GROWTH PERFORMANCE OF CATFISH (*Clarias gariepenus*) CULTURED OF HIGH DENSITY WITH BIOFLOC SYSTEM

Petrus Hary Tjahja Soedibya[1], *Emyliana* Listiowati[1], *Taufik* Budhi Pramono[1], *Norman* Arie Prayogo[2], *R.* Taufan Harisam[2]

[1]Aquaculture, Faculty of Fisheries and Marine Science, Jenderal Soedirman University, Indonesia
[2]Center of Maritime Bioscience, Jenderal Soedirman University, Indonesia

Abstract. Catfish is a species of freshwater fish that contains a source of protein and it has economic value and has become one of the famous commodities in Indonesia. Biofloc can be one alternative waste fixers intensive cultivation for reduce the waste of inorganic nitrogen and also provide additional protein for increase growth and feed efficiency. This study was to determine the effect of high stocking densities on the growth performance of african catfish in biofloc system. This study used completely randomized design (CRD) with different stocking densities in the system biofloc T1.(1000/m^3), T2.(1500/m^3), T3.(2000/m^3), and T4.(2500/m^3). Animal trials were using jouvenile african catfish with an average weight of 1.06±0.3g, which maintained in a pool tarpoulin cage with water volume ±2000L for 50 days with feeding ratio 3% of the weight biomass. The results showed a significantly different effect ($P<0.05$) against the value of hepatosomatic index, absolute growth and daily growth rate, but the result not significant at spesific growth rate. The second treatment (T2) showed the best results than others in the growth rate and daily growth rate with a value of 6.45±3.1g for absolute growth and 0.13±0.06g for daily growth rate. The four treatment showed the best results than others in the hepatosomatic index with value 4.7 ± 1.8%. These findings demonstrate a role of biofloc technology in catfish aquaculture.

1 INTRODUCTION

Catfish is a species of freshwater fish that contains a source of protein and it has economic value. Catfish has become one of the commodities that serve as food ingredients into the food menu like in Indonesia. fishery commodities continues to increase each year so that the need for innovation in order to increase production [1]. Catfish production progress over the last few years show results very significantly by 21.82% per year from 69386 tonnes in 2005 to 145 099 tonnes in 2009. During the 2010-2014 rise in catfish fish production increased by 450%, or an average increase by 35% per year which in 2010 amounted to 270.6 thousand tons increased to 900.000 tons in 2014.

[1]Corresponding author: hary_tjahja@yahoo.co.id

Limited natural resources such as water and land, making intensification as the option most likely to increase aquaculture production [6]. Many studies have been carried out to develop reproduction and culture techniques for *C. Gariepinus* [2,3,4]. Intensive aquaculture systems are characterized by an increase in the density of fish and additional food from outside. On the cultivation environment is good and sufficient feed, an increase in density will result in increased production of aquaculture [5]. Moreover, the intensification of aquaculture, especially stocking rate increase unfavorable impact on the preservation of health and the environment in the form of environmental degradation cultivation. Environmental degradation caused by organic waste from feed residue and dirt, the waste is generally dominated by inorganic nitrogen compounds are toxic.

Biofloc technology can be one alternative waste fixers in intensive cultivation, this technology is the most profitable to reduce the waste of inorganic nitrogen, this technology can also provide additional protein for animal feeding to increase growth and feed efficiency. Biofloc is a combination of macro-and microorganisms including bacteria, microalgae, fungi, protozoa, metazoan, and nematodes. Floc biomass formed in bodies of water may be consumed by fish as additional sources of feed and as water purifier.

Several studies have shown that the application of biofloc technology plays a role to improve water quality, biosecurity, productivity, feed efficiency, and reduce production costs through lowered feed expenses. Theoretically and practically, the application of biofloc technology improves water quality by controlling ammonia concentrations and improving nutrient consumption as it is consumed by the organism cultured [8]. Floc biomass formed in bodies of water may be consumed by fish as additional sources of feed and as water purifier. Bacteria as main component of biofloc is capable to produce polyhydroxybutyrate (PHB) which is useful in aquaculture. The advantages of PHB are an energy reserve for fish, digestible in intestine, increasing unsaturated fatty acid, and increasing growth of fish [7]. Therefore, the aim of this study was to evaluate growth rates of African catfish, *Clarias gariepenus* juveniles treated with high density bioflocs system.

2 MATERIAL AND METHODS

2.1 Experimental Fish

Catfish (*C. gariepinus*) with size approximately 1.06±0.3g/ fish was used as tested material with different stocking density. For seven days prior to treatment, catfish was cultured in a pool terpaulin cage. Volume of each pool was 2,3 m^3, filled with 2000 L well water, equipped with aerator system with minimum water exchange. The experiments divided into 4 groups, which were 1.(1000/m^3), 2.(1500/m^3), 3.(2000/m^3), and 4.(2500/m^3). The fish was treatment for 50 days. Sampling to measure fish growth was conducted once everyday. During the research, fish were fed on commercial pellet (protein 37% and fat 10%) as much as 3% of total body weight daily. The water temperature, dissolved oxygen, pH , Ammonia, nitrite and nitrate were monitored every weeks. The sample of water was taken every week to calculate the amount of phytoplankton. Every sampling time, 6 fish captured for the replicant samples.

2.2 Specific growth rate

This parameter was calculated as the weight of the fish after 50 days, calculation was conducted using equation by Abdel-Wahab *et al.,* [9]:

$$SGR = (\text{Ln } Wt - \text{Ln } Wo)/t \times 100\% \quad (1)$$

SGR expressed as %/day, Wo and Wt were the weight of the fish during the day of measurement (t) and initial stage (o) expressed as gram (g), while experiment period was expressed as day (t).

2.3 Daily growth rate

This parameter was calculated as the weight of the fish after 50 days, calculation was conducted using equation by Abdel-Wahab *et al.,* [9]:

$$DGR = \frac{(Wt - W0)}{t} \quad (2)$$

DGR expressed as g/day, W0 and Wt were the weight of the fish during the day of measurement (t) and initial stage (o) expressed as gram (g), while experiment period was expressed as day (t).

2.4 Absolute Growth

This parameter was calculated as the weight of the fish after 50 days, calculation was conducted using equation by Abdel-Wahab *et al.,* [9] :

$$AG = Wt - W0 \quad (3)$$

AG expressed as g, W0 and Wt were the weight of the fish during the day of measurement (t) and initial stage (o) expressed as gram (g).

2.5 Hepatosomatic Index

This parameter was calculated as the weight of the fish after 50 days, calculation was conducted using equation by Abdel-Wahab *et al.,* [9]:

$$\%HSI = WL / Wb * 100 \quad (12)$$

HSI expressed as %, WL were the weight of the liver during the day of measurement and Wt were the weight of the fish during the day of measurement expressed as gram (g).

2.6 Data analysis

Data from specific growth rate, daily growth rate and absolute growth was statistically measured using one-way analysis of variance using SPSS software (versi 17.00) at confidence interval of 95% ($p<0.05$). LSD test was following when significant difference present. Data of water quality was analyzed in description.

3 RESULTS AND DISCUSSION

3.1 Specific growth rate

In catfish, specific growth rate (SGR) on 50 days biofloc treatment were 0.87-1.15 (Figure 1). The peak level of SGR (1.15) was recorded at 50 days treatment on group 4 ($2500/m^3$). SGR in catfish was increased based on biofloc density treatment. Growth of fish depends on several factors: the type of fish, genetic nature and the ability to use food, disease resistance and supported by environmental factors such as water quality, feed and space or stocking density [10]. Although the quality of the water can affect the growth rate, but in general the quality of the water treatment biofloc in this study showed good results so that the water quality is not a factor for the low growth rate of fish biofloc treatment. Fish growth can occur if the amount of feed nutrients are digested and absorbed by fish greater than the amount required for maintenance of the body [11]

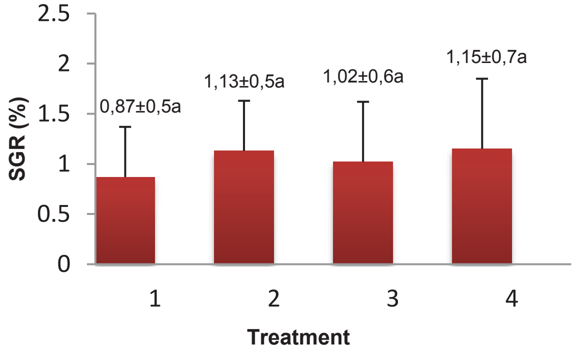

Fig 1. Specific growth rate of catfish (*C. gariepinus*) Are Cultured Of High Density With Biofloc System. Different letters indicate Significantly different (p<0.05). 1). Treatment density 1000/m^3 in biofloc system, 2 Treatment density 1500/m^3 in biofloc system 3. Treatment density 2000/m^3 in biofloc system and 4.Treatment density 2500/m^3 in biofloc system.

The Specific Growth Rate (SGR) of all treatment were not significantly. In this study, showed that the value of SGR of all treatment were high. The addition of Bacillus sp., cells into the feed had positive impact on fish digestive system due to exogenous enzymes released by the cells, thus expenditure energy was more effective during digestion [12]. Energy difference resulting from this process can be used for the growth. Ekasari *et al* (2016) mentioned that the increasing growth rate of aquatic organisms provided with probiotic in their feed was related to higher enzymatic digestion activity together with vitamin synthesis, therefore, digestibility and organism weight were also increased. Spesific growth rate value in all treatment of the obtained values average of 1.04±0.12%/day. one treatment shows that at low stocking density generate value growth also lower. it is suspected because the space that is wide enough to make the fish a lot of activities so that a lot of energy used for activity and metabolic processes than for growth . In line with the statement Soedibya [14, energy used for metabolic processes very high, so the energy portion reserved growth to be reduced.

3.2 Daily growth rate

The average daily growth rate in the one treatment of 0.09 ± 0.02 g/day, two treatments of 0.13±0.06g/day, three treatments of 0.10±0.04g / day and the treatment of four of 0,10±0,03 g / day. ANOVA test based on the value of daily growth rate of catfish (Clarias gariepinus) showed a significantly (P <0.05), followed by further test of LSD. Average daily growth value based Least Significant Difference test showed that the first treatment was significantly different to two treatments. Treatment of two significantly different with the other treatment. Two treatment showed best growth results seen from the average absolute growth was 0.13 ± 0.03 g. The average value of daily growth rate in the treatment of two highest than the other treatments. It is believed to be related to the carrying capacity (carrying capacity of the environment), the higher stocking densities used, the carrying capacity decreases [15]. Competition in obtaining food is thought to be one cause of declining daily growth rate in the treatment of the three, although food is available but the fish can not reach due to space limitations. This can lead to stress which results in decreased appetite [12]. Reduction appetite resulted in low nutrients entering and absorbed in the body of the fish. As a result, the energy obtained from the overhaul of these nutrients is only used for fishing activities, whereas the energy for growth is reduced so that the growth of fish decreased.

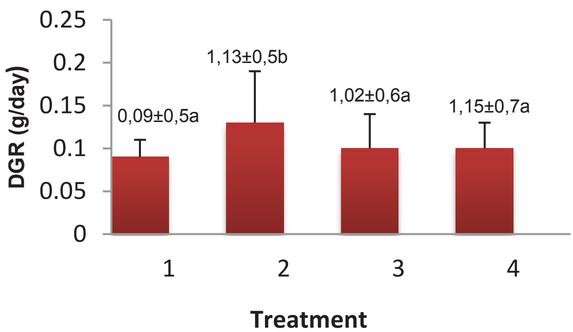

Fig 2. Daily growth rate of catfish (*C. gariepinus*) Are Cultured Of High Density With Biofloc System. Different letters indicate Significantly different (p<0.05). (1. Treatment density 1000/m^3 in biofloc system, 2 Treatment density 1500/m^3 in biofloc system 3. Treatment density 2000/m^3 in biofloc system and 4.Treatment density 2500/m^3 in biofloc system)

Treatment two with a stocking density of 1500/m3 able to utilize the feed is well evidenced by the value of daily growth rate higher than the one treatment, the treatment of three and four treatments. The feed given to each of equal treatment that is equal to 3% of the body weight of fish. Fish body weight at the two higher treatment so that the amount of feed given to more than one treatment, treatment of three and four treatments. Therefore, the energy produced was greater, the energy obtained from the feed is used for the body's activity and growth. Contributions floc is available for 24 hours also affect growth. Flocs contains nutrients needed by fish, one of which is a protein. Protein floc in the treatment of two higher at 22.24%, while on the treatment, the treatment of three and four treatment floknya protein content of 19.25%, 15.83% and 21.60% with a protein content of feed (pellets) which given the same on each treatment which amounted to 28.75%. The protein content of different floc this is one cause of fish growth rate is different for each treatment.

3.3 Absolute Growth

Absolute growth value in the treatment of the obtained values of 4.76±1.3 g, while the treatment of the two obtained values of 6.45±3.1 g, and the treatment was 5.14±2.2 g three and four treatments of 5.14±2.2 g. Based on ANOVA test, the value of the absolute growth of african catfish (Clarias gariepinus) were cultivated at high stocking density with biofloc system showed significantly different results. Absolute growth value based Least Significant Difference test showed that the first treatment was significantly different to two treatments. Treatment of two significantly different with the other treatment. Two treatment showed best growth results seen from the average absolute growth is 6.45 ± 3.1 g.

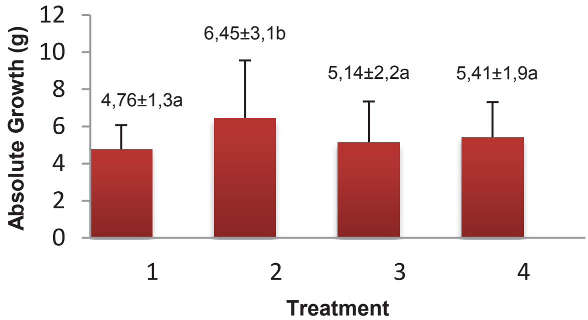

Fig 3. Absolute Growth of catfish (*C. gariepinus*) are cultured of high density with biofloc system. Different letters indicate Significantly different ($p<0.05$). (1. Treatment density 1000/m^3 in biofloc system, 2 Treatment density 1500/m^3 in biofloc system 3. Treatment density 2000/m^3 in biofloc system and 4.Treatment density 2500/m^3 in biofloc system)

Growth performance in the third and fourth treatment showed that the higher density, growth was even more low absolute weight. This is in accordance with the opinion of Hickling [17] which states that fish growth will be faster when kept at low stocking density which would otherwise be slow when a solid high stock density. Increased density will be followed by a decrease in growth (critical standing crop) and if it has to some extent (carrying capacity) growth is to be stopped altogether. Factors that affect the carrying capacity include water quality, feed, and the size of the fish. Space and food supply are factors that also affect the growth of fish, where the fish will grow better if both of these factors can be met, and otherwise growth will slow if one or both are lacking. This result indicated that Biofloc was able to increase growth. Similar result also indicated by another research using inoculating heterotrophic bacteria addition into biofloc-based culture media for catfish was able to increase the survival rate and growth performance [12].

Biofloc which also serves as a source of natural food fish available 24 hours in the maintenance of an effect on the growth of the body. The nutritional content of different flocks on each pool resulted in an absolute growth of fish each different treatment. Protein is available in all four treatment tends to be higher than other treatments that is equal to 28.75% of feed pellets and floc protein analysis results in the amount of 21.60%. This causes excess protein, so there is no storage repository for amino acids. Therefore, foods containing excess amino acids will be used immediately to meresintesis body proteins and other nitrogen compounds. The carbon skeleton oxidized or converted to glucose or fats, and amino group is converted into ammonia [13].

3.4 Hepatosomatic Index (%)

Hepatosomatic index (HSI) value in the treatment of the obtained value of 3.3 ± 1.5%, while the treatment of the two obtained a value of 3.7 ± 1.8%, and the treatment of the three at 3.5 ± 1.4% and the treatment of four of 4.7 ± 1.8%. Based on ANOVA test, hepatosomatic index value of african catfish (Clarias gariepinus) were cultivated at high stocking density with biofloc system showed significantly different results. Furthermore, the test results Least Significant Difference, the index value hepatosomatic showed that the treatment of the significantly different from the treatment of four and is equal to the treatment of two and three, the treatment of two significantly different from the treatment of four and the same as the treatment of one and three, and treatment three significantly different treatments four and equal treatment with one and two. The four treatments significantly different from the treatment of one, two and three.

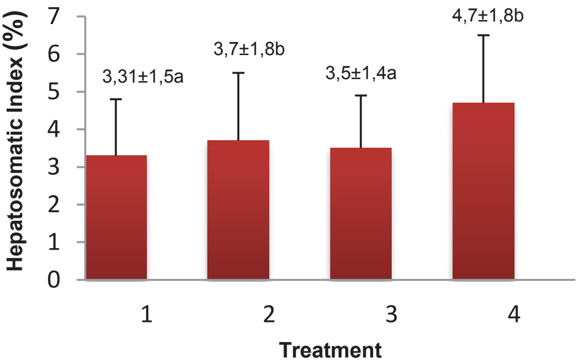

Fig 4. Hepatosomatic Index of catfish (*C. gariepinus*) are cultured of high density with biofloc system. Different letters indicate Significantly different (p<0.05). (1. Treatment density 1000/m^3 in biofloc system, 2 Treatment density 1500/m^3 in biofloc system 3. Treatment density 2000/m^3 in biofloc system and 4.Treatment density 2500/m^3 in biofloc system)

The liver is an important organ which secretes material for the process of digestion. Material reserve nutrients commonly found in liver cells are fat and glycogen granules. In general, the liver serves as the metabolism of carbohydrates, fats and proteins as well as a place to produce bile [18]. One of the sources of energy used in the fish while maintaining its development comes from the heart. The fish feed supply shortage in addition to its metabolism is reduced, the fish did not get enough energy source, so it will use an energy source that comes from the heart. Hepatosomatic index value in the treatment of the first, second and third tend to be lower than the fourth treatment. It is suspected that more fish using existing reserves of energy in the body compared to the fourth treatment. This is consistent with the statement Lenhardt *et al.* [19], the index hepatosomatic used to describe the distribution of energy in fish, namely the decrease in the index value hepatosomatic. This indicates that the presence of energy reserves in the liver is used to maintain the body's metabolism.

The fourth treatment showed the best hepatosomatic index value is 4.7 ± 1.8%. It is suspected that the fish on the fourth treatment at a density of 2500 head/m3 tend not many activities due to limited space for stocking density is very high, so much energy is stored in the liver than used to perform the activity. Furthermore, the results of the proximate analysis of protein content in the pellet given was quite high at 28.75%. In addition, the fish in the treatment of the fourth gain additional nutrients from the floc that act as natural food sources are available for 24 hours. Based on the results of the proximate analysis of the nutrient content of floc on media pisciculture fourth treatment showed a fairly high value protein content reached 21.60 %. This shows that the four treatments, nutrition fish have been met so that the metabolism of many stored in the liver. Hepatosomatic index is usually used to indicate a problem in nutrition, because of the relative size of the liver correlated with the state of nutrition given to the quality of the fish [9]. Increased value HSI showed increased amounts of nutrients are absorbed and subsequently cause the amount of nutrients accumulated in the liver increased [20].

The results are consistent with research that has been done by the Soedibya *et al.* [21] showed that the index value hepatosomatic resulting from maintenance on the system biofloc with a stocking density of fish catfish 500/m^3 significantly different from the stocking density 250/m^3 and 375/m^3, dense stocking higher yield index value hepatosomatic better for allegedly fishing save more energy than is used to move because of the limited space due to high stocking density. Sadekarpawar and Parikh [22] states that the liver is a metabolic organ in fish that HSI values can also be used as a biomarker in detecting environmental conditions of test animals. Hepatosomatic high index value does not always show high growth anyway, since fish growth is also affected by other factors such as environmental and genetic.

3.5 Abundance of phytoplankton

The abundance of plankton in a biofloc is more common than phytoplankton groups. Where, plankton from Microcystis and Coelosphaerium genus belongs to a group of phytoplankton that is Cyanophyceae class. Phytoplankton growth was supported by the availability of nutrients. The higher the content of nutrient in the water, the more abundant phytoplankton that spurred the growth of zooplankton. The phytoplankton of the class Cyanophyceae or blue-green algae was highly abundant because this type of phytoplankton was easy to grow in water with high nutrients in the form of N, P and K. Besides, this type of algae is normally used by the trophic structure or organism as a source of food (Bernardi and Giussani, 1990).

Table 1. Abundance of phytoplankton in catfish cultivation with biofloc system

Number	Class	Abundance of phytoplankton (ind/l)			
		T1	T2	T3	T4
	Chlorophyceae				
1	*Actinastrum* sp.	392	1124	1400	865
2	*Scenedesmus* sp.	589	1463	1186	2122
3	*Pediastrum* sp.	107	250	375	811
4	*Diatoma* sp.	9	18	0	0
5	*Characium* sp.	0	0	36	0
	Chyanophyceae				
6	*Oscillatoria* sp.	999	829	1828	936
7	*Coelosphaerium* sp.	2961	2550	3380	2809
8	*Spirulina* sp.	0	214	178	0
9	*Anabaena* sp.	0	0	45	0
	Sum	5057	6448	8428	7543

Biofloc technology, forming a floc from organic material life, is fused into clumps consisting of various water microorganisms including bacteria, algae, fungi, protozoa, metazoan, rotifers, nematodes, Gastrotricha, and other organisms that are suspended by detritus. Giving molasses in a biofloc could supply organic C in continuity or in accordance with the content of nitrogen in the water. Thus, the content of nutrients like N, P and K will be abundant in the biofloc. The abundance of the nutrient content can lead to the growth of plankton in the form of Phy (plants) that will make the growth of zooplankton sustainable. The research conducted by Andrian (2010) about the growth of plankton in various types of different animal manure that contains nutrients such as nitrogen, phosphorus, and potassium shows that plankton will be easy to grow in a pool that has much nutrient content of 1.00 ppm N, P 0, 80 ppm and 0.4 ppm K.

According Avnimelech [8], biofloc is generally can be formed from the residue of feed, metabolism, and feces from aquaculture. Residual feed and fecal waste water will produce inorganic nitrogen. The inorganic nitrogen can be converted into single cell protein with the addition of carbon material water and can be used to feed fish, shrimp and plankton. The condition of C:N ratio is balanced in cultivation media. Heterotrophic bacteria will utilize N, both in organic and inorganic form for the growth of plankton so that the concentration of N in the water is reduced. Comparison between the carbon (C) and nitrogen (N) (C:N ratio) is very important to note in biofloc system so that bacteria can grow well and it will affect the growth of phytoplankton.

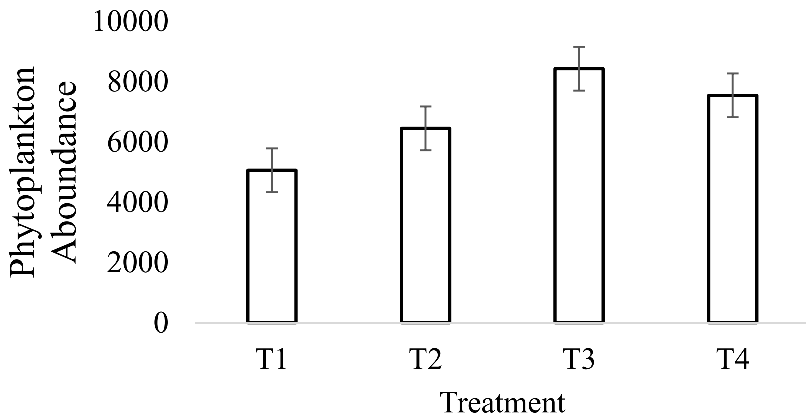

Fig 5. Phytoplankton abundance in catfish cultivation with biofloc system

Plankton may experience changes in community composition (succession) as a result of changes in physical (light intensity and temperature), chemical (nutrients, water quality, and toxins), and biological (competition and predation) condition. This opinion is justified by Reynolds (1990), who stated that phytoplankton abundance change is a response to environmental variables such as temperature, light, nutrient availability, and the abundance of predator. Odum (1971) in Pratiwi *et al.* (2010), states that an ecosystem is developed from time to time. It is occurred by stimulus in the form of nutrients and it is characterized by the change of the genus that is dominant.

The dominance of plankton in a biofloc was mostly composed of groups of phytoplankton especially Cyanophyceae class of Microcystis genus and the difference in the dynamics of plankton that occurred during the treatment period. However, not all plankton could be found in significant amount in each pool per week. In addition, differences in the dynamics of plankton in biofloc pool were quite diverse as seen from the difference in the amount of plankton abundance on a weekly basis for each pool. In each week of observation, the phytoplankton of Cyanophyceae class showed the highest abundance thatwas varied in each pond.

3.6 Water quality

Water quality in every treatment were analyzed. Ammoniac on 50 days biofloc treatment were 0.70-13.01 ppm, Nitrat were 2.17-12.17 ppm, nitrit 0.03-3.66 ppm, DO were 7.4-8 ppm, Temperature were 25-29^0, and pH were 5-7 (Table 2). The peak level of Ammoniac (13.01) was recorded at group 4 (2500/m^3), the peak level of Nitrat (12.17) was recorded at group 1 (1500/m^3), and the peak level of nitrit (3.66) was recorded at group 2 (2500/m^3). For the DO, temperature and pH, every treatment group had a same condition.

Ammonia is a major end product of protein breakdown in fish. The fish will digest the protein in the feed and excrete ammonia through their gills and urine. Ammonia in the cultivation environment is also derived from the decomposition of organic material such as food remains, dead algae, and aquatic plants [28]. At the beginning of the study of ammonia ranged 8.63-13.005mg/L. High levels of ammonia caused by the accumulation of the metabolism of the fish and the unconsumed feed consumed. Once that happens a gradual decline in each treatment until the end of the study of ammonia ranged 0.7488-7.6123mg/L. According to Green and Schrader (2015) that the increased levels of ammonia in the culture system can be affected by pH and temperature. At low water pH (acidic) ammonia tend to be more in the form of NH4+, while the high water pH (alkaline) ammonia tend to be more in the form of NH3. At low water temperatures tend to be more ammonia in the form of NH4+, while the high water temperatures tend to be more ammonia in the form of NH3.

Table 2. Water quality during maintenance

Treatment	Ammoniac (ppm)	Nitrat (ppm)	Nitrit (ppm)	DO (ppm)	Temperatur (°C)	pH
1	0.70-10.98	5.49-12.17	0.03- 2.11	7.6-8	25-29	5-7
2	7.61-8.64	4.32-11.96	0.06-3.66	7.6-8	25-29	5-7
3	0.83-8.77	5.48-10.90	0.08-2.11	7.6-8	25-29	5-7
4	0.75-13.01	2.17-11.03	0.03-2.00	7.4-8	25-29	5-7

Nitrite is a result of the oxidation of ammonia in a nitrification process which is then converted into nitrate [27[. The measurement results nitrite levels were obtained at the start of the maintenance ranges 0.0323-0.0792 mg/L. The concentration of nitrite tend to fluctuate to indicate the occurrence of nitrification in maintenance media. The occurrence of nitrification in maintenance media can be seen by comparing the value of ammonia, nitrite, and nitrate, which the current value of high ammonia nitrite then the value is low and vice versa. According to Mosha *et al.* [16], the main effect of nitrite compounds in the body of the fish is a change in the transport of oxygen and the oxidation of compounds in tissue. Ferric ion oxidizes nitrite which converts hemoglobin into methemoglobin. Methemoglobin low ability to bind and transport oxygen from aquatic environments throughout the body causing the fish to experience hypoxia (lack of oxygen) and cyanosis (blue skin bruising and because of the blood on hold). The high increase in the concentration of nitrite nitrogen in the first treatment that stocking density 2.000 head per pond, thought to be one of the factors that cause high levels of mortality in the treatment.

Nitrate (NO3) is the main form of nitrogen in natural waters and is a major nutrient for plant growth and algae. Nitrates are highly soluble in water and are stable. This compound is produced from the oxidation of nitrogen compounds in the water is perfect. Nitrification which is the process of oxidation of ammonia to nitrite and nitrate is an important process in the nitrogen cycle and takes place in aerobic conditions. The oxidation of ammonia to nitrite made by the bacteria Nitrosomonas, while the oxidation of nitrite to nitrate made by the bacteria Nitrobacter. Both types of bacteria are a chemotrophic bacteria, ie bacteria that obtain energy from a chemical process . Nitrate is an end product of the nitrification process. Nitrates are not toxic for fish except in very high concentrations (>100 mg/L). Under anaerobic conditions, nitrate can be removed with the aid of denitrifying bacteria will convert nitrates into nitrogen gas. The observation of the nitrate content of water pisciculture media during the study in Figure 8 shows that the concentration of nitrate nitrogen all treatments tend to fluctuate with the patterns and values are almost the same. Nitrates have 1.000-3.000 ppm limit value so it is rarely the cause of death in fish[27].

Dissolved Oxygen plays an important role in the culture system, especially in intensive aquaculture systems that employ biofloc. This is because the metabolic activity of microbes to decompose the organic material requires sufficient amount of oxygen continuously (Green and Matthew., 2017). The results of the measurement of dissolved oxygen (DO) in the water used for pisciculture *C. gariepenus* at 7.4 to 8 ppm which is still appropriate quality standards applied cultivation Government Regulation No.28 Year 2001. Oxygen levels are not only important for the metabolic activity cells but also can affect the structure of floc. According to Wilen and Balmer [24], the dissolved oxygen concentration is higher, floc size will be larger and more compact so that it will more easily be used as feed by fish.

The pH value of the water reflects a balance between acids and bases in water. The observation of the pH value of maintenance media showed that at the beginning of the maintenance of the pH value is quite low, but in the middle of maintenance, normal pH value in the range of 6.8 to 7.0. According Boyd [25], a pH below 6.5 or greater than 9.0 can reduce the ability of fish reproduction and growth. While the pH value ranging from 6-9 maintenance media, it is still in line with the range of water quality standard for cultivation in Government Regulation No. 82 Year 2001.

Temperature is a factor that affects the growth and survival of fish. The water temperature will affect the rate of growth, the rate of metabolism and appetite of fish [25]. The difference in temperature that occurs during pisciculture looks quite volatile, which in the early morning just 25ºC temperature maintenance, then increased fairly high at 28ºC, and then stabilized until the end of the study. According Green and Schrader [23], optimal temperature range for catfish farming is 25-30ºC. So that the temperature fluctuations that occur during maintenance is still in normal condition with a range that can be tolerated by fish. Temperature affects the various chemical reactions in the body of water, including the effect on the solubility of oxygen in water and metabolism of fish, so it will affect fish growth [26]. Fluctuations in temperature also affects the activity of bacteria in media biofloc maintenance. The high activity of bacteria characterized by decreasing the amount of oxygen in the afternoon, when the temperature reached the peak or the maximum value. The high activity of these bacteria is offset by the addition of molasses as a carbon source to be converted into cellular proteins of bacteria in the afternoon after feeding. At the time of low temperature, high oxygen solubility, and vice versa. In addition, the temperature also affects the strength and morphology floc. The optimal temperature to maintain the stability of flocks ranged between 20-25ºC, while the temperature is too high (> 35 ° C) may cause a decrease in the stability of the floc [26].

4 Conclusions

In summary, the bioflocs system can enhance growth of juvenile catfish *C. batrachus*. Density of biofloc have played an important role in promoting growth in catfish, however this deserve further investigations

The first author would like thank to Ministry of Research, Technology and Higher Education of the Republic of Indonesia for providing research funding of the study.

References

1 Hermawan, A., Sudaryono, and S. Prayitno. Journal of Aquaculture Management and Technology. **3**, 35-42 (2014)
2 Fagbenro, O. and Jauncey, K. Biores. Tech. **51,** 29-35 (1995)
3 Richter, C.J.J., Eding, E.H., Verreth, J.A.J. and Fleuren, W.L.G. Blackwell Science, Cambridge, pp. 242-277. (1995).
4 ÇEK, Fiehriban and Erdal Yilmaz. Turk J Zool. **31**, 35-46 (2007)
5 Shafrudin, D.,Yuniarti., and M, Setiawati. Jurnal Akuakultur Indonesia. **5**, 137-147 (2006)

6 Asaduzzaman, M., M,A, Wahab., M,C,J, Verdegem., S, Huque., M,A, Salam., and M,E, Azim. Aquaculture. **280:** 117–123 (2008)
7 De Schryver., P. R. Crab., T, Defoirdt, N. Boon, and W. Verstraete. Aquaculture**. 277**, 125–137 (2008)
8 Avnimelech, Y. Aquaculture. 176, 227-235 (1999)
9 Abdel-Wahab A. Abdel-Warith, El-Sayed M.I. Younis, Nasser A. Al-Asgah. Saudi Journal of Biological Sciences 23, 404–409 (2016)
10 Hepher. B. and Y. Pruginin. *Commercial fish farming: With special reference to fish culture in Israel.* (John Wiley and Sons, New York, 1981)
11 Amon P. Shoko, Samwel M. L., and Yunus D. Mgaya. Effect of stocking density on growth performance, survival, production, and financial benefits of African sharptooth catfish (Clarias gariepinus) monoculture in earthen ponds. Journal Journal of Applied Aquaculture Volume 28, Issue 3. 2016.
12 Yusuf, M. W., N. B. P. Utomo., M. Yuhana., Widanarni. Journal of Fisheries and Aquatic Science. **10**, 523-532 (2015)
13 Julie Ekasaria, Muhammad A.S., Wiyoto W., Ratih F. H., Gilang S. L., Rosi S., Muhammad A. and Muhammad Z. J. Aquaculture Volume **464**, 1 2016
14 Soedibya PHT. *Variasi Fisiologis Ikan Gurami (Oshpronemus gouramy Lac.) dalam Menghadapi Ketersediaan Sumber Pakan [Disertasi]*. (Bogor: Institut Pertanian Bogor. 1999)
15 Onada OA, Ogunola OS Effects of Catfish (*Clarias gariepinus*) Brood-stocks Egg Combination on Hatchability and Survival of Fish Larvae. J Aquac Res Development **2**, (2017)
16 Mosha S.S., Kang'ombe J., Jere W., Madalla N. J Aquac Res Development **7**, 441 (2016)
17 Hickling, C.F. *Fish Culture*. (London : Faber and Faber. P : 348. 1971)
18 Farhat and Mukhtar A.K. Journal of Applied Aquaculture. **23**, (2011)
19 Lenhardt, Mirjana., I. Jarić., P. Cakić., G. Cvijanović., Z. Gačić., J. Kolarević. Turk. J. Vet. Anim. Sci. **33**, 209-214 (2009)
20 Bekeh A.F., Olatunji A.E., Bassey W.K. J Aquac Res Development. 6, 378 (2015).
21 Soedibya, P. H. T., E. Listiowati. *Prosiding Seminar Nasional Percepatan Desa Berdikari Melalui Pemberdayaan Masyarakat Dan Inovasi Teknologi.* (LPPM Unsoed Purwokerto. 2014)
22 Sadekarpawar, S., and P. Parikh. World Journal of Zoology **8** ,110-118 (2013)
23 Green B.W., and Schrader KK. J Aquac Res Development. **6,** 314, (2015)
24 Wilen, B. M. and P. Balmer. Water Research **33,**391-400 (1999)
25 Boyd, C. E. and Likhtykopper. *Water Quality Management in Pond* (Fish Culture. Auburn: University Alabama, 1981)
26 Kuhn, D.D., Lawrence, A.L., Boardman, G.D., Patnaik, S., Marsh, L., and Flick G.J. Aquaculture. **303**, 28-33 (2010)
27 Green B. W. and Matthew E. M. Journal Journal of Applied Aquacultur. **29**, (2017)