Utilization of biofloc pond water as a substitute for nutrition in the pak choi hydroponic system

Raju1*, S Panggabean1, R B M I Fatoni2 and A Irfan3

1Department of Agricultural Engineering, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia.
2Department of Agribusiness, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia.
3Department of Mechanical, Faculty of Engineering and Computer Science, Qur’anic Science University.

E-mail: *muhammadraju@usu.ac.id

Abstract. Increased fish consumption needs can be overcome by high stocking density in fish farming. Stocking density and high feeding rise the problem of increasing organic waste which can reduce water quality. Biofloc technology is one alternative that can overcome this problem by adding the amount of organic carbon in the pond, thereby increasing the C / N ratio of water that will grow heterotrophic bacteria. The basic principle of biofloc technology is the assimilation of inorganic nitrogen by heterotrophic microbial communities in cultivation media which can then be utilized by aquatic organisms as a food source. The government through the Ministry of Marine Affairs and Fisheries promotes freshwater fish farming with biofloc technology. The objective of this research was to assessing the effect of biofloc pond water on pak choi growth. The research was conducted for two months, planting the pak choi in pipe line using rockwool as its growth media. The cultivation used two treatments, biofloc pond water and ab mix as its nutrition. The result showed that pak choi growth with biofloc pond water was lower than ab mix nutrition.

1. Introduction

Fish consumption are increased every year. This fish consumption increasement relates to fish availability demand and need. High stocking density in fish farming can overcome these demand and need. High feeding are requested to conduct high stocking density and it rises the problem of increasing organic waste which contributes in water quality reduction. Biofloc technology is one alternative that can overcome this problem by adding the amount of organic carbon in ponds thereby increasing the C / N ratio of water which will grow heterotrophs bacteria.

The basic principle of biofloc technology is the assimilation of inorganic nitrogen by heterotrophic microbial communities in cultivation media which can then be utilized by aquatic organisms as a food source [1]. The nitrogen in question is obtained from fish metabolism which is then transformed into lumps of protein that can directly used by fish, so fish are cultivated obtain additional protein from floc as natural food, beside pellet feed which is given.

The government through the Ministry of Maritime Affairs and Fisheries is promoting freshwater fish farming with biofloc technology. After the previous success developing technology for developing biofloc systems for catfish, now Ministry of Maritime Affairs and Fisheries through the Directorate...
General of Fisheries Cultivation in collaboration with researchers at Bogor Agricultural University applying this environmentally friendly technology to Tilapia. Some advantages of applying biofloc technology are: can improve survival rate (SR) of more than 90% and without water change. Tilapia aquaculture water with a biofloc system has no odour, so it does not disturb the surrounding environment and can be synergized with cultivation of plants such as vegetables and fruits. Other advantage is the feed conversion ratio (FCR) or the ratio between the weight of the feed has been given in one cycle of the cultivation period with a total weight (biomass) produced in tilapia is able to reach 1.03, means very efficient feed usage, in order to produce 1 kg of Tilapia only requires 1.03 kg of feed. When compared with maintenance in the usual pool FCR reached 1.5 [2].

Aquaponics technology can optimize the function of ponds water and help improve pool water quality in addition to the biofloc technology described above. The basic principle of aquaponics is the using of leftover food and fish waste that can worsening the quality of pond water as fertilizer by plants as well as filtering pool water so that when returning to the pool, the water becomes clean from ammonia and more suitable for fish growth.

Agricultural land in Indonesia is getting narrower every year. According to the data published by the Ministry of Agriculture of the Republic of Indonesia, land agriculture in Indonesia decreased from 39,253,769 hectares in 2013 to 36,743,524 hectares in 2016. The narrowing of agricultural land became challenges in providing food for the community. Technology hydroponics can be an alternative in providing food with utilization narrow land. Meanwhile, the government is working on national food security program so that it can provide food for people without having to import. Therefore, a combination of technology biofloc along with aquaponics can be a strategic part of achieving the food security program. The objective of this research was to assessing the effect of biofloc pond water on pak choi growth.

2. Material and methods
The research was conducted for two months. The materials and equipments were plastic pond with diameter of 1 meter, 200 Tilapia fish (*Oreochromis niloticus*), pak choi seeds, rock wool, net pot, water pump, aerator, pipes and ruler. The research was started from pond preparation and build the two hydroponic pipe series for pond water and AB mix solution, continued to biofloc formation. While doing the pond preparation, seeding was carried out on rockwool in net pots. The seed was showering two times a day, morning and afternoon to keep them moist.

A and B powder was dissolved to each 5 litres of water to produce concentrated solution of A and B. AB mix nutrient was formed by diluting A and B concentrate into water by ratio 5 mL A and B concentrate to 1 L of water. AB mix solution was placed to bucket and flowed to the pipe series using mini water pump with power of 40 watts. AB mix solution was flowed back to the bucket and continue the process. Pond water was also flowed to other pipes series using same specification of mini water pump. The pipe series was placed above the pond and pond water was circulating from pond and flowed back to it.

Grown seeds after seeding for approximately ten days were placed into pipe series. There were twenty plants placed to each pipe series. Plants growth were measured every three days using a ruler, started from first day they were placed to the pipe series. Measurements covered plants height also leaf length and width that can be explained and shown in Figure 2 [3], while leaf area was calculated using the formula

\[
\text{leaf area} = 0.6 \times \text{leaf length (cm)} \times \text{leaf width (cm)} \quad [3]
\]
3. Results and discussion

3.1. Pak choi growth

Pak choi plants that have been sown for one week are transferred to a series of pipes hydroponics. Two series have been prepared beforehand and drained by biofloc pond water in the first set and ab mix nutrient water in the second set. Set parameters in the form of plant height, length and width of leaves, leaf area and fresh weight of plants after harvest. The leaves measured are the leaves that look the biggest. Direct measurements are made for measure plant height parameters, length and width of leaves and fresh weight of plants. High, length and width are measured using a ruler while fresh weight is measured with using digital scales. Leaf area parameters are obtained by calculating using the formula. Plants can be seen in Figure 3. From the picture it can be seen that the plants fed with nutrients from biofloc pond water grow slower compared to plants that have ab mix nutrient solution. This is possible occurs because pond water contains insufficient nutrients for plant growth.
Inadequate nutrition results in plant leaves becoming stunted and yellow. Few amount of nutrition can be caused by the low ability of bacteria to decompose fish waste so the ammonia levels in the pond are still high.

3.2. Leaf area
Leaf area is calculated using a formula. From Table 1 it can be seen that plant leaf area with ab mix nutrients have exceeded the leaf area of plants with biofloc pond water on the second data collection or on the 4th day after being transferred to the pipe circuit. Taken further data shows that ab mix leaf area is getting bigger and the difference to pond water leaf area is also getting bigger. The leaf area of ab mix plant when harvested is equal to 39.98 cm$^2$.

### Table 1. Plant average measurements and leaf area calculation

| Data | Pond Water | AB Mix |
|------|------------|--------|
|      | Height (cm) | Length (cm) | Width (cm) | Area (cm$^2$) | Height (cm) | Length (cm) | Width (cm) | Area (cm$^2$) |
| 1    | 2.8        | 0.6      | 0.9      | 0.31        | 2.5        | 0.5        | 0.7        | 0.24        |
| 2    | 2.9        | 0.9      | 0.7      | 0.37        | 2.6        | 1.2        | 0.8        | 0.56        |
| 3    | 3.2        | 1.2      | 0.8      | 0.58        | 3.5        | 1.8        | 1.3        | 1.41        |
| 4    | 3.6        | 1.5      | 1.1      | 0.96        | 6.1        | 3.6        | 2.4        | 5.27        |
| 5    | 4.1        | 1.7      | 1.1      | 1.06        | 10.2       | 6.5        | 4.4        | 17.11        |
| 6    | 4.8        | 1.8      | 1.1      | 1.14        | 16.1       | 10.0       | 6.6        | 39.98        |

3.3. Fresh weights
Fresh weights of plants were weighed with digital scales after harvesting. Harvesting was done by cutting the base of the lowest plants stems, just above the rockwool surface. Cutting was done by using a sharp cutter knife. The plants which were harvested were plants with ab mix nutrients. From the weighing results obtained the highest weight plants at 44.1 grams and the lowest is 5.0 grams with an average fresh weight of 23.6 grams. Fresh weights of plants with pond water have not been harvested because the plants are still small so that the fresh weight cannot be weighed yet.
4. Conclusion

Pak choi growth with nutrient of pond water is lower than AB Mix nutrient. Pond water is not able to substitute AB Mix as nutrient for pak choi growth which caused by bacteria inability to decompose large amount of ammonia and the condition of pond water is too concentrated, making it difficult for plants to absorb nutrients contained in pond water.

References

[1] De Schryver P and Verstraete W 2009 Nitrogen removal from aquaculture pond water by heterotrophic nitrogen assimilation in lab-scale sequencing batch reactors Bioresource Technology 100 p 1162-1167

[2] Ministry of Maritime Affairs and Fisheries 2018 KKP kembangkan teknologi budidaya baru, sistem bioflok untuk ikan nila [Ministry of Maritime Affairs and Fisheries develop new cultivation technologies, biofloc systems for tilapia] kkp.go.id

[3] Prasetyo, J 2014 Efek paparan bunyi dengan variasi jenis dan pressure level terhadap pertumbuhan dan produktivitas sawi hijau (Brassica juncea L.) [The effect of exposure sound with types and variations pressure level on mustard green growth and productivity (Brassica juncea L.)] Master Theses Bogor Agricultural University

Acknowledgments

The research was fully supported by Universitas Sumatera Utara based on contract of TALENTA USU research implementation for fiscal year 2019 No: 4167/UN5.1.R/PPM/2019 date: 01 April 2019.