IOP Conf. Series: Earth and Environmental Science **137** (2018) 012026 doi:10.1088/1755-1315/137/1/012026

Analysis of growth performance and benefits of a high density catfish *Clarias gariepinus* Burchell culture in biofloc system

F Basuki, T Yuniarti, D Harwanto and T Susilowati.

Aquaculture Department, Faculty of Fisheries and Marine Science Diponegoro University. Jl. Prof. H. Soedharto SH, Tembalang Semarang, 50275. Indonesia

E-mail : fajar.basuki@live.undip.ac.id

Abstract. The aim of the study was to determine the growth performance and calculation of business profit of catfish in various densities using biofloc system. Catfish fingerlings, 8±0.2 g each, were used in this research. There were three treatments in various densities, i.e. P_1: 1,100; P_2: 1,200 and P_3: 1,300 fingerlings/m^3. After 4 months observation, the results showed that growth performance regression from P_1, P_2, and P_3 was Y (P_1) = 7.66 + 30.7 X (r2 = 0.971); Y (P_2) = 7.45 + 23.6 X (r2 = 0.996) and Y (P_3) = 6.5 + 23.63 X (r2 = 0.996), respectively. The P_1 harvest time was achieved within 3 months; while P_2 and P_3 were 4 months. Total yield/tank in P_1, P_2 and P_3 were 297.00, 295.29 and 309.52 kg, respectively. The calculation of business profit per tank per month of P_1, P_2 and P_3 were 626,784.17; 399,058.77 and 351,793.65 IDR (Indonesian Rupiah), respectively. Meanwhile, result of R/C ratio of P_1, P_2 and P_3 were 1.60, 1.5 and 1.4, respectively. Since the calculation of R/C ratios were ≥ 1, this culture method is considered feasible as a business.

1. Introduction

Based on statistical data, the production of catfish *Clariasgariepinus* (Burchell 1822) in Central Java has been increasing rapidly. In 2013, the production was recorded at 62.686 tons and reached 75,236 tons in 2013 or an increase of 20.02% within a year [1].The increase in catfish culture has been supported by several reasons such as: biological reasons (fast growing, easy cultivation, readily consumes fabricated feed, and tends to be resistant to disease), social reasons (good market value), and physical reasons (resistant to environmental changes) [2].

Fish farmers and aquaculturists have tried to implement high density catfish farming. The catfish is labyrinth fish, so it is possible to cultivate it using high density technology such as the biofloc technique. According to a previous study [3], high density catfish culture using biofloc has reached 50 catfish/100L of water or 500 catfish/1000 L of water with the weight of the catfish at 2.3±0.12 g/fish. High density catfish culture using biofloc means that catfish were stocked into concrete tanks (vol. 1 m^3), where each tank contained 1,000 juveniles (mean bodyweight: 2.5 g) [4].

Catfish culture with the biofloc system in closed recirculation containers is one technique that can be implemented to increase catfish production. The biofloc system allows high density catfish culture so that production increases [5]. Biofloc is a collection of various organisms including bacteria, fungi, protozoa or algae incorporated in a floc. High density catfish culture produces more waste so it needs regular stirring that allows waste to be suspended which is then processed aerobically by heterotrophic bacteria into inorganic compounds. The remaining organic material derived from feed

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

or dirt will cause a decrease in water quality. Biofloc technology can add organic carbohydrates through an increase in C/N ratio and stimulate the growth of heterotrophic bacteria. Probiotics also serve as immunostimulants to decrease FCR, inhibit pathogenic bacteria and improve water quality [3].

The aim of this research was to observe the performance of growth and to predict the harvest weight and analyze the profit per pool with various densities and R/C ratio.

2. Methodology

Tested Fish : Catfish fingerlings weighing 8 ± 0.2 grams/fingerling or 8 ± 0.2 g/fingerling in various densities as treatment: P_1 (1.100 fingerlings/m^3 or 3.300 fingerlings/pool); P_2 (1,200 fingerlings/m^3 or 3,600 fingerlings/pool) and P_3 (1,300 fingerlings/m^3 or 3,900 fingerlings/pool).

Pool: The pool was made from plastic with a diameter of 3 m and equipped with a 6 mm iron frame. The total volume of water in each pool was 3000 L. The fingerlings were adapted and stocked into the pool randomly.

Feed Preparation: The feed was a commercial pellet containing 31-33% protein; 3-5% fat; 4-6% fiber, 10-13% ash, and 11-13% water. Each kilogram of pellet was added with 5cc EM4 bacteria in 150 cc fresh water. Each ml of EM4 contains *Lactobacillus casei* ($2.0x10^6$ cell/ml) and *Sacharomyces cerevisiae* ($3.5x10^5$ cell/ml).

Pool Preparation: Before stocking the fingerlings, pools were filled with fresh water until reaching the height of 43 cm, so that the volume of fresh water would be ± 3 m^3, salt was added at 600 grams/pool or 200 grams/m3, molasses as much as 300 cc/pool or 100 cc/m^3 and 5 cc of EM4 [4]. The water was replaced periodically if the water quality variable was exceeding the allowed threshold.

Pool Recirculation: For pool recirculation, three water pumps powered by 33 watt electricity were used in each pond.

Experiment Design: Adapted catfish fingerlings were adapted and stocked into pools randomly, according to the treatments of P_1 (1,100 fingerlings/m^3 or 3,300 fingerlings/pool); P_2 (1.200 fingerlings/m^3 or 3.600 fingerlings/pool) and P_3 (1.300 fingerlings/m^3 or 3.900 fingerlings/pool).

Fish Growth Measurement: Individual growth rates were measured every two weeks (14 days) after the catfish were cultured. Duration of the culture was 16 weeks or 4 months. Data was then analyzed based on regression analysis using SPSS 20.

Survival Rate (SR): Measured from the final number of fish divided with the initial number of fish then multiplied by 100% [3].

Food Convertion Rasio (FCR): Measured by comparing the total feed (g) with the total fish weight (g) [6].

Benefit-Cost Ratio: Calculating the ratio of revenue (R) and cost (C).

Criteria: R/C >1: feasible; and R is revenue or total revenue, which is the total of the catfish selling price, while C is cost or total production cost [7].

3. Results and Discussion

3.1. Growth Performance

Weight observation is important since the selling of harvest is based on the total weight of catfish. Based on the observation, high-density catfish culture in biofloc shows that in week 4 (month 1) all treatments show a considerable weight increase. It shows that the quality of feeding and water quality have positive effects on the fish but the levels of response was different in each treatment. P1 shows a weight increase of 37.92 ± 0.74 gr; P2 shows a weight increase of 30.25 ± 0.99 gr and P3 shows a weight increase of 27.65 ± 1.78 gr.

The observation on growth was continued. In the 3rd month (week 12), P1 showed the best results, reaching the weight of 100 ± 3.54 gr or ready for harvest. P2 reached the weight of 78.54 ± 0.63 gr, which was higher than P3 at 77.9± 0.67 gr. The weight of catfish in P2 and P3 do not meet the criteria for harvesting i. e. 100 gram. The dynamics of growth can be seen in figure 1. The regression

analysis on P1 shows the equation YP1 = 6.46 +7.81 X which means that after 12 weeks or 3 months it can be predicted that the catfish have reached 100g or the ideal harvest weight. While for treatment P2, the equation is YP2 = 6.53 + 6.0 X meaning that after 12 weeks or 3 months culture, the weight of catfish is estimated at 78.54 ± 0.63 gr or not ready for harvest and requires 4 more weeks to reach ideal weight. The treatment P3 shows the regression equation YP3 = 6.71 + 5.94 X meaning that after culturing for 12 weeks or 3 months, the weight of catfish is estimated as 77.9± 0.67 gr or not ready for harvest and needs 4 more weeks to reach ideal weight.

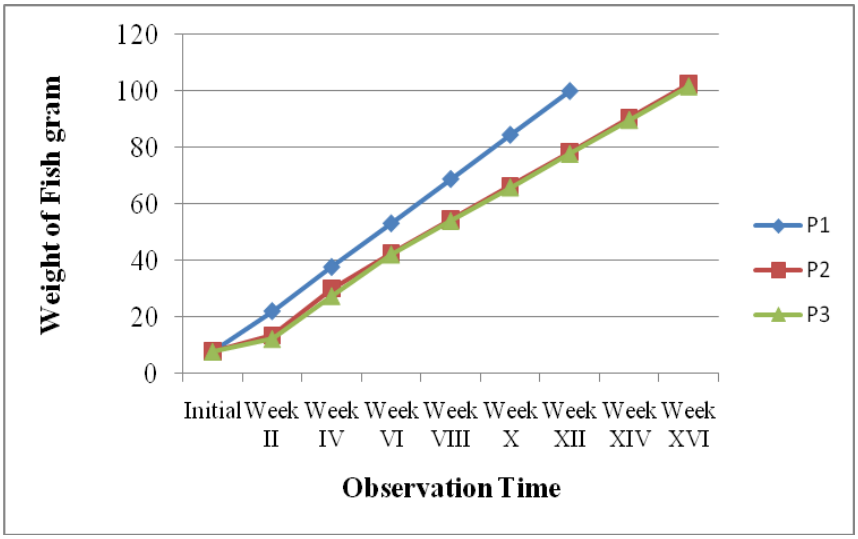

Figure 1.The dynamics of Catfish growth rate based on the weight in various densities which are maintained based on biofloc.

3.2. Survival rate (SR)

As soon as the fingerlings were stocked into the pools, there was a change to the water quality. The fingerlings have a good chance of survival as long as the water quality can be well maintained. However, sometimes the quality of water decreases suddenly, leading to the death of fish. The quality of water used in the research was closely monitored, yet the survival rate changes every four weeks or one month (table 1).

Table 1. Survival rate (SR) per month.

Treatment	Initial (%)	Weeks IV (%)	Weeks VIII (%)	Weeks XII (%)	Weeks XVI (%)
P1	100	98	96	95	----
P2	100	96	92	87	85
P3	100	95	88	83	78

3.3. Production per pool and Total Revenue (IDR)

After culturing for 3 months, the individual weight of the fish in P_1 reached 100 grams with a survival rate (SR 95 %) hence the total production of P1 amounted to 313.5 kg. At the price of 16,000 IDR/kg, the total revenue was estimated at 5,016,000 IDR. Treatment P_2 and P_3 weighed under 100 g/fish so the culture continued to 16 weeks or 4 months. After 4 months, P2 reached the individual weight of 102.53 grams and with a Survival Rate (SR) of 85 %, so total production of P2 amounted to 313.74 kg. At the price of 16,000 IDR/kg, the total revenue was estimated at 5,019,869

IDR. P3 reached the individual weight of 101.75 grams with the Survival Rate (SR) at 78 %, so total production of P3 amounted to 309.52 kg. Selling at the price of 16,000 IDR/kg, the total revenue was estimated at 4,952,376 IDR. The dynamics of production and total revenue can be seen on table 2.

Table 2. Production and total revenue (IDR).

Treatment	Total Stocking (fish)	Weigh (gr)	SR (SR)	Total Production (kg)	Price	Total Revenue (IDR)
P1	3,300	100	95	313.5	16,000	5,016,000
P2	3,600	102.53	85	313.7418	16,000	5,019,869
P3	3,900	101.75	78	309.5235	16,000	4,952,376

3.4. Cost

In fish cultivation, cost estimation is the determining factor of continuation. This research provides cost estimation for high-density catfish culture using biofloc. The costs estimated in these activities are the cost of feed, the depreciation cost of tarp, depreciation cost of pumps, electricity, labor, and cost of fingerlings.

The research shows the lowest cost is P_1, which amounts to 2,980,213 IDR, followed by P_2 at 3,325,163 IDR, while the highest is P_3 with the amount of 3,360,163 IDR. The dynamics of cost is presented in table 3.

Table 3. Total cost (IDR).

Treatment	Feeding cost	Depreciation Cost of Tarp	Depreciation Cost of Pump	Electricity	Labor	Fingerling Cost	Total Cost
P1	166,6000	62,500	113	291,600	300,000	660,000	2,980,213
P2	169,4000	83,333	150	427,680	400,000	720,000	3,325,163
P3	172,9000	83,333	150	427,680	400,000	780,000	3,360,163

3.5. Benefit cost ratio

The estimations of business profit per pool per month are P_1: 678,595.83 IDR; P_2: 423,676.37 IDR and P_3: 398,053.17 IDR. While the result of R / C ratio shows P_1: 1.68; P_2: 1.51 and P_3: 1.47. The dynamics of benefit-cost ratio can be seen in table 4.

Table 4. Benefit-Cost Ratio (IDR).

Treatment	Total Revenue	Total Cost	Profit (3-4 months)	Profit per Month	R/C
P1	5,016,000	2,980,213	2,035,788	678,596	1.68
P2	5,019,869	3,325,163	1,694,706	423,676	1.51
P3	4,952,376	3,360,163	1,592,213	398,053	1.47

4. Discussion

Initial growth is very important in the maintenance of fish, especially catfish. The result shows that water quality at the beginning of the experiment was in accordance with the standard of maintenance [8] as well as good feed management, which can be seen from the growth of the fish. The research

shows the daily growth rate ranged from 0.87 – 1,02 grams/day. According to a previous study [3], high-density cultured catfish in biofloc with an initial weight of 2.3 gram $fish^{-1}$ show a specific growth rate (SGR) as much as 6.35 % after cultured for 42 days. Meanwhile, another study [4] showed that high-density cultured catfish in biofloc with an initial weight of 2.5 gram $fish^{-1}$ result in a final weight of around 4.9 – 8.7 grams after cultured for 35 days. The research conducted by Channel Catfish using biofloc technology [8] showed that fish having an initial weight of 217 g/fish, stocking density 1.4, 2.1, or 2.8 kg/m^3, resulted in an individual harvest weight ranging from 658-829 g/fish. The research of the channel catfish stocker [9] showed that catfish (0.26 kg/fish) stocked into earthen ponds at approximately 0.22 kg/m3 (11.115/ha) grew at 4.0 g/d, achieved a mean final weight of 0.91 kg/fish in 164 days, and consumed 1.17 kg feed/fish.

Observations on survival rates (SR/%) revealed the result between 78-95 %, while previous research Yusuf *et al*. [3], showed that high-density cultured catfish in biofloc with an initial of weight 2.3 gram/fish resulted in 86.67-89.33% of SR after cultured for 42 days. Additionally, another research Hapsari [4], founded that high-density cultured catfish in biofloc having an initial weight of 2.5 gram/fish resulted in 85.8-91.4 % of SR after cultured for 35 days. Furthermore, the Tilapia survival rate was observed at 98-99 % using biofloc technology [10].

Fish cultured for 3-4 months showed an individual growth between 100-102.53 and a SR between 78-95 %. Therefore, the production of each $3m^3$ pool ranged between 309.52-313.5 kg or 103.57 - 104.5 kg/m^3. The growth of catfish culture based on biofloc shows a higher rate compared to tilapia [10]. Research shows that daily tilapia growth ranges between 0.1 g/fish/day, with the initial fingerling weight at 3.37-3.44 gram/fish. Moreover, tilapia with growth rates of up to 0.3 g/day yielding up to 300 mt/ha have been reported in well managed bioflocs ponds, so that production reaches $30kg/m^3$ water [11].

High-density catfish culture using biofloc is a profitable business; it can even be an option for home industries, or small and large scale industries. The research shows that the growth of fish, survival rate, food conversion ratio, total expenditure, total income, and profit can be well calculated. The research also shows that R/C ratio of the business ranges from 1.47 – 1.68 meaning that the business is profitable [7,11].

5. Conclusion

The growth performance of catfish cultured with biofloc shows a simple regression line for treatment P1, showing the equation YP1 = 6.46 +7.81 X which means that after 12 weeks or 3 months it can be predicted that the catfish will have reached 100g or the ideal harvest weight. While for treatment P2, the equation is YP2 = 6.53 + 6.0 X meaning that after the culture of 12 weeks or 3 months, the weight of catfish is estimated as 78.54 ± 0.63 gr or not ready for harvest and needs 4 more weeks to reach ideal weight. The treatment P3 shows the regression equation YP3 = 6.71 + 5.94 X meaning that after culturing for 12 weeks or 3 months, the weight of catfish is estimated as 77.9± 0.67 gr or not ready for harvest and needs another 4 weeks to reach ideal weight. The estimation of business profit per pool per month of P_1, P_2, and P_3 were 678,596; 423,676 and 398,053 IDR, respectively. While the result of the R / C ratio showed P_1 was 1.68; P_2 was 1.51 and P_3 was 1.47. Since the calculation of R/C ratios were ≥ 1, high-density catfish culture using the biofloc technique is considered feasible as a business.

Based on the research, it is advised that high density catfish culture based on biofloc is proven feasible. The ideal density should be 1,100 fingerlings/m^3 or 3,300 fingerlings/pool to obtain the monthly profit of 678,596 IDR. To reach a minimum monthly income of 2,000,000 IDR, three ponds should be maintained.

6. References

[1]. Director General of Aquaculture 2013 Statistical Data Series Cultivation Fishery Production-Indonesia, Production of Catfish, Gurame, Other (Dirjen Perikanan Budidaya 2013 Data

Statistik Series Produksi Perikanan Budidaya-Indonesia, 2009-2013 Produksi Lele, Gurame, Lainnya)
[2]. Jamabo, N A and R I Keremah 2009 Effect of Stocking Density on Growth and Survival Rate of the Fingerling on Clarias gariepinus (Burchell, 1822) *Int. J. Fish.* **4** 55-57
[3]. Yusuf, M W, N B P Utomo, M Yuhana and Widanarni, 2015 *J .Fish. Aquat. Sci* **10** 523-532
[4]. Hapsari, F, 2016 *AACL Bioflux*, **9**
[5]. Kareem, O K and A N Olanrewaju 2015 *J. Fish. Aquat. Scie* **10** 400-404.
[6]. Islam M Z , Md R I Sarder and Md R I Akhand 2015 *IJFAS* **2** 186-191.
[7]. Hidayah, I , 2010 *Jurnal Budidaya Pertanian* **6**
[8]. Green B W and K Schrader 2015 *J. Aquac. Res. Dev.* **6** 314
[9]. Green B W and C R Engle 2004 Growth of stocker channel catfish to large market size in single-batch culture *J. World Aquac. Soc.* **35** 25-32
[10]. Abduljabbar A A , A M Nour. T Srour, N El-bermawy, W A Fayed and A T Mansou 2015 *Global Journal of Fisheries and Aquaculture Researches* **2** 64-80
[11]. Ogello, E O, S M Musa, C M Aura, J O Abwao and J M Munguti 2014 *Int. J. Aquac. Fish. Sci.* **5** 21-39

Acknowledgments
This research is supported by the Rector of Diponegoro University and the Dean of the Faculty of Fisheries and Marine Sciences under contract number 2270 / UN7.3.10 / LT / 2017 fiscal year 2017