p-ISSN. 2579-4752
e-ISSN. 2620-7397

Akuakultura, 8:2 (2024): 44-50

AKUAKULTURA

Effect of Adding Tuna Fish Bone Meal as a Source of Calcium Minerals in Feed in Freshwater Vannamei Shrimp (*Litopenaeus vannamei*) Cultivation

Pengaruh Penambahan Tepung Tulang Ikan Tuna Sebagai Sumber Mineral Dalam Pakan Pada Budidaya Udang Vaname (*Litopenaeus vannamei*) Di Air Tawar

Received: August 2024, Revised: September 2024, Accepted: September 2024
DOI: 10.35308/ja.v8i2.10208

Khairul Umam[a], Andre Rachmat Scabra*[a], Thoy Batun Citra Rahmadani[a]

[a] *Aquaculture Study Program, Faculty of Agriculture, University of Mataram, Pendidikan street no. 37, Mataram City, West Nusa Tenggara*

Abstract

The aim of this research is to analyze the effect of giving tuna bone meal as a mineral source to vaname shrimp cultivated in freshwater media, at doses of 1%, 2%, 3% and 4%. Fish bones are a form of fish processing industry waste that contains the highest calcium among fish body parts, because the main components of fish bones are calcium, phosphorus and carbonate. The calcium content in tuna bone meal is higher than the calcium content in other fish bone meal, namely in catfish bone meal 13.48%, mandidihang fish bone meal 2.12%, catfish bone meal 30.95% and in fish bone meal tuna ranges from 23-39%. Based on research that has been carried out, the addition of tuna fish bone meal has a real influence on the growth of specific weight, absolute weight, specific length, absolute length but there is no significant difference to FCR. The best value was obtained in Treatment 5 with the addition of tuna bone meal at a dose of 4% (4 grams / 100gram feed). Specific weight values at P5 (2.85%), absolute weight (27.8), absolute length (6.00cm), specific length (3.46%)

Keywords: calcium, vaname shrimp, fresh water, fish bones

Abstrak

Tujuan dari penelitian ini ialah untuk menganalisa pengaruh pemberian tepung tulang ikan tuna sebagai sumber mineral pada udang vaname yang di budidaya di media air tawar, dengan dosis 1%, 2%, 3%, dan 4%. Tulang ikan merupakan salah satu bentuk limbah industri pengolahan ikan yang mengandung kalsium paling tinggi diantara bagian tubuh ikan, karena komponen utama tulang ikan adalah kalsium, fosfor dan karbonat. Kandungan kalsium dalam tepung tulang ikan tuna lebih tinggi dibanding kandungan kalsium pada tepung tulang ikan lainnya yakni pada tepung tulang ikan lele 13,48%, tepung tulang ikan mandidihang 2,12%, tepung tulang ikan patin 30,95% dan pada tepung tulang ikan tuna berkisar 23-39%. Berdasarkan penelitian yang telah dilakukan penambahan tepung tulang ikan tuna memberikan pengaruh nyata pada pertumbuhan berat spesifik, berat mutlak, Panjang spesifik, Panjang mutlak namun tidak berbeda nyata terhadap FCR Nilai terbaik di dapatkan pada Perlakuan 5 dengan penambahan tepung tulang ikan tuna dengan dosis 4% (4 gram / 100gram pakan). Nilai berat spesifik pada P5 (2,85%), berat mutlak (27,8), panjang mutlak (6.00cm), panjang spesifik (3,46%).

Kata kunci: *kalsium, udang vaname, air tawar, tulang ikan*

1. Introduction

Vaname shrimp (*Litopenaeus vannamei*) is one of the aquatic products that has high economic value. According to data from the Ministry of Maritime Affairs and Fisheries (2020), vaname shrimp is one of the main aquaculture products produced in the largest quantities during the 2012-2018 period. This type of shrimp is popular throughout Indonesia, starting from the islands of Sumatra, Java, Bali, NTB and Sulawesi. On a broader scale, especially internationally, Indonesia is the 4th largest producer of vaname shrimp after China, India and Vietnam. Vaname shrimp have several advantages, namely high survival rate, high appetite, more resistance to disease, high stocking density, relatively short maintenance time, namely around 90 – 100 days, able to adapt to low environmental temperatures, and are euryhaline, namely tolerance to wide salinity (Riani *et al*., 2012).

Based on the euryhaline properties of vaname shrimp, vaname shrimp have the potential to be cultivated in freshwater media. This ability opens great opportunities for farmers to develop vaname shrimp cultivation in fresh waters so that vaname shrimp production can increase. However, the problem faced by vaname shrimp cultivators in freshwater media is that their growth is not optimal due to the lack of minerals found in fresh water. The success of vaname shrimp cultivation in

** Korespondensi: Aquaculture Study Program, Faculty of Agriculture, University of Mataram, Pendidikan street no. 37, Mataram City, West Nusa Tenggara*
e-mail: andrescabra@unram.ac.id

freshwater is largely determined by the availability of minerals in water bodies (Kaligis, 2019). Crustaceans, including shrimp, really need minerals to maintain basal metabolism and growth. The mineral composition of low salinity waters can influence the growth of cultivated vaname shrimp. The most important minerals for shrimp survival are calcium, potassium, phosphorus and magnesium (Sakthivel *et al*., 2014).

Calcium functions in the shrimp molting recovery process. If the molting process is faster, the growth of cultivated shrimp will also be faster, because after the molting phase, the shrimp's appetite will increase. However, if the calcium content in the cultivation pond cannot meet the shrimp's needs, the hardening of new shrimp shells will be slow, thus affecting shrimp growth, where new shrimp shells that have not yet fully formed will be attacked or eaten by other shrimp (cannibalism).

One ingredient that contains calcium is fish bone meal. Fish bones are a form of fish processing industry waste that contains the highest calcium among fish body parts, because the main components of fish bones are calcium, phosphorus and carbonate. The high calcium content in fish bone meal makes fish bone meal very potential to be used as a food additive to increase the calcium content in food products (Untailawam, 2021). One of the fish that has quite a lot of fish bone waste is tuna which has calcium levels reaching 23-39% (Pangestika *et al*., 2021). (Mustari, 2022) has conducted research on giving tuna bone meal to tilapia and succeeded in influencing the absolute growth of tilapia.

Calcium is usually given in the rearing water media and research on adding calcium for rearing vaname shrimp in fresh water has been carried out, one of which is research by (Scabra *et al*., 2024) which added calcium through the rearing water media. The results of this research state that adding calcium through water can increase the survival and growth of vaname shrimp cultivated in freshwater. However, there is another method that needs to be done, namely adding calcium through feed. (Darwantin & Sidik, 2016) stated that even though it is found in water, the condition of calcium in the water is often unstable, therefore it is necessary to add calcium using other methods, namely adding high levels of calcium to feed. Care must be taken to ensure that it is not toxic to shrimp. When making feed, a calcium mixture is added to the feed ranging from 2-5% of the total amount of raw materials for making feed (Yulianto *et al*., 2021).

The method of adding calcium to feed is very effective in providing additional calcium for shrimp, because with this method the feed given can be directly digested along with the calcium contained in the feed (Restari *et al*., 2019). Therefore, to develop vanamei shrimp cultivation in freshwater cultivation media, research on the effect of adding fish bone meal as a source of minerals in feed is important to carry out.

2. Materials and Methods

2.1. Time and Place

This research was carried out for 45 days, starting on February 14 to March 28, 2024, testing was carried out at the Production and Reproduction Laboratory of the Aquaculture Study Program, Department of Fisheries and Marine Sciences, Faculty of Agriculture, University of Mataram.

2.2. Research Procedures

a. Preparation of Research Containers

The maintenance containers used are 15 units with a capacity of 40 liters. The maintenance container is cleaned in running water. Next, the containers are placed according to the predetermined position, then each container is filled with 20 liters of freshwater and equipped with one aerator for each container to supply oxygen to the water, then labeled according to the treatment.

b. Media Preparation

Media preparation includes filling the container with freshwater, the container is filled with 20 liters of fresh water. Then freshwater is given Mineral (Table 1). These materials are provided as a mineral source in the rearing media for vaname shrimp in freshwater.

Table 1.
Mineral composition

Mineral	Doses	gram/100 L	gram/20 L
CaO	80 ppm	8	1.6
MgSO4	40 ppm	4	0.8
KH2PO4	45 ppm	4.5	0.9
KCL	15 ppm	1.5	0.3
NaCL	1 ppt	100	20

c. Preparation of Test Animals

Vannamei shrimp larvae used as test animals were obtained from. The larvae used were shrimp larvae in the PL 10 phase with a total of 10,000 shrimp. Before the research was carried out, the test animals were acclimatized first and fasted for 24 hours. Saline acclimatization is carried out by reducing salinity gradually. After fasting, feeding is done little by little to prevent the shrimp from getting stressed and dying. At the time the research began, shrimp were already PL 20 old.

d. Flour Making

First, the fish bones are boiled for 30 minutes, after that the fish bones are washed using running water to separate the remaining meat that is still attached, then the fish bones are dried in the sun for 5 hours, then softened using a pressure cooker for 2 hours. The fish bones that have been pressure treated are washed again to remove any remaining fat, the next process is to place the fish bones in the oven for 1.5 hours at a temperature of 180 degrees, then blend and sift (Pangestika *et al*., 2021).

e. Acclimatization of test animals

Before stocking in rearing containers, an acclimation process is first carried out on the shrimp larvae. Shrimp larvae are placed in a temporary rearing container in the form of a tub filled with seawater. Acclimatization is carried out in the form of reducing salinity levels to 0 ppt. The reduction in salinity was carried out over 10 days slowly, where every day it was reduced by 10%. The aim of this acclimatization is to accustom white shrimp larvae to life at a salinity of 0 ppt, and to prevent the shrimp from stress due to a sudden decrease in salinity which will result in death. To reduce the salinity level to the desired salinity, this is done by adding fresh water. So, the reservoir is filled with sea water and fresh water is added, after everything is mixed evenly, the amount of salinity is measured, for example, during the 10-day period, 1 bucket of water is thrown away, then 1 bucket of fresh water is added to the reservoir until the salinity is 2 ppm, the salinity is 0 after it is moved. into the container with the treatment water that has been provided.

f. Feeding

Feeding of shrimp is carried out with a frequency of 5 times a day, namely at 07.00, 11.00, 15.00, 19.00, amounting to 7% of the shrimp's body weight. The feed given is in the form of crumble-sized pellets.

g. Water change and siphoning

Syphoning is done before giving food in the morning, then the cultivation container is refilled with water to which calcium Ca(OH)2 has been added which has been dissolved first. Water changes are carried out according to field conditions. The water used in the water change process is water that has been added with various minerals which have been dissolved for 24 hours. Water changes are carried out by adding the amount of water that was wasted during siphoning.

2.3 *Research Parameter*

a. Survival rate

The survival rate (SR) of vaname shrimp is calculated using the formula in(Scabra, Marzuki, & Alhijrah, 2023):

$$SR : \frac{Nt}{No} x\ 100\ \%$$

Information:
SR = Fish survival rate (%).
N0 = Number of fish at the start of the study (tails).
Nt = Number of fish at the end of the study (tails).

b. Specific Length

$$LPPS = \frac{LnLt - LnLo}{t}\ x\ 100\%$$

Information:
LPPS = Specific growth rate (%/day)
Wt = Average length of shrimp at the end of the study (g)
Wo = Average length of shrimp at the beginning of the study (g)
T = maintenance time (days) (Prawira *et al.*, 2014).

c. Specific weight

$$LPBS = \frac{InWt - InWo}{t}\ x\ 100\%$$

Information:
LPBS = Specific weight growth rate (%/day).
Wo = Average weight of seeds at the start of the study (g).
Wt = Average weight of seeds on day t (g).
T = Length of cultivation (days). (Scabra *et al.*, 2023)

d. Feed convertion ratio

$$FCR = F /(Wt + D) - Wo)$$

Information:
FCR: Feed conversion ratio.
Wt: Final fish weight (grams).
Wo: Initial fish weight (grams).
F: Feed given (grams).
D: Weight of dead fish during rearing (grams) (Yulihartini *et al.*, 2017).

2.3. Data Analysis

The influence of the action on the observation parameters was analyzed using using analysis of variance (ANOVA). If the test results between treatments significantly different then further tests will be carried out using DUNCAN with 95% confidence level.

3. Result and Discussion

a. Survival Rate

Based on research that has been carried out, it was found that the highest survival rate (SR) value was in the P5 treatment, and the lowest survival rate value was in P1.

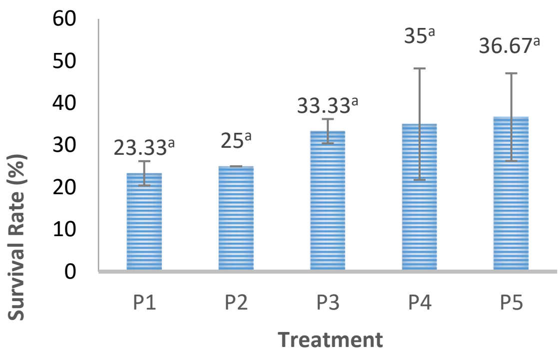

Figure 1. Survival rate data

The low survival rate value in P1 is thought to be due to a lack of calcium for vaname shrimp. Calcium plays a role in the process of osmoregulation or balancing body fluids with the environment. This is supported by (Pamungkas, 2012) who states that, under osmotic pressure, vaname shrimp will absorb salt ions such as Na+, K+, Cl and water into their blood and recirculate them, then the shrimp will remove these ions again from the blood. towards the outside environment. (Pamungkas, 2012) also stated that calcium is the dominant ion in determining osmotic pressure. Lack of calcium can cause shrimp osmotic pressure to be disturbed. This is confirmed by (Pamungkas, 2012) that, lack of calcium when rearing vaname shrimp, triggers disruption of osmotic pressure and causes the shrimp to be unable to osmoregulate so that the shrimp will experience stress. This stress causes more water to enter the shrimp's body and more salt ions to leave the body, as a result the kidneys will work harder to pump water out of the body. If this continues to happen, the kidneys will be damaged and cause death of the shrimp. The survival rate value at P5 is the highest but still low for vaname shrimp cultivation. The low survival rate at P5 is thought to be due to the high level of cannibalism. Cannibalism occurs when shrimp molt or shed their old skin, at that time the shrimp become soft and weak, and will emit a distinctive aroma that can invite other shrimp to eat them. This is confirmed by (Safitrah *et al.*, 2020) who stated that when shrimp shed their skin, the shrimp will be vulnerable to being eaten by other shrimp because the aroma of molting shrimp can stimulate other shrimp to eat it. The detachment of the shrimp's skin causes the shrimp to lose its body protection, and ultimately it is very easy to be preyed on by other shrimp.

b. Specific Length

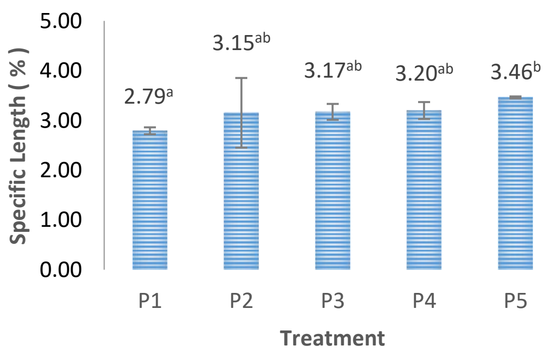

Figure 2. Specific length data

Specific length growth rate is a parameter to determine the specific length growth rate per day during maintenance. Based on the research results in Figure 6, it shows that the specific length growth rate value increased in P2, P3, P4, and P5, the lowest value was in P1 at 2.79%, the low specific length growth rate in P1 was caused by the absence of additional bone meal. tuna fish so that the length growth in P1 is lower than P2, P3, P4, and P5. The specific length growth values at P2, P3, and P4 were 3.15%, 3.17%, and 3.20% respectively. These values continued to increase, presumably due to the addition of tuna fish bone meal in each treatment with different doses, namely P2. (1%), P3 (2%), P4 (3%). A significant increase occurred in P5, namely 3.46% with a dose of tuna bone meal of (4%), the calcium content in tuna bone meal can help facilitate the molting process in shrimp, calcium helps shrimp in the process of hardening their skin after molting so that the shrimp's molting rate will increase and the more frequently the shrimp molts, the better the shrimp's growth will be. This is in accordance with the statement by (Supono *et al.*, 2022) that in vaname shrimp cultivation activities the need for calcium is very necessary because calcium functions to speed up the molting process of white vaname shrimp so that the shrimp will experience growth.

c. Specific weight

Specific weight growth rate is a parameter to determine the weight growth rate per day during maintenance. Based on research that has been carried out, it was found that the specific weight value continued to increase at P2 to P5 with the values P2 (2.23%), P3 (2.36%), P4 (2.40), and P5 (2.85%) increasing the specific weight value It is suspected that this was due to the addition of tuna bone meal to feed P2, P3, P4, and P5. The P1 value, namely (1.66%) is the lowest value, this is due to the absence of the addition of tuna bone meal in P1 feed, the highest increase occurred in P5, this is due to the dose of tuna bone meal in P5 feed which is equal to (4%) is the highest compared to other treatments.

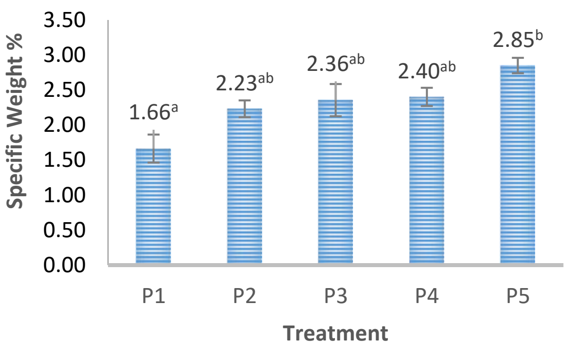

Figure 3. Specific weight data

Tuna fish bone meal contains calcium, which is good for shrimp, calcium can help shrimp during the molting phase, calcium can speed up the re-hardening of shrimp shells that have shed their old shell or called molting. This was confirmed by (Cheng, 2012) who stated that crustacean animals such as shrimp really need potassium for molting, especially when their new skin hardens. Vaname shrimp change their old skin to support their body growth, this is supported by (Astifa *et al.*, 2022) that the change of shell in vaname shrimp occurs when the body size of the shrimp gets bigger, but the shrimp shell does not get bigger because the shrimp shell is stiff. or cannot enlarge with its body, so to adjust, the shrimp will shed its old shell and re-form a new shell with the help of calcium.

d. Feed Convertion Ratio (FCR)

The feed conversion ratio is a useful parameter to determine the amount of feed needed to produce one kilogram of meat in aquaculture or the amount of feed converted into meat. Based on the research results, it was found that the highest FCR value was at P1 with a value of 1.23 and the lowest value was at P5, namely 1.06. The FCR value at P5 is low, due to optimal use of feed by shrimp for growth.

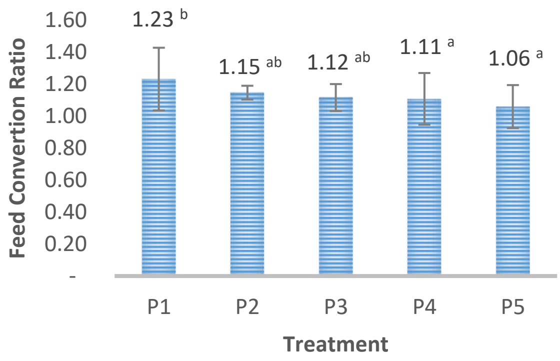

Figure 4. Feed convertion ratio data

The food consumed will turn into energy in the shrimp's body, this energy will be used first to maintain its life. If the energy requirements to maintain their life are met, the shrimp will use the remaining energy for growth. This is in accordance with (Yulihartini *et al.*, 2017), that growth occurs when the amount of energy used exceeds the need to maintain life. In P1, potassium deficiency causes the use of more energy to defend itself from environmental conditions, because calcium plays a role in the process of adapting shrimp to their environment. As a result, shrimp use more energy to survive than to grow.

e. Alkalinity

Alkalinity is a water quality parameter that functions as a buffer for water pH fluctuations or as a guard so that the pH value does not continue to change. Alkalinity that is too low in the water can cause shrimp to frequently molt or molt abnormally, on the other hand, if the alkalinity value is too high it will cause shrimp to have difficulty molting.

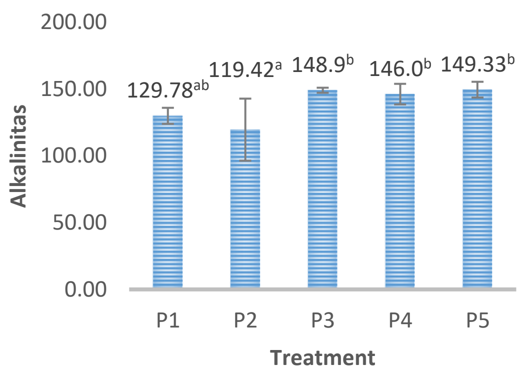

Figure 5. Alkalinity data

Based on research that has been carried out, alkalinity values ranging from 100 - 152 ppm are obtained. This value is still considered optimal for cultivating vaname shrimp. This is in accordance with the statement by (Sitanggang & Amanda, 2019) that the optimal value of alkalinity for cultivating vaname shrimp is around 100. – 150 ppm. High alkalinity values above 150 can be corrected by changing the maintenance media water.

f. Total Bacterial Count (TBC)

Total Bacterial Count (TBC) is a parameter to determine the total number of bacteria in water. Bacteria are pathogens that are often found in vaname shrimp cultivation, one of the bacteria that is often found is *Vibrio* sp. As a pathogenic bacterium, vibrio bacteria are very dangerous for vaname shrimp because they can cause vaname shrimp to become infected with disease.

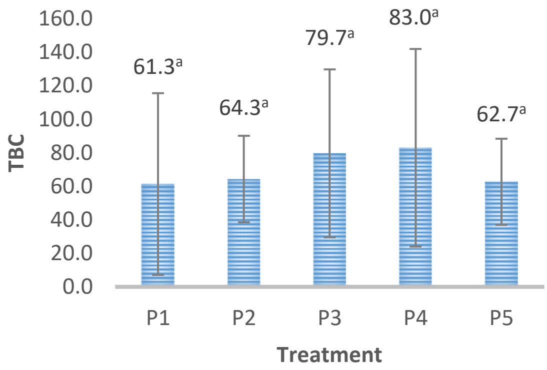

Figure 6. Total bacterial count data

Vibrio bacteria will be dangerous if their abundance in waters exceeds the threshold. This is in accordance with (Utami *et al*., 2016) statement, that if the density of *Vibrio* sp. In waters of more than 1.4 x 104 CFU/Ml, it can cause sick shrimp and can result in death of vaname shrimp. Also confirmed by (Suwoyo & Tampangallo, 2015) stated that vibrio is capable of producing hemolysin substances, hemolysin substances can damage and destroy blood cells in vaname shrimp. Based on research that has been carried out, the TVC density value was the lowest at P4 (100.3 x 106 CFU/ml) and the highest at P2, namely (183 x 106 CFU/ml). Meanwhile, the total value of TB bacteria was the lowest in P1 (61 x 106 CFU/ml) and the highest in P4 (83 X 106 CFU/ml).

g. Water Quality

pH is a water quality parameter that is useful for measuring the acidity or alkalinity of water. pH functions to accelerate chemical reactions in the culture water media and speed biochemical reactions in the shrimp body. Based on the results of the research, it was found that the pH value ranged between 7 - 8.5, this value is still considered optimal for vaname shrimp cultivation. This is in accordance with the statement by (Supriatna, 2020) that the pH value tolerance for vaname shrimp cultivation ranges from 7.0 – 8.5. At this value, shrimp can carry out optimal growth. Low pH values can inhibit the moulting process of vaname shrimp.

Water temperature greatly influences the condition of white vaname shrimp that are kept, especially on the survival of white vaname shrimp. According to (Syukri & Ilham, 2016) temperature has an impact on oxygen consumption, metabolic rate and activity of white vaname shrimp. Based on research that has been carried out, the water temperature value is found to be between 28 - 31ºC, this value is still considered optimal for cultivating vaname shrimp. This is confirmed by (Scabra *et al.*, 2023) who stated that the optimal value of media temperature in vaname shrimp cultivation is between 26 - 32ºC, if the temperature is below the tolerance value it can cause a decrease in appetite for white vaname shrimp.

Dissolved oxygen (DO) is a parameter that determines the availability of oxygen in the cultivation media water. The lack of oxygen in the water can inhibit all white shrimp activities because DO is important for the shrimp to breathe. The lack of oxygen in the water can also inhibit the metabolic process in the shrimp. Based on the results of dissolved oxygen measurements in the research, it was found that the dissolved oxygen value ranged between 5 - 6 mg/L, these results are classified as optimal for vaname shrimp cultivation. This is in accordance with the statement by (Scabra *et al*., 2023) that the optimal value of dissolved oxygen in vaname shrimp cultivation is >4mg/L, continuously low concentrations of dissolved oxygen can disrupt the growth of vaname shrimp. The need for dissolved oxygen will increase as shrimp growth increases, white vaname shrimp need oxygen for the respiration process, the greater the weight of the shrimp, the greater the need for oxygen.

Ammonia is a dangerous substance that needs to be considered in cultivation activities. The ammonia substance appears because of leftover feed and feces that accumulate in the pond. The ammonia value in cultivation water still has a threshold limit. The high amount of ammonia in the water can harm vaname shrimp, ammonia can cause vaname shrimp to become stressed and lose their appetite, leading to death. Based on research carried out, the ammonia values obtained ranged between. The ammonia values obtained ranged between. 0.05 – 0.1 mg/L, the value obtained is still considered optimal for rearing vaname shrimp. This is in accordance with the statement from (Scabra *et al*., 2021) that the dangerous value of ammonia in vaname shrimp cultivation media is >0.1 mg/L.

4. Conclusion

Based on research that has been carried out, the addition of tuna fish bone meal has a real influence on the growth of specific weight, absolute weight, specific length, absolute length but there is no significant difference to FCR. The best value was obtained in Treatment 5 with the addition of tuna bone meal at a dose of 4% (4 grams / 100 grams of feed). Specific weight values at P5 (2.85%), absolute weight (27.8), absolute length (6.00cm), specific length (3.46%).

Table 1.
Average water quality measurement

	Parameter			
	Temperature (ºC)	pH	DO (mg/L)	Amonnia (mg/L)
optimal	26-32	7,08,3	5-6	0,05-0,1
	26-32	7,0-8,5	>4	>0,1

Sumber : (1) (Scabrai et al., 2023)(2)(Scabra et al., 2023); (3) (Scabra *et* al.,2023)

Acknowledgement

The author would like to thank Mr Andre Rachmat Scabra, S.Pi., M.Si. and Mrs. Thoy Batun Citra Rahmadani, S.Pi., M.Si. who has provided much guidance in the preparation of journals, for his services in helping and energy during research. The author also does not forget to thank all parties who have helped from preparation to publication of this journal.

References

Astifa, A., Rajamuddin, M. A. L., & Yuliadi, Y. (2022). Akselerasi moulting larva udang Vaname (*Litopenaeus vannamei*) dengan pemberian kalsium hidroksida Ca(OH)2. *Agrokompleks*, *22*(2), 7–17. https://doi.org/10.51978/japp.v22i2.401

Cheng, W. (2012). (Cheng, 2012). In *The Routledge Handbook of Language and Intercultural Communication* (Issue June, pp. 148–163).

Darwantin, K., & Sidik, R. (2016). Efisiensi Penggunaan Imunostimulan dalam Pakan Terhadap Laju Pertumbuhan, Respon Imun dan Kelulushidupan Udang Vannamei (*Litopenaeus vannamei*). *Jurnal Biosains Pascasarjana*, *18*(2), 123. https://doi.org/10.20473/jbp.v18i2.2016.123-

139

Kaligis, E. Y. (2010). Laju Pertumbuhan, Efisiensi Pemanfaatan Pakan, Kandungan Potasium Tubuh, Dan Gradien Osmotik Postlarva Vaname (*Litopenaeus vannamei*, Boone) Pada Potasium Media Berbeda. *Jurnal Perikanan Dan Kelautan Tropis*, *6*(2), 92. https://doi.org/10.35800/jpkt.6.2.2010.168

Mustari, T. (2022). Pengaruh Penggunaan Tepung Tulang Ikan Tuna dan Tepung Eceng Gondok (*Eichhornia crassipes*) dalam Pakan Buatan Terhadap Pertumbuhan Ikan Nila …. *AquaMarine (Jurnal FPIK UNIDAYAN)*, *9*(April), 8–13. https://www.ejournal.lppmunidayan.ac.id/index.php/aquamarine/article/view/1103

Pamungkas, W. (2012). Aktivitas Osmoregulasi, Respons Pertumbuhan, Dan Energetic Cost Pada Ikan Yang Dipelihara Dalam Lingkungan Bersalinitas. *Media Akuakultur*, *7*(1), 44. https://doi.org/10.15578/ma.7.1.2012.44-51

Pangestika, W., Widyasari Putri, F., & Arumsari, K. (2021). The Utilization of Patin Fish Bone Powder and Tuna Fish Bone Powder in Making Cookies. *Jurnal Pangan Dan Agroindustri*, *9*(1), 44–55.

Prawira, M. A., Sudaryono, A., & Rachmawati, D. (2014). Pengganti Tepung Ikan dengan Tepung Kepala Lele dalam Pakan Terhadap Efisiensi Pemanfaatan Pakan dan Pertumbuhan Juvenil Udang Vaname (*Litopenaeus vannamei*). *Journal of Aquaculture Management and Technology*, *23*(4), 1–8. http://ejournal-s1.undip.ac.id/index.php/jfpik

Restari, A. R., Handayani, L., & Nurhayati, N. (2019). Penambahan Kalsium Tulang Ikan Kambing-kambing (Abalistes stellaris) pada pakan untuk keberhasilan gastrolisasi udang galah (Macrobrachium rosenbergii). *Acta Aquatica: Aquatic Sciences Journal*, *6*(2), 69. https://doi.org/10.29103/aa.v6i2.1560

Riani, H., Rostika, R., & Lili, W. (2012). Efek Pengurangan Pakan Terhadap Pertumbuhan Udang Vaname (*Litopenaeus vannamei*) Pl - 21 Yang Diberi Bioflok. *Jurnal Perikanan Kelautan*, *3*(3), 207–211.

Safitrah, L., Setyowati, D. N., & Astriana, B. H. (2020). Efektivitas Ekstrak Kulit Pisang Kepok (*Musa balbisiana Colla)* Untuk Menurunkan Kanibalisme Pada Udang Vaname (*Litopenaeus vannamei*). *Jurnal Kelautan: Indonesian Journal of Marine Science and Technology*, *13*(1), 36–44. https://doi.org/10.21107/jk.v13i1.5941

Sakthivel, A., Selvakumar, P., & Gopalakrishnan, A. (2014). Effect of Mineral Deposition on Shrimp (*Litopenaeus vannamei)* in High Alkaline Water of Pennar River, Andhra Pradesh of southeast coast of India. *Journal of Aquaculture Research and Development*, *5*(4), 5–10. https://doi.org/10.4172/2155-9546.1000241

Scabra, A. R. (2023). Pengaruh Pemberian Kalsium Hidroksida (Ca(OH)2) dan Fosfor (P) Terhadap Pertumbuhan Udang Vaname (*Litopenaeus vannamei*) Pada Media Air Tawar. *Jurnal Ruaya : Jurnal Penelitian Dan Kajian Ilmu Perikanan Dan Kelautan*, *11*(1), 39–51. https://doi.org/10.29406/jr.v11i1.4855

Scabra, A. R., Cokrowati, N., & Wahyudi, R. (2023). Penambahan Kalsium Karbonat (CaCO3) pada Media Ir Tawar Budidaya Udang Vaname (*Litopenaeus vannamei*). *Samakia : Jurnal Ilmu Perikanan*, *14*(2), 129–140. https://doi.org/10.35316/jsapi.v14i2.1382

Scabra, A. R., Junaidi, M., & Hafizi, A. (2024). Growth of Vannamei Shrimp (*Litopeneaus vannamei*) in Rearing Media with Different Salinities. *Jurnal Biologi Tropis*, *24*(2), 26–36. https://doi.org/10.29303/jbt.v24i2.5904

Scabra, A. R., Marzuki, M., & Alhijrah, M. R. (2023). Addition of Calcium Carbonate (CaCO3) and Magnesium Sulfate (MgSO4) to Vannamei Shrimp (*Litopenaeus vannamei*) Rearing Media in Fresh Water. *Jurnal Biologi Tropis*, *23*(1), 392–401. https://doi.org/10.29303/jbt.v23i1.4461

Scabra, A. R., Marzuki, M., Cokrowati, N., Setyono, B. D. H., & Mulyani, L. F. (2021). Peningkatan Kelarutan Kalsium Melalui Penambahan Daun Ketapang (*Terminalia catappa)* Pada Media Air Tawar Budidaya Udang Vannamei (*Litopennaeus vannamei)*. *Jurnal Perikanan Unram*, *11*(1), 35–49. https://doi.org/10.29303/jp.v11i1.250

Scabra, A. R., Marzuki, M., & Rizaldi, A. (2023). Effect of calcium hydroxide (Ca(OH)2) and Magnesium Sulfate (MgSO4) on Vaname Shrimp (*Litopenaeus vannamei*) Cultivation in Freshwater Media. *Acta Aquatica: Aquatic Sciences Journal*, *10*(1), 77. https://doi.org/10.29103/aa.v1i2.9501

Supono, S., Puspitasari, D., & Sarida, M. (2022). Pengaruh Penambahan Kalsium Pada Media Kultur Salinitas Rendah Terhadap Performa Udang Vaname (*Litopenaeus vannamei)*. *Journal of Tropical Marine Science*, *5*(2), 90–97. https://doi.org/10.33019/jour.trop.mar.sci.v5i2.3214

Supriatna, M. (2020). Model pH dan Hubungannya dengan Parameter Kualitas Air pada Tambak Intensif Udang Vaname (*Litopenaeus vannamei*) di Banyuwangi Jawa Timur. *JFMR-Journal of Fisheries and Marine Research*, *4*(3), 368–374. https://doi.org/10.21776/ub.jfmr.2020.004.03.8

Suwoyo, H. S., & Tampangallo, bunga rante. (2015). Perkembangan Populasi Bakteri Pada Media Budidaya Udang Vaname (*Litopenaeus vannamei*) dengan Penambahan Sumber Karbon. *OCTOPUS Jurnal Imlu Perikanan*, *4*(1), 365–374.

Syukri, M., & Ilham, M. (2016). Pengaruh Salinitas Terhadap Sintasan Dan Pertumbuhan Larva Udang Windu (*Penaeus Monodon*). *Jurnal Galung Tropika*, *5*(2), 86–96. https://doi.org/10.31850/jgt.v5i2.166

Untailawam, R. (2021). Studi Kandungan Kalsium Dalam Tepung Tulang Ikan. *Molluca Journal of Chemistry Education (MJoCE)*, *11*(1), 55–60. https://doi.org/10.30598/mjocevol11iss1pp55-60

Utami, W., Sarjito, & Desrina. (2016). Pengaruh Salinitas Terhadap Efek Infeksi Vibrio Harveyi Pada Udang Vaname (*Litopenaeus vannamei*). *Journal of Aquaculture Management and Technology*, *5*(1), 82–90. https://ejournal3.undip.ac.id/index.php/jamt/article/view/10691p

Yulianto, T., Putri, D. S., Miranti, S., & Putra, W. K. A. (2021). Utilization of Shrimp Shell Waste as Alternative Raw for Mariculture. *E3S Web of Conferences*, *324*, 3–6. https://doi.org/10.1051/e3sconf/202132403006

Yulihartini, W., Rusliadi, & Alawi, H. (2017). Pengaruh

Penambahan Calsium Hidrosida Ca(OH)2 terhadap Moulting, Pertumbuhan dan Kelulushidupan Udang Vannamei (*Litopenaeus vannamei*). *Jom Faperika Unri*, *1*, 1–12. https://www.neliti.com/journals/jom-faperika-unri