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Productive performance of Nile tilapia juveniles in water reused from biofloc systems

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Results show adequate yields, survival and other productive parameters

Results of this study evaluating the productive performance of Nile tilapia juveniles experimentally reared at high density using water reused from prior biofloc technology cultures indicate that tilapia can be grown using water from these systems with adequate yields, survival and other productive parameters. Photo by W.A. Djatmiko (Wie146), CC BY-SA 3.0 <https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons

Biofloc technology (BFT) provides several advantages for aquaculture production, including better and more cost-efficient nutrition through the production of various microorganisms (bacteria, fungi, microalgae and zooplankton), improved water quality, pathogen exclusion and lower water use. The reduction in water consumption using BFT could be greater if the same water is reused in multiple culture cycles.

Available information is limited regarding fish and crustacean culture using reused biofloc water. The effects this BFT water reuse on the productive performance and nutritional quality of the cultivated organisms must be evaluated, including the potential spread of diseases or parasites to the new batch of cultured animals, or increased accumulation of salts or toxic substances in the water that could possibly affect the production and quality of the harvested fish or shrimp.

There is also a need to evaluate other production parameters, including proximal composition (main food components, including protein, carbohydrates, lipids and others) and other parameters that can provide important information about the health condition of the cultivated organisms since it is possible to establish a direct connection between environmental factors and their effect on the target organ, for instance, when a reduction or increase in size of key organs, such as liver or gonad, occurs.

Based on current knowledge, we hypothesized that Nile tilapia can be cultured in biofloc using up to 100 percent reuse water derived from other BFT systems, because previous studies have shown that the species tolerates adverse environmental conditions and is considered to be one of the most physiologically adaptable species to biofloc culture, which allows cultivation at high densities. Successful implementation of this strategy could improve Nile tilapia production and water use in its commercial production.

This article – adapted and summarized from the **original** (https://doi.org/10.1007/s40071-019-0218-9) [Gallardo-Collí, A. et al. 2019. Reuse of water from biofloc technology for intensive culture of Nile tilapia (*Oreochromis niloticus*): effects on productive performance, organosomatic indices and body composition. *Int. Aquat. Res.* 11, 43–55 (2019)] – evaluated the productive performance and other production parameters of Nile tilapia juveniles experimentally reared at high density using water reused from prior BFT cultures.

Study setup

The study was carried out in the Laboratory of Genetic Improvement and Aquaculture Production of the Technological Institute of Boca del Rio, Veracruz, Mexico, over a 14-week grow-out period.

A completely randomized design was used with two treatment conditions: tilapia culture in biofloc (TB) and tilapia cultured in biofloc utilizing reused water (RW), with three replicates per treatment. At the end of the biofloc maturation period (BP), three experimental tanks were connected to each BP tank, and one settling chamber per BP tank was used. All components were installed inside a greenhouse covered with shade mesh. During the study, floc-rich water was continuously recirculated, running from the BP tank into the experimental tanks by means of a submersible pump and was returned by gravity, the water lost by evaporation or sludge extraction was recovered with water from the artesian well.

The BP and the experimental tanks were stocked with juvenile Nile tilapia (79.28 ± 14.44 grams initial average weight; 12.44 ± 0.70 cm initial average length) without sexual selection and maintained at a density of 100 fish per cubic meter. The female:male ratio of the fish batch was 39:61 and 40:60 for the TB and RW treatments, respectively. A

commercial formulated feed was fed to the tilapia twice daily at 2 percent of their estimated total biomass and was periodically adjusted. For biometric data, 40 fish from the BP tank and 20 fish per experimental tank were measured (weight and standard length) biweekly. Molasses was added to the BP tanks periodically to support the biofloc.

For detailed information on the study's experimental design and system used; biofloc and fish management; data collection including proximal composition of Nile tilapia and biofloc; and statistical analyses, refer to the original publication.

Results and discussion

In our study, the survival of juvenile tilapia cultivated with reuse water from BFT systems was high (>98 percent). This suggests that reuse water derived from previous BFT cultures can be used in the development of a new biofloc culture and does not negatively impact the survival of tilapia. The survival rate recorded in the present study is comparable to the survival rate reported by other researchers for tilapia (93 to 95 percent) when cultivated in biofloc from first-use water or reused water (50 percent inclusion), and the high survival rate (99 percent) observed in the *L. vannamei* shrimp cultured in biofloc with reuse water at a 100 percent inclusion level.

The daily weight gain, DWG, of the tilapia (0.79 grams per day) observed in the RW treatment exhibited similar values to those reported for the mixed culture of *O. niloticus* with biofloc (0.52 to 0.83 grams per day), which suggests that the growth of tilapia during their culture in biofloc with reuse water was not affected by the quality of the water from the previous BFT culture. Therefore, the useful life of the water can be prolonged at least for the development of a new biofloc culture cycle. This is consistent with reports from other researchers that indicated that the use of the same water from prior BFT cultures is highly beneficial for the culture of *L. vannamei* shrimp, because good water quality is maintained, and the productive performance is increased.

After 14 weeks of culture, the total production of tilapia (16 kg per cubic meter) was similar to the value reported in previous studies (16 to 18 kg per cubic meter), which indicates that the cultivation of tilapia in biofloc with reuse water did not affect the productive performance. The fillet yield of fish (22 percent) in both treatments was lower than the minimum value of 26 percent reported by other researchers in tilapias of 230 grams. However, this low value is justified by differences in weight since there is a positive correlation between tilapia weight and fillet weight. Additionally, the proximal composition [main food components, including protein, carbohydrates, lipids and others] of tilapia was not affected, as indicated by the protein, lipid and ash percentages which are similar to the values reported in heavier tilapia (530 grams) with a fillet yield of 30 percent.

The reuse water contained a high concentration of total dissolved solids, TDS [combined content of all inorganic and organic substances dissolved in a liquid], but as the maturation period progressed, a reduction in TDS concentration was observed, which could be related to the proliferation of microalgae since this microorganism utilized inorganic nutrients for growth. The proliferation of microalgae resulted in a photoautotrophic [organisms that use energy from light in their metabolic processes] biofloc during the first weeks of culture; these microorganisms, in addition to oxygenating the water, were an important source of macronutrients and micronutrients for the cultivated organisms.

During the study, the TDS accumulation was higher in the TB treatment than in the RW treatment. This difference may have been due to a greater abundance of microalgae in the RW system, resulting from the consumption of nutrients derived from the mineralization processes carried out by bacteria and protozoa present in BFT systems. Microalgae, bacteria, protozoa and other microorganisms, and particulate organic material are part of the biofloc and provide significant nutrition, so it is probable that their consumption by tilapia contributed to the observed improvements in productive performance.

A decrease in water pH was recorded after the eighth week of the tilapia culture. This pH reduction in the water was accentuated in the TB treatment, which suggests greater pH stability resulted from the use of reuse water in the RW treatment. This observation is consistent with other, previous studies indicating minimal pH variation in the water of BFT cultures.

Midway through the culture period, the settleable solids (SS, the material in a sample that settles out of suspension after a defined time period) concentration in the water was observed to exceed the recommended maximum value for tilapia cultivation (50 mL per liter), which was related to the elevated amount of food that entered the water by the increase in fish biomass. The excessive SS concentration was a result of the nitrogenous waste derived from the consumption of feed by tilapia, which is subsequently used by heterotrophic [requiring organic compounds of carbon and nitrogen for nourishment] bacteria to produce microbial biomass, consequentially causing an increase the

production of biofloc. The excessive production of biofloc was controlled using a settling chamber; this action was necessary to prevent gill blockage by excess solids present in the water. The partial removal of biofloc from water improves biofiltration and decreases nitrate concentration; however, its extraction can affect the microbial community by removal of microorganisms associated with the biofloc.

Previous studies have suggested that in biofloc cultures, fish growth and the increase in microbial biomass reduce the concentration of dissolved oxygen (DO) in the water. We observed this too: following the seventh week of tilapia culture, the DO concentration in the water decreased in both treatments, which was attributed to both the growth of the fish and the continuous increase in the concentration of SS.

The water consumption in both treatments during the growout period was less than the value of 40 percent previously estimated by other researchers, which confirms that the implementation of BFT cultures with reuse water can be used to further reduce the water consumption derived from freshwater aquaculture. Also, BFT culture using reuse water minimizes the discharge of nutrients into natural water bodies.

Perspectives

Our results showed that the reuse water from the BFT systems used to establish new biofloc cultures prolonged the useful life of the water and reduced overall water consumption. The cultivation of Nile tilapia in biofloc can be established with reuse water from BFT systems without adverse effects on their survival, productive performance, proximal composition and gonadal maturity. Additionally, good water quality can be maintained during tilapia culture, so it could be considered as an additional strategy to maintain or increase production of Nile tilapia.

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