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Recirculatory Aquaculture System using in Rainbow Trout (*Oncorhynchus mykiss*) Culture

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SUMMARY

The expansion of the cold-water aquaculture sector faces challenges due to limited suitable sites and environmental concerns. Recirculating Aquaculture Systems (RAS) have emerged as a crucial solution, particularly for high-demand species like rainbow trout (*Oncorhynchus mykiss*). This article explores the introduction and success of rainbow trout farming in India, focusing on its growth conditions, water temperature requirements, and the benefits of RAS compared to traditional flow-through systems. The study discusses the sustainable practices and economic viability of RAS-based trout farming, emphasizing its potential to enhance production while minimizing environmental impacts.

INTRODUCTION

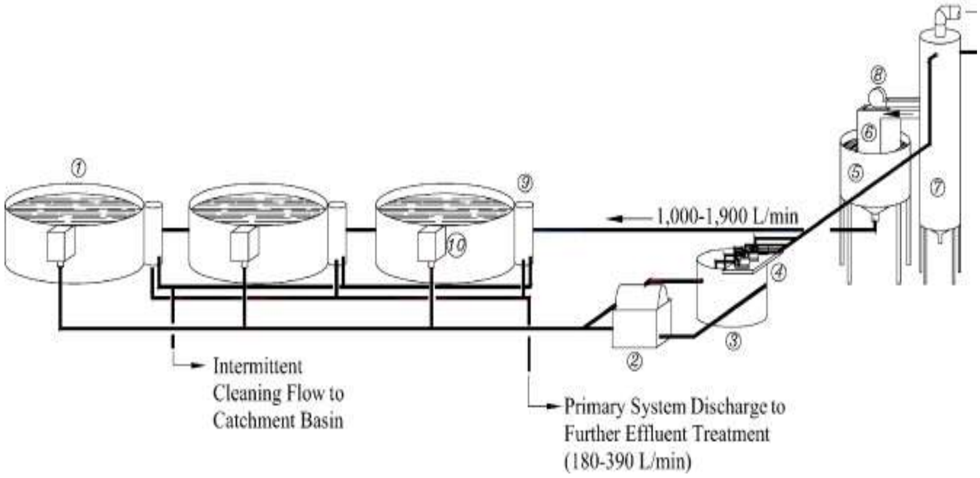
The cold-water aquaculture sector is expanding rapidly but it is faced with two main obstacles: a lack of suitable sites for expansion and the requirement to lessen its adverse environmental impacts. RAS in cold-water plays a crucial role due to high demand and production. RAS works on the principle of reusing the culture water after various levels of filtration, targeting to provide optimum water conditions for better fish growth and welfare. Many rapid growing and highly profitable species, including as carp and trout, have been introduced in order to make use of the cold-water supply. The rainbow trout (*Oncorhynchus mykiss*) a carnivorous fish species that prefers cold, temperate water. Because of this, it does well in the water systems of the states in the Himalayas, Assam, Kashmir etc. Rainbow trout is a fast growing, cold-water fish in India that typically growing to sizes of 0.3–1.2 kg. It is most commonly grown where it contributes over 90% of total production, although earthen ponds and RAS structures made of other materials are also used (Singh et al., 2017). The main objective of introducing rainbow trout (*Oncorhynchus mykiss*) to the Indian Subcontinent was for sport or recreational fishing (Jhingran and Sehgal, 1978; Singh and Lakra, 2011).During the British colonial era in the late 19th and early 20th centuries, trout was first introduced to India. The British made their own attempts in the northwest and peninsula regions of the nation, where trout could be found in cold, appropriate water (Vass et al., 2010). The objective was to raise brood stock for seed production and its distribution to various users in the region. The attempt has proved to be a success and opens a new possibility of commercial farming and culture of rainbow trout by using artificial breeding and RAS

Water Temperature:

The water quality parameters were conducive for trout farming except on a few occasions when water temperature exceeds 20.0°C, which can easily be offset by supplying extra fresh water in the specific rearing units. Rainbow trout farming can be taken for production of marketable size of 250- 350 g weight in a period of 12 –15 months at a water temperature of 10.0 -16.0o C. Apart from the required rearing space, good quality and quantity of water with balanced feed are the important prerequisites for success of trout farming.

Recirculatory Aquaculture System:

In RAS water is filtered both mechanically and biologically, and suspended debris and metabolites are eliminated. This technique uses the least amount of water and land possible to cultivate fish at high densities across a variety of species. The country's limited culture facilities make it necessary to utilize the highland lakes, river streams, and other aquatic bodies above 2500masl that are currently present since they are underutilized for aquaculture (Singh, 2019).Recirculating aquaculture systems (RAS) can be utilized for intensive trout production, while rainbow trout (*Oncorhynchus mykiss*) are mostly produced in extensive systems (ES) (Samuel-Fitwi et al., 2013). Given that India's massive trout production systems rely on scarce resources, their output and emissions may not have an adverse effect on the environment (Meriac et al., 2014). However, increasing trout culture might have an effect on the ecosystem in addition to using water and resources as feed appropriately. Thus, it is highly recommended that India also implements RAS-based intensive trout production. A 32m3 semi-commercial RAS system with bigger culture tanks (7 m3 water volume) and smaller experimental tanks (0.5 m3).



Summerfelt, Steven & Davidson, John & Waldrop, et al (2004).

The RAS The system is made up of two moving bed biological filters that remove ammonia and nitrite, radial flow separators, mesh screen drum filters, and UV filters for disinfection. It also includes a settable and suspended particles filter. Pumps that circulate water are used to do this continually. It is feasible to produce 1.2 MT of trout every crop cycle (2.4 MT annually, at the stocking density of 40 kg per m3) using the existing pilot-scale RAS setup. Furthermore, RAS-based rainbow trout farming may be made more sustainable by utilizing biogas generated from fish waste sludge and clean energy sources like solar energy, which is abundant in hilly areas. Furthermore, crop length in RAS may be shortened to 5–6 months (as opposed to the 12–14month cycle in FTS) and productivity can be increased per unit of time by regulating water temperature.

Comparison of RAS with Raceway:

As an illustration, a water flow rate of 600L/minute is needed to sustain 1000 kg of trout at a stocking density of 25 Kg/m3 in a flow through raceway system trout farm (FTRS). As a result, 50–200 m3 of water (depending on the various methods of computation) are needed to produce 1 kilogram of rainbow trout in FTRS. This seems unsustainable given the depletion of water supplies and restricts rainbow trout farming to a small area of the uplands of India. In order to meet the blue revolution fish production objectives by 2030, it is thus essential to use intensive farming techniques that are climate resilient and include making the most use of the water and land that are now available. It is significant to highlight that, according to advances in science with Recirculating Aquaculture Systems (RAS), the amount of water needed for trout cultivation has been drastically reduced less than 1 m3 of water is needed for every kilogram of fish produced, with stocking densities as high as 100 kg/m3. When comparing the environmental effects of FTS and RAS, it is shown that RAS increases the food conversion ratio by 27%, decreases water reliance by 93%, and reduces eutrophication potential by 26-38%. By regulating water recirculation and oxygenation needs, it is possible to significantly reduce energy consumption, even the negative aspect of the high energy requirement in RAS (16 kWh per kg fish). About 250 kg of rainbow trout are collected and sold during the experiment from two of the grow-out tanks. Based on observation, the controlled water conditions in RAS lead to much quicker growth rates (from 100 g to 800 g in four months) than in FTRS. We are now evaluating the system for full production cycles and the RAS system's economic viability for rainbow trout farming in India. Because RAS farming practices can be carried out from almost anywhere in the Indian upland region with limited water availability and lower land footprints something that is not possible with current farming practices in flow through raceways—they can significantly contribute to an increase in trout production.

CONCLUSION

Rainbow trout farming in India has evolved significantly, thanks to advancements in RAS technology. The success of introducing rainbow trout for sport fishing during the colonial era has paved the way for commercial farming using artificial breeding and RAS. The optimal water temperature range for trout farming, coupled with the efficient filtration and water reuse in RAS, has led to higher productivity and faster growth rates compared to traditional methods. Moreover, the environmental benefits of RAS, such as reduced water reliance and eutrophication potential, make it a sustainable option for scaling up trout production in India's upland regions. Embracing RAS-based intensive farming techniques will not only meet the increasing demand for trout but also contribute to the country's aquaculture objectives in a climate-resilient manner.

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