Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 10 [6] May 2021 : 96-100

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
ORIGINAL ARTICLE **OPEN ACCESS**

Comparative study on growth performance and survival of diploid and triploid Golden mahseer (*Tor putitora*) at early stage

***Bipin Kumar Vishwakarma[1], H. C. S. Bisht[1], N. N. Pandey[2] and Sheetal Sharma[1]**
1Department of Zoology, D. S. B Campus, Kumaun University, Nainital
2ICAR-Directorate of Coldwater Fisheries Research, Bhimtal, Uttarakhand- 263136, India
*Corresponding author: bipin.k.vish@gmail.com

ABSTRACT
Induction of triploidy in fish has been found to be useful for increasing growth in juveniles, and for extending survival and improving growth in mature fish. An attempt has been made to assess the growth performance and survival rate of triploid golden mahseer (Tor putitora). The study was conducted for 120d in re-circulated glass aquaria with gravel bed, 2 weeks after complete absorption of yolk sac.The initial length and weight was recorded as 14.4±0.843mm, 0.083±0.009g for diploids and 14.4±0.663mm, 0.084±0.007 for triploid group. The final data reflected significant difference in growth performance which was observed 19.8% better in triploids (1.609±0.478g) over diploids (1.342±0.253g). The survival rate was recorded as 95% for triploid and 92% in diploid stock. Initial trend of increasing growth in triploids reflects superior growth traits in triploids, which would be helpful for achieving better growth for this species in aquaculture. This is the first report of triploidy induction and growth evaluation in golden mahseer.
***Key words**: Tor putitora, chromosome manipulation, growth performance, survival, triploidy induction*

Received 25.02.2021 Revised 29.04.2021 Accepted 18.05.2021

INTRODUCTION

Golden Mahseer (*Tor putitora*) a member of Cyprinid family, known as the king of rivers and one of the most promising fish species of coldwater. The species is crowned as first choice of anglers worldwide and always remains high in demand due to flesh delicacy and quality protein. However, the species reflects a slow growth in captive condition as a major percentage of nutrition is being utilized in gonadal development rather than somatic growth. Hence the aquaculture enhancement of this fish has become a major concern. Inducing Polyploidy by manipulation in the sets of chromosomes to the original diploid complement is one of a technique for aquaculture enhancement. In the last five decades, genetic approaches based upon chromosomal manipulations in fish have already passed through their experimental phase and pilot testing and they were accepted to varying extent by commercial aquaculture of sturgeons, salmonids, cyprinids, catfishes, percids and cichlids for production of triploid- and/or monosex fish populations [1, 2, 3, 6, 9, 13]. Triploidy is characterized by the change in normal diploid (2n) set of chromosomes to the state of triploid (3n) with an additional set of chromosomes [3, 10, 15, 16]. As such, it is expected that triploids would retain a normal growth rate while the sexually mature diploids dedicate a significant energy portion for reproduction and thus the growth rate is compromised [12, 19]. Hence, it is expected a better growth rate from triploid fish than the diploid counterpart due to the extra genomic material. The pattern of allelic expression varied among genes and within a gene indifferent tissue[8, 23]. For production point of view the advantages of sterility in triploid fish are more obvious when the cultivation period of the fish extends beyond sexual maturation because sterility causes energy needed for gamete production to be channel into somatic growth [11]. Suzuki *et al*. [29] reported better survival, growth in triploid cyprinid Loach (*Misgurnusan guillicaudatus)* over the diploid counterpart. Mukti *et al*.[20] reported a comparison in the growth performance, survival rate, flesh, and proximate composition of sex-grouped triploid and diploid Nile tilapia (*O. niloticus).* Growth performance and gonadal development of transgenic tilapia, *O. niloticus* was studied by Razak *et al*. [25] who reported that transgenic diploids were superior in growth performance, followed by transgenic triploids, non-transgenic diploids and non-transgenic triploids.

MATERIAL AND METHODS

The present study was carried out for 120 days at ICAR-Directorate of Coldwater Fisheries Research (ICAR-DCFR), situated at Bhimtal **(**Latitude 29^0 21'N, Longitude 79^0 34'E, 1370 masl**)**, Uttarakhand. Approximately, 100 triploid and diploid fries were reared for 120 days in re-circulatory aquaria system (90x90x48cm) equipped with an overhead pump. Under gravel filter was placed at the bottom of the tank which was prepared using plastic pipes of 25mm diameter for uniform circulation of water. The Aquaria tank was equipped with a water thermostat (Sobo200WL) to maintain water temperature at 25^{0}C.

Mature wild brooders of Golden mahseer (average age group 2-5 years) were used for diploids and triploids seed production. Induction of triploidy was conducted by thermal shock at 40°C temperature for 3min and pressure shock at 7500psi for 5min after post fertilization time of 12min. After the shock treatments the eggs were kept for incubation in trays with recirculatory system at 25^{0}C water temperature. For the conformity of ploidy, a direct method of karyotyping, standardized by Felip*et al.*, [7] based on Kligerman and Bloom, [17]was followed for obtaining chromosome plates from newly-hatched fish larvae. After the incubation the fry were transferred to the re-circulated glass aquaria to acclimatize for 15 days. Initial length and weight of fry was recorded for both the groups. During the experimental period both the group were fed with same starter feed for mahseer with 35% of protein content, prepared by ICAR-DCFR, Bhimtal. Final growth performance and survival was recorded for each group. Statistical analysis was done by one way analysis of variance (ANOVA) with 5% significance level.

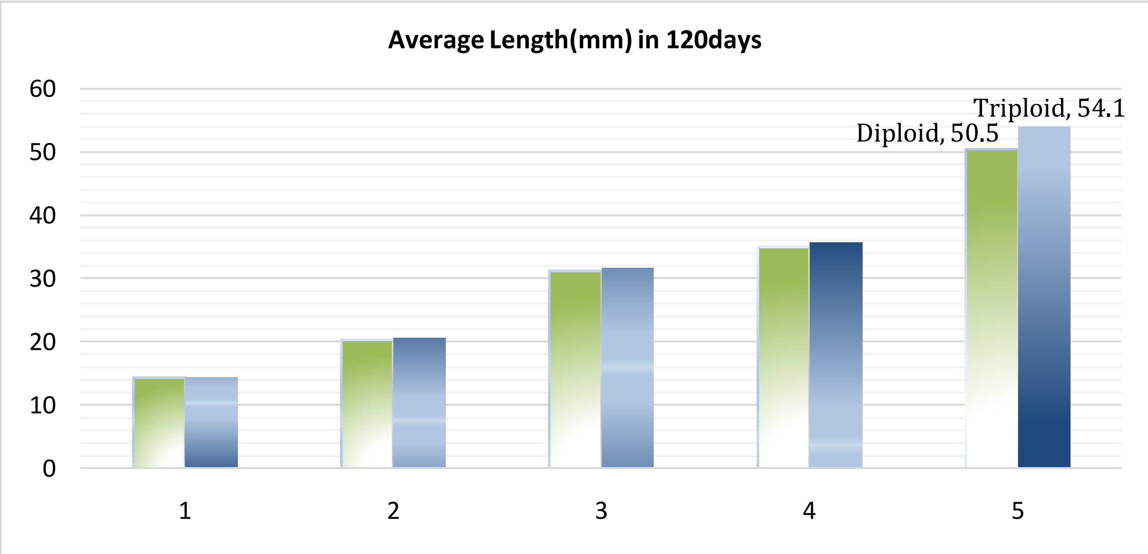
RESULT AND DISCUSSION

The observed initial weight for diploids and triploids was 0.083±0.009g and 0.084±0.006g, respectively, while observed length was 14.4±0.84mm and 14.4±0.66mm for diploid and triploid, respectively. The final observed average weight was 1.342±0.253g and 1.609±0.478g for diploids and triploids, while the average length was observed as 50.5±3.808mm and 54.1±3.45mm for diploid and triploid, respectively (Table-1). Observed data reflect 19.8% better growth in triploids over the diploids in field observation. The survival of triploid fry was observed as 94%, while it was 92% in diploid stock. In catfish and Tilapia, triploids have a better growth rate than diploids at maturation [4, 30, 32]. Nawchi and Esa, [22] reported higher specific growth rate of 1.097 in triploids of *Oreochromis mosambicus* as compare to diploids as 0.913. Nawchi, [21] stated that a triploid grew faster and larger than its ordinary diploids. Better growth has been reported in triploids of Tilapia and European catfish at the age of 14 weeks [18, 30]. Pradeep, *et al.,* [24] reported that the average body weight of triploids of tilapia (215.5 ±3.61g) after rearing of 120 days was significantly higher than that of diploid control (191.9 ±1.74g), but survival among triploids was inferior to diploid. Higher growth rates of rainbow trout were also recorded by Sheehan, *et al*., [27]; Suresh and Sheehan, 1998 [28] and in turbot, *Psetta maxima* by Cal, *et al.,* 2006 [5]. Almost similar and higher survival rate in the present study might be due to the more conducive larval rearing conditions. In the present study water temperature was maintained with the help of aquarium thermostat at 25±0.270C. The observed values of water quality parameters are within permissible limits for brood stock and larval rearing of golden mahseer as per described by Joshi *et al*., 2018 [14] and Riar*et al*., 2019 [26].

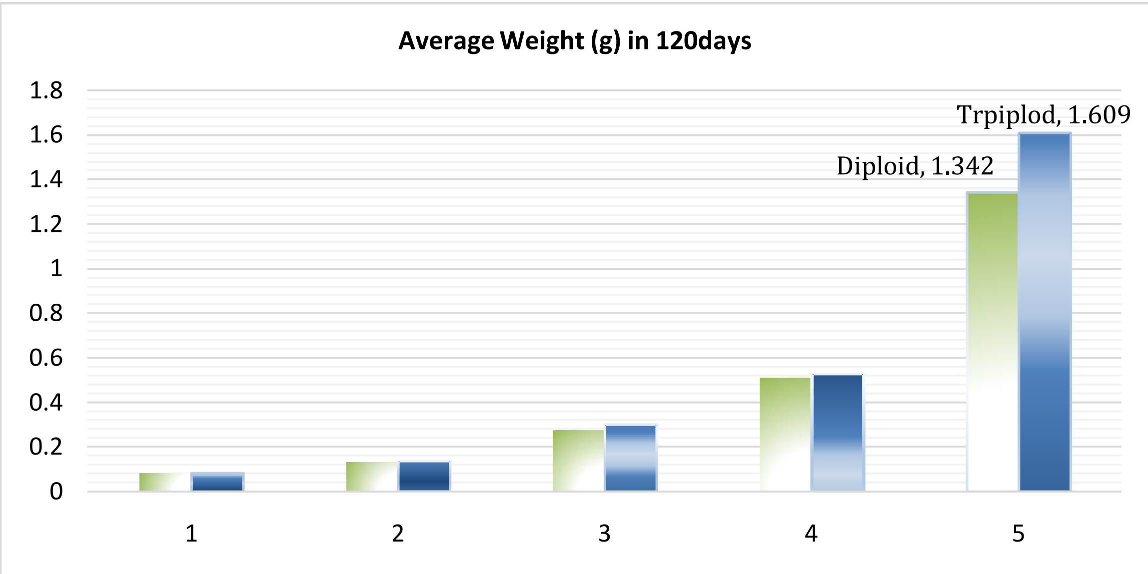
Inducing triploidy by using physical shocks such as abrupt changes in pressure and temperature is a safe and reliable method which does not involve potentially harmful chemicals or radiation. The underlying principle is that the application of thermal (heat or cold) and/or mechanical (pressure) shock to the zygote at appropriate time of post fertilization prevents the extrusion of the second polar body during second meiosis, which results in three chromosome sets in every embryonic cell. Induction of triploidy in fish has been found to be useful for the sterility, for increasing growth in juveniles, and for extending survival and improving growth in mature fish. The characteristics of triploid fish are thus known to have a beneficial impact on fish production economics. Among other important food fishes in mountainous region of India, one of the specialized and specific groups of economic significance is the "mahseer" belonging to the family cyprinidae having a wide distribution occurring all along the foot hills of Himalaya.

Table 1. Growth performance in Diploid and triploid Golden mahseer (*Tor putitora*)

		Diploid		Triploid	
Sr. No.	**Days**	**Length (cm)**	**Weight (g)**	**Length (cm)**	**Weight (g)**
1	**0**	14.4±0.843	0.083±0.009	14.4±0.663	0.084±0.007
2	**30**	20.4±1.35	0.132±0.018	20.7±1.25	0.139±0.014
3	**60**	31.3±2.95	0.275±0.074	31.7±2.36	0.301±0.067
4	**90**	35.1±6.48	0.511±0.244	35.8±6.18	0.528±0.217
5	**120**	50.5±3.808	1.342±0.253	54.1±3.45	1.609±0.478
Survival %		92		95	



A



B

Plate 1: A B: Difference in growth performance of Diploidy and triploidy *Tor putitora* in 120d

CONCLUSION

This is the first report of triploidy induction in Golden mahseer, which is an important indigenous fish of food and sport value in Indian Himalayan region and is a highly preferred food fish of hill people. The present study has proved that production of triploid golden mahseer is feasible through pressure shock effectively and also by heat shock without major reduction in survival. As triploids, are expected to grow faster, it can have a good impact on the aquaculture of this species. Further, sterile fish would be helpful for availability of large fish to anglers and to promote fish based eco-tourism for better livelihood to the people in hills.

ACKNOWLEGEMENT

The authors are thankful to Director, ICAR-Directorate of Coldwater Fisheries Research(ICAR-DCFR), Bhimtal for providing the opportunity to carry out this work along with their valuable guidance, useful suggestions and facilities during the research. They are also grateful to the Head, Department of Zoology, DSB Campus Kumaun University, Nainital for able guidance to carry out the study.

REFERENCES

1. Arai K (2001). Genetic improvement of aquaculture finfish species by chromosome manipulation techniques in Japan. Aquaculture 197:205–228

2. Beardmore JA, Mair GC, Lewis RI (2001). Monosex male production in finfish as exemplified by tilapia: application, problems, and prospects. Aquaculture 197:283–301.
3. Beaumont, A.R. and Hoare, K., 2003. Genetic structure in natural populations. *BEAUMONT, AR; HOARE, K. Biotechnology and genetics in fisheries and aquaculture. Oxford: Blackwell Science*, pp.47-72.
4. Brämick, U, Puckhaber, B., Langholz, H. J., &Hörstgen-Schwark, G. (1995). Testing of triploid tilapia (*Oreochromis niloticus*) under tropical pond conditions. *Aquaculture*, *137*(1-4), 343-353.
5. Cal, R. M., Vidal, S., Gómez, C., Álvarez-Blázquez, B., Martínez, P., & Piferrer, F. (2006). Growth and gonadal development in diploid and triploid turbot (*Scophthalmus maximus*). *Aquaculture*, *251*(1), 99-108.
6. Donaldson EM (1996). Manipulation of reproduction in farmed fish. *Anim Reprod* Sci 42:381–392
7. Felip, A., Carrillo, M., Herráez, M.P., Zanuy, S, and Basurco, B. (2009). Advances in fish reproduction and their application to broodstock management: a practical manual for sea bass. Zaragoza: CIHEAM / CSIC-IATS, p. 61 - 65.
8. Garcia-Abiado, MAR., Dabrowski, K, Christensen, JE, Czesny, S and Bajer, P, (1999). Use of erythrocyte measurements to identify triploid saugeyes. *North American Journal of Aquaculture*, *61*(4), pp.319-325.
9. Gomelsky, B (2003). Chromosome set manipulation and sex control in common carp: a review. *Aquat Liv Res* 16:408–415
10. Haffray, P., Bruant, J.S., Facqueur, J.M. and Fostier, A., 2005. Gonad development, growth, survival and quality traits in triploids of the protandrous hermaphrodyte gilthead seabream *Sparusaurata* (L.). *Aquaculture*, *247*(1-4), pp.107-117.
11. Hassan, A., Okomoda, V.T. and Pradeep, P.J., 2018. Triploidy induction by electric shock in red hybrid tilapia. *Aquaculture*, *495*, pp.823-830.]
12. Henken, AM, Brunink, AM, Richter, CJJ, (1987). Differences in growth rate and feed utilization between diploid and triploid African catfish, *Clarias gariepinus* Burchell, 1822. Aquaculture 63: 233–242.
13. Hulata, G (2001). Genetic manipulations in aquaculture: a review of stock improvement by classical and modern technologies. *Genetica* 111:155–173.
14. Joshi, K.D., Das, S.C.S., Pathak, R.K., Khan, A., Sarkar, U.K. and Roy, K., 2018. Pattern of reproductive biology of the endangered golden mahseer *Tor putitora* (Hamilton 1822) with special reference to regional climate change implications on breeding phenology from lesser Himalayan region, India. *Journal of Applied Animal Research*, *46*(1), pp.1289-1295.
15. Kalbassi, MR and Johari, SA, (2008). A study on the production possibility of all-female triploid rainbow trout (*Oncorhynchus mykiss*). *Journal of science and technology of agriculture and natural resources*.
16. Kapuscinski, A.R. and Miller, L.M., 2007. Genetic Guidelines for Fisheries. *University of Minnesota Sea Grant Program*.
17. Kligerman, A.D. and Bloom, S.E. (1977). Rapid chromosomes preparation from solid tissues of fishes. *Journal of Fisheries Research.* Board Canada, 34(2):266-269.
18. Krasznai, Z., & Marian, T. (1986). Shock-induced triploidy and its effect on growth and gonad development of the European catfish, Silurusglanis L. *Journal of fish biology*, *29*(5), 519-527.
19. Mol, K., Byamungul, N., Cuisset, B., Yaron, Z., Ofir, M., Melard, C., Castelli, M., Kuhn, E.R. (1994). Hormonal profile of growing male and female diploids and triploids of the blue tilapia, *Oreochromis aureus*, reared in intensive culture. *Fish PhysiolBiochem*. 13: 209–218.
20. Mukti, A.T., Carman, O., Alimuddin, A., Zairin Jr., M and Suprayudi, MA, (2020). Growth performance, survival rate, flesh, and proximate composition of sex-grouped triploid and diploid Nile tilapia (*Oreochromis niloticus*). *Turkish Journal of Veterinary and Animal Sciences*, *44*(2), pp.290-298
21. Nwachi O.F., 2011. The culture of diploid and triploid *Heterobranchus bidorsalis* indoor hatchery. Journal of Research in Animal Science 2072 1(1)001-004pp.
22. Nwachi, O. F., &Esa, Y. B. (2016). Comparative growth and survival of diploid and triploid Mozambique tilapia (*Oreochromis mossambicus*) reared in indoor tanks. *Journal of environmental biology*, *37*(4 Spec No), 839-843.
23. Pala I, Coelho MM, Schartl M (2008). Dosage compensation by gene-copy silencing in a triploid hybrid fish. CurrBiol 18: 1344–1348.
24. Pradeep, P.J., Srijaya, T.C., Papini, A. and Chatterji, A.K., 2012. Effects of triploidy induction on growth and masculinization of red tilapia [*Oreochromis mossambicus* (Peters, 1852) × *Oreochromis niloticus* (Linnaeus, 1758)]. *Aquaculture*, *344*, pp.181-187.
25. Razak, SA, Hwang, GL, Rahman, MA and Maclean, N, (1999). Growth performance and gonadal development of growth enhanced transgenic tilapia *Oreochromis niloticus* (L.) following heat-shock-induced triploidy. *Marine Biotechnology*, *1*(6), pp.533-544.
26. Riar, M.G.S., Raushon, N.A., Chowdhury, P. and Rahman, M.K., (2019). Effect of stocking density on growth performance and the survival of golden mahseer, Tor putitora (Hamilton) in primary nursing system. *Parameters*, *1*(T2), p.T3.
27. Sheehan, R.J., Shasteen, S.P., Suresh, A.V., Kapuscinski, A.R., Seeb, J.E., (1999). Better growth in all-female diploid and triploid rainbow trout. Trans Am Fish Soc 128: 491–498.
28. Suresh, A. V., & Sheehan, R. J. (1998). Muscle fibre growth dynamics in diploid and triploid rainbow trout. *Journal of Fish Biology*, *52*(3), 570-587.
29. Suzuki Ryo , Teruyuki Nakanishi, Takashi Oshiro, (1985). Survival, growth and sterility of induced triploids in the cyprinid loach *Misgurnusan guillicaudatus*. /Nippon Suisan Gakkaishi, *51*(6), pp.889-894.

30. Tiwary BK, Kirubagaran R & Ray AK (1997). Induction of triplody by cold shock in Indian catfish, *Heteropneustes fossilis* (Bloch). *Asian Fisheries Science* 10, 123-129.
31. Valenti, R.J.(1976). Induced polyploidy in *Tilapia aurea* (Steindachner) by means of temperature shock treatments. *Journal of fish biology.* **7**:519-528.
32. Wolters, WR, Libey, GS and Chrisman, CL, (1982). Effect of triploidy on growth and gonad development of channel catfish. *Transactions of the American Fisheries Society*, *111*(1), pp.102-105.

CITATION OF THIS ARTICLE

B K Vishwakarma, H. C. S. Bisht, N. N. Pandey and S Sharma. Comparative study on growth performance and survival of diploid and triploid Golden mahseer (*Tor putitora*) at early stage. Bull. Env. Pharmacol. Life Sci., Vol10 [6] May 2021 : 96-100