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Strategies for Effective Plankton Management in Kijing Taiwanese (*Anodonta woodiana*, Lea): A Study on Stocking Density and Aquaculture Techniques

Rema Apria Ningrum[a]*, Moh. Awaludin Adam[b], Nanda Diniarti[a], Yulia Dewi Anjani[a], Irfan Maulana[a]

[a] Programe Study of Aquaculture, Faculty of Agriculture, University of Mataram, Mataram, Indonesia
[b] Research Center for Marine and Land Bioindustry, National Research and Innovation Agency (BRIN), Lombok Utara,Indonesia

* Corresponding author: remaaparia1501@gmail.com

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Abstract

Understanding the dynamics of plankton in Kijing Taiwanese (*Anodonta woodiana*, Lea) cultivation is crucial for optimizing growth performance. This study aims to investigate the influence of stocking density and cultivation methods on the daily population dynamics of plankton in Kijing Taiwanese aquaculture. The experimental study tested different stocking densities in cultivation ponds, namely 5, 10, and 15 ind/m^2. Descriptive analysis was employed to interpret the data obtained. The results indicate that Kijing Taiwanese absorb approximately 40 liters/day of water with particle sizes ranging from 0.1 to 5.0 µm, achieving 100% and 99.5% filtration for particles > 4.0 µm and organic matter, respectively. Various class of plankton were identified in the cultivation ponds, including Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae, Euglenophyta, and Pyrophyta, with abundances ranging from 2000-68000 ind/cell. The study observed an increase in plankton abundance by approximately 700-2000 ind/cells daily. Water quality measurements revealed pH 7.4, temperature 29.4°C, TDS 92.3 mg/L, turbidity 9-45 NTU, BOD 1-3, DO 5 mg/L, and phosphate (PO_4) 0.3 mg/L. This research concludes that there is an influence between kijing stocking density and plankton population density. The interactions that occur are significantly different, because there are significant differences. The higher the distribution density of kijing, the lower the plankton population in the cultivation pond. Further research is recommended to explore the correlation between the abundance of specific plankton types and the growth of Kijing Taiwanese, considering nutrient elements.

Keywords: Aquaculture, Cultivation, Plankton Dynamics, Kijing Taiwanese.

1. Introduction

The Kijing Taiwanese (*Anodonta woodiana*, Lea) can be called a filter feeder bivalve in waters because of its ability to clean waters, filter dirt (residual feces and feed), heavy metals, types of organic matter both suspended and particulate, and the like (Komarawidjaja, 2006). According to Yanti (2021), in 2015 market demand for kijing reached 11,859 tons, in the following year, namely 2016, it increased to 54,801 tons, and there continues to be an increase every year in 2017 reaching 70,000 tons. This high market demand is due to the fact that mussels taste quite good and are highly nutritious, one of which is protein around 7.37%, fat 0.78%, carbohydrates 3.3%, water 87% and ash content around 1.6%. Apart from that, shell waste from mussels is often made into souvenirs such as beads, shells from mussels themselves can also be used as animal feed, besides that, mussels can produce pearls. Therefore, the cultivation of mussel shells itself has the potential to last for a long period of time (Rahayu dan Rahman, 2015).

The survival of mussels is influenced by several factors, including food and environmental quality in the living habitat of mussels (Hamidah, 2006). Plankton in waters plays a role in providing oxygen, besides that plankton can also be a source of food for an organism (Edhy *et al.*, 2010). Previous research stated that the types of plankton preferred by kijing are Chlorophyta and Cyanophyta with populations that are not very large (Rahayu and Rahman, 2015). The availability of food for kijing is inseparable from the fertilization carried out in ponds, this is because fertilizer can make waters fertile, increase plankton growth and be used as natural food (Marnis *et al.*, 2023).

It is important to know the dynamics of plankton in waters, especially in keeping mussels in order to improve the growth performance of mussels and avoid things that can be detrimental in keeping mussels. Therefore, this research was carried out to determine the effect of different stocking densities and cultivation methods of Taiwanese kijing on the daily population dynamics of plankton in cultivation ponds so that they can be adjusted to regular fertilization. The aim of this research is to analyze the effect of different stocking densities of Kijing Taiwanese on the daily population dynamics of plankton in cultivation ponds. It is hoped that this research can be a source of information and can complement knowledge on shellfish cultivation, and can be applied directly by farmers in the cultivation of Kijing Taiwanese

2. Methods

2.1 Time and Study Site

This research was carried out for 60 days starting from September-October 2023, at the Lenek Fish Seed Center (BBIL), Lenek District, East Lombok Regency, West Nusa Tenggara. Identification and observation of plankton was carried out at the Aquaculture Environmental Laboratory, Aquaculture, Mataram University. The method used in this research is an experimental method. The treatments tested were differences in stocking density in cultivation ponds. For the floating method (Figure 1. (b), the kijing rearing container uses a 25 cm diameter waring which is assembled like a basket, while for the bottom method, a plastic basket is used. For the floating method, it is placed hanging on bamboo on the side of the prepared pool. Meanwhile, for the bottom method (Figure 1. (a), the prepared container is placed at the bottom of the maintenance pond to a depth of ±1 meter. There are 3 maintenance ponds used, each filled according to its treatment.

(a) (b)

Figure 1. (a) Bottom Method; (b) Floating Method

The test biota came from the Lenek Fish Seed Center (BBI) and the Kokoq Timuk Lenek Kalibambang Freshwater Fish Cultivator Group. In each rearing container, a kijing is placed according to the treatment carried out. In this case, each container bag contains 5, 10, and 15 tails with an average length of 3 (2.4-3.9 cm), 5 (4.5-5.7 cm), 7 (6 .3-7.0 cm) with a weight of 3 (11.5-47.72 grams), 5 (48.62-91.33 grams), 7 (107.32-128.15 grams) per kijing. Carpet maintenance is carried out for 60 days, with a pool area of ±10×10 meters, with a pool height of 1 (one) meter with a volume of around 50 m^3 or ½ of the pool height. During maintenance, sampling is carried out on the kijing every 2 weeks, plankton samples are taken every day at noon and observations of the plankton are carried out every 10 days, as well as water quality measurements are carried out every 10 days.

2.2 Identify Plankton Diversity

Identification of plankton diversity and abundance was carried out at the Aquaculture Environmental Laboratory, Aquaculture, Mataram University. Plankton samples from each treatment were taken using a plankton net, then 5 ml of formalin was added as a sample preservative and Lugol was added to color the plankton, then observed using a microscope with 10 times and 40 times magnification. Sampling was carried out during the day at around 11.00-13.00 Central Indonesia Time (WITA). This was done because the plankton were at peak photosynthesis. This is in according to Nirmalasari (2018), during the day phytoplankton are in optimum condition. This means that taking plankton samples during the day is highly recommended. When observing plankton samples under a microscope, the first thing to do is drop the sample onto a slide which is then covered with a cover glass and make sure the tool used has been sterilized first.

2.3 Calculation of Plankton Density

According to Dewi (2023), plankton density can be calculated using a haemocytometer, by calculating the plankton density in 25 boxes visible on the haemocytometer using a hand counter. The number of plankton calculated is multiplied by 10^4. Cell abundance can be calculated using the formula:

$$\textbf{Cell abundance (cell/mL) = average number of cells} \times 10^4$$

2.4 Diversity Index

According to Cahyaningtyas *et al.* (2013) the diversity index formula can be calculated using the following formula:

$$H' = - \sum Pi \ In \ Pi$$

Note:
H’ = Shanon-Wiener diversity Index
Pi = ni/N ni = Number ind to-i
N = Total number of individual
Criteria:
H’<H’3= stability of the biota community in prime condition (stable) or clean quality.

2.5 Dominance Index

According to Odum (1993) in Nirmalasari (2018) the dominance index calculation can be calculated using the following Simpson's dominance index formula :

$$C = -\sum \left[\frac{ni}{N}\right]$$

Note:
C = Simpson dominant index
Ni = Number of individual of i spesies
N = Total number of individual
S = Number of types

The plankton dominance index C ranges from 0 and 1. In this case, if the C value = 0 and/or <1, means that in the water there are no dominating cells, conversely if C ≥ 1 then it can be said that in the water there are many cells dominate.

2.6 Data Analysis

The data obtained in this study was processed using Microsoft Excel and then analyzed descriptively. the results of this research were presented carefully and clearly to explain the abundance of plankton found during the research and the best type of phyplankton for the survival of the kijing. According to Suryana (2010), descriptive methods are carried out using survey techniques, case studies, comparative studies, studies of time and motion, behavioral analysis and documentaries.

3. Results and Discussion

3.1 Results

3.1.1 Identify Plankton Diversity

Based on the observations that have been made, the results of plankton identification found in the rearing ponds of Taiwanese kijing (*Anadonta woodiana*, Lea), there are several types of phytoplankton and zooplankton found with quite significant differences between rearing ponds 1, 2 and 3. The abundance of plankton can be seen in table 1 below.

Table 1. Plankton Abundance Data(Cells/ml)

No.	Plankton Species	Pond 1		Pond 2		Pond 3	
		A	**B**	**A**	**B**	**A**	**B**
	Diatom (Bacillariopyta)						
1	*Navicula libonensis*	8000				22000	
2	*Chaetoceros compressus*	10000					
3	*Chaetoceros socialis*	2000					
4	*Cyclotella quillensis*	22000					
5	*Chaetoceros calcitrans*						
6	*Chaetoceros rotosporus*	6000					
7	*Navicula tantula*	4000		20000			
8	*Achnanthes linearioides*		14000				
9	*Achnanthes alteragracillima*					4000	2000
10	*Navicula transitans*						
11	*Naviculla tantula*					13400	11600
12	*Chaetoceros calcitrans*	6000		6000			
13	*Cylindrotheca fusiformis*					6000	34000
14	*Navicula cincta*			12400	4000	8000	4000
15	*Naviculla protractoides*						
16	*Achnanthes sp.*				2000		
17	*Naviculla protractoides*				2000		
18	*Achnanthes alteragracillima*		4800			4000	2000
19	*Achnanthes kolei*					2000	4000
20	*Achnanthes minuttisima*					22000	8000
21	*Navicula menisculus*					20800	
22	*Gyrosigma acuminatum*					24000	4000
23	*Navicula pupula*						2000
24	*Nitzschia sigmoidea*						2000
	Chlorophyta						
25	*Pedinoonas minor*	14000	14000	12000			
26	*Nannochloropsis oculata*	349500	319000	325200	416600	551500	603600
27	*Micratinium bornhemiense*	10000	10000	4000		6000	
28	*Micractinium pussilum*	2000		6000			
29	*Chorella sorokiniana*	414000	354000	445900	155000	282000	325000
30	*Coloeocystis ampla*	2000	12000	22800			
31	*Anabaena cylindrica*	2000		4000			
32	*Spirogyra tenuissima*	2000					
33	*Chlorococcum macrostigmatum*	2000					8000
34	*Hematococcus sp.*	6000			18000		
35	*Dictyosphaerium reniforme*	16000					
36	*Scenedesmus carinatus*		56000	24600		6800	2000
37	*Scenedesmus brasilensis*			7400		4000	
38	*Scenedesmus oblicuus*			8800			
39	*Scenedesmus cuadricauda*			2000			
40	*Scenedesmus quadricauda*				32000		
41	*Trochiscia hystryx*			22000			
42	*Dunaliella baedawii*					10000	2000
43	*Mesotaenium caldariorum*					2000	
44	*Chlorella pyrenoidosa*						12000
45	*Scenedesmus rasilensis*						20000

No.	Plankton Species	Pond 1		Pond 2		Pond 3	
		A	B	A	B	A	B
	Cyanophyta algae						
46	*Croococcus* sp.				2000		
47	*Phormidium lucidum*				2000		
48	*Pseudoanabaena* sp.				10000		
	Phyrrophyta						
49	*Prorocentrum maxicanum*			2000			
50	*Protoperidinium divergens*		22000				14000
	Crysophyta, haptopyta						
51	*Synura* sp.	16000	26000				2000
52	*Mallomonas heterospina*					8400	6000
	Desmis						
53	*Closterium navicula*			56000	4000		

3.1.2 Effect of Stocking Density and Pond Conditions on Plankton

The findings of the conducted research generally indicate that varying stocking densities in kijing aquaculture result in diverse outcomes regarding plankton population and abundance in the culture medium. In this regard, statistically, there is no significant difference observed at the 95% confidence level among the figures followed by the same letter (Table 2).

Table 2. The influence of deer stocking density and pond conditions on plankton abundance

Treatment (ind/pond)	Pond		Average
	a (Inlet)	b (Outlet)	
P1 (5 ind/pond)	7.6a	5.8ab	6.7
P2 (10 ind/pond)	7.8a	4.2b	6.2
P3 (15 ind/pond)	7ab	7ab	7
Average	7.5	5.8	(+)

3.1.3 Gastric Analysis of Taiwanese Kijing Clams

Based on observations that have been made, several types of plankton were found in the bodies of mussels. In this case, individual plankton observations were carried out at the beginning and end of the research. The types of plankton found can be seen in the table 3 below:

Table 3. Types of Plankton in Individuals

No.	Species	Treatment		
		P1	P2	P3
1.	*Navicula libonensis*	✓		
2.	*Nannochloropsis oculata*	✓	✓	✓
3.	*Chorella sorokiniana*	✓	✓	✓
4.	*Scenedesmus quadricauda*		✓	

3.1.4 Diversity Index

Plankton diversity index when raising mussels for 60 days in a rearing pond with a density of Taiwanese muskling (Figure 2). In 60 days maintenance activities, the highest diversity index value was found in P3, with an average of 2.110, followed by P2 with an average value of 2.071. Meanwhile, the lowest diversity index was found in the P1 section at 2.035.

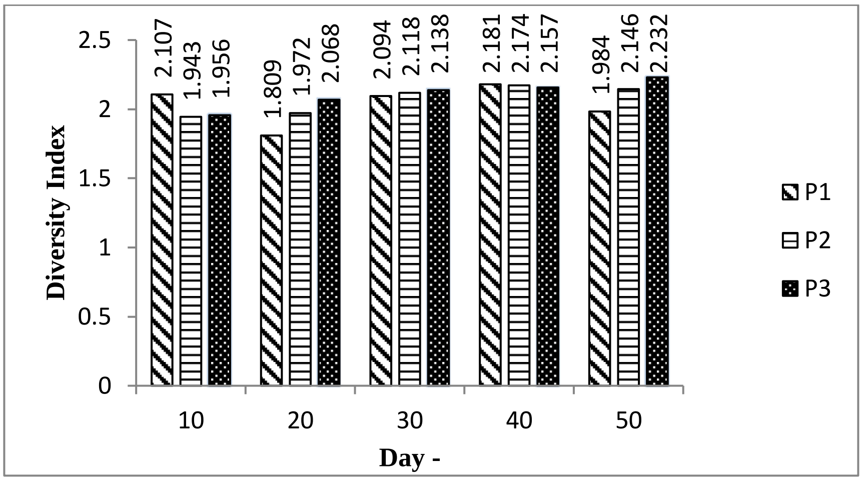

Figure 2. Diversity Index

3.1.5 Dominant Index

The plankton dominance index in raising Taiwanese mussels for 60 days with the administration of various different types of probiotics ranged from 0.15-0.16 (Figure 3). During 60 days maintenance, a significant dominance index value was obtained, in this case P1 received the highest dominance index value with an average value of 0.16. Meanwhile, P2 and P3 have the same dominance index value, namely around 0.15.

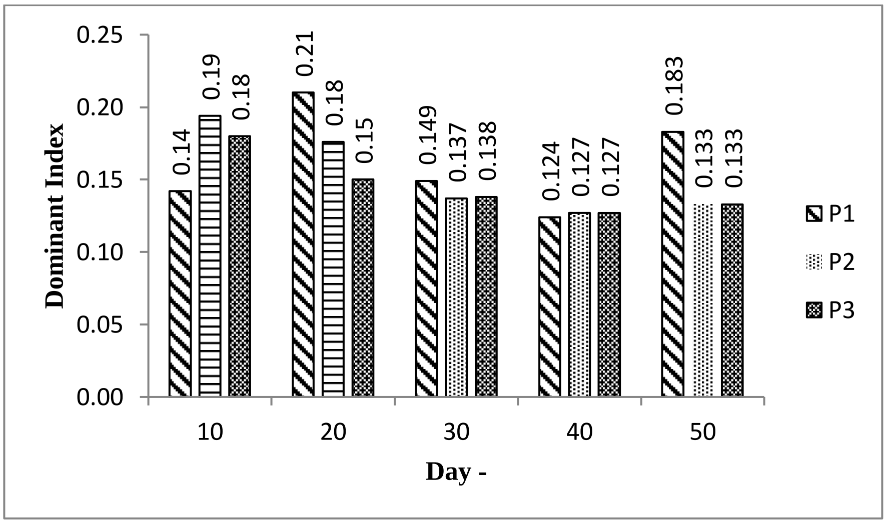

Figure 3. Dominance index

3.1.6 Water Quality Parameters

One of the biggest functions of environmental parameters is to determine the condition of plankton abundance.

Table 4. Water Quality Data

Parameters	Value	references
BOD	1-5	3 mg/L (Nataliah *et al*., 2022).
Phosphate (PO4)	0-0,25 mg/L	0,1 mg/L (Nur *et al.*, 2018).
Turbidity	3,69-5,5 NTU	5-6 NTU (Syaifullah, 2014).
Temperature	27,25-31,4˚C	25-30˚C (Rasyid *et al*., 2018).
TDS	81-99 mg/L	1.000/L (Andriyani *et al*., 2014).
pH	6,29-8,86	6,7-8,2 (Sieger *et al*., 2019).
TAN	0,01	< 0.1 mg/L (Sudirman, 2023).

The table above illustrates that the water quality conditions are optimal during the cultivation of Taiwanese kijing clams. In this case the temperature value ranges from 27.2 - 31.4°C, the pH value ranges from 6.29 - 8.6, the BOD value ranges from 1- 5 mg/L, Phosphate (PO4) 0-0.25 mg/L, turbidity between 3.69-5.5 NTU, and TDS 81-99 mg/L. Except for the phosphate (PO4) and TAN values, there was an increase which was slightly higher than the optimum temperature for raising mussels.

3.2 Discussion

In waters, plankton act as oxygen suppliers because there is photosynthetic activity in their life. Apart from that, plankton is used as natural food by other organisms in the waters. In waters, plankton is divided into two, namely phytoplankton and zooplankton. Phytoplankton has a main role, namely as primary producers for zooplankton life (Aini, 2022). It can be seen from table 1 that the number of plankton genera found in each maintenance pond has significant differences and there are 6 classes found, namely Diatoms (Bacillariopyta), Chlorophyta, Cyanophyta algae, Cyanophyta, and Crysophyta, hatopyta and desmis. In pool 1 there are 23 genera, in pool 2 there are 19 genera, while in pool 3 there are around 25 genera. The greatest abundance of plankton was found in pond 3 at 2,065,100 cells/mL, with *Nannochloropsis oculata* and *Chorella sorokiniana* as the most commonly found species. Syafriani and Apriadi (2017) states that there are several types of plankton that are often found in waters, namely Bacillariophyceae, Dinopyceace, and blue green algae (Cyanopyceae). Meanwhile, according to Cahyaningtyas *et al.* (2013), the types of plankton found in freshwater waters are Cyanophyceae, Bacillariophyceae, Xantophyceae, Pyrophyta, Chlorophyceae, Ciliata, Entromostraca and Dinophyceae. According to Adiwilaga *et al.* (2012) Plankton is divided into two, namely, phytoplankton and zooplankton. In this case, these two types live floating on the surface of the waters and next to each other. In general, in freshwater the phytoplankton commodities that are often found are phytoplankton from the classes Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae, Euglenophyta and Pyrophyta.

The abundance of plankton in a body of water is greatly influenced by its environment. From table 1 above it can be seen that the abundance found in each pond has quite significant differences. In pond 3, it can be seen that the abundance of plankton is the greatest, while in ponds 1 and 2 it is lower than in pond 3. This is because in pond 3, the water quality is very optimal for plankton growth compared to the other ponds. Pool 3 is a pool that is closer to the water source. In this study, an average abundance of plankton was found to be 21,364 cells/ml. The abundance of plankton of this magnitude can be said to be high and considered good. According to Cahyaningtyas *et al.* (2013), plankton with a number of >12,000 cells/L is classified as high abundance. The average abundance of plankton in a body of water ranges from 241 cells/L - 218 cells/L.

In this study, the phytoplankton that was most commonly found was Bacillariophyceae (diatoms). Bacillariophyceae is a type that is quite large and important in waters. Based on these results, it can be seen that mussels as macrobenthos filter feeders prefer various types of food to be consumed, in this case it can be seen from the type, quantity and size in the environment where they live. According to Ukels (1969) in Anwar (2004), around 95% of the contents of the digestive organs of filter feeder organisms such as oyster shells are diatoms (Bacillariophyceae). As for Rahayu and Rachman (2015), shellfish are classified as one of the macrobenthos which consume their food by filtering the media around their place of residence. On their research, the main foods favored by mussels were detritus (80.5%), algae Bacillariophyceae (8.3%), Chlorophyceae (7.14%), Euglenophyceae (1.99%), Cyanophyceae (1.57%). %) and Rotaria (0.27%). Of the many types of plankton that exist during rearing activities, there are two types of plankton that are preferred by mussels as food, namely those from the Chlorophyta and Cyanophyta classes with not many numbers, in this case only around 1-2 individuals/ml. This can be classified as less fertile or dystrophic because the plankton abundance is less than 50 - 200 mg.C.m^{-3}.

Identification of plankton is carried out to find out what type of plankton the kijing likes as food and then helps the kijing grow well. The abundance of plankton in a body of water is greatly influenced by its environment. Apart from that, fertilization before pond maintenance activities can also influence the growth process of both plankton and the growth of organisms in the maintenance pond. According to Nugroho (2020), fertilization in maintenance ponds can help to grow plankton cells, apart from that, fertilization can also increase nutrients and/or nutrients in the waters. one type of fertilizer that is widely used in maintenance ponds is a type of manure derived from livestock manure or similar. Manure or what is usually called organic fertilizer has several benefits, namely improving soil structure, increasing soil resistance and microbiological processes and can help increase the value of soil cation capacity. In this case, it can be seen from the growth of organisms in the maintenance pond, namely the mussels and other organisms in the pond.

The diversity index value was found to be an average of 2.035-2.110. In maintenance activities for 60 days, the highest diversity index value was found in P3, namely with an average of 2.110, followed by P2 with an average value of 2.071. Meanwhile, the lowest diversity index was found in the P1 section at 2.035. The stability value of the biota community can still be said to be in prime condition (stable) or clean quality (Figure 2). According to Cahyaningtyas et al. (2013) if H'<H'3, means the aquatic biota community is in good condition or clean quality. The average dominance indeks varied from 0.15-0.16 (Figure 3). During 60 days maintenance, a significant dominance index value was obtained, in this case P1 the highest dominance index value with an average value of 0.16. Meanwhile, P2 and P3 have the same dominance index value, namely around 0.15. The dominance index value is still quite normal because there are no dominating cells in the rearing pond. Acording to Odum (1993) in Nirmalasari (2018) which states that The plankton dominance index C ranges from 0 and 1. In this case, if the C value = 0 and/or <1, means that in the water there are no dominating cells, conversely if $C \geq 1$ then it can be said that in the water there are many cells dominate.

Based on research that has been carried out, the temperature level in the maintenance pond is 30°C. With a pool temperature level of this size, this can be said to be quite good. According to Rasyid et al. (2019), when rearing generally have an average temperature level of 25°C-30°C and at this temperature level the tilapia fish can be said to be at normal temperature levels. Temperature itself is one of water quality parameters that plays a very important role in the survival of fish in a body of water. The TDS value obtained ranges between 81 and 99 mg/l. TDS itself is a parameter for determining the number of particles and organic and non-organic compounds in waters, which in this case has a tolerance value for biota, especially for freshwater , namely 1000mg/l (Andriyani et al., 2014). Meanwhile, turbidity value in the maintenance pond, was 3.69-5.5 NTU. According to Syaifullah (2014), in cultivation activities the turbidity value that can tolerate is around 5-6 NTU.

Apart from the parameters above, there are other chemical parameters, namely BOD and Phosphate (PO4), which in this study obtained optimum values. BOD is 1-5 mg/l and Phosphate (PO4) is 0-0.25 mg/l. In general, BOD helps to determine the concentration of organic matter in waters. In this case, organic materials themselves can cause a decrease in water quality in a body of water, especially in terms of pH and temperature. The BOD value itself can be called an indicator of the ammonia oxidation process to nitrite, this is what influences the nitrite value in waters. The quality standard for BOD is around 3 mg/l in cultivation activities (Nataliah *et al.*, 2022). High phosphate concentrations exceeding the level of ecosystem assimilation capacity cause water quality to decrease, which can cause the growth process of an organism to be hampered (Septory *et al.*, 2021).

The TAN value obtained ranges between 0.01 mg/l, in this case the TAN value is influenced by the accumulation of waste substances released when metabolism occurs. The metabolic products of organisms will be directly excreted into their environment, one of which is ammonia. According to Sudirman et al. (2023), TAN is a water quality parameter in the form of total ammonia from a body of water. TAN can be called a sensitive water quality in waters, especially in cultivation activities for organisms, in this case TAN can become toxic if it exceeds the normal concentration threshold, which is around < 0.1 mg/l.

4. Conclusion

The influence of kijing stocking density on plankton population does not show any significant interaction or difference, as there is no significant variance. In this case, the higher the stocking density of kijing, the lower the plankton population in the cultivation pond. Further research with periodic fertilization is needed to obtain better and more accurate results regarding plankton abundance and kijing feeding habits, with different density ratios and repetitions.

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