

PAPER • OPEN ACCESS

Water Quality in the Maintenance of *Oreochromis niloticus* through Environmentally Friendly Biofloc Technology

To cite this article: Endah Rita Sulistya Dewi *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **835** 012008

View the [article online](#) for updates and enhancements.

You may also like

- [Comparison Of Growth Of Organic Tilapia From Selective Breeding Program, Fed With Organic Pellet Feed and Duckweed Under The Biofloc Farming System](#)
N Kitcharoen and P Poonnoy
- [Effect of freeze-dried biofloc as A Dietary Supplement on Water Quality and Growth Performance of red Tilapia \(Hybrid\)](#)
Tarq Binalshikh-Abubkr and Marlia Mohd Hanafiah
- [The effect of different dose on biological performance and its correlation with growth of nile tilapia \(*Oreochromis niloticus*\)](#)
Y R Widyastuti, E Setiadi, A Saputra et al.



ECS
The
Electrochemical
Society
Advancing solid state &
electrochemical science & technology

DISCOVER
how sustainability
intersects with
electrochemistry & solid
state science research

Water Quality in the Maintenance of *Oreochromis niloticus* through Environmentally Friendly Biofloc Technology

Endah Rita Sulistya Dewi^{1*}, Ary Susatyo Nugroho¹, Maria Ulfah¹

Departement of Mathematics, Sciences and Information Technology, Universitas PGRI Semarang, Indonesia

*endahrita@upgris.ac.id

Abstract. This Population growth that continues to increase demands continuous availability of food. Aquaculture is one of the sectors of food production which has the highest growth rate in the world. Facing this opportunity, aquaculture is faced with several challenges related to limited natural resources such as water and land, as well as waste water from aquaculture. Furthermore, the application of best aquaculture practices in aquaculture product certification requires environmentally friendly aquaculture practices. *Oreochromis niloticus tilapia* is a type of freshwater consumption fish and is now a popular pet fish in freshwater ponds in Indonesia. This study aims to analyze water quality in the maintenance of Tilapia through environmentally friendly Biofloc technology. This research method was designed in the form of Research and Development. The results showed that the water quality was proper for pond operation using minimal water exchange, the development of dense microbial populations through the management of microbial populations could control the concentration of ammonia in the water. Bacteria in ponds form biofloc, producing microbial proteins that make it possible to recycle unused feed protein, so as to minimize pollution.

Keywords: Biofloc, *Oreochromis niloticus*, Environment Friendly

1. Introduction

Aquaculture is a form of maintenance and breeding of various kinds of aquatic animals or plants that use water as its main component. Common activities include fish cultivation, shrimp cultivation, oyster cultivation, seaweed cultivation (algae).

Aquaculture is an activity to produce aquatic biota (organism) in a controlled environment in order to get profit. In the next two decades, it is estimated that the demand for fish or non-fish will double due to the increase in world population. No doubt, aquaculture is a very reliable industry. It is estimated that in 2020, aquaculture will produce more than 68 million tons, reaching 40% of global seafood production [1].

Tilapia (*Oreochromis niloticus*) is a cheap source of animal protein for human consumption. Fish farming can be done in ponds or rearing tanks. In the process of growth, protein metabolism by aquatic organisms generally produces ammonia as a result of excretion. At the same time, the protein in feces and inedible feed will be broken down by bacteria into the same product, thus the more intensive a cultivation activity will be followed by the higher concentration of nitrogen compounds especially ammonia in water [2-3].

The high organic waste from artificial feed (pellets) and feces resulting from intensive fish maintenance will cause buildup and sedimentation at the bottom of the maintenance water media, so a



decomposition process is needed. If not decomposed the maintenance media will be decomposed anaerobically by anaerobic bacteria then form toxic gases such as sulfuric acid, nitrite, and ammonia and have a negative impact on the metabolism of aquatic organisms to death. To reduce organic waste and will be discharged into public waters, water quality management is needed so that the maintenance media remain in good condition. One of the efforts is a biological approach by utilizing bacterial activity to accelerate the process of decomposition of organic waste.

Along with the development of technology through a biological approach, biofloc technology has been applied to maintain the quality of aquaculture. Biofloc technology is a technology to use both heterotrophic and autotrophic bacteria that can convert organic waste intensively into flock-shaped microorganisms, which can then be utilized by fish as a food source [4-5]. Within the floc there are several forming organisms such as bacteria, plankton, fungi, algae, and suspended particles that affect the structure and nutrient content of biofloc, but the bacterial community is the most dominant microorganism in floc formation in biofloc [6].

Biofloc technology or active suspension technique, uses constant aeration to enable the process of aerobic decomposition and keep bacterial flocks in suspension [7]. In this system heterotrophic bacteria that grow with high density function as bioreactors that control water quality especially N concentrations as well as a source of protein for the organisms that are kept. Furthermore according to [6], states that the formation of biofloc by heterotrophic bacteria generally aims to increase nutrient utilization, avoid environmental stress and predation.

This research is important to assess the efficiency of water use, ammonia content in water, the use of nutrients as natural food and the reduction of waste pollution in tilapia fish farming. It is expected that perpetrators of aquaculture will continue to prioritize the use of science and technology in the management of sustainable aquaculture businesses.

2. Methods

This research is a research development (R & D) . The development procedure uses the Borg and Gall model. Biofloc technology application is also carried out in this activity, namely making biofloc pools, preparing water media, growing floc, feeding management and water quality management.



Figure 1. Biofloc Ponds

The application of biofloc technology is carried out in a round tarpaulin pond with a diameter of 150 cm, height, 100 cm. Maintenance water media is 1.5 m³ and fish density is 300 fish/m³. At the beginning before the fish were stocked, probiotics were given, namely EM4 floc forming at a dose of 5 cc/m³. The addition of probiotic bacteria was carried out along with the accumulation of feed given in the maintenance media for 42 maintenance days and the length of the fish was measured at the beginning and the end of maintenance. During maintenance measured water quality including ammonia, temperature, DO, and pH was carried out on days 0, 21 and 42.

3. Results and discussion

From the results of the study water quality data obtained in the measurement period are as follows:

Table 1. Data on Biofloc Pond Water Quality in Tilapia Maintenance

Parameters	Day 0	Day 21	Day 42
Ammonia	0.015 mg / L	0.02 mg / L	0.013 mg / L
Temperature	26 ⁰ C	28 ⁰ C	28 ⁰ C
DO	5.2 mg / L	8.4 mg / L	8.57 mg / L

pH	6	6	7
----	---	---	---

Next, the ammonia content for 42 days, with sampling on day 0, day 21 and day 42, is presented in Figure 2.

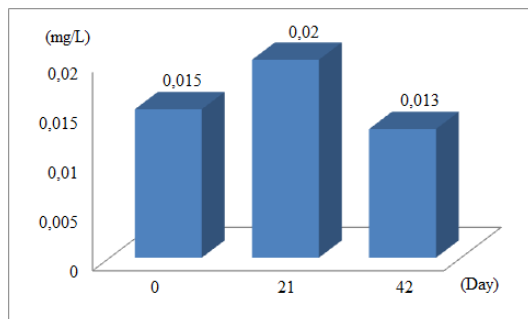


Figure 2. Ammonia Content in Biofloc Ponds

From this graph, it can be seen the average ammonia content of 0.016 mg / L, which means that the ammonia content in the pond is still below the quality standard. This condition can occur due to bacteria that can break down waste from fish, namely the *Nitrosomonas* bacteria, which convert Ammonia into Nitrites, Nitrites are then converted into Nitrates by *Nitrobacter* bacteria. According to [8] requirements, the maximum limit of ammonia levels for fish farming activities is <0.02 mg / L.

By [9] asserted that decomposition of ammonia by microbes can be done by deamination process. Deamination is the process of dismantling proteins into amino acids, then amino acids are broken down into ammonia and some other substances by the bacteria producing urease enzymes, with this enzyme urea can be broken down into ammonium carbonate, while ammonium carbonate is easily broken down into ammonia, carbon dioxide and water, also confirmed by [10] that the urease enzyme is the only catalyst enzyme in hydrolyzing urea. [11] added that the genus *Bacillus* is a microbe from a class of bacteria that is able to synthesize urease well in waters.

The need for good water quality in intensive fish maintenance requires an environmentally friendly technology so that the low organic matter in the maintenance media and the low waste that is discharged into public waters, in this case biofloc technology can provide a solution.

Broadly speaking, intensive maintenance of *Tilapia* with biofloc technology is more effective than without biofloc technology. And some supporting parameters such as temperature, DO, and pH are still within the maintenance threshold of *tilapia*. Provision of probiotics such as EM4 (Effective Microorganisms 4) has an important meaning in maintaining water quality by the process of breaking down waste materials into more useful organic matter. According to the opinion of [12] which states EM4 contains fermented and synthetic microorganisms consisting of Lactic Acid bacteria (*Lactobacillus sp*), Photosynthetic Bacteria (*Rhodopseudomonas sp*), *Actinomyces sp*, *Streptomyces sp* and Yeast (yeast)) and cellulose decomposers.

[13] said that EM (Effective Microorganisms) consists of photosynthetic bacteria, lactic acid bacteria, actinomycetes, yeast and fermented fungi. Photosynthetic bacteria form beneficial substances that produce amino acids, nucleic acids and bioactive substances derived from harmful gases and function to bind nitrogen from the air. Lactic acid bacteria function to ferment organic material into lactic acid, accelerate the overhaul of organic matter, lignin and cellulose, and suppress pathogens with lactic acid produced. Actinomycetes produce anti-microbial substances from amino acids produced by photosynthetic bacteria. Yeast produces antibiotic substances, produces enzymes and hormones, yeast secretion becomes a substrate for effective microorganisms of lactic acid bacteria actinomycetes. Fermentation fungi are also able to break down organic matter quickly which produce anti-microbial ester alcohol, and eliminate the foul odor.

These microbes also play a role in floc formation. The formation of flocks in the pool can be seen with the characteristics of the pool does not smell, the color of the flocks in the pool is green which indicates in the pool more phytoplankton is formed.

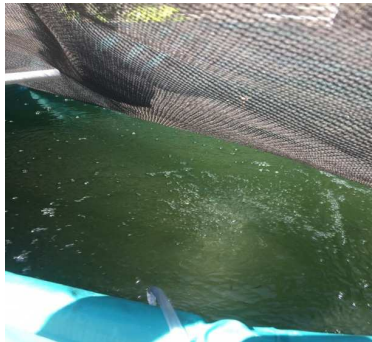


Figure 3. Floc formation

Concentrations of temperature, DO, and pH in each treatment ranged from 26-28°C; 5.2-8.57 mg / L; and 6-7. The three parameters show the results in the maintenance media are within reasonable limits for the growth of tilapia. Temperature requirements according to [8] 25-32°C as well as (DO) dissolved oxygen is within the proper limits for the growth of tilapia, according to the requirements of [8] SNI, DO is a minimum of 3 mg / L tilapia can still grow well at dissolved oxygen 5.2-8.57 mg / L. The pH concentration of water in the pond is within a reasonable limit for the growth of tilapia, ranging from 6-7 while [8] requirements are 6.5- 8.5.

Ammonia's toxicity to aquatic animals is very dependent on pH, temperature and salinity. At high pH the NH₃ levels will rise, and vice versa. When ammonia levels are high, the ability of fish to excrete ammonia is reduced. This causes an increase in ammonia levels in the blood and body tissues. This will increase blood pH levels and have a detrimental effect on enzyme sharing reactions and membrane stability. Negative effects include damage to the gills, reducing the capacity of blood to carry oxygen and histological damage to red blood cells [14]. From the results of observations of Ammonia (NH₃) in ponds during the study containing ammonia with an average concentration of 0.016 mg / L. This proves that the role of flocks in ponds is able to maintain ammonia concentration during the tilapia aquaculture process. This condition is in accordance with the statement of [15] if the level of ammonia in the waters contained in an amount that is too high is greater than 1 mg / L can not be suspected of pollution.

4. Conclusion

1. Ammonia levels in biofloc ponds contain ammonia with an average concentration of 0.016 mg / L, still below the quality standard.
2. Water quality in biofloc ponds is declared feasible during maintenance of Tilapia.
3. Provision of EM4 forms biofloc and produces microbial proteins that play a role in recycling unused feed proteins, so as to minimize pollution.

Acknowledgement

Thanks to Direktorat Riset dan Pengabdian Masyarakat, Direktorat Jendral Penguatan Riset dan Pengembangan, Kementerian Riset, Teknologi dan Pendidikan tahun 2019, who have provided this research grant.

References

- [1] Pangkey, H. "Pengembangan Akuakultur di Wilayah Kota Tidore Kepulauan". Jurnal Perikanan dan Kelautan. IV (2): 27-34. 2008.
- [2] Avnimelech, Y. "Sustainable land-based aquaculture-rational utilization of water, land and feed". Mediterranean aquaculture journal (41):45-55. 2008
- [3] Avnimelech, Y., and Kochba M. "Evaluation of Nitrogen Uptake and Excretion by Tilapia in biofloc Tanks", Using ¹⁵N tracing Aquaculture 287: 163-168.2009
- [4] de Schryver P, Verstraete W. "Nitrogen Removal from Aquaculture Pond Water by Heterotrophic Nitrogen Assimilation in Lab-Scale Sequencing Batch Reactors". Bioresource Technology. 100(3): 1162-1167. 2009. <http://doi.org/d24f5t>

- [5] Avnimelech Y. "Biofloc Technology" - a Practical Guide Book, 2nd edition. United States (US): The World Aquaculture Society. 2012
- [6] de Schryver P, Crab R, Defoirdt T, Boon N, Verstraete W. "The basics of bioflocs technology: The added value for aquaculture". *Aquaculture*. 277(34): 125-137. 2008. <http://doi.org/d9wr3>
- [7] Azim, M.E and D.C Little. "The Biofloc Tecnology (BFT) in Indoor Tanks: Water Quality, Biofloc Composition, and Growth and Welfare of Nile Tilapia (*Oreochromis niloticus*)". *Aquaculture*, 176:227-235. 2008.
- [8] Badan Standardisasi Nasional. SNI 7550 : 2009, "Produksi ikan Nila ((*Oreochromis niloticus* Bleeker) kelas pembesaran di kolam air tenang. Author. 2009.
- [9] Waluyo L. "Mikrobiologi Umum". Malang (ID): Universitas Muhammadiyah Malang Press. 2007.
- [10] Gianfreda L, Bollag JM. "Influence of natural and anthropogenic factor on enzyme activity in Soil". *Soil Biochemistry*. 9: 123-176. 1996
- [11] George M, Cyriac N, Nair A, Hatha AAM. "Diversity of Bacillus and Actinomycetes in the water and sediment samples from Kumarakom region of Vembanadu lake". *Indian Journal of Geo-Marine Sciences*. 40(3): 430-437. 2011
- [12] Javaid, A. & Bajwa, R. "Field evaluation of effective microorganisms (EM) application for growth, nodulation, and nutrition of mung bean". *Turkish Journal of Agriculture and Forestry*, 35(4), pp.443–452. 2011
- [13] Irmak, S. & Cil, A. "The Effects of Microbial Fertilizer Application on Yield and Some Yield Elements of Peanut in Cukurova Region in Turkey". *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 2(1), pp.880–888. 2011.
- [14] Boyd CE. "Water Quality in Warm Water Fish Ponds". Fourth Printing. Auburn. University Agricultural Experiment Station, Alabama, USA. 359 p. 1988
- [15] Irawan. "Faktor-Faktor Penting dalam Proses Pembesaran Ikan di fasilitas Nursery dan Pembesaran". 2009. Diambil dari www.sith.ipb.ac.id