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# Growth Performance and Survival of Climbing Perch (*Anabas testudineus* Bloch) Raised in Conventional and Bioflocs System

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The aim of this research is to analyze the performance of growth and survival of climbing perch (*Anabas testudineus* Bloch) which was raised in bioflocs and conventional systems. It investigated the difference in the initial size of the fry stocked with climbing perch has effect. The experimental

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design used in this study was a Factorial Completely Randomized Design (CRD) with 2 factors and 3 replications: Factor A: climbing perch aquaculture Systems; A1: climbing perch in conventional system of; A2: the climbing perch in bioflocs system; Factor B: Initial Size of fry Stocking; B1: fry size 3 ± 0.5cm; B2: fry size 5 ± 0.5cm and B3: fry size 7 ± 0.5cm. The research was conducted for 90 days with daily growth parameters (SGR), weight and length growth, survival rate, food conversion, flocsvolume density (FVD), and main water quality parameters (water temperature, pH, dissolved oxygen and dissolved ammonia).The results showed that the bioflocs system was able to increase the average growth in the range of 12-67% with an average of 29.73% when compared to conventional systems. The highest value for the daily growth rate or Specific Growth Rate (%/day) was for fry with a size of 7 cm in the bioflocs system (8,419%). The fry size of 3 ± 0.5cm in the bioflocs system had the highest difference in standard length (4.33 cm) while the highest average length during maintenance was the seed size of 7 ± 0.5 cm in the bioflocs system. The survival results of climbing perch fish during the study were based on the highest score on the seed size of 3 ± 0.5cm in the bioflocs system. The survival range of the bioflocs system is 94.89 - 99.67% and that of the conventional system is 82.00 - 94.26%. Thus the bioflocs system is able to increase survival in the range of 5-14% when compared to conventional systems. The bioflocs system is able to provide better feed efficiency than conventional systems in the range of 34-39%. The average value of floc volume density (FVD) in the bioflocs system is in the range of 5.35 – 8.16 ml/L, which is still ideal but can still be improved. Water temperature during the study period, air and water temperatures ranged from 28.54 to 28.71 (ºC), the degree of acidity in all treatments was in the range 6.34 – 7.27, dissolved oxygen levels were in the range 5.77 – 6.90 mg /L) while the average measurement results for ammonia levels (mg/L) were in the range of 0.49 – 0.57 mg/L. The temperature ranges in the studies on conventional and bioflocs systems are within the acceptable range for fish farming Water temperature during the study period, air and water temperatures ranged from 28.54 to 28.71 (ºC), the degree of acidity in all treatments was in the range 6.34 – 7.27, dissolved oxygen levels were in the range 5.77 – 6.90 mg /L) while the average measurement results for ammonia levels (mg/L) were in the range of 0.49 – 0.57 mg/L.

*Keywords: Fry size; climbing perch; bioflocs; conventional.*

## 1. INTRODUCTION

The climbing perch (*Anabas testudineus* Bloch) is one of the fish species that have potentials. It is very popular for consumption, especially on the islands of Kalimantan Sumatra, and Java because of its delicious taste [1]. So far, most of the consumption needs have been obtained from nature, such popularity has experienced a very significant reduction, some of its aquaculture efforts have been carried out by fish farmers using traditional pond techniques - conventional in Central and South Kalimantan. However, the production rate is still relatively low due to low stocking density (15 fish/$m^2$). Even though high stocking densities in intensive culture can increase the growth and survival rate of aquaculture fish [2]. Different stocking densities of climbing perch have been reported for examples, 10 fish/$m^2$ [3], 15 fish/$m^2$ [4], and 14 fish/$m^2$ also reported that high stocking densities resulted in lower production performance compared to lower stocking densities [5]. The climbing perch is one of the economically important fish originating from swamp waters; where swamp waters are part of the wetland as the Basic Scientific Pattern of Lambung Mangkurat University. The price of climbing perch measuring 8-9 per kilogram can reach Rp. 100.000,00 - Rp. 140.000,00 , subject to availability due to seasonal influences.

The size of the fish fry is important related to the rate of their rearing period. Several research reports on initial fry size in fish rearing as stated by [6], used catfish fry sizes 9.5 ± 1.7 cm long and 7 ± 2 grams in weight. Sangkuriang catfish frys were 2 – 3 cm (2.9 g) /head) and 5 – 8 cm (6.2 g/head) [7] Soedibya et al, [8], using fry size test fish have an average weight of 1.85 ±0.09 g reared in terpoline ponds with a diameter of 1.72 m and a height of 1.05 m with a water volume of ±2,000 L in four units with different densities, namely 1,000 individuals/$m^3$, 1,500 individuals/$m^3$, 2,000 individuals/$m^3$, 2,500 fish/$m^3$ With a weight of 20- 30 g/head, tilapia fry are reared in circular tanks with a density of 55–80 fish/$m^3$ or equal to 0.7-3 kg/$m^3$. The stocking density of vannamei shrimp is 100 individuals per $m^2$ (1,000,000 individuals/ha) [9]. The fish used is gourami fry with a length of 5-7 cm which is reared in a cylindrical tub with a diameter of 1 meter and a height of 1 meter [10], the initial average size of the fish is 6.23 ± 0.15 cm and 4.47 ±0.15 grams [11]. Gouramy measuring 5-7 cm using [12], the initial weight of each size is 5 ± 0.00 g and 2 ± 0.00 gram [13] maintenance in ponds using initial size with an initial length of climbing perch0.75 ± 0.01 cm and a weight of 0.20 grams in all treatments [14]. 2±0.00 grams [13] rearing in ponds using the initial size with an initial length of climbing perch 0.75 ± 0.01 cm and a weight of 0.20 grams in all treatments [14]. 2 ± 0.00 grams [13] rearing in ponds using the initial size with an initial length of climbing perch0.75 ± 0.01 cm and a weight of 0.20 grams in all treatments [14].

A study was conducted in 6 earthen ponds to examine the effect of stocking density on the growth, survival and production of Thai climbing perch (Anabas testudineus Bloch). Three stocking densities (treatments) were compared: ponds with 350, 400 and 550 individuals per decimal (0.01 acre). All treatments were randomized and duplicated. Artificial feed containing 34% crude protein was initially applied 20% of the total fish weight per day. Gradually the feeding rate was reduced to 15, 12, 10, 8 and 5% of the total fish weight per day. Feeding rates per pond are adjusted every two weeks after weighing at least 20% of the fish stocked. The trial duration is 90 days. The results showed that all growth parameters were higher in ponds with lower stocking density than ponds with high stocking density, while the total fish yield was higher in ponds with higher stocking density than in ponds with lower stocking density. The cost-benefit analysis reveals that all three systems are economically profitable. However, ponds with a stocking density of 550 individuals per decimal are the most profitable systems. Further research is still needed to further optimize the stocking density of climbing perchin aquaculture ponds. Until then, stocking 550 individuals of the Thai variety climbing per hour per decimal will result in good production for fish cultivators in the South and Southeast Asia region. [5].

One of the obstacles in the development of climbing perch aquaculture is site maintenance. A rearing place is a place where the living habits of fish are kept both intensively and semi-intensively, to fulfill aquaculture strategies in bioflocs systems with limited natural resources such as water and land. so that intensification is the most possible option using bioflocs system technology for aquaculture activities on the scale of seed to enlargement. The link between climbing perch and the bioflocs system needs to be developed, according to Ekasari [15], to apply to new species and find solutions to problems.The purpose of this research was to analyze how the performance of growth and survival of climbing Perch aquacultured with the bioflocs system and conventional whether there were differences in the fish size.

## 2. MATERIALS AND METHODS

### 2.1 Tools and Materials

The tools and materials used in this study can be seen in Table 1 and Table 2.

**Table 1. Types, quantity and use of research tools**

| No | Tool's name | Amount | Utilities |
|---|---|---|---|
| 1 | One meter diameter Bioflocs pond | 9 pcs | Fish rearing containers (research) |
| 2 | Conventional pool One meter in diameter | 9 pcs | Fish rearing containers (research) |
| 3 | Scrap | 4 pieces | Catch fish |
| 4 | Plastic | 1 pack | Containers provide feed |
| 5 | Ruler | 1 piece | Measure the length of the fish |
| 6 | Scales | 1 piece | Measure the weight of the fish |
| 7 | Aerators | 2 pieces | Make DO stable |
| 8 | Do meter | 1 piece | DO meters |
| 9 | PH meter | 1 piece | PH meter |
| 10 | Test ket | 1 piece | Ammonia meters |
| 11 | Conical funnels | 1 piece | Measure the flock |
| 12 | Digital scales | 1 piece | Measure the ingredients in grams |
| 13 | Scales | 1 piece | Weigh the total weight of the fish |
| 14 | Laminating paper | 18pcs | Code randomized study design |

**Table 2. Type, amount and use of research materials**

| No | Ingredient | Amount | Utilities |
|---|---|---|---|
| 1. | Climbing perch fry | 10,800 heads | Test fish |
| 2. | chlorine | 120 gram/m$^3$ | Bioflocs media |
| 3. | Salt | 10 kg/m$^3$ | Bioflocs media |
| 4. | Dolomitic limestone | 800 grams/m$^3$ | Bioflocs media |
| 5. | Molasses / molasses | 800 grams/m$^3$ | Bioflocs media |
| 6. | Pineapple | 4 kg/m$^3$ | Bioflocs media |
| 7. | Probiotics | 40mL/m$^3$ | Bioflocs media |
| 8. | PK (Potassium Permanganate) | 40mL/m$^3$ | Drugs |
| 9. | Pellets pf 1000 | kg | Test feeds |

## 2.2 Research design

The experimental design used in this study was a Factorial Completely Randomized Design (CRD) with 2 factors and 3 replications:

Factor A: Climbing perch Aquaculture System
- A1: the Climbing perch in conventional cystem
- A2: the climbing perch in bioflocs system

Factor B: Initial Size of Fry Stocking
- B1: Fry size 3 ± 0.5cm
- B2: Fry size 5 ± 0.5cm
- B3: fry size 7 ± 0.5cm

The combination (Table 3) of treatment of the 2 (two) factors is:

| Size of Fry Spread | Aquaculture System | |
|---|---|---|
| | Conventional System (SK) = A1 | Bioflocs System (SB) A2 |
| B1 = 3cm | A1B1 | A2B1 |
| B2 = 5 cm | A1B2 | A2B2 |
| B3 = 7 cm | A1B3 | A2B3 |

## 2.3 Research Procedure

1. Preparation of research containers

**a. Conventional pool**

1) Conventional pools are circular tarpaulin pools with a diameter of 1 meter and a height of 100 cm.
2) The pond to be used was first cleaned using a solution of PK (*Potassium permanganate*) to avoid disease and bacteria.
3) The pool was filled with water to a 65 cm level.
4) The water in the conventional ponds were changed every 2 days as much as 10 cm/m$^3$

**b. Bioflocs pond**

1) Fill with water as much as 1 m$^3$ or as high as 65 cm using direct well water.
2) Making bioflocs media, making bioflocs media is carried out simultaneously from the provision of chlorine, dolomite, salt, lime, molasses and probiotics.
3) Media preparation begins with the addition of 15 grams/m$^3$ of chlorine and is aerated for 3-4 days.
4) Giving salt as much as 2.5 kg/m$^3$ in aeration for 1 day.
5) Giving dolomite lime as much as 100 gr/m3 by taking a container filled with water, then stirring the lime in the container and putting the white lime juice into the pond, then letting it sit for 2 days with aeration and measuring the pH of the pool water.
6) Give as much molasses as 100 gr/m$^3$ with the addition of pineapple as much as 1 kg by means of a blender, after the pineapple is blended it is then put into the pond together with the molasses.

7) Giving probiotics as much as 10 mL/m$^3$ and aerated for 5-6 days before adding fish.
8) For bioflocs ponds, water deposits are removed every 2 days to keep the media good, then in 1 week molasses is given as much as 50 mL/m$^3$ according to the SOP procedure for media treatment.

2. The fry used according to the treatment were 3, 5 and 7 cm in size, the fry came from cultivators at Mentaos cultivators. The fry stocking was carried out in the morning and evening, because the temperature was relatively low, before stocking the fish fry, a sample of 20% (120 fish) of the total fish in the pond was taken. Take the fish fry using a scoop and then weigh all 120 fish fry and then measure the length of each fish.

3. Feeding, the feed given is in the form of feed that has been fermented first. How to ferment feed as follows:

   i. Take 1 kg of PF 1000 feed
   ii. Add 50 mL of molasses, 10 mL of probiotics and 200 mL of mineral water
   iii. Mix all the ingredients in 1 bowl, stir until evenly distributed, about 5-10 minutes until the feed is slightly dry
   iv. Put the fermented feed into an airtight plastic.
   v. Leave the feed for 2 days and then the feed can be used for fish. Feeding from bioflocs and conventional treatments is the same as 5% of the total weight of fish in the pond. Feeding is done 2 times a day (morning and afternoon). The artificial feed or commercial feed used in this study was 1000 pf type feed, because 1000 pf feed is suitable for fish mouth openings with sizes between 0.8 – 2.5 mm (Anonymous, 2012).

4. Sampling of fish fry was carried out every 10 days, sampling was carried out on 20% of the total fish, namely 100 individuals.

## 2.4 Observation Parameters

**a. Absolute Growth (grams)**
**b. Specific growth rate (SGR)**

The specific rate of growth (SGR) is calculated using the formula from Zonneveld et al. [16]:

$$\mathbf{SGR} = \frac{\mathbf{LnWt - LnWo}}{\mathbf{t}} \mathbf{\ x\ 100\%}$$

Information:

SGR = specific daily growth rate (%/day)
Wt = average weight ± fish at the end of the study (g/head)
Wo = average weight ± average fish at the beginning of the study (g/head)
t = time (long maintenance)

**c. Standard Long Growth (cm)**

The standard growth length is calculated by the formula Zonneveld et al. (1991):

$$\mathbf{L = Lo - Lt}$$

Information:

L = Growth in absolute length (cm)
Lt = fish body length at the end of the study (cm)
Lo = fish body length at the beginning of the study (cm)

**d. Feed Conversion Ratio**

According to Rodde et al. [17], the feed conversion ratio (FCR) is calculated based on the following formula:

$$\mathbf{FCR} = \frac{\mathbf{F}}{\mathbf{Wt + D\ ;\ F\ Wo}}$$

Information:

FCR = Feed conversion ratio
F = Weight of feed given (grams)
Wt = Biomass of test animals at the end of rearing (grams)
D = Weight of dead fish (grams)
Wo = Biomass of test animals at the start of rearing (grams)

**e. Survival**

Survival Rate calculations using the formula Effendi [18], namely:

$$\mathbf{SR} = \frac{\mathbf{Nt}}{\mathbf{No}} \mathbf{\ x\ 100\%}$$

Information :

SR = Survival rate (SR) %
Nt = Number of fish at the end of rearing
No = Number of fish at the start of stocking

**f. Environmental Quality**

**1. Floc Volume Density**

The abundance of flocs was taken using an Imhoff cone so that the flocs could be filtered out. Floc volume is a representation of the density of floc particles in a water column [19]. The volume of the floc that settles is recorded and then calculated using the formula:

$$mL/L = \frac{mL}{L}$$

**2. Water quality**

## 2.5 Hypothesis

1. Main Effect of Factor A

H0 = Different aquaculture systems have no significant effect on the growth performance and survival of climbing perch (*Anabas testudenius* Bloch)
H1 = Different aquaculture systems have a significant effect on the growth performance and survival of climbing perch (*Anabas testudenius* Bloch)

2. Main Factor Factor B

H0 = Different fry sizes have no significant effect on the growth performance and survival of climbing perch (*Anabas testudenius* Bloch)

H1 = Different fry sizes have a significant effect on the growth performance and survival of climbing perch (*Anabas testudenius* Bloch)
3. Interaction Factors Factor A and Factor B

H0 = The interaction of the aquaculture system and the size of the fry of the climbing perch at different stages did not significantly affect the growth performance and survival of the climbing perch (*Anabas testudenius* Bloch)

H1 = The interaction of the aquaculture system and the size of the fry of the climbing perch at different times significantly affected the growth performance and survival of the climbing perch (*Anabas testudenius* Bloch).

## 2.6 Data Analysis

The data obtained from the results of this study were growth data, survival rate, feed-conversion ratio before analyzing the data was varied, the data was tested for normality and homogeneity test. The normality test, homogeneity test is carried out to ensure that the data is normally and homogeneous as is the requirement for conducting Factorial Completely Randomized Design (CRD). The data were analyzed by means of the F test (significance) with the SPSS 24 program to find out the difference between the treatment and the post hoc test. The environmental quality data was obtained based on descriptive measurement results to determine the effect on growth and survival.

## 3. RESULTS AND DISCUSSION

### 3.1 Results

#### 3.1.1 Absolute weight growth

The results of observations on the average absolute weight growth of climbing perch fish are presented in Table 4, Table 5 and Fig. 1, which were observed from stocking to the end of the study with sampling done every 10 days for 90 days.

**Table 3. Water quality measurement methods**

| Parameter No | Units | Tool type | How to use |
|---|---|---|---|
| Physical :<br>1. Temperature | $^{o}C$ | thermometer | Dipped in the pool on one side of the container in a submerged position |
| Chemical:<br>2. DO | mg/L | DO-meter | Dipping, DO-meter into the pool see the results of the scale that has been listed on the DO meter display |
| 3. pH | - | PH meter | Insert the pH meter into a pool of water and wait until the number scale stops. |
| 4. Ammonia | mg/L | Test Kits | Take water samples and dip the test kit paper in the water sample. |

**Table 4. Performance of the average absolute population growth (grams) of climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days**

| Perlakuan | Hari ke | | | | | | | | | Jumlah | Rerata |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | | |
| BFC3 | 655.00 | 1316.67 | 1706.67 | 2113.33 | 2488.33 | 3050.00 | 3641.67 | 4071.67 | 4740.67 | 24694.00 | 2469.40 |
| BFC5 | 1883.33 | 2493.33 | 3016.67 | 3291.67 | 4150.00 | 4550.00 | 5410.00 | 5868.33 | 6342.33 | 39293.17 | 3929.32 |
| BFC7 | 3216.67 | 3980.00 | 4383.33 | 4683.33 | 5016.67 | 5316.67 | 5703.33 | 6330.00 | 6829.00 | 49040.67 | 4904.07 |
| K3 | 582.75 | 1081.42 | 1727.25 | 2136.08 | 2548.42 | 3091.67 | 3551.67 | 3905.00 | 4172.67 | 23636.00 | 2363.60 |
| K5 | 2041.67 | 2393.33 | 2575.33 | 2883.33 | 3550.00 | 3940.83 | 4434.33 | 5006.67 | 5405.33 | 34380.83 | 3438.08 |
| K7 | 3308.33 | 3733.33 | 4100.00 | 4308.33 | 4471.67 | 4661.67 | 5080.00 | 5515.00 | 5731.33 | 44329.67 | 4432.97 |

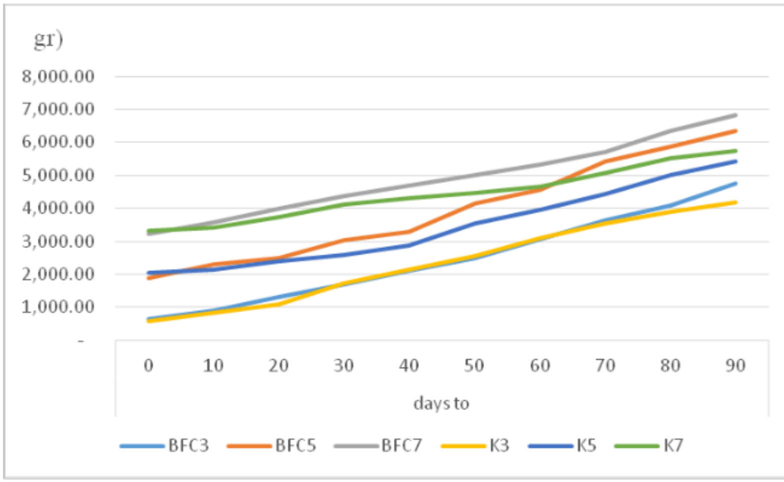


**Fig. 1. Performance of average absolute population growth (grams) of climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days**

*Information :*
*BFC3: bioflocs system seed size ± 3.00 cm*
*BFC5: bioflocs system seed size ± 5.00 cm*
*BFC7: bioflocs system seed size ± 7.00 cm*
*K3 : conventional system seed size ± 3.00 cm*
*K5 : conventional system seed size ± 5.00 cm*
*K7 : conventional system seed size ± 7.00 cm*

From Table 4 and Fig. 1, it shows that there is a difference in the average performance value of the average absolute population growth (grams) of climbing perch fish reared for 90 days in the bioflocs and conventional systems with differences in the initial size of the fry. The BFC7 treatment showed the highest absolute growth performance among all the treatments given with an average of 4,289.46 grams, followed by the K7 treatment (3,917.15 grams), BFC5 (3,358.51 grams), K5 (2,951.60 grams), BFC3 (2,042.74 grams) and K3 (1,988.06 grams).

The results of the ANOVA test in this study showed that the output obtained a Significance value of the size of the climbing perch fish seed with a significance value0.000 < 0.05,which showed differences between treatments. Based on the output of the maintenance media (bioflocs and conventional) a Significance value of0.281 > 0.05,so that the maintenance media between bioflocs and conventional systems there is no difference. Based on the output of the interaction between seed size and maintenance media, the Sig. of 0.864 > 0.05, which indicates that there is no interaction between the two treatments. Furthermore, post hoc tests were carried out for seed size.

**Table 5. Differences in mean size of fish fry in bioflocs and conventional systems**

| Dependent Variable: Absolute Growth | | |
|---|---|---|
| **Seed Size in Bioflocs System (I)** | **Seed Size in Conventional System (J)** | **Mean Difference (IJ)** |
| Seed Size 3 | Seed Size 5 | -1267.1980* |
| | Seed Size 7 | -2252.0155* |
| Seed Size 5 | Seed Size 3 | 1267.1980* |
| | Seed Size 7 | -984.8175* |
| Seed Size 7 | Seed Size 3 | 2252.0155* |
| | Seed Size 5 | 984.8175* |

Based on Table 5 seed size ± 3.00 cm, in the bioflocs system showed a significant difference at the 0.05 level with fry of ± 5.00 cm and ± 7.00 cm in the conventional system,seed size ± 5.00 cm in the bioflocs system showed a significant difference at the 0.05 level with fry of ± 3.00 cm and ± 7.00 cm in the conventional system and seed size of ± 7.00 cm in the bioflocs system showed a significant difference in level of 0.05 with fry of ± 3.00 cm and ± 5.00 cm in conventional systems.The absolute number growth, the BFC7 treatment was able to grow 13% (K7), 54% (K3), 67% (K5), 57% (BFC3) and 22% (BFC5). Meanwhile, when compared between bioflocs and conventional systems of the same size, the results were 12% (BFC3 with K3), 14% (BFC5 with K5) and 13% (BFC7 and K7). Overall the bioflocs system was able to increase the average growth when compared to conventional systems in the range of 12-67% with an average of 29.73%. .

### 3.2 Specific Growth Rate (%/day)

Observations from stocking to harvesting with sampling were carried out every 10 days, from the beginning to the end of the study it can be seen that the Specific Growth Rate (%/day) of climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days can be seen in Table 6 and Fig. 2.

The highest value for the daily growth rate or Specific Growth Rate (%/day) was in the BFC7 treatment (8.419%), followed by the K7 treatment (8.313%), BFC5 (8.181%), K5 (8.044%), BFC3 (7.684%), and K3 (7,638 %). The results of the ANOVA test in this study showed that the output obtained a Significance value for the size of the climbing perch fish seed with a significance value of 0.000 <0.05, which indicates differences between treatments. Based on the output of rearing media (bioflocs and conventional) a significance value was obtained. of 0.315 > 0.05, so there is no difference in the maintenance media between the bioflocs and conventional systems. Based on the output of the interaction between seed size and rearing medium, a significance value of 0.839 > 0.05 was obtained, which indicated that there was no interaction between the two treatments. Then a post hoc test was carried outfor seed size to SGR (%/day)and bbased on Table. 7 , seed size ± 3.00 cm in the bioflocs system showed a significant difference at the 0.05 level with fry of ± 5.00 cm and ± 7.00 cm in the conventional system, seed size ± 5.00 cm in the bioflocs system showed a significant difference at the 0.05 level with fry of ± 3.00 cm in the conventional system and ± 7.00 cm seed size in the bioflocs system showed a significant difference at the 0.05 level with fry size ± 3.00 cm in conventional systems.The treatment of the seed size of the three treatments that were given a mean value was significantly different in all treatments, where the seed size of ± 7 cm had the best median value.Seed size 3 is in subset 1, different from seed sizes 5 and 7, which are in subset 2.

### 3.3 Standard Length Growth (cm)

Growth in standard length (cm ) can be seen in Table 8, Fig. 3.

Based on Table 8 and Fig. 3, the BFC3 treatment had a higher standard length difference (4.33 cm) followed by the K3 treatment (4.22 cm), BFC5 (3.56 cm), K5 (3.03 cm), BFC7 (2.60 cm) and K7 (1.32cm). while the highest average length during maintenance was in the BFC7 treatment (8.16 cm) and the lowest was in K3 (5.24 cm). This difference occurs due to the initial size treatment when stocking and rearing media. The growth in standard length of climbing perch fish has a significance value of 1,000 > 0.05, meaning that seed size has no significant effect on the growth of standard length, while the rearing media with the bioflocs and conventional systems also have no significant effect because of its significance value.1,000> 0.05, the significance value of the interaction between seed size and rearing medium was also not significantly different, because the value was 1.000 > 0.05, so a post hoc test was not needed.

### 3.4 Survival RATE (%)

The results and survival rates (%) of this study are presented in Table 9 and Fig. 4.

The results of the ANOVA test showed the significance value of the live climbing perch fish0.08 > 0.05,which shows seed size has no significant effect on survival, bioflocs and conventional maintenance media have a significant effect on survival because of their significance value0.000<0.05, while the significance value of the interaction between seed size and rearing media was not significantly different. The post hoc test for survival with maintenance media showed the results of the analysis in Table 7. The maintenance media for the bioflocs system had a significant effect compared to the conventional system on survival.

**Table 6. Specific Growth Rate (%/day) of climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days**

| Treatment | Days to | | | | | | | | | Total | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | | |
| **BFC3** | 6,739 | 7,111 | 7,362 | 7,572 | 7,731 | 7,938 | 8,113 | 8,218 | 8,374 | 69,157 | 7,684 |
| **BFC5** | 7,649 | 7,725 | 7,926 | 8,003 | 8,248 | 8,327 | 8,508 | 8,581 | 8,658 | 73,625 | 8,181 |
| **BFC7** | 8,089 | 8,195 | 8,290 | 8,353 | 8,423 | 8,479 | 8,551 | 8,659 | 8,732 | 75,771 | 8,419 |
| **K3** | 6,660 | 6,905 | 7,390 | 7,582 | 7,756 | 7,950 | 8,084 | 8,175 | 8,238 | 68,741 | 7,638 |
| **K5** | 7,573 | 7,686 | 7,756 | 7,873 | 8,090 | 8,185 | 8,304 | 8,426 | 8,498 | 72,392 | 8,044 |
| **K7** | 8,036 | 8,129 | 8,223 | 8,268 | 8,304 | 8,346 | 8,437 | 8,519 | 8,553 | 74,815 | 8,313 |

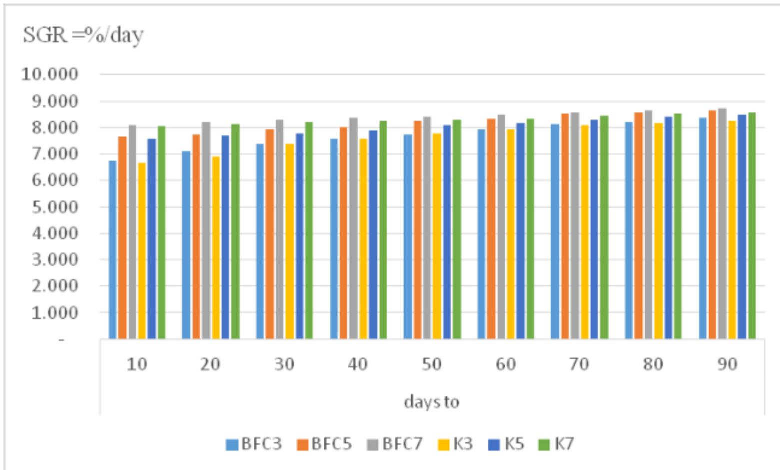


**Fig. 2. Specific growth rate (%/day) of climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days**

**Table 7. Post hoc test results for the size of climbing perch fry reared for 90 days**

| | | |
|---|---|---|
| **Dependent Variable: SGR<br>Independent Variable : Seed Size** | | |
| **Bioflocs System (I)** | **Conventional System (J)** | **Mean Difference (IJ)** |
| Seed Size 3 | Seed Size 5 | **-.4801*** |
| | Seed Size 7 | **-.7125*** |
| Seed Size 5 | Seed Size 3 | **.4801*** |
| | Seed Size 7 | -.2325 |
| Seed Size 7 | Seed Size 3 | .7125* |
| | Seed Size 5 | .2325 |

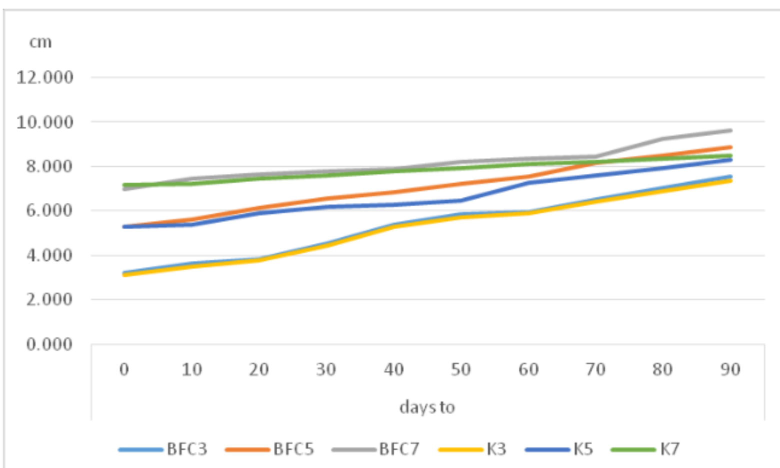


**Fig. 3. Growth in average standard length (cm) of climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days**

**Table 8. Growth in standard length (cm) of climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days**

| Treatment | Days to | | | | | | | | | | | Length difference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | Average | |
| BFC3 | 3,233 | 3,637 | 3,833 | 4,517 | 5,400 | 5,833 | 5,950 | 6,517 | 7,050 | 7,567 | 5,354 | 4,33 |
| BFC5 | 5,300 | 5,633 | 6,133 | 6,583 | 6,833 | 7,233 | 7,533 | 8,150 | 8,470 | 8,867 | 7,074 | 3,57 |
| BFC7 | 7,000 | 7,467 | 7,627 | 7,780 | 7,883 | 8,200 | 8,350 | 8,467 | 9,250 | 9,600 | 8,162 | 2,60 |
| K3 | 3,133 | 3,520 | 3,797 | 4,463 | 5,277 | 5,700 | 5,887 | 6,430 | 6,887 | 7,353 | 5,245 | 4,22 |
| K5 | 5,267 | 5,400 | 5,900 | 6,200 | 6,300 | 6,450 | 7,250 | 7,600 | 7,917 | 8,300 | 6,658 | 3,03 |
| K7 | 7,167 | 7,240 | 7,450 | 7,600 | 7,780 | 7,917 | 8,117 | 8,200 | 8,350 | 8,483 | 6,658 | 1,32 |

**Table 9. Average survival (%) of climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days**

| | Hari ke | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Perlakuan | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | Jumlah | Rerata |
| BFC3 | 99.667 | 99.110 | 99.113 | 99.667 | 99.890 | 99.780 | 99.777 | 100.000 | 100.000 | 897.003 | 99.667 |
| BFC5 | 94.223 | 92.220 | 94.223 | 94.223 | 96.223 | 92.220 | 96.110 | 94.667 | 99.890 | 854.000 | 94.889 |
| BFC7 | 98.074 | 99.443 | 99.333 | 99.667 | 99.410 | 99.780 | 99.557 | 98.447 | 98.557 | 892.268 | 99.141 |
| K3 | 96.777 | 93.557 | 97.000 | 98.333 | 99.667 | 99.333 | 98.330 | 82.333 | 83.000 | 848.330 | 94.259 |
| K5 | 86.333 | 84.333 | 84.113 | 84.443 | 86.223 | 84.000 | 82.777 | 89.337 | 90.447 | 772.007 | 85.779 |
| K7 | 93.663 | 56.777 | 84.777 | 83.553 | 81.330 | 80.333 | 86.333 | 89.220 | 82.000 | 737.987 | 81.999 |

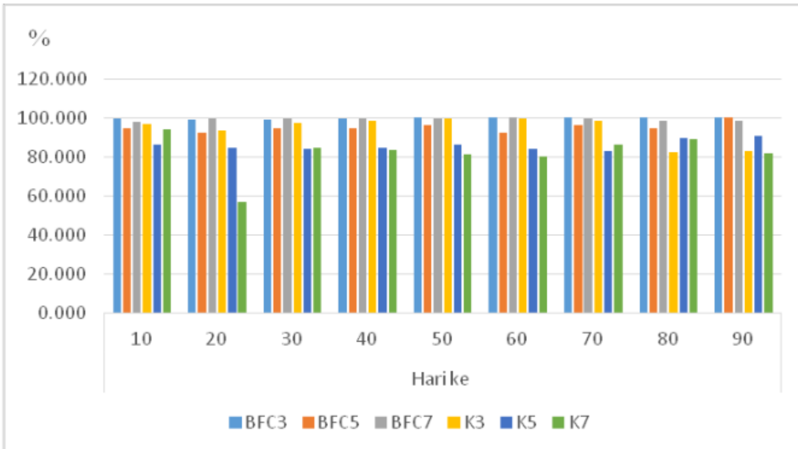


**Fig. 4. Average survival (%) of climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days**

**Table 10. Comparison of conventional and bioflocs maintenance media on the survival of climbing perch fish**

**Pairwise Comparisons**
**Dependent Variable: Graduation Life**

| (I) Maintenance Media | (J) Maintenance Media | Mean Difference (I-J) |
|---|---|---|
| Bioflocs System | Conventional System | **7.195*, b** |
| Conventional System | Bioflocs System | **-7.195*,c** |

The results of the living climbing perch fish during the study were based on the highest scores in the following order:BFC3 (99.67 %), BFC7 (99.14%), BFC3 (94.26%), K3 (94.26 %), K5 (85.78%) and K7 (82.00%). The survival range of the bioflocs system was 94.89-99.67% and that of the conventional system was 82.00 - 94.26%. Thus the bioflocs system is able to increase survival in the range of 5-14% when compared to conventional systems.

### 3.5 Feed Conversion Ratio (FCR)

Results and analysis of the average food conversion of climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days are presented in Table 11 and Fig. 5.

The results of the anova test in this study showed that the output obtained a Significance value for the size of the climbing perch fish fry with a significance value of 0.004 <0.05, which indicates a significant difference between treatments. Based on the output of the rearing media (bioflocs and conventional) a Significance value was obtained. of 0.00 < 0.05, so that the maintenance media between the bioflocs and conventional systems have a significant difference. Based on the output of the interaction between seed size and rearing media, it showed that there was no interaction between the two treatments. Then post hoc tests were carried out on the size of the fry and the rearing medium on the feed conversion ratio on a single basis. the mean difference between seed sizes 3, 5 and 7 in the bioflocs system and the conventional system showed no significant difference. All sizes were in subset 1. The average feed conversion ratio results during the experimental treatment were ordered as follows: BFC7 (1.316) BFC5 (1.319), BFC3 (1.359), K3 (1.763), K5 (1.816) and K7 (1.831). When viewed from this value, it shows that the bioflocs system is able to provide better feed efficiency than conventional systems in the range of 34-39%.

**Table 11. Feed conversion ratio for climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days**

| Treatment | Days to | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | |
| BFC3 | 1,3633 | 1,3533 | 1,3533 | 1,3567 | 1,3067 | 1,3567 | 1,3633 | 1,4067 | 1,3767 | 1,3596 |
| BFC5 | 1,3633 | 1,3100 | 1,3067 | 1,2267 | 1,3400 | 1,2833 | 1,3100 | 1,4067 | 1,3233 | 1,3189 |
| BFC7 | 1,3633 | 1,3100 | 1,3067 | 1,2267 | 1,2667 | 1,3167 | 1,3300 | 1,4067 | 1,3233 | 1,3167 |
| K3 | 1,9433 | 1,6667 | 1,8200 | 1,7267 | 1,8600 | 1,6900 | 1,7567 | 1,6500 | 1,7500 | 1,7626 |
| K5 | 2,3433 | 1,7500 | 1,7300 | 1,7500 | 1,8267 | 1,6633 | 1,6900 | 1,6600 | 1,9267 | 1,8156 |
| K7 | 2,2033 | 2,0700 | 1,9367 | 1,8300 | 1,9000 | 1,6900 | 1,6633 | 1,5833 | 1,6020 | 1,8310 |

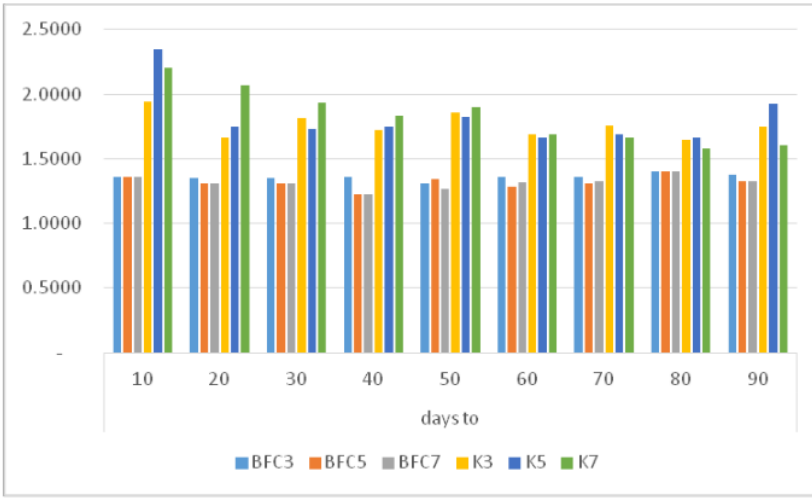


**Fig. 5. Feed conversion ratio for climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days**

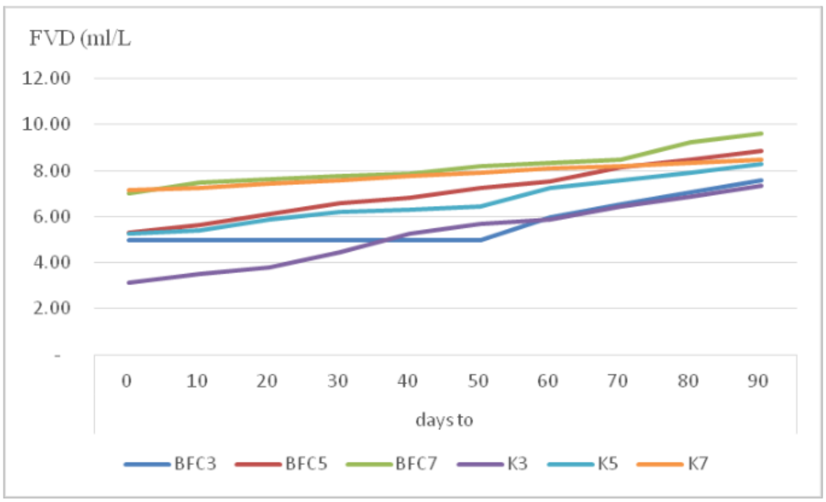


**Fig. 6. Floc content (ml/L) of climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days**

### 3.6 Floc Volume Density (FVD)

The floc volume density (ml/L) of climbing perch fish during the study can be seen in Table 12, Fig. 6. The mean value of the floc content in each treatment was sorted as follows: BFC 3 = 5.35 ml/L, BFC5 = 7.07 ml/L, BFC7 = 8.16 ml/L, K3 = 5.24 ml/L, K5 = 6.66 ml/L and K7 = 7.83 ml/L. The floc content in the conventional treatment is not biofloc produced by the system, because measurements using an Imhoff funnel only measure sediment from filtering one liter of media water.

**Table 12. Floc volume density (ml/L) of climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days**

| Treatment | Days to | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | |
| BFC3 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,00 | 5,95 | 6,52 | 7,05 | 7,57 | 5,35 |
| BFC5 | 5,30 | 5,63 | 6,13 | 6,58 | 6,83 | 7,23 | 7,53 | 8,15 | 8,47 | 8,87 | 7,07 |
| BFC7 | 7,00 | 7,47 | 7,63 | 7,78 | 7,88 | 8,20 | 8,35 | 8,47 | 9,25 | 9,60 | 8,16 |
| K3 | 3,13 | 3,52 | 3,80 | 4,46 | 5,28 | 5,70 | 5,89 | 6,43 | 6,89 | 7,35 | 5,24 |
| K5 | 5,27 | 5,40 | 5,90 | 6,20 | 6,30 | 6,45 | 7,25 | 7,60 | 7,92 | 8,30 | 6,66 |
| K7 | 7,17 | 7,24 | 7,45 | 7,60 | 7,78 | 7,92 | 8,12 | 8,20 | 8,35 | 8,48 | 7,83 |

**Table 13. Range and average results of measurements of water temperature (°C), pH, dissolved oxygen (mg/L) and dissolved ammonia (mg/L) of Climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days**

| Treatment | Water temperature (°C) | pH | Dissolved oxygen (mg/L) | Dissolved ammonia (mg/L) |
|---|---|---|---|---|
| BFC3 | 28.60 | 7.24 | 6.90 | 0.50 |
| BFC5 | 28.63 | 7.27 | 6.88 | 0.49 |
| BFC7 | 28.61 | 7.24 | 6.70 | 0.50 |
| K3 | 28.63 | 6.45 | 5.85 | 0.55 |
| K5 | 28.71 | 6.43 | 5.87 | 0.54 |
| K7 | 28.54 | 6.34 | 5.77 | 0.57 |

### 3.7 Water Quality

The results of water quality measurements (water temperature (°C), pH, dissolved oxygen (mg/L) and dissolved ammonia (mg/L) of climbing perch fish (*Anabas testudenius* Bloch) reared for 90 days can be seen in Table 13. The water temperature during the study period, air and water temperatures ranged from 28.54 to 28.71 (ºC).From the results of this study the range of acidity degrees in all treatments was in the range of 6.34 – 7.27. The average dissolved oxygen measurement results were in the range of 5.77 – 6.90 mg/L).the average measurement results for ammonia levels (mg/L) were in the range of 0.49 – 0.57 mg/L.

## 4. DISCUSSION

Discussion on the performance of growth and survival of climbing perch fish (Anabas testudenius Bloch) which were aquacultured for 90 days with the bioflocs system and the conventional system with differences in the initial size of the fry stocked from the observed parameters of absolute weight growth (grams) and specific growth rate - growth rate daily growth (%/day), standard length growth (cm), survival rate (%) feed conversion ratio, floc volume density (ml/L), water quality and plankton analysis are detailed below:

### 4.1 Absolute Weight Growth

The fry size ± 3.00 cm, in the bioflocs system showed a significant difference at the 0.05 level with fry of ± 5.00 cm and ± 7.00 cm in the conventional system, seed size ± 5.00 cm in the bioflocs system showed a significant difference at the 0.05 level with fry of ± 3.00 cm and ± 7.00 cm in the conventional system and the fry size of ± 7.00 cm in the bioflocs system showed significant differences at the 0.05 level with frys of ± 3.00 cm and ±5.00 cm in conventional systems. Based on absolute number growth, the BFC7 treatment was able to grow 13% of the treatment (K7), 54% (K3), 67% (K5), 57% (BFC3) and 22% (BFC5). Meanwhile, when compared between bioflocs and conventional systems of the same size, the results were 12% (BFC3 with K3), 14% (BFC5 with K5) and 13% (BFC7 and K7). Overall the bioflocs system was able to increase the average growth when compared to conventional systems in the range of 12-67% with an average of 29.73%. According to Ekasari [20] the application of bioflocs technology in rearing systems for several aquaculture species can increase net productivity by 8–43%, relative to non-bioflocs control (traditionally with water exchange, clear water systems or recirculating aquaculture systems).

Kohinoor, et al. [21] Reporting on growth performance was carried out to evaluate the growth performance and cross production of climbing perch fish (*Anabas testudineus* Bloch) The results showed that among the treatments in the growth system, the highest average yield weight was 69.25 ± 9.01 g found in T4 (Thai climbing perch) , which differed significantly (P<0.05) from all other treatments. While T3 (local climbing perch) also showed the lowest average harvest weight of 33.38 ± 8.74 g and showed a significant difference (P <0.05) among all treatments. The average harvest weight of the two groups of crosses, namely T1 and T2, were 50.83 ± 6.65 and 59.94 ± 7.83 g, respectively, and these results were not statistically significant (P>0.05) between them but significant among all other treatments.

The study evaluating the growth and performance of this study was conducted to evaluate the growth and production performance of Thai climbing perch and Vietnamese climbing perch (Anabas testudineus Bloch) for four months from April to July 2014. There were two treatments each with three replications. Three ponds in treatment-1 (T-1) were stocked with

Vietnamese climbing perch fish, while the other three ponds designated as treatment-2 (T-2) were stocked with Thai climbing perch. Fish were fed with commercial pellet feed (30% crude protein). Pond water quality parameters are monitored weekly and are within the acceptable range for fish farming. The average harvest weight for treatment-1 was significantly higher than treatment-2. After four months of rearing, the gross fish production was 15,352 and 9. 456 Kg/ha each obtained from Vietnam and Thailand lines. The results indicated that higher average growth and production were observed in the Vietnamese strain than the Thai climbing perch [21].

Fish stocking density is species specific and is considered as one of the important aspects for optimizing feed and water quality management in bioflocs systems [22,23]. This research was conducted to determine the optimum stocking density of superior cultivated fish species, namely perch anabas testudineus in the bioflocs system. Fish fingerlings with an average initial weight of 0.80 ± 0.02 g were reared in bioflocs tanks for 13 weeks with three different stocking densities, 300 (T-300), 450 (T-450), and 600 (T-600). m− 3 fish in triplicate, and the fish were fed a commercial diet at 3% of their body weight. At the final harvest, significant differences in growth and body composition were observed between treatments. T-300 and T-450 showed the same growth pattern ($p > 0.05$), while fish on T-600 recorded very poor growth ($p < 0.05$). Models fitted for all growth variables were quadratic, and individual daily feed intake was linear. Although the regression model for yield was not significant ($p = 0.072$), the highest yield (kg $m^{-3}$) was achieved at T-450. Dry matter, protein, and fish fat content remained unaffected ($p > 0.05$), whereas a significant difference in ash content ($p < 0.05$) was observed between treatments with the highest being found in fish from T-600. These results indicate that in the early stages of cultivation, the optimum stocking density of climbing perch fish in the bioflocs system was 300–450 m and fish fat remained unaffected ($p > 0.05$), whereas a significant difference in ash content ($p < 0.05$) was observed between treatments with the highest being found in fish from T-600. These results indicate that in the early stages of cultivation, the optimum stocking density of climbing perch fish in the bioflocs system was 300–450 m and fish fat remained unaffected ($p > 0.05$), whereas a significant difference in ash content ($p < 0.05$) was observed between treatments with the highest being found in fish from T-600. These results indicate that in the early stages of cultivation, the optimum stocking density of climbing perch fish in the bioflocs system was 300–450 m³ [24].

Referring to this study of all the treatments given as a whole the bioflocs system was able to increase the average growth compared to the conventional system in the range of 12-67% with an average of 29.73%.

## 4.2 Specific Growth Rate

The highest value for the daily growth rate or Specific Growth Rate (%/day) was in the BFC7 treatment (8.419%), followed by the K7 treatment (8.313%), BFC5 (8.181%), K5 (8.044%), BFC3 (7.684%), and K3 (7,638 %). Kazi et al. [25] reported a range of mean weight gain (grams) 27.48±0.62c with SGR (%) 2.24±0.03c - 2.52±0.03a. Daily average weight gain (3.18±1.576g/d) [26]. Kazi et al, 2021, reported specific growth rates (SGR) ranging from 1.75 to 2.30%/day. Hasan et al. [27] stated that the SGR value of climbing perch fish reared in hapa ranged between 3.69 and 3.82% day-1 which was higher than the current study. Uddin et al [28] found that the SGR value of climbing perch fish kept in cages in Kaptai Lake ranged between 2.24 and 2.52%/day.The results of the study [29] showed that the SGR range was between 4.08 ± 0.52- 4.09 ± 1.11ns (%/day).

Arnuparp, et al. [29] using three local glucose sources consisting of molasses, rice flour and rice bran especially the last two carbon sources designed to be combined with molasses in a ratio of 50 : 50 before being added to the aquaculture ponds. The experiment was carried out in a cylindrical shape with a diameter of 2.5 m. and 1m. height by 0.8 m. water depth. The water volume was maintained between 2.5 -3 tonnes at all times along with dissolved oxygen maintained above 4 mg/L throughout the culture period. The stocking density of fish was stocked at a rate of 50 fish/$m^3$. Fish were fed according to the catfish feeding program within 120 days before harvest. All three carbon sources are added to the system when the ammonia reaches more than 0.05 mg./L together with controlling 15 : 1 for the C : N ratio. The results showed that the growth of climbing perch fish reached the largest market size, namely 4 fish/kg. When to add all carbon sources. In addition, body weight gain, average daily weight gain, feed conversion ratio, specific growth rate and survival rate were not significant (P>0.05). However, it had a significant relationship between fish growth and bioflocs concentration in each treatment (P<0.05). Therefore, climbing perch fish is one of the most suitable species to be cultivated in a bioflocs system by adding rice flour or bran as a good alternative carbon source. specific growth rate and survival rate were not significant (P>0.05). However, it had a significant relationship between fish growth and bioflocs concentration in each treatment (P<0.05). Therefore, climbing perch fish is one of the most suitable species to be cultivated in a bioflocs system by adding rice flour or bran as a good alternative carbon source. specific growth rate and survival rate were not significant (P>0.05). However, it had a significant relationship between fish growth and bioflocs concentration in each treatment (P<0.05). Therefore, climbing perch fish is one of the most suitable species to be cultivated in a bioflocs system by adding rice flour or bran as a good alternative carbon source.

If the results of this study are related to the results of previous studies, especially with a higher Specific Growth Rate, for fry sizes 3, 5, and 7 reared in bioflocs systems and conventionally using floating pellet feed with 34% protein and the presence of a floc content with 36.42% protein, as well as the possibility of differences in endemic varieties of climbing perch fish thought to be triggers in daily growth. The treatment with a stocking density of 7 cm in the bioflocs system compared to other treatments because it had the highest specific growth rate (SGR) (8,419%) and was higher than previous studies.

### 4.3 Standard Length

The BFC3 treatment had a higher standard length difference (4.33 cm) followed by the K3 treatment (4.22 cm), BFC5 (3.56 cm), K5 (3.03 cm), BFC7 (2.60 cm) and K7 (1.32cm). While the highest average length during maintenance was in the BFC7 treatment (8.16 cm) and the lowest was in K3 (5.24 cm). This difference occurs due to the initial size treatment when stocking and rearing media. Haque et al. [30] reported the final average length gain (cm) of Vietnamese climbing perch fish in the range of 13.58 ± 0.01 - 13.70 ± 0.03, cm. with initial length not informed only an average weight of 1.01 gram during maintenance September 01, 2013 to April 02, 2014 (7 months). Widiyati et al, [31], used frys of initial length in the range of 2-3 cm, but did not inform the length at the end of the study, only provided information on the initial weight in grams and the final weight in grams. With weight gain in the range of 1.83-2.73 grams during 40 days of maintenance. Kazi et al, [25] used an average initial length of 5.80 cm, during 90 days of rearing it produced a final length in the range (cm) 11.15 ± 1.04a -12.50 ± 0.66a, with a difference range of 5.35 – 6.70 cm. Anantharaja et al. [32], used the initial size with a length range of 5.60 ± 0.57 cm while the final length in the aquaponic system was 9.02 ± 0.54 cm and 8.19 ± 0.59 cm in the conventional system with an additional length of 3.6 cm and 2.59 respectively cm during maintenance of 42 days.

The treatment with stocking density of 7 cm in the bioflocs system was more than the other treatments with a difference in length of 4.33 cm and a final length of 8.16 cm.

### 4.4 Survival Rate

The survival results of climbing perch fish during the study based on the highest score were sorted as follows: BFC3 (99.67%), BFC7 (99.14%), BFC3 (94.26%), K3 (94.26%), K5 (85.78%) ) and K7 (82.00%). Haque et al [30], reported a range between 92.50 ± 2.200- 95.12 ± 1.120 (%)., Waseeh et al, [26] reported a range of 92.75% - 98.5%, Jannat et al [5] reported the survival rate of climbing perch fish ranged from - 96.57 ±0.03a %. Mandal et al. [33], which also shows the same thing (96%). Whereas Zafar, et al, [13], reported for the Vietnamese climbing perch variety the survival range was 93.25 - 95.14% and the mature variety was 64.00 – 72.00% [25], the survival rate of the research was around 57.67 ± 1.53c - 71 ± 1.0a 67±1.0b %. The highest (93.60%) and lowest (83.06%) survival rates were in Thai climbing perch (T4) and local climbing perch (T3) [21]. Survival rate (%) 95.15±0.43 ns96 - 96 . 0 6 ± 0 . 0 8 ns [29].

If seen from the value of the research results, both the treatment of fry size and the maintenance media of the bioflocs and conventional systems are in accordance with several previous studies. The best value is obtained attreatment with stocking density of fry size±7cm and± 3 cmin the bioflocs systemwith a passing grade of 99.67%. The survival range of the bioflocs system was 94.89-99.67% and that of the conventional system was 82.00 - 94.26%. Ekasari et al. [20]; Ekasari et al. [34]; Emerenciano et al. [35], argued thatBioflocs technology can support the provision of good quality fry by increasing the reproductive performance of aquaculture fish and increasing the immunity and resistance of fish.

The bioflocs system is able to increase survival in the range of 5-14% when compared to conventional systems [36,37]. It is suspected that the small seed size is able to adapt to the rearing environment and the ability of the climbing perch fish disease resistance to be smaller is better.

### 4.5 Feed Convention Ratio

The average feed conversion results during the treatment study were ordered as follows: BFC7 (1.316) BFC5 (1.319), BFC3 (1.359), K3 (1.763), K5 (1.816) and K7 (1.831). When viewed from this value, it shows that the bioflocs system is able to provide better feed efficiency than conventional systems in the range of 34-39%.

Arnuparp, et al. [29] reported that the feed conversion ratio (FCR) research results ranged from 1.55 ± 1.32 - 1.57 ± 1.02The feed conversion ratio (FCR) values of research results [26] ranged from 1.48 to 1.85, and 1.56. Kazi et al, [25] reported that FCR food conversion values ranged from 2.81 to 3.19, the lowest value. Uddin et al. [28] reported FCR ranging from 2.65 to 2.93 when cultured in Kaptai Lake cages. The results of this study have similarities with Christensen's experiments. Hasan et al [27] reported that the FCR values of climbing perch fish kept in hapa ranged from 3.31 to 3.99, higher than this study. This is presumably due to the use of low quality pellet feed by Hasan et al [27], Moniruzzaman et al [38] observed FCR (2.81-3.19).

When compared with the results of the above studies it is better for maintenance in the bioflocs system. While the conventional system is still in line with previous research. The handling of the production of bioflocs media, availability of flock and feed content of 34% protein and floc protein content of 36% is thought to have resulted in a better feed conversion ratio.The bioflocs system is able to provide better feed efficiency than conventional systems in the range of 34-39%.

### 4.6 Floc Volume Density (FVD)

The mean value of floc volume density (FVD) in each treatment was ordered as follows: BFC 3 = 5.35 ml/L, BFC5 = 7.07 ml/L, BFC7 = 8.16 ml/L, K3 = 5.24 ml/L, K5 = 6 .66 ml/L and K7 = 7.83 ml/L. The floc content in the conventional treatment is not bioflocs produced by the system, because measurements using an Imhoff funnel only measure sediment from filtering one liter of media water. According to [25], ideal floc content in a bioflocs system for shrimp is in the range of 5 – 15 ml/L, tilapia fry is in the range of 5-20 ml/L, juvenile to adult size (consumption size) is in the range of 20 - 50 ml/L. According to Avnimelech [19], the number of flocks in the range between 1-10 mg/liter is considered low and between 10-20 mg/liter is considered moderate. The floc content of climbing perch fish reared by bioflocs and conventional systems was in the range of 15.50 – 43.06 ml/L [39]. Because the range of flocs for all treatments was in the range of 5.24 – 8.16 ml/L, in line with the opinion [35], but lower than the results of the study [39]. Thus the results of this research are ideal according to [35], whereas according to Avnimelech [19], the number of flocs in the range between 1-10 mg/liter is considered low and between 10-20 mg/liter is considered moderate. Arnuparp et al [29], reported the floc content of Papua fish rearing in the range of 170 ± 0.81b - 190 ± 0.10. (mg/L) . Sumitro et al [40] reported a floc volume density of 60-80 ml/L, more suitable for cultivating catfish in a bioflocs system. Thus there is an opportunity to increase the content of floc so that the availability of bioflocs is more consumed by Papua fish.

### 4.7 Water Quality

The water temperature during the study period, air and water temperatures ranged from 28.54 to 28.71 (°C).From the results of this study the range of acidity degrees in all treatments was in the range of 6.34 – 7.27. The average dissolved oxygen measurement results were in the range of 5.77 – 6.90 mg/L).the average measurement results for ammonia levels (mg/L) were in the range of 0.49 – 0.57 mg/L.The temperature ranges in studies on conventional and bioflocs systems are within acceptable ranges for fish farming, and these results are consistent with the findings of Uddin et al [41], Uddin et al [28], Bashar et al [42], Bashar et al [43], Moniruzzaman et al [38], and Moniruzzaman et al [44]. Boyd (1982) has also reported that the water temperature range from 26.06 to 31.97°C is suitable for fish farming whereas according to [35],in the bioflocs system in the range of 28–30° [29] reported water quality for climbing perch fish in the bioflocs system with a water temperature range of 26.80 - 30.67 °C. A good degree of acidity for the bioflocs system is in the range of 6.8–8.0 [35], while the results of the study were lower than the results of the study [39] on the climbing perch fish bioflocs system in the range of 7.6 – 7.8 [29] reported water quality for climbing perch fish using the bioflocs system with an acidity range of 7.85 – 8.14.

Oxygen is the most important stress factor with a direct impact on the health and survival of caged fish [45]. For optimal fish growth, DO levels should be above 5 ppm for warm water fish species (Boyd 1982). The DO concentration at the experimental sites ranged from 5.1 to 7.8 mg L-1, which is within the acceptable range for aquaculture and is in line with the findings of Uddin et al [28] Bashar et al [42], Bashar et al [43], and Alamgir [46]. However, fish can survive at concentrations of 0.50 mg L-1 ,, but the most suitable DO range for fish farming is suggested from 5.0 to 8.0 mg L-1 (DoF 1996) [30, suggested that the dissolved oxygen content of the bioflocs system was above 4 mg/L [23] reported water quality for climbing perch fish using the bioflocs system with a dissolved oxygen range of 4.80 - 5.01 mg/L. From the results of this study, the dissolved oxygen content in all treatments was within 5.87 - 6.90 mg/L. Thus the dissolved oxygen content is good for the formation of bioflocs, the growth and life of the Papuan fish [35] dissolved ammonia content should be less than 1 mg/L whereas according to [39] the results of research on the climbing perch fish bioflocs system obtained values in the range0.24 ± 0.05c - 0.78 ± 0.10a, Ammonia-nitrogen (mg/L) 0.05-0.85 0.06-0.92 [21,29] reported water quality for climbing perch fish using the bioflocs system with a dissolved ammonia range of 0.019 - 0.021 mg/L .

## 5. CONCLUSION

1. The bioflocs system was able to increase the average growth when compared to conventional systems in the range of 12-67% with an average of 29.73%.The highest value for the daily growth rate or Specific Growth Rate (%/day) was for fry with a size of 7 cm in the bioflocs system (8,419%). The seed size of 3 cm in the bioflocs system had the highest standard length difference (4.33 cm) while the highest average length during maintenance was the seed size of 7 cm in the bioflocs system.
2. The results of the living climbing perch fish during the study based on the highest score were at 3 cm seed size in the bioflocs system. The survival range of the bioflocs system is 94.89 - 99.67 % and that of the conventional system is 82.00 - 94.26%. Thus the bioflocs system is able to increase survival in the range of 5-14% when compared to conventional systems.
3. The bioflocs system is able to provide better feed efficiency than conventional systems in the range of 34-39%. The average value of floc content in the bioflocs system is in the range of 5.35 – 8.16 ml/L, still quite ideal but can still be improved.
4. The water temperature during the study period, air and water temperatures ranged from 28.54 to 28.71 (°C),degree of acidity in all treatments in the range of 6.34 – 7.27, dissolved oxygen levels in the range of 5.77 – 6.90 mg/L) whilethe average measurement results for ammonia levels (mg/L) were in the range of 0.49 – 0.57 mg/L.The temperature ranges in the studies on conventional and bioflocs systems are within the acceptable range for fish farming.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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