GSJ: Volume 12, Issue 1, January 2024, Online: ISSN 2320-9186

www.globalscientificjournal.com

WATER QUALITY MANAGEMENT FOR AFRICAN CATFISH (CLARIAS SP) CUTIVATION IN BIOFLOC TANK IN APUNG VILLAGE, BULUNGAN REGENCY, NORTH KALIMANTAN PROVINCE (LOW PH WATERS)

Christina Juliana Silalahi[1], Gatot Hari Priowirjanto[2], Rita Rostika[2], Mochhamad Ikhsan Cahya Utama[1]

[1] Tropical Marine Fisheries Study Program, Faculty of Fisheries and Marine Sciences, Padjadjaran University
[2] Fisheries Study Program, Faculty of Fisheries and Marine Sciences, Padjadjaran University
E-mail: christina20003@mail.unpad.ac.id;

KeyWords

Biofloc; Clarias sp; Water quality; Acidic waters; Cultivation; Low PH Waters; Enlargement

ABSTRACT

This research aims at evaluating the African catfish cultivation that employed biofloc technology to make it capable of meeting customers' demands and to be business opportunities for the people of Apung Village, Tanjung Selor District, Bulungan Regency. The African catfish cultivation that used biofloc technology was first developed in Apung Village, where the demand for the fish was so large, yet the number of its cultivators was still highly limited. The obstacles in cultivating fish in Apung Village lies in its water quality with its acidic pH and the difficulty to obtain water. Thus, the fish cultivation that employs biofloc tank technology has served as an alternative to address the water quality issue. This is because biofloc technology is the one that could deal with low water quality.

Since no fish cultivation had used biofloc tank technology in Apung Village, this activity began with developing the biofloc tank and the fish to be cultivated was determined based on the one that had a great demand, in this case the African catfish. This African catfish cultivation started from stocking 1,500 fish of 4-7 cm size in one biofloc tank. The observations were carried out during the building of biofloc tank, fish stocking and harvesting. The African catfish was kept from August through December 2023. The water quality was observed from such parameters as pH, temperature, DO, and TDs. From the research, it could be concluded that the African catfish could be cultivated in Apung Village despite its less optimal water quality as a result of the acidic pH (5 - 6). This was possible because the African catfish could still tolerate it, as could be seen from the fish wight growth during the stocking until the harvesting.

INTRODUCTION

African catfish is one of freshwater fish with high demand from the market. According to the Indonesian Statistics' (BPS) 2015 data as quoted by *Ruherlistyani et. al. (2017)*, during the 2011-2015 period its production increased by 21.31%/year. The production of this fish from cultivations at national level in 2011 was 337,557 tons, and in 2015 this increased to 722,623 tons. Despite this 70% increase in production and the fact that Indonesians consumed fish above the desirable dietary pattern rate at 30.14 kg/capita/year, the attempt to meet fish consumption target of 50.65 kg/capita/year in 2018 and the following years should still be strived *(Idris et. al., 2018).*

The number of African catfish cultivators in Apung Village is still highly limited, even if the opportunity for the fish cultivation business is so great. Some of the factors that get in the way is the acidic waters (pH 5-6). Another issue is the difficulty to procure water. Considering these limitations, the cultivation that makes use of biofloc technology can be one good way to cultivate fish. This is possible due to the absence of the need to replace water in the tank while keeping the fish. The cultivation using biofloc technology serves as one alternative to address water quality issue in aquaculture adapted from the conventional domestic waste management technique. Biofloc technology is beneficial to improve water quality, increase biosecurity, enhance productivity, increase feed efficiency and also decrease production costs through the reduced feed costs *(Avnimelech, Kochba, 2009; Ekasari, 2008; Hari., et al., 2006; Kuhn., et al., 2009; Taw, 2010).*

Biofloc comes from the words "*bios*", meaning life, and *"floc"* which means a lump. Thus, biofloc is a group of organisms such as bacteria, algae, protozoa, worms, and others that combine into a lump or flock. Cultivating fish using biofloc technology means multiplying the number of beneficial bacteria and microbe in the fish cultivation media, in order to improve and maintain the water quality stability and suppress toxic compounds such as ammoniac, as well as suppress the development of pathogenic bacteria, to allow the fish to grow and develop well *(Suprapto, 2013).*

Currently, the cultivation of African catfish using biofloc technology has been initiated in Apung Village. The successful management of water quality as a media in fish cultivation by applying the biofloc technology has been an inspiration for others to cultivate fish (in an area owned by State Junior High School 8 Tanjung Selor) Apung Village, Bulungan Regency. This research aims at cultivating the African catfish by applying biofloc technology to allow the fulfillment of customers' demands and to be a business opportunity for the people of Apung Village.

METHOD

The main program of apprenticeship in Apung Village was cultivating African catfish by employing biofloc tank technology. The program commenced with making the biofloc tank of 3-meter diameter. The materials needed to construct the biofloc tank were; wire mesh (for the tank wall frame), gutter carpet to coat the tank wall, 3-meter diameter tarpaulin, pipe, a pair of scissors and glue.

The making of the tank began with measuring the area width and levelling it. Then, a circle was made at the tank size of 3-meter diameter. Next, the bricks were structured to shape a circle and an outlet for the tank water disposal was made. Afterward, the wire mesh was installed, the tip of which was tied to a steel or wire to lock it up. Then, the gutter carpet was laid and at its upper part a pipe was installed to bind the carpet and the wire mesh. Then, the tarpaulin was installed and on its middle part a hole was made to dispose of the tank water (for the tank water disposal purpose, a pipe that had been punctured for water disposal was installed). Then, the punctured pipes were installed to shape a circle on the outer wall of the tank for aeration and finally aeration tap, aeration hose, and aeration stone were all installed.

The next step was installing the blower. It began with making the blower house on the tank edge. For aeration purpose, a pipe was connected from the blower to the tank. After everything was set, a trial was done to test the aeration current flow strength. The aeration flow was made to circle the tank and a rope was attached to make the aeration even.

The tank was filled with water at around 20-30 cm height to make a floc in the biofloc tank. The materials to make the floc included; dolomite lime 50g/m³, probiotic 100ml/m³, crushed salt 1000g/m³. The tank water was left for 5-7 days with sufficient aeration to allow the floc to grow well. A floc could be said to have grown well if the tank floor was slippery and the tank water did not have a strong smell. When the floc could be used, the water was added to 70 cm height. A day later the fish could be stocked.

The African catfish seeds were kept for 3 months, from the initial stocking of 5-7 cm size until it reached 20-25 cm size. The feed provided to this fish contained protein 35% of 3%-5% per biomass weight/day. The feed was provided based on the sample weight measurement and sampling results once every 10 days. The sampling was done to discover the fish weight growth. The ultimate length was the organism average size at certain age (Effendi, 2003). The feeding frequency was 3 times a day, namely in the morning at 08.00, in the afternoon at 12.00 and in the late afternoon at 17.00. The water quality was observed once every 2 days.

The physical parameters observed included water temperature and the total dissolved solid (TDS). Meanwhile, the chemical parameters observed included dissolved oxygen (DO) and water acidity (pH). The dissolved oxygen was measured using DO meter and the pH, temperature, and TDS were measured using a water quality meter.

RESULT AND DISCUSSION

According to *Ekasari (2009)*, biofloc technology is one of the current technologies developed in aquaculture aimed at improving the water quality and feed efficiency. The biofloc tank was first made on 28 August through 28 September 2023. Figures 1 and 2 show the initial condition of the area and the finished tank.

Figure 1. Initial condition of area on which the biofloc tank is to be built

Figure 2. The condition after the biofloc tank has been built

Once the biofloc tank was built and the aeration was installed, the next thing to do was filling it with water up to around 20-25 cm high. Then, the water volume was calculated to discover the floc dose to be administered. To make the floc, the following materials and doses were used; crushed salt 1 kg/m^3, dolomite lime 50 g/m^3, Molasse 100ml/m^3, Probiotic 100ml/m^3.

Volume	= 3.14 X 1.5m X 1.5m X 0.25m = 1.77m^3
Crushed salt	= 1 kg X 1.77 m^3 = 1.77 kg/m^3
Dolomite lime	= 50 g X 1.77 m^3 = 88.5 g/m^3
Molasse	= 100 ml X 1.77 m^3 = 177 ml/m^3
Probiotic	= 100 ml X 1.77 m^3 = 177 ml/m^3

Figure 3 The floc made in the biofloc tank

Once all materials were put into the tank, it was left for 5-7 days with the aeration turned on. Whether the floc was successfully made or not could be seen from the greenish water, not too strong odor, and slippery tank wall. The generated biofloc media could also give faster and healthier growth of African catfish *(Suparno, 2016).*

Once the floc was successfully made, the water could be added up to 70 cm high. After 3 days, the tank could be stocked with the African catfish seeds. The African catfish seeds were stocked on 11 October 2023 at 19:00 local time. As many 1,500 fish seeds of 4-7 cm size were stocked initially. Prior to stocking the seeds to the tank, the fish needed to be acclimatized or familiarized with the tank water temperature first.

Figure 4. African catfish stocking

During the first week of African catfish seed keeping, it was fed one every 2 hours. This was to find out how much feed the African catfish seeds could consume. After 10 days, the seeds were sampled to discover the fish weight to calculate the needs of feed for the fish in one tank. Five fish were sampled. The data obtained from the sampling and feed calculation are presented below.

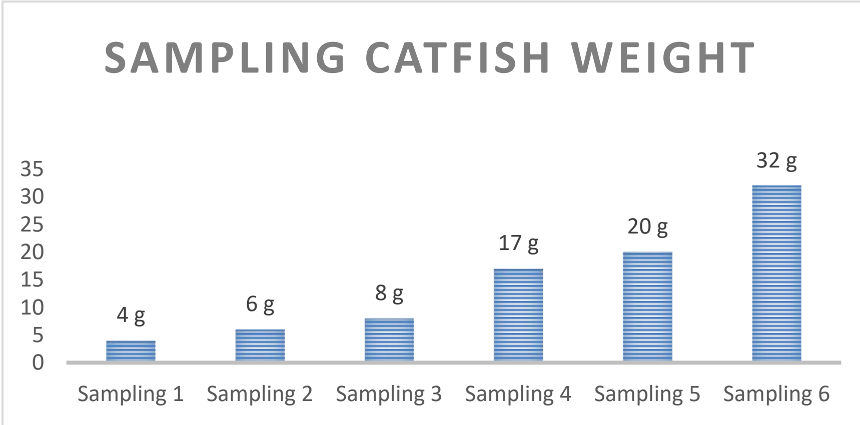

Figure 5. African catfish weight diagram

From the sampling result, it can be seen that the growth of African catfish was still slow because of the less optimal water quality at low pH. This made the African catfish's appetite low and it significantly affected its growth.

Table 1. Calculation of African catfish's feed needs

Date	Pond	Weight	Feed Requirements
18-Okt-2023	**Pond 3**	0,020 kg	0,020 kg = 20 g : 5 tails= 4 g Formula= B x 3% x Total fish = 4 g x 3% x 1450 = 174 g/day
29-Okt-2023	**Pond 3**	0,030 Kg	0,030 kg = 30 g : 5 tails = 6 g Formula = B x 3% x Total fish = 6 g x 3% x 1450 = 261 g/ day
09-Nov-2023	**Pond 3**	0,040 Kg	0,040 kg = 40 g : 5 tails = 8 g Formula = B x 3% x Total fish = 6 g x 3% x 1450 = 348 g/ day
19-Nov-2023	**Pond 3**	0,085 Kg	0,085 kg = 85 g : 5 tails = 17 g Formula = B x 3% x Total fish = 17 g x 3% x 1450 = 739 g/ day
29-Nov-2023	**Pond 3**	0,100 Kg	0,100 kg = 100 g : 5 tails = 20 g Formula = B x 3% x Total fish = 20 g x 3% x 1450 = 870 g/ day
09-Des-2023	**Pond 3**	0,160 Kg	0,160 kg = 160 g : 5 tails = 32 g Formula = B x 3% x Total fish = 32 g x 3% x 1450 = 1.392 g/ day

The fish was fed 3 times a day; at 08:00, 13:00, and 17:00 local time. While the amount of feeds had been calculated, the feeding was done in ad libitum (gradually), aiming to prevent the unconsumed feed from turning into ammoniac. This was because when the amount of unconsumed feed was large, it would negatively affect the water quality and, thus, might result in the fish death.

Figure 6. Feeding the African catfish

In keeping the fish, it was important not only to feed the fish, but also to measure the water quality in the tank. This was because poor water quality would affect the fish. This included the fish's decreased appetite and vulnerability to disease. Some physical parameters were observed, including water temperature and total dissolved solid (TDS). Meanwhile, the chemical parameters observed were dissolved oxygen (DO) and water acidity (pH). The water quality was measured using pH meter and DO meter. The water quality was measured twice a day, at 08:00 and 17:00 local time. The data on this water quality measurement and the Indonesian National Standards' (SNI) water quality were presented below.

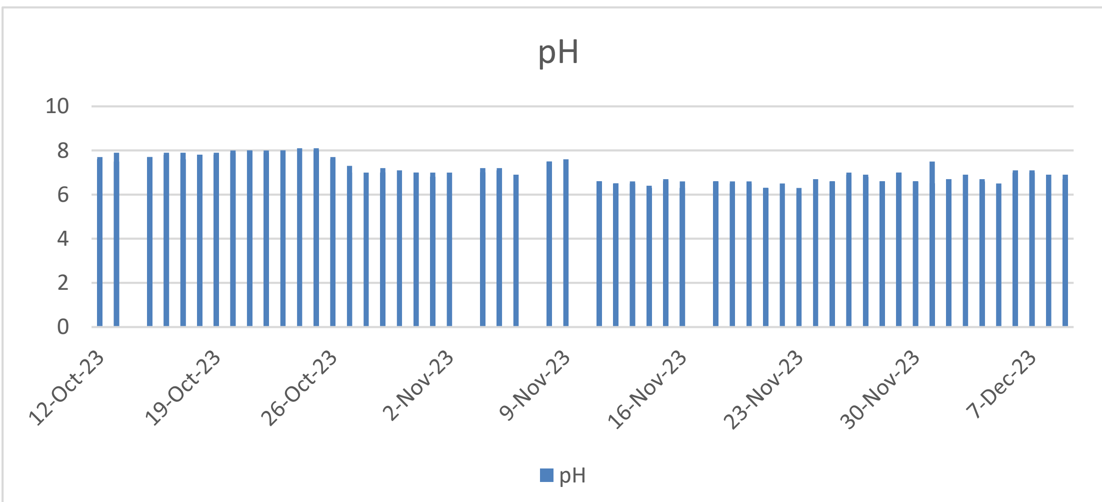

Figure 7. Water quality (pH) diagram

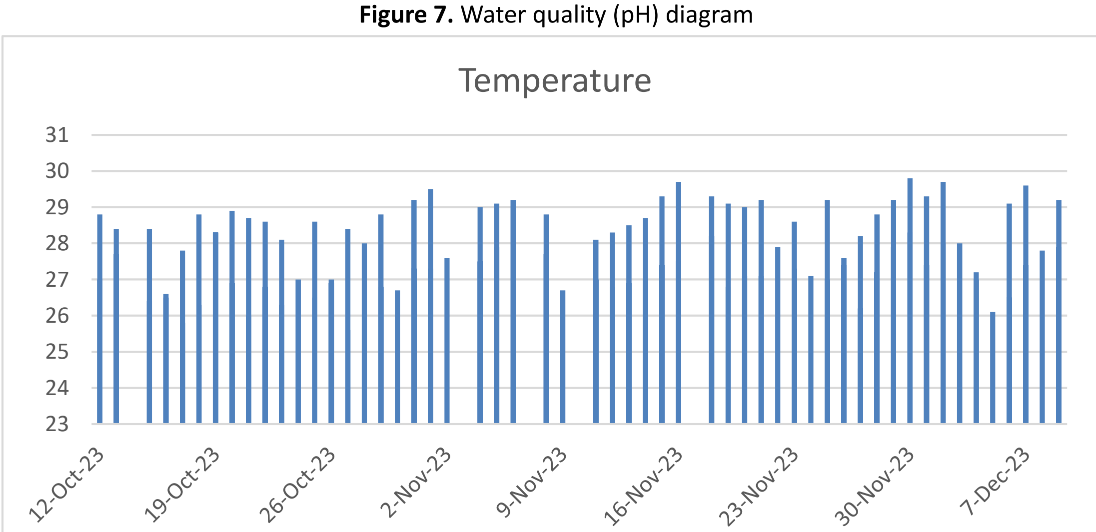

Figure 8. Water quality (Temperature) diagram

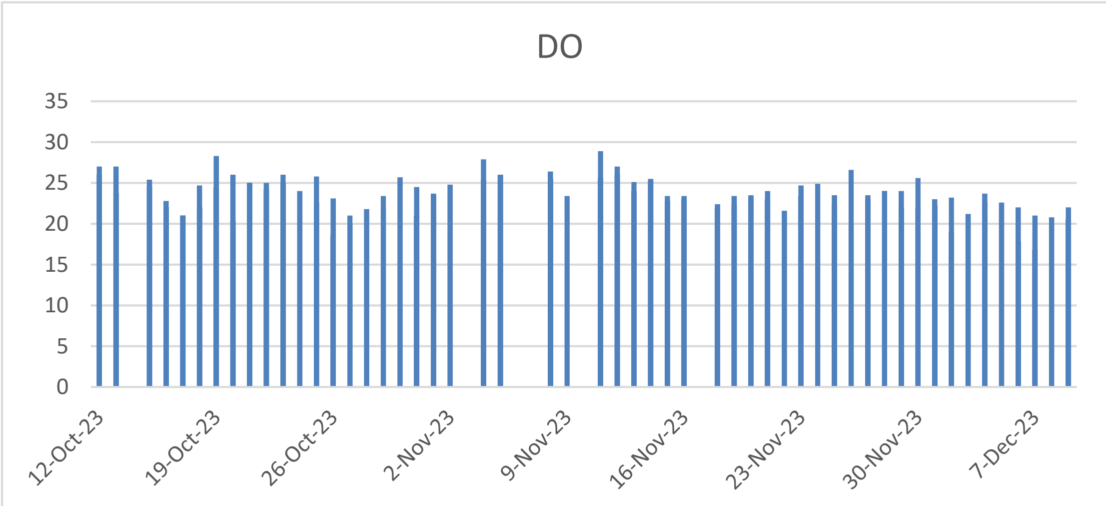

Figure 9. Water quality (DO) diagram

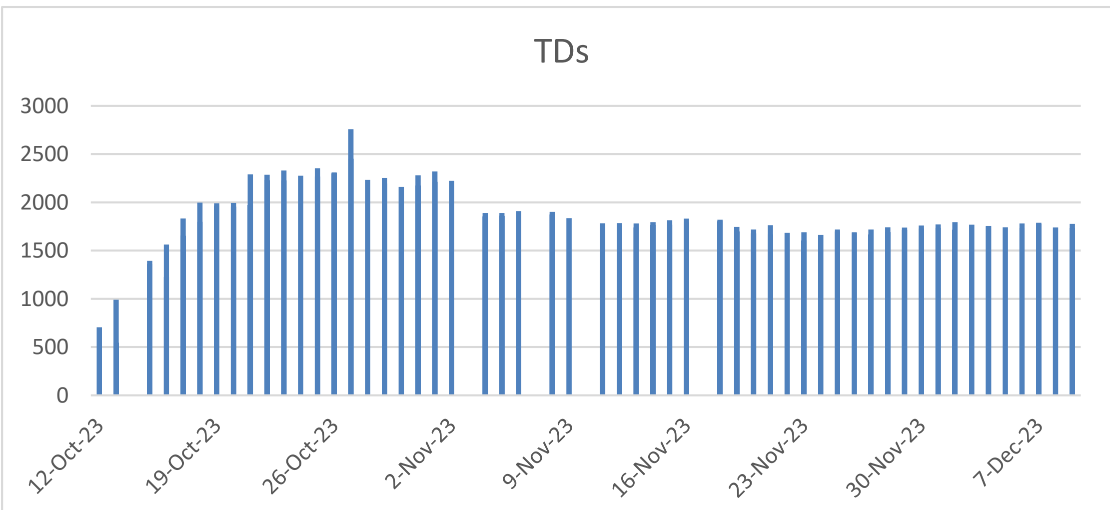

Figure 10. Water quality (TDS) diagram

While the African catfish was kept, when the pH turned <6, a lime could be administered to increase the pH by 10g/m^3. And if the pH turned >7, probiotic could be added directly to the tank to improve the water quality in the tank and it could also be mixed with the feed. This aimed at serving as the fish supplement. As the experience had taught us, the higher the temperature was, the higher the pH would be. However, during the rainy season, the lower the temperature was, the lower the pH would be.

While the African catfish was kept, in comparison to SNI's water quality parameter scores, those of the tank cultivation were still within the feasibility range for cultivating the African catfish. Despite the low pH, the occurring changes were still within the tolerance limit for African catfish. According to *Hepher (1978)*, the cultivation intensification was successful without lowering the growth rate if the four environmental factors were carefully considered. These four factors included: temperature, feed, oxygen supply, and metabolism wastes. Meanwhile, *Effendi (2003)* suggested that fish could grow thanks to the successful attempt to obtain food. The fish growth could be affected by two factors, namely external and internal ones. The former included fish feed and water quality, and the latter were those factors that were hard to discover such as genetic attributes, age and sex. According to *Stickney (2005),* the good oxygen concentration for African catfish was more than 3 mg/L.

According to the Indonesian National Standardization Agency, **SNI 6484.3:2014** the measurements of water quality parameters for Nile tilapia and African catfish were:

Table 2. Water quality parameters as per SNI

Parameters	
Temperature (°C)	25-30
pH value	6,5-8
Dissolved oxygen (mg/l)	Minimum 3
Minimum water level (cm)	-
Water color	Greenery

Regarding the mortality of African catfish fish keeping, the total number of dead fish during the fish keeping were 55. From this number, the lowest death rate was on 6-7 December 2023, and the highest one on 2 December 2023. The factor that affected this fish death was poor water quality. This poor water quality was typically the result of uncertain weather. Constant rains would reduce the tank's water pH, reducing the fish's appetite.

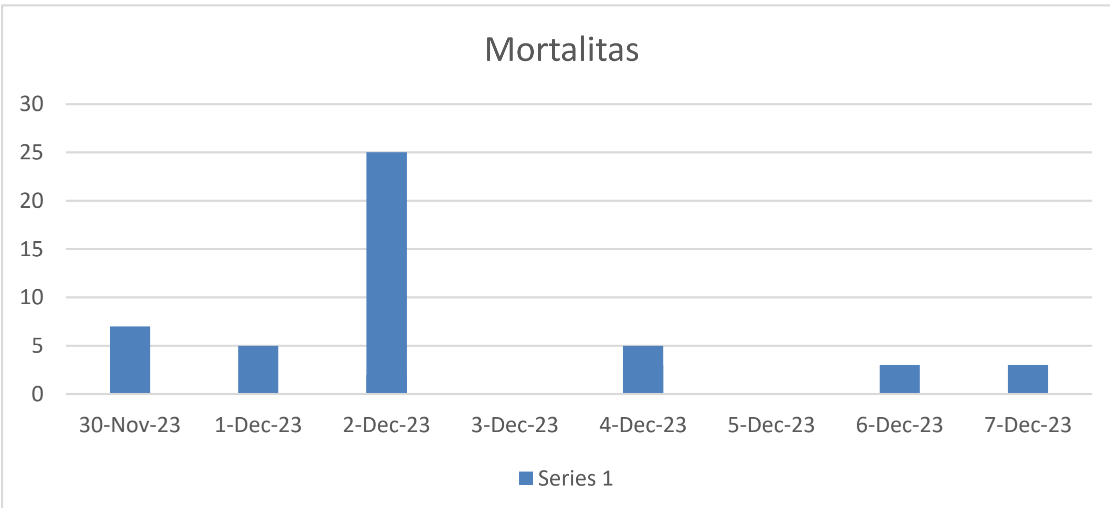

Figure 11. African catfish mortality diagram

From the African catfish cultivation in biofloc tank in Apung Village, some lessons could be learned. The low pH waters in Apung Village was not an obstacle to cultivate African catfish. The fish could still be cultivated in low pH waters when it could be engineered in such a way that it was feasible for use in fish cultivation.

Schryver et al. (2008) suggest that biofloc technology is a cultivation technology of heterotrophic bacteria and algae in flocs in a controlled water quality by transforming ammonium into microbial protein to allow it to reduce residue in feed *(Avnimelech., Kocba, 2009).* Biofloc technology aims at improving the efficiency of feed utilization by forming the macroaggregate microbe biomass from organic materials and dissolved compounds *(Serfling, 2006)*.

The benefits of using this biofloc tank technology in cultivating fish was that it could minimize the necessity to change water considering that it was hard to obtain water in Apung Village. This made this technology highly eco-friendly. It also made the need to use feed lower than other conventional systems.

Conclusion

Based on the result and discussion, a good water quality in the African catfish cultivation required an eco-friendly-based technology to make the organic materials in the fish keeping media and the wastes disposed of to the public waters as low as possible. This made the biofloc technology the perfect answer to it.

Applying the African catfish cultivation in Apung Village using biofloc tank technology allowed the cultivators to not replace the water during the fish keeping and to save the feed. This was different from non-biofloc fish cultivation. The low pH could be addressed by administering lime at 10mg/m^3. However, the African catfish could still tolerate when the water pH was 5. Therefore, it is still pretty safe to apply the African catfish cultivation using biofloc technology.

In terms of pH comparison, the African catfish cultivation in Apung Village had a pH range from 5 to 6, while SNI set that the pH for African catfish cultivation shall be between 6.5 and 8. Yet, the African catfish in this cultivation could still tolerate it when the pH was still at 5.

Acknowledgment

The writers would like to extend their gratitude to Padjadjaran University and Seamolec that have guided and provided assistance in completing this research in MBKM (Merdeka Belajar Kampus Merdeka) program. We would also like to thank our partner PT. Pesona Khatulistiwa Nusantara that has facilitated us in carrying out this MBKM (Merdeka Belajar Kampus Merdeka) program, allowing us to complete this apprenticeship well.

References

[1] Avnimelech,Y. 1999. Carbon/Nitrogen Ratio as A Element In Aquaculture System, Aquaculture 176 : 227-235.

[2] Avnimelech, Y., Kochba, M. 2009. Evaluation of Nitrogen Uptake Andexcretion by Tilapia in Bio floc Tanks, using 15N tracing. Aquaculture 287:163-168.

[3] Badan Standarisasi Nasional. 2000.. SNI 01-648.1-2000, Induk Iikan Lele Dumbo *(larias gariephinus x C. Fuscus)* Kelas Induk Pokok (Parent Stock).

[4] Boyd, C.E. 1990. Water Quality Management in Aquaculture and Fisheries Science. Amsterdam: Elsevier Scientific Publishing Company. 3125p.

[5] Effendi, M.I. 2003. Biologi Perikanan. Bandung: Yayasan Pustaka Nusantara.

[6] Ekasari, J. 2008. Bioflocs Technology: the Effect of Different Carbon Source, Salinity and the Addition of Probiotics on the Primary Nutritional Value of the Bioflocs. Thesis. Faculty of Bioscience Engineering. Ghent University. Belgium.

[7] Hepher, B., Sandbank, E., Shelef, G. 1978. Alternative Protein Sources for Warmwater Fish Diets.

[8] Hari, B., et.al. 2006. The Effect of Carbohydrate Addition on Water Quality and the Nitrogen Budget in Extensive Shrimp Culture Sistems. Aquaculture 252:248-263.

[9] Idris, T., Sukmawan, D., Prihatmajanti, D., Setiawan, Wijianti, D., Nizar, M., Sidiharta, D.I. 2018. Peraturan Direktur Jendral Perikanan Budidaya Kementrian Kelautan dan Perikanan No. 65/PER-DJPB/2018 Tentang Petunjuk Teknis Penyaluran Bantuan Pemerintah Budidaya Ikan Lele Sistem Bioflok Tahun 2018. Direktorat Jenderal Perikanan Budidaya. Jakarta.

[10] Kuhn, D.D., et.al. 2009. Microbial Floc Meal as a Replacement Ingredient for Fish Meal and Soybean Protein in Shrimp Feed. Aquaculture 296:51-57.

[11] Ruherlistyani, Sudaryati, D., Heriningsih, S. 2017. Budidaya Lele dengan Sistem Kolam Bioflok. LPPM UPN VY. Yogyakarta.

[12] Suparno., Muhammad., Qosim. 2016. Pengaruh Pengembangbiakan Bioflok Pada Peningkatan Produksi Dan Kualitas Ikan Lele, Jurnal Inovasi dan Teknologi, Vol. 5. No. 1.

[13] Suprapto., Samtafsir S.L. 2013. Bioflok-165 Rahasia Sukses Teknologi Budidaya Lele, Depok (ID): AGRO 165.

[14] Stickney, R.R. 2005. Aquaculture: An Introductory Text. Oxford: CABI Publishing, 265p.

[15] Schryver, P.D., et.al. 2008. The Basics of Bio-flocs Technology: The Added Value for Aquaculture. Aquaculture 277:125-137.

[16] Serfling, S.A. 2006. Microbial Flocs: Natural Treatment Method Supports Freshwater, Marine Species in Recirculating Sistems. Global Aquaculture Advocate June 2006:34-36.

[17] Taw. 2010. Biofloc Technology Expanding at White Shrimp Farms: Biofloc Systems Deliver High Productivity with Sustainability. Global Aquaculture Advocate, Global Aquaculture Alliance, St. Louis, Missouri, USA.