Asian Journal of Fisheries and Aquatic Research

Volume 21, Issue 2, Page 48-54, 2023; Article no.AJFAR.95761
ISSN: 2582-3760

Effectiveness of Reverse Osmosis (RO) Water on the Growth of Denison Fry (*Puntius denisoni Day, 1865*)

Jodi Darmawan [a*], Ujang Subhan [a++] and Zahidah [a#]

[a] *Department of Fisheries, Padjajaran University, Sumedang, Indonesia.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJFAR/2023/v21i2537

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/95761

Original Research Article

Received: 20/11/2022
Accepted: 25/01/2023
Published: 04/02/2023

ABSTRACT

This research aims to determine the optimal addition of reverse osmosis water for the growth and survival rate of Denison fish fry. The preliminary test was carried out on 16-22 May 2022 and the main research was carried out on 4-31 July 2022 at Pt. Waris, Breedlife Fish Farm, and Central Jakarta. The research method was carried out experimentally using a completely randomized design (CRD) method consisting of five treatments with three replications, namely the treatment of 100% groundwater maintenance media, the addition of 25%, 50%, 75% reverse osmosis water and the use of 100% reverse osmosis water. . The fish used are Denison fish seeds with a size of 2-3 cm. Fish were treated for 28 days. The feed given is Tubifex sp worms. and given daily ad satiation. Parameters observed were water quality in the form of temperature, total dissolved solids (TDS), degree of acidity (pH) measured every day, and ammonia measured every week. The main parameters of this research are the specific growth rate (SGR) and survival rate (SR). Based on the research results, it was concluded that the addition of reverse osmosis water in the range of 25-50% resulted in the survival performance of Denison fry with a rate of 98% and a specific growth rate in the range of 3.14-3.39%.

[++] *Lecturer;*
[#] *Professor;*
**Corresponding author: Email: jodi17001@mail.unpad.ac.id, jodidarmawan99@gmail.com;*

Keywords: Reverse osmosis water; groundwater; total dissolved solids; pH; specific growth rate; survival rate; water quality; denison fry.

1. INTRODUCTION

Ornamental fish is one of the leading commodities that still requires more intensive development efforts in Indonesia, considering that the ornamental fish export market is still wide open. The export value of Indonesian ornamental fish based on data from the United National Commodity Trade Statistics in 2009 reached 11.7 million US dollars or 3.12% of the total world ornamental fish exports reaching 73.8 million US dollars. Based on data from the Ministry of Trade, Indonesia's ornamental fish export volume in th2011 ached 11.56%, and in 2014 increased to 19.79%. The data records that in recent years the national ornamental fish production has continued to increase from 1.19 billion fish in 2017 to 1.22 billion fish in 2018 to grow to 1.28 billion fish with a value of Rp.19.81 billion in 2019 [1]. This data proves that the export of ornamental fish from Indonesia is increasing every year. One of ornamental fish species currently in demand for export commodities is *Puntius Denisoni*, also called *Sahyadria Denisoni*. This fish is one type of ornamental fish commodity that has a high economic value.

The high price and demand for ornamental fish, exploitation of Denison fish in greater numbers and sold at higher prices, threaten the survival and sustainability of its availability in the wild. Overexploitation of ornamental fish from the wild for trade is the main reason for their population depletion [2]. Efforts to ensure the availability of *S. Denisoni* in the long term are the development of captive technology [3]. Aquaculture is one of the efforts to increase the number of fish which includes manipulation and modification of the environment, bio reproduction, density, feed management, and others, which can cause stress (stress) on cultured fish so that they are susceptible to both infectious and non-infectious diseases [4]. In aquaculture, the health of the aquaculture environment is one of the critical success factors. The health element of the cultivation environment in question is the emergence of disease. Diseases are one of the biggest factors for crop failure [5]. In closed system cultivation activities, diseased aquatic environments can cause mass fish deaths in a short time [6].

The cultivation factor that has the closest influence on the physiological condition of fish is water quality. It is undeniable that poor water quality and not in accordance with standard fish parameters can have a negative impact on fish [7]. One of the efforts to improve water quality is the application of the reverse osmosis process. The reverse osmosis membrane serves as a barrier for all dissolved salts, inorganic molecules, and organic molecules with a molecular weight greater than 100u. On the other hand, water molecules freely flow through the membrane and form non-mineral water called product water [8]. Reverse osmosis water is generally used for desalinating seawater into fresh water, purifying clean water for medical, industrial, and domestic applications [9]. The concept of water quality improvement carried out on reverse osmosis is in line with the needs of the fishing industry for good water quality, but there have not been many studies that have evaluated the use of reverse osmosis water in the fishing industry, especially its effect on the live performance of Denison fingerling [10]. It is necessary to conduct research that can evaluate the treatment of reverse osmosis water with groundwater as a comparison along with the combination of the two waters, on the live performance of Denison fingerling.

2. MATERIALS AND METHODS

The research was conducted in 4-31 July 2022 at Pt. Waris, Breedlife Fish Farm, Jakarta, Indonesia. The research method was carried out experimentally using a completely randomized design (RAL) method consisting of five treatments with three replications, with different treatments. The details of the treatment given are as follows; treatment A (100% groundwater), treatment B (75% groundwater + 25% reverse osmosis water), treatment C (50% groundwater + 50% reverse osmosis water), treatment D (25% groundwater + 75% reverse osmosis water) and treatment E (100% reverse osmosis water).

Aquariums with dimensions 40x40x50 cm are used in this research as many as 15 pieces. The aquarium preparation stage begins with washing the aquarium, installation of aeration, reservoir containers, and other supporting tools using running water, after that they are soaked with 30 ppm chlorine and the installation is operated for 24 hours, then rinsed with water so that there is no chlorine substance that can later be removed. Water for each treatment (5 treatments) was prepared in each reservoir according to the composition of the treatment, and 25 liters of water were also added to each aquarium according to the treatment (Fig. 1). The aquarium that has been filled with water is then aerated with uniform strength in each aquarium. The thing that was done after the preparation of the rearing container was the acclimatization fish test. The test fish used were Denison fingerlings measuring 2-2.5 cm (Fig. 2). The newly arrived fish are adapted to the environmental temperature by immersing a plastic bag in fish reservoir water. Furthermore, the reservoir water is slowly inserted into the plastic to adjust the water parameters in the bag, with the reservoir water parameters. The fish are then removed along with the water slowly.

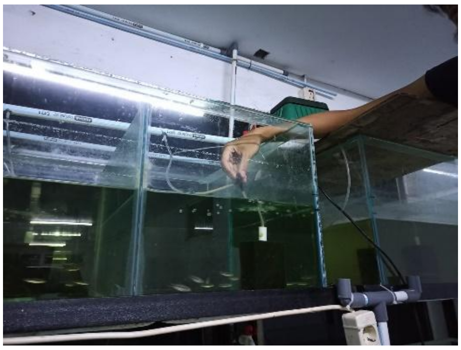

Fig. 1. Research installation

Fig. 2. Denison fingerling

The fingerling used was a total density of 1 fish per liter of water or equal to 25 fish per rearing container (750 fish in the whole study). Fish rearing was carried out for 15 days, with different water compositions based on the treatment given, where treatment A used 100% groundwater, treatment B 50% groundwater + 50% reverse osmosis water, and treatment C 100% reverse osmosis water. Fingerlings were fed with silk worms (*Tubifex* sp.) on an ad satiation basis or the feed was always available in the aquarium. Feed is given three times a day with the amount of 3% of the total fish biomass. Water changes were carried out once a week using treated water that had been prepared in each treatment reservoir. Water quality measurements in the form of temperature, dissolved oxygen and pH were measured every day during fish rearing. Ammonia levels were measured once every week (day 0, 7, 14, 28). Survival rate were observed every day and calculated in the end of rearing by the formula [11]:

$$SR = \frac{Nt}{N0}$$

Description:

SR = Survival Rate (%)
Nt = Number of fish at the end of fish keeping (ekor)
No = Number of fish at the beginning of fish keeping (ekor)

Measurement of weight gain is calculated once a week along with water quality measurements. The biomass data obtained is then used to calculate the Specific Growth Rate of fish with the formula [12], as follows:

$$SGR = \frac{(\ln Wt - \ln Wo)}{t} \times 100\%$$

Description:

SGR = Specific growth rate (%/day)
Wt = Weight of fish at the end of fish keeping (g)
W0 = Weight of fish at the beginning of fish keeping (g)
t = Amount day of fish keeping

Analysis of the data used is an analysis of variance (ANOVA) with the F test at a 95% confidence interval to determine whether a treatment has a significant effect on survival rates and specific growth rates. If the treatment shows a significant difference, then the Duncan test or follow-up test is carried out. Meanwhile, water quality data were analyzed descriptively and compared with the obtained literature.

3. RESULTS AND DISCUSSION

Water quality plays an important role in influencing fish growth and survival (Huang and Chiu 1997). Good water quality can support optimal fish growth. On the other hand, decreasing water quality can reduce fish appetite which results in slow growth. Water quality that does not support the life of the fish will cause stress to the fish and can even cause death and reduce the survival rate which in turn can reduce the biomass of the fish that are kept. However, if the water quality is good, the growth of fish will be fast and the survival rate is high so that the biomass increases [13]. Several water quality parameters used in rearing fingerling for 28 days in this research were temperature, dissolved oxygen, pH, and ammonia. The results of water quality measurements in the rearing of Denison fish can be seen in Table 1.

The temperature range during the rearing of Denison fingerling was 28 ± 0.2°C in all treatments. Based on these results, the maintenance temperature calculated by ANOVA showed no significant difference between treatments and was still in accordance with the environmental temperature limit in its natural habitat, namely 27.0 ± 4.1 °C [16]. Fish growth increases with increasing water temperature to a certain level and then decreases at higher temperatures [17]. The DO range during rearing Denison fingerling was 5.7 ± 0.3 mg/l. Based on these results, although there were some changes and differences in DO, it was still in accordance with the environmental temperature limit in its natural habitat, which is 5.48 ± 1.3 mg/l [16]. Low levels of oxygen could affect the biological function and slow growth, and could even lead to death [18]. High DO concentrations increased the oxygen uptake capacity, thereby reducing the proportion of metabolic energy. The range of pH during the rearing of Denison fingerling was 7.3 ± 0.6 mg/l. Based on these results, the pH of maintenance that was suitable for the habitat of the Denison fingerling was 6.6 ± 0.6 mg/l only treatment D (7.3 ± 0.2 mg/l) while the other treatments were not suitable for the habitat of the Denison fish [16]. As time goes by, the pH and dissolved oxygen will be lower [19]. A common substance that causes acidity in water is CO2. An increase in CO2 in water will be followed by a decrease in dissolved oxygen [20].

The range of TDS during the rearing of Denison fingerling was 155.6 ± 97.5°C in all treatments. Based on these results, treatments A, B, and C were still compatible with the habitat environment of the Denison fish, while treatments D and E were not suitable [16]. "Pure" water will pass through the fish cells very quickly, while water with some TDS will move more slowly. Fish use their kidneys to pump this water out. Fish kidneys in hard water don't have to work too hard. But the higher the TDS, the harder it is for the fish to do this, so the toxins stay longer in their bodies which affects their physiology and causes stress, and this will inevitably lead to a shorter lifespan depending on the species and the grade. TDS also directly and significantly affects the osmoregulation that occurs in the gills. When TDS causes a change in osmotic pressure, red blood cells can change shape; Low osmotic pressure will drain red blood cells from water, causing them to collapse, and high osmotic pressure will flood them with water, causing cells to expand. Both of these results will have a serious impact on breathing [21]. The range of ammonia during the rearing of Denison fingerling is 0.006 ± 0.004 mg/l which is safe and in accordance with the optimum limit for fish rearing [22].

Based on the results of the study, treatment A produced the highest survival rate, which was 100%, while treatment E produced the lowest survival rate, which was 77%. The survival rate decreases as the use of reverse osmosis water increases (Fig. 3). When compared with the parameters of water quality, temperature and dissolved oxygen in treatment E are in accordance with quality standards. Toxic ammonia in treatment E of 0.005 ± 0.002 mg/l was the lowest compared to other treatments. This shows that temperature, dissolved oxygen and ammonia are not the main causes of fish death in this case.

Based on the TDS parameter, treatment E, which was 31 ± 10 mg/l, was the lowest compared to the other treatments. The water resulting from the filtration process of the reverse osmosis membrane which is selective makes the TDS low in the water in treatment E. The low dissolved solids will affect the low osmotic pressure of the water. The low osmotic pressure draws water from the red blood cells causing the cells to shrink, and the high osmotic pressure causes water to be absorbed into the red blood cells causing the cells to expand. Both of these results will have a serious impact on breathing [21]. Based on [22], Denison fish have living habitats scattered in the rivers of the Ghatz section which have TDS parameters in the range of 150 - 360 mg/l. The TDS in treatment E was below the TDS range in the original habitat of the Denison fish. The incompatibility of TDS water parameters is indicated as one of the reasons for the low survival rate of Denison fish in treatment E. The TDS of E treatment water could not be tolerated by Denison fish.

Table 1. Water parameter on fishkeeping compared by references

Parameter	Perlakuan					Pustaka
	A	B	C	D	E	
Suhu (°C)	28 ± 0,2	28 ± 0,2	28 ± 0,2	28 ± 0,1	28 ± 0,2	28 *
DO (mg/l)	5,6 ± 0,6	5,5 ± 0,8	5,2 ± 0,9	6± 0,5	6±0,8	≥ 5 *
pH	7,9 ± 0,1	7,7 ± 0,2	7,4 ± 0,2	7,3 ± 0,2	5,9 ±1,2	6,5 – 8,5 *
TDS (mg/l)	283,2 ± 12,1	212,6 ± 8,7	160,3 ± 8,8	93,7 ± 9,5	31,3 ± 16,3	1000 **
Amonia (mg/l)	0,009 ± 0,001	0,007 ± 0,002	0,007 ± 0,002	0,006 ± 0,002	0,005 ± 0,002	< 0,02 ***

Information: (*)[14], (**)PP No. 22 year 2021, (***)[15]

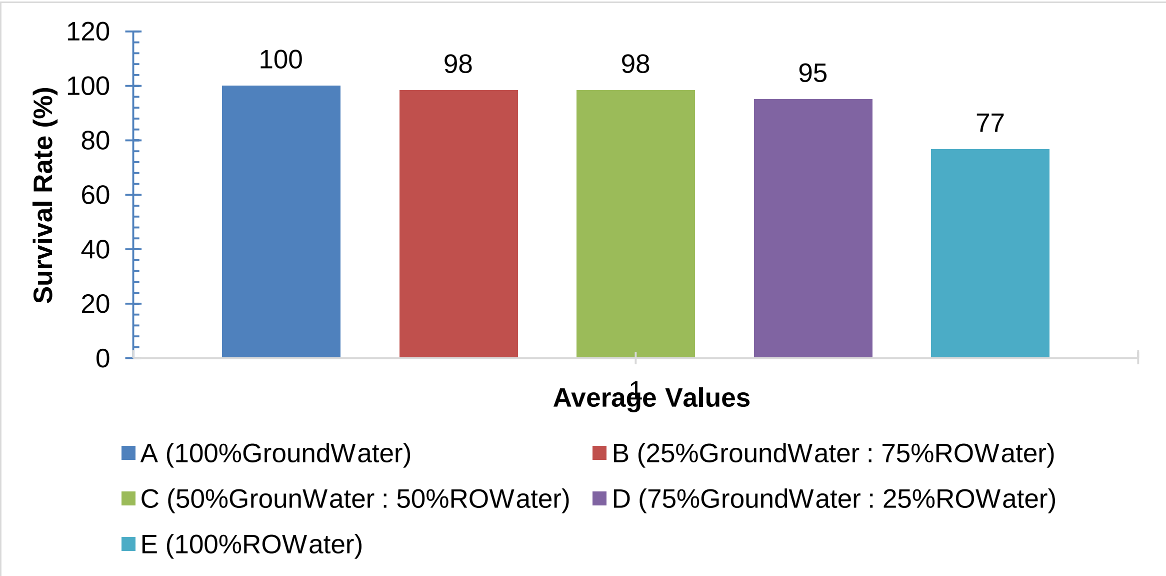

Fig. 3. Survival rate of denison fingerling

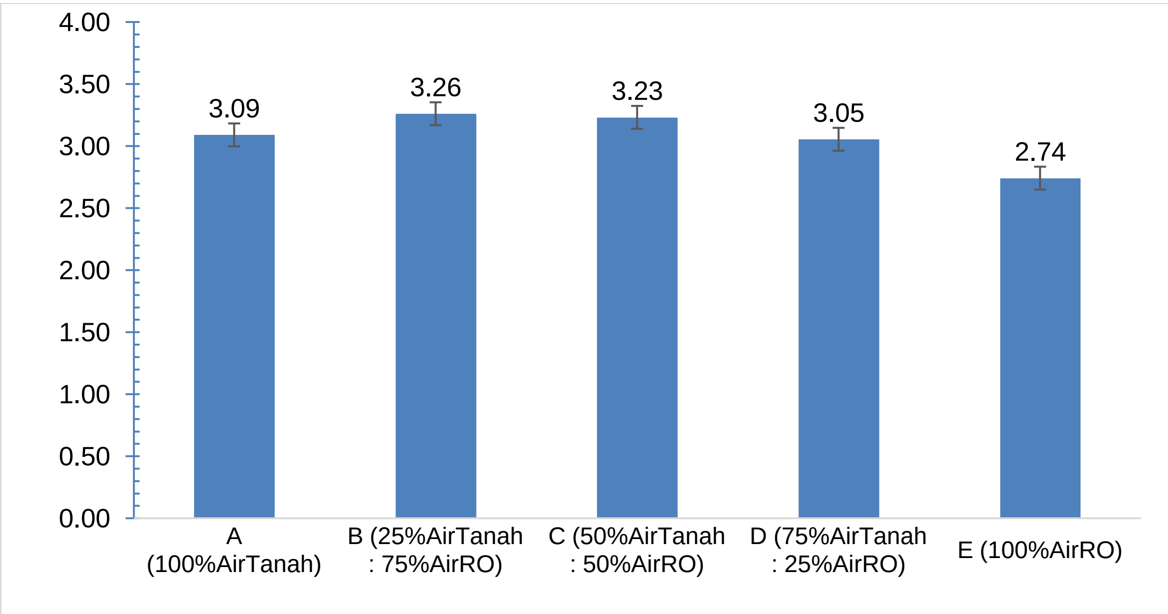

Fig. 4. Specific growth rate of denison fingerling

The percentage of specific growth rate in treatment E resulted in the lowest specific growth rate, is about 2.74 ± 0.19%, while the treatment with the highest specific growth rate was in treatment B, namely 3.26 ± 0.04%. When compared with the parameters of water quality, temperature and dissolved oxygen in treatment E are in accordance with quality standards (Fig. 4). Ammonia treatment E of 0.005 ± 0.002 mg/l was the lowest compared to other parameters. Ammonia is a compound resulting from the metabolic excretion of fish, the size of the ammonia can also indicate the high or low rate of fish metabolic processes [11]. The low amount of ammonia in treatment E indicated a low metabolic rate in fish in treatment E. The low metabolic rate provided a low energy allocation for fish growth.

As seen from the TDS parameter, treatment E, which was 31 ± 10 mg/l, was the lowest compared to other treatments. Low dissolved solids will affect the low osmotic pressure of water. The low osmotic pressure draws water from the red blood cells, causing the cells to shrink, and the high osmotic pressure causes water to be absorbed into the red blood cells, which causes the cells to expand. Both of these results will have a serious impact on breathing [21]. The process of respiration is closely related to the burning of energy in the metabolic process of fish and so on will have an impact on the growth rate of fish. Based on [11], Denison fish have living habitats scattered in the rivers of the Ghatz section which have TDS parameters in the range of 150 -360 mg/l. The TDS in treatment E was below the TDS range in the original habitat of the Denison fish. The TDS of E treatment water could not be tolerated by Denison fish.

The results of research from Pratiwi (2019) with the same fish stadia and stocking density treatment showed that the specific growth rate of the average Denison fish fry was 2.79 ± 0.01% [23]. The results of research from Mercy & Sajeevan (2014) with the same fish stadia and feed treatment showed a specific growth rate of 2.91 ± 0.52% [24]. When compared with the specific growth rate in this research, especially in treatment B and C, it resulted in a higher specific growth rate. Treatments B and C resulted in a higher specific growth rate compared to the other treatments. The addition of reverse osmosis water in the range of 25–50% produces water parameters that support better fish growth rates when compared to other treatments. The water quality that has the most influence and is the difference between the treatments in this research is TDS, pH, and ammonia. This water parameter has a significant influence on the specific growth rate of Denison fish seeds.

4. CONCLUSION

The research results showed that there was an effect of adding reverse osmosis water on the survival performance of Denisoni fish fry. The addition of reverse osmosis water in the range of 25–50% resulted in the best growth rate for Denisoni fish fry, which was 3.23-3.23% with a survival rate of 98%. The use of 100% reverse osmosis water is not recommended for maintenance of Denisoni fish fry because it produces a low growth rate of 2.74% and a survival rate of 77%.

ACKNOWLEDGEMENT

We would like to thank The Faculty of Fisheries and Marine Science, Padjadjaran University, Indonesia for making this research possible.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Luthfiana N. KKP: Ornamental fish cultivation increases community income amid a pandemic; 2021.
2. Raghavan R, Prasad G, Pereira B, Anvar Ali PH, Sujarittanonta L. 'Damsel in distress'-the tale of miss kerala, puntius denisoni (Day), an endemic and endangered cyprinid of the Western Ghats biodiversity hotspot (South India). Aquatic Conservation: Marine and Freshwater Ecosystems. 2009;19(1):67–74.
3. Ogale SN. Mahseer breeding and conservation and possibilities of commercial culture. The Indian experience. 193--212. (Petr T, Swar DB eds.) Cold water fisheries in the trans-Himalayan countries. FAO Rome. Fisheries Technical Paper. 2002;431:376.
4. Aryani N, et al. Parasites and diseases of fish. Unai Press. Pekanbaru; 2011.
5. Bosma RH, Verdegem M. Sustainable aquaculture in ponds: Principles, practices and limits. Livestock Science - Livest Sci. 2011;139:58–68. Available:https://doi.org/10.1016/j.livsci.2011.03.017

6. Jasminandar Y. Prevalence of parasites and diseases of freshwater fish cultured in Kupang Regency. Journal of Life and Physical Sciences. 2011;1(4):13–16.
7. Day SF. On the fishes of cochin, on the Malabar Coast of India. Proceedings of the Zoological Society of London. 1865;33(1):286–318. Available:https://doi.org/10.1111/j.1469-7998.1865.tb02337.x
8. Salt Y, Dinçer S. An option for special separation operations: Membrane processes. Sigma. 2006;4:1–23.
9. Seno A. Reverse osmosis maintenance and repair in order to increase fresh water production For Mv. Mara Di Pt. Tirta Samudra Caraka. Papers; 2019.
10. Efendi H. Assess the water quality. Yogyakarta: Kanisius; 2003.
11. Efendi H. Study of water quality for aquatic resources and environment. Canisius. Yogyakarta; 2003.
12. Zonneveld N, Huisman EA, Boon JH. The principles of fish farming. PT Gramedia Pustaka Utama; 1991.
13. Supono S. Environmental management for aquaculture; 2015.
14. SNI. Production of Main Goldfish (*Cyprinus carpio* Linneaus) Majalaya strain main parent stock class (Parent Stock). SNI; 1999.
15. Boyd CE. Fundamentals of aquacultural engineering. Thomas B. Lawson. The Quarterly Review of Biology. 1997;72(1):97–97. Available:https://doi.org/10.1086/419720
16. Saifullah ASM, Kabir MH, Khatun A, Roy S, Sheikh MS. Investigation of some water quality parameters of the Buriganga River. Journal of Environmental Science and Natural Resources. 2012;5(2):47–52.
17. Yoo GY, Lee JY. The effect of feeding frequency, water temperature, and stocking density on the growth of the river puffer *Takifugu obscurus* reared in a zero-exchange water system. Fisheries and Aquatic Sciences. 2016;19(1):1–7.
18. Kordi MGH, Tancung AB. Management of water quality in aquaculture. Rineka Cipta. Jakarta. 2007;208.
19. Huang WB, Chiu TS. Effects of stocking density on survival, growth, size variation, and production of Tilapia fry. Aquaculture Research. 1997;28(3):165–173.
20. Boyd CE, et al. Water quality management for pond fish culture. Elsevier Scientific Publishing Co; 1982.
21. Evans M. The ins & outs of osmosis. Tropical Fish Hobbyist. 2004:76–84.
22. Lawson TB. Fundamentals of aquacultural engineering. Chapman and Hall, New York; 1995.
23. Pratiwi R. Production performance of denisoni fish (*Puntius denisonii*) in recirculating systems with different stocking densities; 2019.
24. Mercy TV. Sajeevan S. Early growth performance of an endangered barb, *Sahyadria denisonii* (Day 1865) Fed with Different Diets; 2014.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/95761