JURNAL PERIKANAN DAN KELAUTAN
Volume 29 No. 1, February 2024: 86-93

e-issn : 2721-8902
p-issn : 0853-7607

Effect Nitrobacter with Different Dosage of Water Quality Parameters for Maintenance Media of North African Catfish (*Clarias gariepinus*)

Pengaruh Nitrobacter dengan Dosis Berbeda terhadap Parameter Kualitas Air untuk Media Pemeliharaan Benih Ikan Lele Sangkuriang (Clarias gariepinus)

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Received
December 13, 2023

Accepted
January 30, 2024

Abstract

North African catfish (*Clarias gariepinus*) is a food ingredient with high protein content, so it is needed as a source of nutrition. In intensive catfish farming activities, there are constraints on water quality. The high stocking density causes a high value of ammonia. In addition, Nitrobacter, in an intensive aquaculture system, is expected to improve water quality. Especially ammonia, so that it can increase the growth and survival of fish. This study aims to determine the effect of Nitrobacter with different doses on the maintenance of North African catfish. This research was conducted from September to October 2022 at the Aquaculture Environmental Quality Laboratory, Department of Aquaculture, Faculty of Fisheries and Marine, Universitas Riau, Pekanbaru. The research method used in this study was a completely randomized design (CRD) 1 factor with five treatment levels and three replications. The treatment in this research is P0: Dosage Nitrobacter 0 mL/L, P1: Dosage Nitrobacter 0.5 mL/L, P2: 1 mL/L, P3: 1.5 mL/L, and P4: 2 mL/L. Giving Nitrobacter is done once a week according to the dose of each treatment. This research was conducted for 30 days. The research results show that dosing Nitrobacter has different effects on reducing ammonia levels and maintaining North African catfish. The best treatment was P3 1.5 mL/L with the smallest ammonia content of 0.0403 mg/L. a specific growth rate of 0.98%. An absolute growth rate of 0.76 g, an absolute length of 1.06 cm, and a survival rate of 81.4%. The value of water quality during the research was 29-30^{0}C, pH 6.5-7.0, and DO 2.9-3.3 mg/L. The value of water quality during the study was good enough to support the survival of North African catfish.

Keywords: Ammonia, Nitrobacter, North African catfish.

Abstrak

Ikan lele sangkuriang (*Clarias gariepinus*) merupakan bahan pangan dengan kandungan protein yang tinggi sehingga sangat dibutuhkan sebagai sumber gizi. Pada kegiatan budidaya ikan lele secara intensif terdapat kendala pada kualitas air. Padat tebar yang tinggi menyebabkan tingginya nilai amoniak. Penambahan Nitrobacter pada sistem budidaya intensif diharapkan mampu memperbaiki kualitas air terutama amoniak sehingga dapat meningkatkan pertumbuhan dan kelangsungan hidup ikan. Penelitian ini bertujuan untuk mengetahui pengaruh Nitrobacter dengan dosis yang berbeda pada pemeliharaan ikan patin Afrika Utara. Penelitian ini dilaksanakan pada bulan September - Oktober 2022 di Laboratorium Kualitas Lingkungan Budidaya Perairan, Departemen Budidaya Perairan. Fakultas Perikanan dan Kelautan, Universitas Riau, Pekanbaru. Metode penelitian yang digunakan dalam penelitian ini adalah Rancangan Acak Lengkap (RAL). 1 faktor dengan 5 taraf perlakuan dan 3 kali ulangan. Perlakuan dalam penelitian ini adalah: P0: Dosis Nitrobacter 0 mL/L, P1: Dosis Nitrobacter 0,5 mL/L, P2: 1 mL/L. P3: 1,5 mL/L, dan P4: 2 mL/L. Pemberian nitrobacter dilakukan seminggu sekali sesuai dengan dosis masing-masing perlakuan. Penelitian ini dilakukan selama 30 hari. Hasil penelitian menunjukkan bahwa pemberian dosis Nitrobacter berbeda pengaruhnya terhadap penurunan kadar amoniak pada pemeliharaan ikan lele sangkuriang. Perlakuan terbaik adalah P3 1,5 ml/L dengan kadar amoniak terkecil yaitu 0,0403 mg/L. Laju pertumbuhan spesifik 0,98%. laju pertumbuhan mutlak 0,76 g dan panjang mutlak 1,06 cm serta tingkat kelangsungan hidup tertinggi 81,4%. Nilai kualitas air selama penelitian suhu 29-30^{0}C, pH 6,5-7,0, dan DO 2,9-3,3 mg/L. Nilai kualitas air selama penelitian cukup baik untuk mendukung kelangsungan hidup ikan lele sangkuriang.

Kata kunci: Amonia, Nitrobacter, Ikan lele sangkuriang.

1. Introduction

North African catfish (*Clarias gariepinus*) is a food ingredient with high protein content. So, it is needed as a source of nutrition in intensive catfish farming. There are constraints on water quality. High stocking densities and accumulated feed waste lead to elevated ammonia values. The feed given exceeds the daily dose, or the presence of environmental factors that affect fish appetite causes suspended solids to increase and settle to the bottom of the pond (Hasibuan et al. 2019). Adding Nitrobacter in the intensive aquaculture system is expected to improve water quality. Especially ammonia, so that it can increase the growth and survival of fish. This study aims to determine the effect of Nitrobacter with different doses on the maintenance of north Asian catfish. The benefits of this research are getting the best Nitrobacter dose in the upkeep of North Asian catfish and reducing ammonia levels during rearing.

According to Rosmaniar (2011), two groups of autotrophic bacteria carry out nitrification (biological oxidation of ammonium). Nitrosomonas requires ammonium as an energy source, and Nitrobacter requires nitrite. Mustofa (2015) stated that the high nitrate content is thought to result in minimal decomposition by aquatic microorganisms. Nitrate is the end product of the nitrification process, namely, the oxidation of ammonia to nitrite and nitrite to nitrate. Water conditions can cause changes in nitrate values. According to Kordi (2010), biologically ammonia can be converted into nitrate (NO_3), a harmless form of nitrification.

Nonetheless, the high ammonia level in intensive cultivation illustrates that the amount of Nitrobacter present can still not balance the amount of ammonia produced. Therefore, adding Nitrobacter in intensive aquaculture systems is expected to improve water quality. Especially ammonia, so that it can increase fish growth and production. This study aims to determine the effect of giving Nitrobacter with different doses on water quality parameters in North Asian catfish rearing media.

2. Material and Method

2.1. Time and Place

This research was conducted from September to October 2022 at the Aquaculture Environmental Quality Laboratory, Department of Aquaculture, Faculty of Fisheries and Marine, Universitas Riau, Pekanbaru.

2.2. Methods

The research method used in this study was a completely randomized design (CRD), one factor with five treatment levels and three replications (Sudjana, 1991). Based on the information printed on the Nitrobacter bottle. The number of Nitrosomonas and Nitrobacter bacteria contained in 1 L is 1x10^8 CFU/mL. The level of treatment in this research is:

P0: Nitrobacter dose 0 mL/L
P1: Nitrobacter dose 0.5 mL/L (5 x10^7 CFU)
P2: Nitrobacter dose 1 mL/L (1 x10^8 CFU)
P3: Nitrobacter dose 1.5 mL/L (15x10^7 CFU)
P4: Nitrobacter dose 2 mL/L (20x10^7 CFU)

2.3. Procedures

2.3.1. Container Preparation

The maintenance container to be used is an aquarium 30 x 30 x 30 cm. The container is washed using clean water and 10% KMnO4 (PK solution). Then, the containers were arranged and randomized as many as 15 units. After entering the water into the research vessel, the following process is mixing the water with 10 g/m³ of urea on a sunny day. In this study, 18 L of aquarium water required 0.18 g of urea. Then, in the evening, Nitrobacter is put into the water with the doses according to the treatment and left for five days (Pasaribu et al., 2016).

2.3.2. Maintenance and Feeding

According to Pasaribu et al. (2016), fish fries were added after the Nitrobacter bacteria were included in the research media and left for five days. The North Asian catfish from farmers in Pekanbaru had a stocking density of 1 fish/L according to the stocking density of catfish fry carried out. 18 L of water is used, so 18 fish are needed with 5-7 cm size in each container, with a total number of frys of 270 fish. Fry maintenance was carried out for 30 days with a frequency of feeding three times daily, namely at 07.00, 12.00, and 17.00 WIB add-satiation with feed in commercial pellets (PF-800).

2.4. Parameters Measured

The parameters measured in this study were water quality, namely ammonia, nitrite, nitrate, pH, dissolved oxygen, and temperature. Water quality parameters were measured at the beginning of the study (day 1), mid-study (day 15), and the end of the study (day 30).

2.5. Data Analysis

Water quality data, namely ammonia, nitrite, and nitrate, are presented in tabular and graphical form. pH, dissolved oxygen, and temperature are shown in tabular form. Data on weight growth, length growth, specific growth rate, and survival are presented in graphical form. Furthermore, the data were analyzed using analysis of variance (ANOVA).

3. Result and Discussion

3.1. Water Quality

Water quality plays a vital role in the survival of North Asian catfish. The water quality parameters measured in this study included ammonia, nitrite, nitrate, pH, dissolved oxygen, and temperature. Ammonia is a form of inorganic N, which is harmful to fish. If the concentration of ammonia and nitrite is high in the rearing medium, they will cause death in fish (Wahyuningsih & Gitarama, 2020), Likewise with nitrates. High nitrate can cause eutrophication, which can trigger rapid algae growth (blooming) so that it can reduce dissolved oxygen concentration at night (Mustofa, 2020). Ammonia measurements during the study can be seen in Table 1.

Table 1. Ammonia concentration during the study

Treatment	Day 1 (mg/L)	Day 15 (mg/L)	30 day (mg/L)
P0 (0 mL/L)	0.1278 ± 0.00020^{e}	0.1454 ± 0.00025^{e}	1.0070 ± 0.00020^{e}
P1 (0.5mL/L)	0.0683 ± 0.00031^{c}	0.0823 ± 0.00031^{c}	0.0803 ± 0.00010^{c}
P2 (1mL/L)	0.0543 ± 0.00055^{b}	0.0788 ± 0.00023^{b}	0.0718 ± 0.00025^{b}
P3 (1.5 mL/L)	0.0473 ± 0.00030^{a}	0.0508 ± 0.00010^{a}	0.0403 ± 0.00025^{a}
P4 (2 mL/L)	0.0692 ± 0.00020^{d}	0.0858 ± 0.00021^{d}	0.0841 ± 0.00010^{d}
Standard		<0.1 mg/L (Kordi, 2010)	

Note: the average value followed by a different letter in the same column indicates a significant difference.

Based on Table 1, it can be seen that the ammonia level on Day 1 of the P0 treatment was 0.1278 mg/L. There was an increase on Day 15, namely 0.1454 mg/L, and it continued to increase on Day 30, namely 1.0070 mg/L. The lowest ammonia level at the beginning of the study was at P3 of 0.0473 mg/L, and the highest ammonia level at P0 was 0.1278 mg/L. Based on the results of the ANOVA test, it showed $p < 0.005$, meaning that giving different Nitrobacter doses significantly affected ammonia levels. The value of ammonia in this treatment was relatively lower than the other treatments and the treatment without Nitrobacter (P0). This shows that Nitrobacter, with a dose of 1.5 mL/L, can effectively reduce ammonia levels. The amount or dose of Nitrobacter influenced this study's decrease in ammonia levels.

The lowest ammonia level at the beginning of the study was at P3 of 0.0473 mg/L, and the highest ammonia level at P0 was 0.1278 mg/L. According to Widanarni et al. (2012), autotrophic bacteria (Nitrosomonas) can utilize the remaining uneaten feed and fish feces at the bottom of the waters and then oxidize the ammonia content. According to Ernawati et al. (2019), this is also that autotrophic bacteria (Nitrosomonas) prevents the accumulation of organic nitrogen at the bottom of the rearing medium, which can degrade water quality. This also shows that P0 has an ever-increasing ammonia level because it was not given Nitrobacter during the study. The increase in ammonia levels in this treatment was due to the remaining feed and feces, which accumulated and took place daily. No siphoning or water replacement was carried out. Hasibuan et al. (2021) stated that high stocking densities and feeding can cause a decrease in water quality due to the accumulation of metabolic wastes such as ammonia, which is toxic to the fish that are kept. The following is the data from Nitrite measurements, as seen in Table 2.

Table 2. Nitrite concentration during research

Treatment	Day 1 (mg/L)	Day 15 (mg/L)	30th day (mg/L)
P0 (0 mL/L)	1.0886 ± 0.00021 ^{e}	1.1730 ± 0.00020 ^{e}	1.3101 ± 0.00015 ^{e}
P1 (0.5mL/L)	0.2975 ± 0.00010 ^{c}	0.7405 ± 0.00050 ^{c}	0.4030 ± 0.00038 ^{c}
P2 (1mL/L)	0.2236 ± 0.00010 ^{b}	0.6350 ± 0.00050 ^{b}	0.3713 ± 0.00025 ^{b}
P3 (1.5 mL/L)	0.1392 ± 0.00020 ^{a}	0.5084 ± 0.00010 ^{a}	0.2975 ± 0.00026 ^{a}
P4 (2 mL/L)	0.3924 ± 0.00020 ^{d}	0.8143 ± 0.00021 ^{d}	0.4979 ± 0.00012 ^{d}
Standard	< 1 mg/L (Kusumawati et al., 2018)		

Note: the average value followed by a different letter in the same column indicates a significant difference.

Based on Table 2 and Figure 2, treatment P0 had the highest nitrite concentration, which ranged from 1.0886-1.3101 mg/L, while treatment P3 had the lowest range, which ran from 0.1392 – 0.2975 mg/L. This shows that the administration of Nitrobacter with different doses had a significant effect ($p < 0.05$) on nitrite concentrations in maintaining North African catfish (*C. gariepinus*)

Changes in nitrite concentrations P1 can be seen in P2, P3, and P4 decreased on day 30, and only at P0 did the concentration increase. Kusumawati et al. (2018) stated that the recommended nitrite concentration for catfish farming is <1 mg/L. Nitrite is a compound formed from the nitrification process with the help of aerobic bacteria. Where ammonia is converted to nitrite and nitrate (Emilia, 2019), nitrite concentrations >0.05 mg/L can be toxic to very sensitive aquatic biota. The high nitrite concentration in the P0 treatment is likely due to the absence of bacteria that can oxidize nitrite to nitrate. According to the statement (Dhiba et al., 2019), organic matter accumulated from leftover feed and fish feces in the rearing media can become ammonia. This then undergoes a nitrification process to form nitrites in water. In addition, nitrite levels are also affected by the absence of utilization of nitrite compounds by microorganisms to convert them into nitrates. Below are the results of Nitrate measurements, which can be seen in Table 3.

Table 3. Nitrate concentration during the study

Treatment	Day 1 (mg/L)	Day 15 (mg/L)	30th day (mg/L)
P0 (0 mL/L)	0.1479±0.00040^{a}	0.2000±0.00047^{a}	1.0021±0.00066^{a}
P1 (0.5mL/L)	0.3458±0.00065^{c}	0.4083±0.00026^{c}	1.1792±0.00065^{c}
P2 (1mL/L)	0.4083±0.00066^{d}	0.4917±0.00021^{d}	1.2104±0.00053^{d}
P3 (1.5 mL/L)	1.0750±0.00108^{e}	2.0125±0.00030^{e}	3.0333±0.00076^{e}
P4 (2 mL/L)	0.2833±0.33452^{b}	0.2938±0.00015^{b}	1.1063±0.79381^{b}
Standard	< 5 mg/L (Pratama et al., 2020)		

Note: the average value followed by a different letter in the same column indicates a significant difference.

Table 3 shows that the lowest nitrate value was found at P0 on Day 1 at 0.1479 mg/L, day 15 at 0.2000 mg/L, and Day 30 at 1.0021 mg/L. In the P1 treatment, the nitrate value on Day 1 was 0.3458 mg/L, Day 15 was 0.4083 mg/L, and Day 30 was 1.1792 mg/L. The nitrate value in the P2 treatment on Day 1 was 0.4083 mg/L. On Day 15, it was 0.4917 mg/L; and on Day 30, it was 1.2104 mg/L. The highest nitrate values were found during the study in the P3 treatment. The P3 nitrate value on Day 1 was 1.0750 mg/L, day 15 was 2.0125 mg/L, and day 30 was 3.0333 mg/L. At P4, the nitrate value on Day 1 was 0.2833 mg/L, week 2 was 0.2938 mg/L, and day 30 was 1.1063. The standard limit for Nitrate concentration for catfish is less than five mg/L (Pratama et al., 2020). This shows that administering Nitrobacter with different doses had a significant effect ($p<0.05$) on nitrate concentrations in maintaining North Asian catfish fry. The high value of nitrate compared to ammonia and nitrite indicates that a good nitrification process has occurred. The low value of nitrite compared to ammonia and nitrate also shows a good nitrification process (Mustofa, 2020). This is because, naturally, the reaction of nitrite to nitrate is much greater than the conversion of ammonia to nitrite (Kabalmay et al., 2017).

Based on Table 4, the pH values obtained in all treatments (P0, P1, P2, P3, and P4) during the study were 6.0-7.0. Syafriadiman et al. (2005) stated that a pH of 7 – 9 is ideal for fish farming. The results of water quality measurements obtained during the study were within a reasonable range for the maintenance of North Asian catfish. Treatment P4 has the lowest range at the end of the study compared to P0, P1, P2, and P3. This happens because of the high dose of Nitrobacter given: the more bacteria, the respiration process. The process of respiration in the ecosystem will increase the amount of carbon dioxide so that the pH of the water decreases (Elpawati et al., 2015). According to Syafriadiman (2016), the decrease in pH value is due to the overhaul of organic matter and humus by microorganisms, reducing pH. The increase in the pH value is due to the formulation of fertilizer in the form of fly ash containing carbon, which raises the pH, and the calcification carried out is also a factor in increasing the pH.

Table 4. pH measurement

Treatment	Day 1	Day 15	30th day
P0 (0 mL/L)	7.0	7.0	6.7
P1 (0.5mL/L)	7.0	7.0	6.7
P2 (1mL/L)	7.0	6.7	6.7
P3 (1.5 mL/L)	7.0	6.6	6.5
P4 (2 mL/L)	7.0	6.5	6.0
Standard	6-8 (BSN, 2004)		

Table 5. DO measurement

Treatment	Day 1 (mg/L)	Day 15 (mg/L)	30th day (mg/L)
P0 (0 mL/L)	3.0	3.2	2.8
P1 (0.5mL/L)	3.2	3.2	2.8
P2 (1mL/L)	3.2	3.2	2.8
P3 (1.5 mL/L)	3.2	3.2	2.8
P4 (2 mL/L)	3.1	3.0	2.5
Standard	>3 mg/L (BSN, 2004)		

Table 6. Temperature measurement

Treatment	Day 1 (^{O}C)	Day 15 (^{O}C)	30th day (^{O}C)
P0 (0 mL/L)	29	29	31
P1 (0.5mL/L)	29	28	28
P2 (1mL/L)	29	29	30
P3 (1.5 mL/L)	29	29	30
P4 (2 mL/L)	29	29	30
Standard	25-30^{0}C (BSN, 2004)		

Based on the results of DO measurements in Table 5, the range of DO in all treatments (P0, P1, P2, P3, P4) was 2,5-3,2 mg/L. DO on days 1 and 2, all treatments had a decent value for the survival of North Asian catfish. This is by the statement of Effendi (2003), the ideal DO level for the growth and development of aquatic organisms being kept is >3 mg/L. Table 6 shows the temperature measurement results obtained during the study, ranging from 28-31^{o}C in all treatments (P0, P1, P2, P3, P4). The temperature range in each treatment is suitable for the life of North Asian catfish. According to Mahary (2017), the ideal temperature in catfish farming ranges from 26 to 31^{o}C.

3.2. Absolute Weight and Lenght Growth

The growth of fry weight of North Asian catfish during the study is presented in Figure 1.

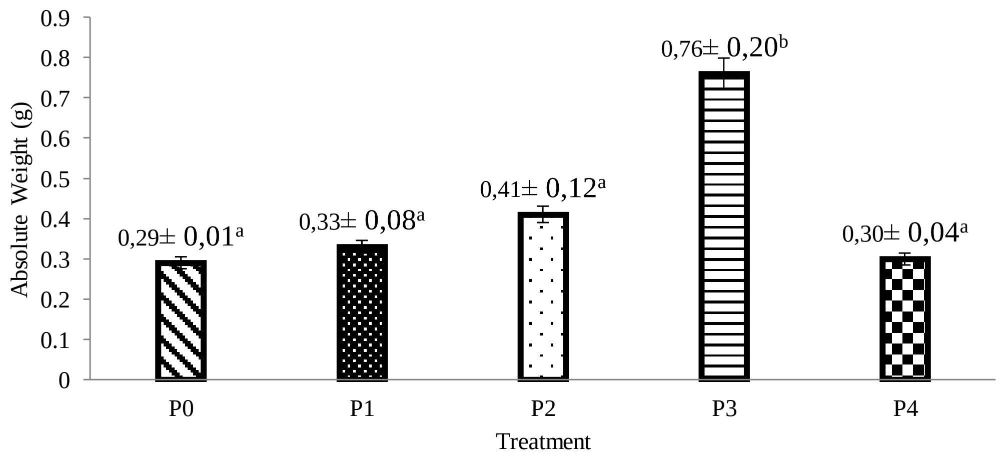

Figure 1. Absolute weight growth of North Asian catfish

The highest weight growth was found in P3 (1.5 mL/L), which was 0.76 g; the lowest was in treatment P0, with an absolute weight of 0.29 grams. The absolute weight growth of North Asian catfish, which was given Nitrobacter at a dose of 1.5 mL/L (P3), had better growth than P0, P1, P2, and P4. The results of the Analysis of Variance (ANOVA) showed that the administration of Nitrobacter at different doses in the P3 treatment (1.5 mL/L) had a significant effect ($p<0.05$) on the absolute weight growth of North Asian catfish. Cahyono (2001) stated that the accumulation of food scraps and fish waste in the waters will produce ammonia. If the ammonia levels are high in water, it can result in slow fish growth.

In this study, absolute length growth was obtained in North Asian catfish. The absolute length growth results can be seen in Figure 2.

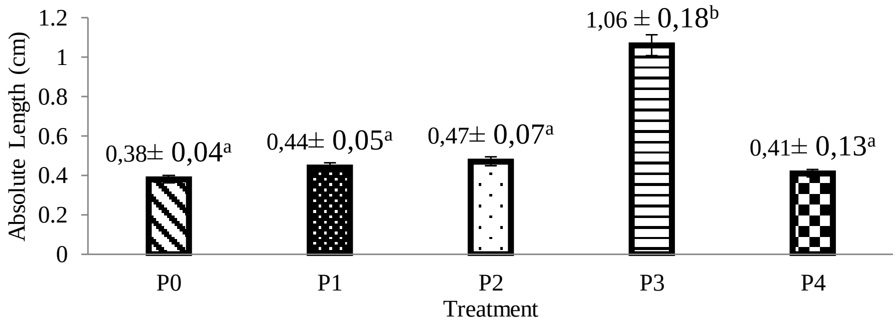

Figure 2. Absolute length measurement results of North Asian catfish

Based on Figure 2, this study's absolute length measurement results obtained the highest in the P3 treatment of 1.06 cm and the lowest in the P0 treatment of 0.38 cm. Based on the results of the analysis of variance (ANOVA), the treatment of Nitrobacter in the P3 treatment (1.5 mL/L) had a significant effect on the growth of North Asian catfish (P<0.05).

3.3. Specific Growth Rate

Based on the results of the study. The specific growth rate of North Asian catfish during the study can be seen in Figure 3.

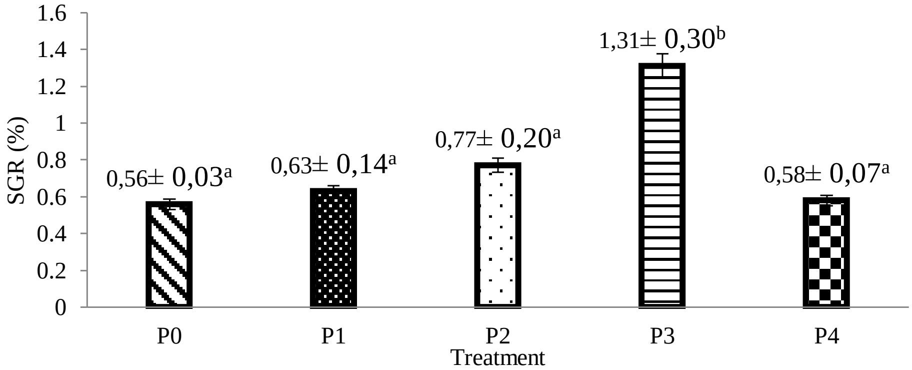

Figure 3. Results of measurement of the specific growth rate of North Asian catfish

Figure 3 shows that the specific growth rate (SGR) with the highest percentage was in the P3 treatment of 0.98%. Moreover, the lowest LPS was in the P0 treatment of 0.42%. Based on the results of the analysis of variance (ANOVA), administration of Nitrobacter at different doses in the P3 treatment (1.5 mL/L) had a significant effect on the specific growth rate of North Asian catfish where (P>0.05).

3.4. Survival Rate

Based on the study results, the results of survival calculations for North Asian catfish. The results of the survival calculation during the study can be seen in Figure 4.

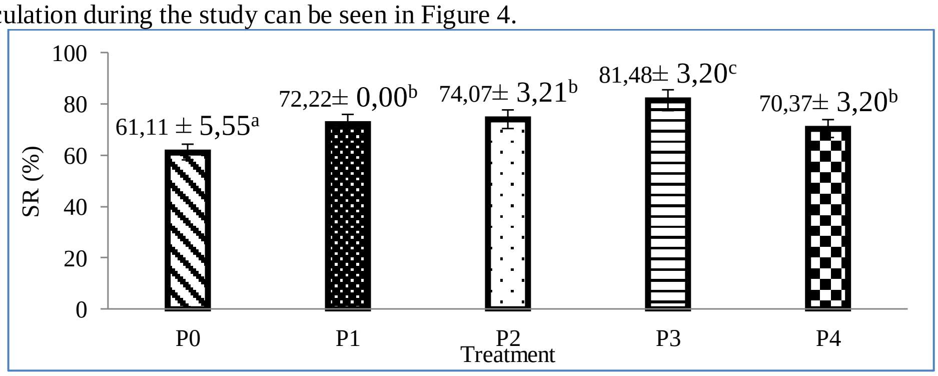

Figure 4. Calculation results of North Asian catfish survival

Based on Figure 4, the survival percentage of north Asian catfish can be seen. The highest survival percentage was found in treatment P3, which was 81.4%. However, the lowest survival percentage was in treatment P0, 61.11%. Based on the results of the analysis of variance (ANOVA), the administration of Nitrobacter at different doses had a significant effect on the survival of North Asian catfish (P<0.05).

Ammonia in water that is not continuously oxidized by bacteria for a long time will become toxic. High concentrations of ammonia in water can cause damage to the gills. Fish are susceptible to disease. It inhibits growth rate and can cause death (Primaningtyas et al., 2015). Decomposition of residual feed that accumulates is toxic or toxic, such as ammonia, which causes disease in cultured fish (Sari et al., 2021). The survival rate of North Asian catfish in the P0 treatment is minimal. This happens because of high ammonia levels; following the statement of Sieger et al. (2019), suppose ammonia levels are high enough. Fish will experience hyperplasia or accumulation of mucus in the gills, so they will have difficulty breathing, which will then cause them to become stressed and die. If the concentration of ammonia and nitrite is high in the maintenance media, it will cause fish death (Wahyuningsih & Gitarama, 2020).

4. Conclusions

Giving Nitrobacter in different doses reduces ammonia levels in maintaining North Asian catfish. The best treatment was P3 1.5 ml/L with the most minor ammonia content of 0.0403 mg/L a specific growth rate of 0.98%. An absolute growth rate of 0.76 g, an absolute length of 1.06 cm, and a survival rate of 81.4%. Value of water quality during research temperature 29-30^{0}C, pH 6.0-7.0, and DO 2.5-3.2 mg/L. The value of water quality during the study was good enough to support the survival of North Asian catfish. Based on the results of the study, the best treatment was suggested, namely P3 of 1.5 mL/L.

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