth performance of fish.

Mean gain in weight (g) = Mean final weight (g) – Mean initial weight (g)

Mean gain in length (mm) = Mean final length (mm) – Mean initial length (mm)

Specific Growth Rate (SGR) and Feed Conversion Ratio (FCR) were calculated at the end of the study period using the formula developed by Hopkins.

$$\text{SGR (\% per day)} = \frac{\text{LogW2} - \text{LogW1}}{\text{T}} \times 100$$

Where, W2 = mean final weight (g), W1 = mean initial weight (g), T is culture period (days)

$$\text{Survival rate (\%)} = \frac{\text{No. of fishes harvested}}{\text{No. of fishes stocked}} \times 100$$

$$\text{FCR} = \frac{\text{Total feed consumed(kg)}}{\text{Total weight gained (kg)}}$$

3. RESULTS AND DISCUSSIONS

3.1 Water quality parameters

The mean dissolved oxygen, temperature and pH recorded was 5.37± 0.37 mg/L, 10.54±0.55°C and 8.83±0.07, respectively. Details of the water quality parameter can be found in Table 3.

Table 3: Mean DO, Temperature and pH recorded during the study period

Month	DO (mg/ L)	Temp (°C)	pH
October, 2018	4.90	11.00	8.70
November, 2018	5.00	11.10	8.90
December, 2018	5.40	11.20	8.85
January, 2019	5.30	10.90	8.80
February, 2019	5.50	10.70	8.80
March, 2019	5.40	10.20	8.90
April, 2019	6.20	10.00	8.80
May, 2019	5.30	9.70	8.80
June, 2019	5.30	10.10	8.90
	5.37± 0.37	10.55±0.55	8.83±0.07

The mean dissolved oxygen (DO) of 5.37± 0.37 mg/L is within the permissible limits of 5 mg/L that is recommended for optimal growth of rainbow trout (Soderberg et al. 1983). Lower levels of DO (below 4 mg/L) can result in reduced growth rate (MacConnel 1989) even causing higher rates of mortality due to asphyxiation (Mathias and Barica, 1985). Water temperature is another important factor determining survivability and growth of aquatic species. Masser (1997) reported the preferred range of temperature for rainbow trout to be 10-20°C. The mean annual temperature observed at Ha (9.70°C and 11.20°C) is slightly on the lower end but within the limits of the optimal spectrum. The pH of the water is a measure of acidification and can affect the growth of fish. A high pH of > 9.00 can cause mortality especially during the early stages (Edwards 1978), while low pH of 4.50-5.50 can be detrimental on the development of embryo and alevins (Dayes 1980). The mean pH of the water in our system was 8.8 ppm which though on the higher end is within the permissible limits.

3.2 Feed conversion ratio

Feed conversion ratio (FCR) measures the efficiency with which bodies of livestock convert animal feed into the desired output. It indicates the ratio of feed that get converted into fish weight. The recommended FCR is 1.5:1 (Fred 1983) wherein 1.5kg of feed is required to produce 1kg of fish weight. Lower FCR values are indicative of better-quality feed. The FCR in our study was 3.5:1 and is more than two folds the recommended levels i.e., more than twice the recommended amount of feed was required to affect a 1kg gain in fish weight. We posit that the elevated FCR could be a result of the relatively inferior quality feed that was used in our study. Rainbow trout is a carnivorous fish and require high supply of crude protein (more than 35%). Our feed on the other hand contained less than 31% CP content. A similar study in Nepal on rainbow trout reported relatively lower growth rate with feed containing less than 20% CP. This is lower than the minimum amount required for swim up frys/fingerlings (Hoitsy et al. 2012).

3.3 Mean gain in length and weight

The mean gain in length and weight were 128.5 mm and 48.70g in nine months. These gains

were observed over a period of 240 days under experimental condition. We recorded an average daily growth rate (SGR) of 1.47% indicating that the fish gained 1.47% of body weight every day.

3.4 Survival rate

Of the 48,863 alevins initially used in the study, 10,176 individuals survived to fry stage. Further, of the 10,176 frys, only 1,886 survived to advanced fingerling stage (i.e 48.8 g). The survivability varied with different stages of development, as indicated in Figure 1. Total survivability of the rainbow trout in this study was 2.69%.

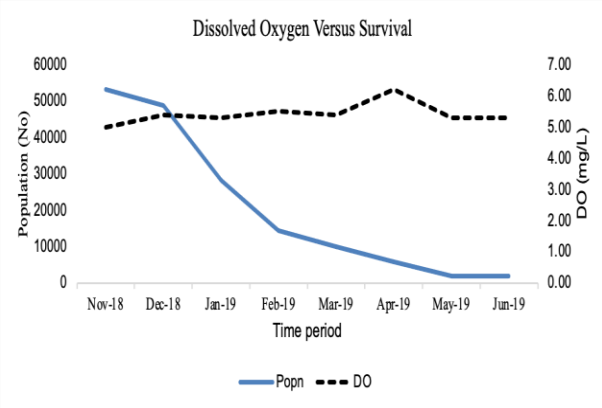

Figure 1: Stage wise mortality and survival of fish population used in the study

Only 2.6% of the 70,000 eyed ova initially stocked survived. Although, the survival rate from eyed ova to fry is quite high (69 %) the survivable rate from fry to fingerling and fingerling to advanced fingerling were 20.3% and 18%, respectively. These rates, which are significantly lower compared to other studies and standards, could be attributed to inferior quality of imported feed used in this study.

4. CONCLUSION

The current study indicates that it is feasible to rear Rainbow trout fingerlings in Bhutan under prevailing water quality. Rainbow trout used in this study showed a net gain of 1.47% and low survivability rate in the fingerlings which could be attributed due to sub-optimal quality feed. This calls for the need to produce high quality fish feed locally or explore a source to purchase higher quality fish feed. The rearing conditions, particularly, water temperature and pH, were slightly on the higher ends of the optimal spectrum, and have adversely affected growth and survivability. As there are no previous studies and baseline information available on these parameters to draw better inferences, the present findings have to be used with caution. Thus, any future study must look into recalibrated parameters particularly high-quality protein rich feed, slightly higher mean water temperature, DO and slightly more acidic water to draw better scientific inferences for wider application in the field.

Acknowledgements

I would like to thank my colleagues at NRCR&LF for their support. I would also like to express my deepest appreciation to Dr. Kezang Wangchuk (ICIMOD) and Mr. Jigme Wangdi, (Specialist, DoL) who took the time to review the manuscript and provided crucial recommendation.

REFERENCES

Caldwell CA and Hinshaw JM. (1995). Tolerance of rainbow trout to dissolved oxygen Supplementation and Yersinia ruckeri challenge. Journal of Aquatic Animal Health, 7: 168-171.

Daye PG (1980). Attempts to acclimate embryos and alevins of Atlantic salmon, Salmo

Edwards DJ (1978). Salmon and trout culture in Norway, p-195. Fishing New Books Ltd, Surrey England.

Fisheries Rehabilitation Enhancement and Development (1983). Rearing in Fish Culture Manual, p-54. Alaska Department of Fish and Game, Juneau, Alaska.

Hoitsy G, Woynarovich A and Moth-Poulsen T. (2012). Introduction to reproduction of trout in the nature. In Guide to the Small-Scale Artificial Propagation of Trout, 9, Food Agriculture Organization, Hungary.

Joshi PL and& Westland Lofvall LM. (1996). Production technology and prospects of trout farming in Nepal. Proceedings of the national symposium on the role of fisheries and aquaculture in the economic development of rural Nepal. Nepal Fishery Society, Kathmandu. Pp. 27-34.

MacConnel E. (1989). Effects of water reuse on lake trout. Progressive Fish Culturist Journal, 51: 33-37.

Masser MP. (1997). Cage Culture: Species suitable for cage culture. Southern Regional Aquaculture Center,163.

Mathias JA and Barica J. (1985). Gas super saturation as a cause of early spring mortality of stocked trout. Canadian Journal of Fisheries and Aquatic Sciences, 42: 268-279.

Matthews KR and Berg NH. (1997). Rainbow trout responses to water temperature and dissolved oxygen stress in two southern California stream pools. Journal of Fish Biology. 50: 50-67.

Molony B. (2001). A Review on environmental requirements and tolerances of Rainbow Trout (Oncorhynchus mykiss) and Brown trout (Salmo trutta) with special references to Western Australia. Department of Fisheries. Department of Fisheries Perth, Western Australia.

Nepal AP, Basnyat SR, Lamsal GP, Joshi PL and Mulmi RM (1997). Economics of Rainbow trout farming system in Nepal. Regional Agricultural Research Station. http://www.fao.org/3/y3994e0o.htm Accessed 1st July 2019.

NSD. (2013). National Strategy Document. National Cold Water Fishery Centre, Department of Livestock, Haa, Bhutan.

Rubin JF. (1998). Survival and emergence pattern of sea trout fry in substrata of different composition. Journal of Fish Biology, 53: 84-92.

Salar L and Rainbow trout, Salmo gairdneri to low pH. Canadian Journal of Fisheries and Aquaculture Sciences, 37: 1035-1038

Soderberg RW, Flynn JB and Schmittou HH. (1983). Effects of ammonia on the growth and survival of rainbow trout in static-water culture. Transactions of the American Fisheries Society, 112: 448-451.

Thuston RV, Phillips GR and Russo RC. (1981). Increased toxicity of ammonia to rainbow trout (Salmo gairneri) resulting from reduced concentrations of dissolved oxygen. Canadian Journal of Fisheries and Aquatic Sciences, 38: 983-988.

Yomamoto A and Iida T. (1994). Oxygen consumption and hypoxic tolerance of triploid rainbow trout (Oncorhynchus mykiss). Fish Pathology, 29: 245-251.