Fisheries Journal, 14 (3), 1055-1068 (2024)
http://doi.org/10.29303/jp.v14i3.1011

THE ADDITION OF CALCIUM CARBONATE AND SODIUM CHLORIDE WITH DIFFERENT RATIOS ON THE GROWTH AND SURVIVAL OF VANAME SHRIMP (*Litopenaeus vannamei*) IN FRESH WATER MEDIA

Penambahan Kalsium Karbonat Dan Natrium Klorida Dengan Rasio Yang Berbeda Terhadap Pertumbuhan Dan Kelangsungan Hidup Udang Vaname (Litopenaeus Vannamei) Di Media Air Tawar

Muhammad Ridwan, Andre Rachmat Scabra*, Zaenal Abidin

Aquaculure Study Program, Mataram University

Pendidikan Street Number 37, Mataram City, Indonesia

*Corresponding author: andrescabra@unram.ac.id

(Received July 2th 2024; Accepted July 19th 2024)

ABSTRACT

This research aims to determine the effect of calcium carbonate and sodium chloride on the growth of vannamei shrimp in rearing media with a salinity of 0 ppt. The research was carried out for 45 days, in the Aquaculture Laboratory and Analysis of sodium chloride levels at the Analytical Chemistry Laboratory, Mataram University. using an experimental method with a completely randomized design, consisting of 4 treatments and 3 replications, Using the Completely Randomized Design method. There were 5 treatments with 3 repetitions in each treatment, So in this research there were 15 experimental units. Data were analyzed using Analysis of Variance (ANOVA), and continued with the Duncan test with a confidence level of 95%. The results of the research show the effect of adding calcium carbonate (40 ppm) and Natrium klorida (1,1 ppt) on the growth of vannamei shrimp (Litopenaeus vannamei), namely survival rate, absolute and specific weight growth, absolute and specific length growth, feed conversion ratio, oxygen consumption rate, diversity coefficient, water quality parameters (temperature, dissolved oxygen (Do), Potential of Hydrogen (pH), ammonia, calcium levels, alkalinity and Natrium klorida (NaCl)), is the best treatment for cultivating vannamei shrimp in fresh water media.

Keywords: calcium carbonate, sodium chloride, vannamei shrimp, growth effect, water quality parameters.

ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh kalsium karbonat dan natrium klorida terhadap pertumbuhan udang vanname dalam media pemeliharaan dengan salinitas 0 ppt. Penelitian dilaksanakan selama 45 hari, di Laboratorium budidaya perairan dan dilakukan

analisis kadar Natrium Klorida di Laboratorium Kimia Analitik, Universitas Mataram. Dengan menggunakan metode Rancangan Acak Lengkap, yang terdapat 5 perlakuan dengan 3 kali ulangan pada setiap perlakuannya, sehingga pada penelitian ini diperoleh adanya 15 unit percobaan. Data dianalisa menggunakan *Analysis of Variance* (ANOVA) dan dilanjutkan dengan ujian Duncan dengan tingkat kepercayaan 95%. Hasil penelitian menunjukkan bahwa Pengaruh penambahan kalsium karbonat (40 ppm) dan natrium klorida (1,1 ppt) terhadap pertumbuhan udang vannamei (*litopenaeus vannamei*) yaitu tingkat kelangsungan hidup, pertumbuhan berat mutlak dan spesifik, pertumbuhan panjang mutlak dan spesifik, rasio konversi pakan, tingkat konsumsi oksigen, koefesien keragaman, parameter kualitas air (Suhu, Oksigen Terlarut(Do), Derajat Keasaman(pH), Amoniak, kadar kalsium, alkalinitas dan Natrium klorida (NaCl)), merupakan perlakuan terbaik pada budidaya udang vaname media air tawar.

Kata Kunci : kalsium karbonat, natrium klorida, udang vanname, pengaruh pertumbuhan, parameter kualitas air.

INTRODUCTION

Vaname shrimp is one of the superior commodities of aquaculture, which is an introduced shrimp and was officially established by the Minister of DKP in 2001, where vaname shrimp cultivation developed rapidly at that time. Currently, vaname shrimp cultivation has been commercialized and is growing very rapidly. Vaname shrimp have quite high market power and prices in both local and international markets. Apart from that, vaname shrimp have a higher immune system compared to tiger prawns (Penaues monodon) and do not require too long to cultivate, so vaname shrimp are in great demand by the public for cultivation (Ismawati et al., 2019).

Vaname shrimp have the advantage of being able to survive in a wide salinity range, namely 2 - 40 ppt and can grow quickly at lower salinities, thus creating opportunities for vaname shrimp cultivators to carry out cultivation activities in fresh water. The condition of shrimp which is able to adapt to low salinity has made some farmers carry out vaname shrimp cultivation activities in fresh water through an acclimatization process (Kusyairi et al., 2019).

The main problem in vaname shrimp cultivation activities is limited land so a method and innovation is needed that can overcome this problem. One way is to carry out cultivation activities in fresh water. However, carrying out cultivation activities in fresh water is not easy and several obstacles are still encountered, such as the low survival rate of post-larvae during the acclimatization process and during rearing. This affects the moulting process which will have an impact on shrimp growth and the growth of vaname shrimp is also influenced by the osmoregulation process which produces a lot of energy (Widodo, et al, 2011).

Efforts to overcome the problem of delayed growth of vaname shrimp that are reared in fresh water or at low salinity can be done by adding calcium and sodium to the rearing media. Calcium (Ca) and sodium (Na) are important minerals from 20 types of minerals identified as having an important role in the shrimp body (Akiyama et al. 1991). According to Boyd (2018), the balance of minerals in waters greatly influences shrimp growth, where the ratio of the mineral composition contained in marine waters (34 ppt) is 304.35 ppm for sodium (Na), 39.13 ppt for magnesium (Mg), 11.59 ppm for calcium (Ca) and 11.01 for potassium (K). Meanwhile, a concentration of 1 ppt has a composition of 27 ppm for Na, 3 ppm for Mg, 1 ppm for Ca and 1 ppm for K. The optimum Ca value for the growth of vaname shrimp in fresh water is 40 ppm (Wahyudi, 2021).

Sodium (Na) is an important mineral from 20 types of minerals identified as having an important role in the shrimp body. Na is a mineral and electrolyte that the body needs to help maintain fluid and electrolyte balance in the body and also plays a role in the work of muscles and nerves. If the sodium content in the water is insufficient, the osmoregulation mechanism is disrupted which ultimately has an impact on growth (Syufi, 2018). Therefore, it is necessary to carry out research regarding the addition of calcium carbonate and sodium chloride to maintenance media with a salinity of 0 ppt.

RESEARCH METHODS

Time and Place

This research was carried out for 45 days at the Aquaculture Laboratory, Aquaculture Study Program, Department of Fisheries and Marine Sciences, Faculty of Agriculture and analysis of Sodium Chloride levels was carried out at the Analytical Chemistry Laboratory, Faculty of Mathematics and Natural Sciences, Mataram University.

Research Design

The research method used in this research was the RAL (Completely Randomized Design) method. In this study there were 5 treatments with 3 repetitions of each treatment, so that in this study there were 15 experimental units. Namely the addition of calcium and NaCl to fresh water media with different ratios.

P1 Water media 30 ppt (pure sea water)
P2 fresh water media + 40 ppm calcium and the addition of 0.8 ppt NaCl
P3 fresh water media + 40 ppm calcium and the addition of 0.9 ppt NaCl
P4 fresh water media + 40 ppm calcium and addition of NaCl 1, ppt
P5 fresh water media + 40 ppm calcium and the addition of 1.1 ppt NaCl

Research Procedures

1. Research Preparation
   a) Making a solution ooc calcium ($CaCO_3$)

      Before being put into the maintenance container, CaCO3 and NaCl were first dissolved in 4 150 L buckets according to the number of experiments (Scabra, Marzuki, Al Hijrah, 2023). Before being put into a bucket filled with water, CaCO3 and NaCl are weighed first. For P2 40 ppm CaCO3 + 0.8 ppt NaCl, P3 40 ppm CaCO3 + 0.9 ppt NaCl, P4 40 ppm CaCO3 + 1 ppt NaCl, and P5 40 ppm CaCO3 + 1.1 ppt NaCl. Before being placed into a 150 l bucket, sufficient water was taken from the bucket using a 3 liter bucket for each treatment, then the weighed CaCO3 and NaCl were placed into each 3 liter bucket then aerated for 24 hours before being poured. into a 150 l bucket.

   b) Prepations of Test Animals

      The biota used as test animals in this research were vaname shrimp fry measuring PL 10, before the research was carried out the test animals were acclimatized for 4 days. At the time the research began, shrimp were already PL 14 old (Scabra, Marzuki, Rizaldi, 2023).

   c) Distribution

      The shrimp rearing process lasts for 45 days, during the shrimp rearing process they are given food 5 times a day every 4 hours at 07:00 in the morning, 11:00, 15:00, 19:00 and 23:00 at night using feed (crumble) is 10% of the shrimp's body weight (Scabra, Junaidi, et al., 2024).

2. Research Parameters
   a) Survival rate

      Survival rate is a measure of the survival rate of cultivated biota. The survival rate can be calculated using the following formula (Restari, 2019), namely:

$$SR\ (\%) = \frac{Nt}{No} \times 100$$

Information :
SR =Life cycle of vaname shrimp

Nt =Number of white vaname shrimp that were alive at the end of the study
No =Number of white vaname shrimp that were alive at the start of the study

b) Spesifik Growth Rate

Specific weight growth rate (LPBS), obtained from data on final weight and initial weight of shrimp during the study. The specific weight growth rate can be calculated using the formula proposed by Ayu (2021), namely:

$$SGR\ (\%) = \frac{LnWt - LnWo}{t} \times 100$$

Information:
SGR = Specific growth rate (%/day)
Wt = Average weight of shrimp at the end of the study (g)
Wo = Average weight of shrimp at the start of the study (g)
T = Maintenance time (days)

c) Spesifik Length Growth Rate

Specific growth rate can be calculated using the (Scabra, Cokrowati, Fatimah) 2023, namely:

$$SGR\ (\%) = \frac{LnWt - LnWo}{t} \times 100$$

Information:
SGR = 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)

d) Feed Conversion Ration (FCR)

The feed conversion ratio is the ratio between the amount of feed given and the shrimp meat produced. FCR was calculated 3 times during the study. FCR is calculated based on the equation proposed by Scabra, Cokrowati, Wahyudi (2023), namely:

$$FCR = \frac{F}{Wt - Wo}$$

Information:
FCR = Feed conversion ratio
F = Amount of feed given during maintenance (g)
Wt = Final biomass (g)
Wo = Initial biomass (g)

e) Oxygen Consumption Rate

Oxygen consumption levels were calculated 3 times during the study, namely at the beginning, middle and end. The level of oxygen consumption is calculated based on the formula Budiardi et al., (2005), namely:

$$OC = V \times \frac{(DO_{to} - DO_{tn})}{W \times T}$$

Information :
OC = Oxygen consumption (mg O2/g/ja
V = Volume of water used in the container (L)

Doto = Initial DO concentration (mg/l)
Dotn = Final DO concentration (mg/l)
W = Weight of shrimp (g)
T = Observation period (hours)

f) NaCl levels in water

NaCl in waters can be calculated using the following formula:

$$NaCl\ (ppm) = \frac{V \times N \times Fp \times 58{,}5}{W}$$

Information :
V = Volume of AgNO2 required in titration (ml)
N = AgNO2 Normality (N)
Fp = Dilution factor
W = Test sample weight (mg)
58.5 = Morality value of AgNO2

g) 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 are significantly different, a Duncan test will be carried out with a confidence level of 95%.

RESULTS and DISCUSSION

Research Results

The effect of adding calcium carbonate (CaCO3) and NaCL on the growth of vannamei shrimp (Litopenaeus vannamei) can be seen from the results of the parameters, namely survival rate, absolute and specific weight growth, absolute and specific length growth, feed conversion ratio, oxygen consumption level, diversity coefficient, water quality parameters (temperature, DO, pH, ammonia, calcium levels, alkalinity and NaCl.

1. *Survival Rate* (SR)

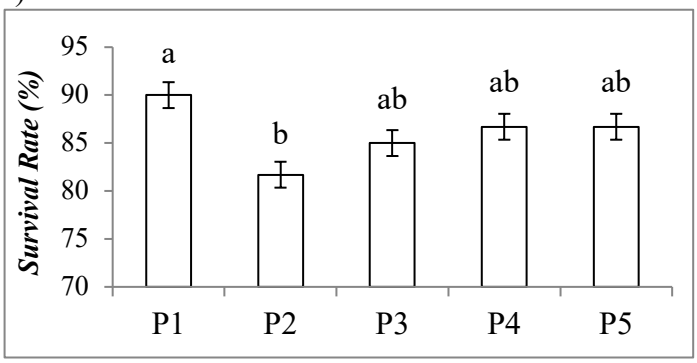

Figure 1 Average SR Value of Vaname Shirmp

The average value of survival rate is presented in Figure 1. Based on the results of one factor analysis of variance (one way anova) with a confidence level of 95%, it shows that the addition of calcium and Nacl with different ratios does not have a significantly different effect (P>0.05%) on the survival of vaname shrimp which were kept for 45 days. P1 had the highest survival value of 90% and the lowest was P2 of 81.7%. P3 was 85%, then followed by P4 and P5 at 86.7%. P1 is not significantly different from p3, p4 and p5 but is significantly different from p2.

2. Growth In Specific Weight

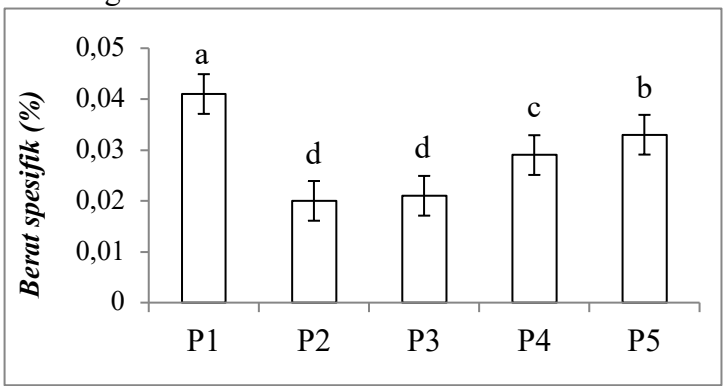

Figure 2 Average Specific Weight Value of Vaname Shirmp

The results obtained in Figure 2 show that the addition of calcium and NaCl with different ratios had an effect ($p>0.05$) on the specific weight value of vaname shrimp. The highest specific weight value was found in treatment P1, namely 0.041% and was different ($p<0.05$) from all treatments. Meanwhile, P3 and P2 have the lowest absolute weight values, namely 0.021 and 0.020% respectively and are not different ($p>0.05$).

3. Specific Length Growht

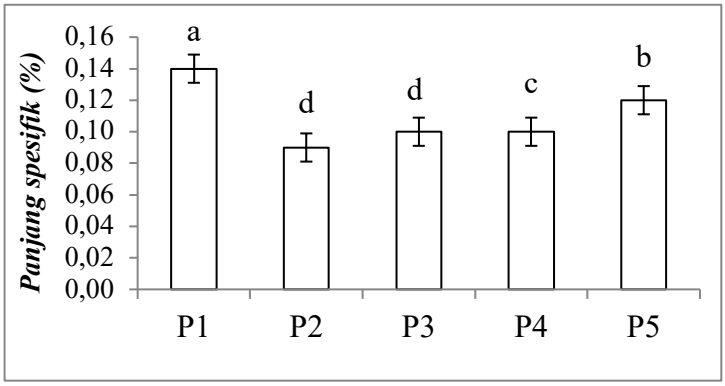

Figure 3 Average Specific Length Value of Vaname Shrimp

The results obtained in Figure 3 show that the addition of calcium and NaCl with different ratios had an effect ($p<0.05$) on the specific length of vaname shrimp. P1 had the highest specific length value, namely 0.14% and was different ($p<0.05$) from all treatments. Meanwhile, the lowest specific length values were found in P3 and P2 with values of 0.10 and 0.09% respectively and were not different ($p<0.05$).

4. Feed Conversion Ratio (FCR)

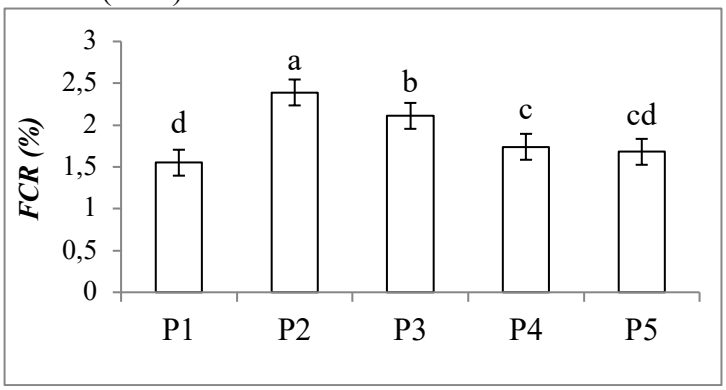

Figure 4 Average FCR Value of Vaname Shirmp

Figure 4 shows that the addition of calcium and NaCl with different ratios had an effect ($p<0.05$) on the FCR value of vaname shrimp reared in fresh water media. The highest FCR value was found in treatment P2, followed by P3 with values respectively 2.39 and 2.11, meanwhile P1 was different ($p<0.05$) from all treatments. P4 and P5 have FCR values that are not different ($p>0.05$) but P4 is different ($p<0.05$) from P1 with values of 1.74 and 1.68 respectively. Meanwhile, P5 and P1 have FCR values that are not different ($p>0.05$), but P1 is different ($p<0.05$) from P4, P3 and P5 with values of 1.68 and 1.55 respectively.

5. Oxygen Consumption Rate (TKO)

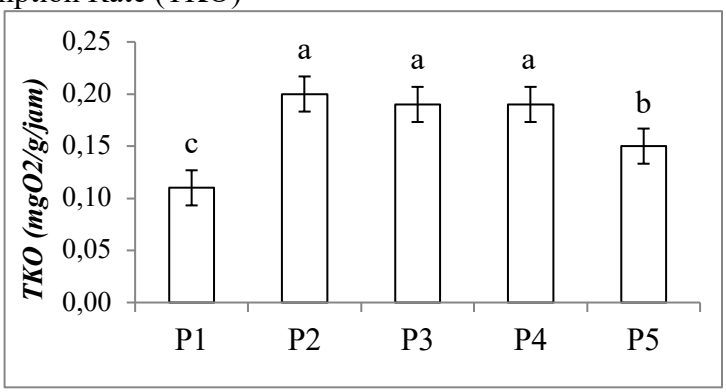

Figure 5 Average TKO of Vaname Shirmp

The addition of calcium and NaCl with different ratios had an effect ($p<0.05$) on the TKO value of vaname shrimp reared in fresh water media. Figure 5 shows that P2, P3 and P4 have the highest TKO values and are different ($p>0.05$) from P5 and P1, namely 0.20, 0.19 and 0.19 mgO2/g/hour. Meanwhile, P1 had the lowest TKO value and was different ($p<0.05$) from all treatments, namely 0.11 mgO2/g/hour.

6. NaCl Levels

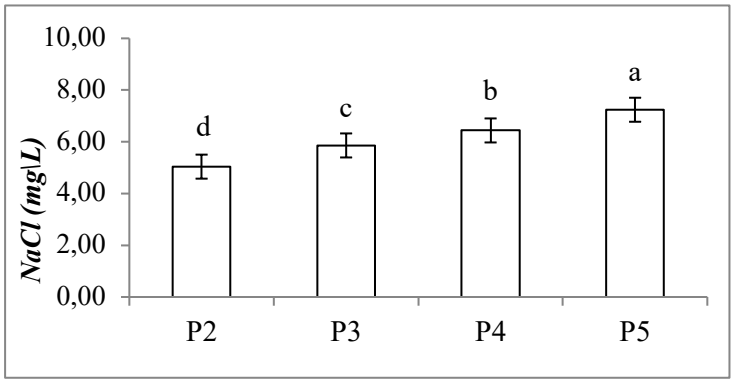

Figure 6 Average NaCl Value

The average NaCl value in Figure 6 shows the influence ($p<0.05$) of adding calcium and NaCl with different ratios to NaCl. P5 is the treatment with the highest NaCl value and is different ($p<0.05$) from all treatments, namely 7.24 mg\L. Meanwhile, the treatment with the lowest NaCl value was in P2 and was different ($p>0.05$) from all treatments, namely 5.04 mg\L.

Discussion

The survival rate (SR) is the number of biota that live in a certain period of time compared to the number of biota at the beginning of maintenance. According to Yunarty and Diana Putri Renitasari's (2022) statement, the survival rate can be determined by counting the number of live shrimp from the beginning to the end of the study. Furthermore, the survival rate (SR) in this study is the main parameter or the first reference to determine the level of success in the research.

The highest survival value was found in P1, this is thought to be because seawater with a salinity of >25 ppt was used, which is the optimum salinity for shrimp growth. According to Yulihartini et al., (2016), the level of survival is influenced by external factors such as competition for space, water quality and feed quality. According to Jayanti et al., (2022) Salinity is one of the water quality parameters that influences the survival and growth of vaname shrimp. Salinity greatly influences the osmoregulation process, namely the efforts of aquatic organisms to control the balance of water and ions between the body and the environment.

Meanwhile, the highest value for treatment was found in P5 and P4, namely 86.7% compared to P3 and P2 which were the same as those maintained in fresh water, allegedly due to the optimal levels of sodium chloride (NaCl) and calcium carbonate (CaCO3) provided in the maintenance media. According to Zaidy (2007) using lime at an optimal dose can increase the number of molting shrimp and maintain the hardness of the shrimp shell. The molting process which does not coincide between one shrimp and another tends to cause cannibalism in the molting shrimp and subsequently results in death. This is confirmed by research by Kaligis et al. (2015) that vaname shrimp whose salinity was reduced to 0 ppt and given 50 ppm calcium were able to maintain the survival rate of the shrimp.

Specific weight growth is an important indicator in the total weight growth of shrimp during rearing and is expressed in percentage units. The highest specific weight growth value maintained in fresh water was found in treatment P5 compared to P4, P3 and P2, thought to be due to the appropriate addition of Ca and Na in the water so that it affected the fulfillment of minerals for shrimp growth. Ca and Na are minerals that greatly influence shrimp growth.

Where Ca has the effect of speeding up the hardening process of shrimp shells, and Na has an effect on changes in salt levels or salinity in the water, thereby speeding up the moulting process in vaname shrimp. According to Satwika (2014), the growth rate of shrimp depends on the frequency of moulting. Moulting is usually followed by an increase in shrimp weight. The mechanism for shrimp to absorb calcium and organic salts comes from the exoskeleton, feed and the environment (Roshaliza et a., 2020). This is confirmed by similar research conducted by Zaidy and Wartono (2009) which stated that the addition of calcium at doses of 30 and 40 mg/l was able to speed up the moulting process in shrimp.

Specific/daily length growth is the increase in shrimp weight during rearing and is expressed in (% cm/day). The high growth in length of P5 reared in fresh water is thought to be due to the addition of appropriate doses of Ca and Na, thereby ensuring sufficient mineral availability in the water. This is in accordance with the statement of Nurhasanah et al., (2021), who stated that a calcium value that is too low is also not good because it slows down the moulting process in shrimp. On the other hand, if calcium levels are too high, it can inhibit the transfer of calcium from the environment into the shrimp's body (Cameron, 1985 in Taqwa et al., 2014). However, the low growth of P2 maintained in fresh water is thought to be due to the addition of a small amount of Ca and Na so that the minerals in the water are not optimal. As is known, Ca and Na are minerals that greatly influence skin hardening and the moulting process in shrimp.

The feed conversion ratio is a value that shows how much feed is converted into meat. A good feed conversion value shows a very low value for each treatment. The lower the feed conversion value, the better the quality and quantity of feed used. The low FCR value in the P5 treatment which was reared in fresh water is thought to be due to optimal provision of Ca and Na in cultivation activities, so that the minerals needed by the shrimp are met. Providing Ca and Na functions to increase the availability of minerals in the waters which will later be used for the molting process and hardening of shrimp shells. One way to ensure that the shrimp feed conversion value is effective or not high is to maintain the stability of water quality parameters as an indicator of the environment where the shrimp live. The results of similar research conducted by Nurhasanah et al., (2021) showed that the addition of CaCO3 was able to increase the appetite of vaname shrimp. Quality The good feed convergence value shows a very low value for each treatment. The lower the FCR value, the better the quality and quantity of feed used. A low FCR value will increase the efficiency of feed absorption by shrimp (Primavera, 1989 in Ariadi et al., 2020). A low FCR value has a good impact on the water quality in the cultivation environment, because the lower the FCR value, the less feed waste will be wasted (Nurhasanah et al., 2021). Meanwhile, the high FCR value in P2 which was reared in fresh water with the addition of 40 ppm CaCO3 and 0.8 ppt NaCl is thought to be due to the low salinity of live shrimp so that the food they eat is used for the osmoregulation process and little for growth.

Oxygen consumption is an indicator to determine the oxygen needs of cultivated biota. Where the highest oxygen consumption level value is found in P2 which is maintained in fresh water with the addition of 40 ppm CaCO3 and 0.8 ppt NaCl, namely 0.20 mg O2/g/hour. Meanwhile, the lowest was in P1 which was maintained in sea water (control). In treatment 2, the highest TKO value was thought to be due to the shrimp's inability to adapt to the decrease in salinity. It can be seen in P2 which is reared in fresh water with the addition of 40 ppm CaCO3 and 0.8 ppt NaCl, which is 0.20 mg O2/g/hour and the shrimp weighs 0.9 gr. The TKO of smaller sized shrimp is relatively higher than that of larger sized shrimp. Small-sized organisms consume more oxygen per unit time and weight than large-sized shrimp because small shrimp require more energy for growth (Budiardi et al., 2005). The TKO value is closely related to growth because a high TKO value will cause slow growth. A high TKO value

indicates that the shrimp are experiencing stress due to the decrease in salinity, so they spend their energy to adapt. This is in accordance with what is said (Widodo et al., 2011) that extreme changes in salinity will trigger the breathing movements of vaname shrimp so that they will increase their metabolic rate and energy expenditure. Meanwhile, the lowest TKO value was found in P1 (sea water), namely 0.11 mg O2/g/hour, allegedly because it was reared in sea water with a salinity of >25 ppt. thus spending energy on the growth process. According to Hamzah, (2004) that low oxygen consumption is related to growth rate. This indicates that the level of oxygen consumption has a relationship with the daily growth rate of weight and length in this study. The lower the level of oxygen consumption, the higher the shrimp growth rate.

Sodium Chloride (NaCl) forms crystals when dry, but like other salts in the body, it dissolves easily in water. If salt dissolves in water, its components separate as particles called ions. The dissolved particles are known as electrolytes. The levels (concentration) of each electrolyte in a solution of dissolved salts can be measured and are usually calculated in units of milliequivalents in each volume of solution (mEq/L) (Hoiriyah, 2019). Physically, salt is a white, crystalline solid object which is a collection of compounds with the largest portion being more than 80% sodium chloride and other compounds such as magnesium chloride, magnesium sulfate and calcium chloride. It is suspected that the highest NaCl level at P5, namely 7.24 mg/L, is able to provide good growth and osmoregulation processes for vaname shrimp. This is in accordance with Syufi's (2018) statement which states that the aim of osmoregulation is to control the concentration of solution in the fish's body. If fish or shrimp are not able to control the osmosis process that occurs, the fish in question will die because there will be an imbalance in the concentration of body solutions which is beyond its concentration limit.

CONCLUSION

The best treatment for white shrimp cultivation in freshwater media is P5, namely the addition of 40 ppm calcium carbonate and 1.1 ppm sodium chloride, with a survival value of 86.7%, specific weight growth of 0.033%, specific length growth of 0.12%, consumption rate oxygen 0.15 mgO2/g/hour, feed conversion ratio 1.68%, and sodium chloride 7.24 mg/l.

RECOMMENDATIONS

Further research needs to be carried out to determine the amount of calcium and sodium chloride mineral absorption when rearing vaname shrimp in fresh water media.

DAFTAR PUSTAKA

Akiyama, D.M., Dominy, W.G, Lawrence AL. (1991). Penaeid Shrimp Nutrition For The Commercial Feed Industry: Revised. *In*: Akiyama, D.M. and R.K.H. Tan (ed.) Proceedings Of The Feed Proceeding and Nutrition Workshop. Thailand and Indonesia, pp: 80-98.

Babu, D., Ravuru, J.N. Mude. (2014). Effect of Density on Growth and Production of *Litopenaeus vannamei* of Brackish Water Culture System in Summer Season with Artificial Diet in Prakasam District, India. *American International Journal of Research in Formal, Applied, & Natural Sciences*. 5(1):10-13.

Budiardi. T., Batara. T., & Wahjuningsih. D. (2005). Tingkat Konsumsi Oksigen Udang Vaname (*Litopenaeus vannamei*) dan Model Pengelolaan Oksigen Pada Tambak Intensif. *Jurnal Akuakultur Indonesia.* 4(1), 89-96.

Buwono, D. (1993). *Tambak Udang Windu Sistem Pengelolaan Berpola Intensif*. Kanisius. Yogyakarta.

Cheng, K. M., Hu, C. Q., Liu, Y. N., Zheng, S. X., & Qi, X. J. (2005). Dietary magnesium

requirement and physiological responses of marine shrimp *Litopenaeus vannamei* reared in low salinity water. *Aquaculture Nutrition*, *11*(5), 385–393. https://doi.org/10.1111/j.1365-2095.2005.00364.x

Darwantin, K., Sidik, R. (2016). Efisiensi Penggunaan Imunostimulan Dalam Pakan Terhadap Laju Pertumbuhan, Respon Imun Dan Kelulushidupan Udang vaname *(Litopenaeus vannamei)*. *Jurnal Biosains Pascasarjana, 18*(2)

Effendi, I. (2004). *Pengantar Akuakultur*. Penebar Swadaya. Jakarta.

Fendjalang, S. N. M., Budiardi, T., Supriyono, E., & Effendi2, I. (2016). Produksi Udang Vaname (*Litopenaeus Vannamei*) Pada Karamba Jaring Apung Dengan Padat Tebar Berbeda di Selat Kepulauan Seribu Production. *Jurnal Ilmu dan Teknologi Kelautan Tropis*, *8* (1), 201–214. https://doi.org/10.25181/peranan.v1i1.1461.

Hadi. (2018). Efek Cekaman Salinitas Rendah Perairan Terhadap Kemampuan Adaptasi Udang Vaname (Litopenaeus vannamei) Faisal Rizki Hadi , Indah Riyantini dan Ujang Subhan , dan Yudi Nurul Ihsan Universitas Padjadjaran Pengembangan Budidaya Air Payau dan Laut menggunak. *Jurnal Perikanan Dan Kelautan*, *IX* (2), 72–79.

Haliman., Adijaya. (2005). *Udang vannamei*. Penebar swadaya. Jakarta

Hamzah, M. 2004. Kelangsungan hidup dan pertumbuhan juvenil udang galah (Macrobrachium rosenbergii de Man) pada berbagai tingkat salinitas media. Tesis S2. Institut Pertanian Bogor. Bogor, 70 hlm.

Ismawati, Destryana, R. A., Huzaimah, N., Studi, P., Hasil, T., Fakultas, P., Universitas, P., Studi, P., Keperawatan, I., Kesehatan, F., & Wiraraja, U. (2019). *Imunitas Udang Vanname (Litopenaeus vannamei) yang Diberi Pakan Tambahan Daun Kasembukan (Paederia foetida Linn .)*. *12*(2), 201–206.

Jayanti.S. L. L., Andi. A. A., Reski. F., Dian. L., & Muh. N. (2022). Pengaruh Perbedaan Salinitas Terhadap Pertumbuhan dan Sintasan Larva Udang Vaname (*Litopenaeus vannamei*). *Aquacoastmarine: J. Aquat.Fish.Sci.* 1(1). 40-48.

Kaligis, E.(2015). Respons Pertumbuhan Udang Vaname (*Litopenaeus vannamei*) di Media Bersalinitas Rendah Dengan Pemberian Pakan Protein Dan Kalsium Berbeda. *Jurnal Ilmu Dan Teknologi Kelautan Tropis*, *7*(1), 225–234.

Kitani, H. (1994). Identification of Wild Postlarvae of The Penaeid Shrimps, Genus Penaeus in The Pasific Coast of Cenral Amerika. *Fisheries Science60*(30), 243-250.

Kusyairi. A, Didik. T, Sri.O.M. (2019). Budidaya Udang Vanamei (*Litopenaeus vannamei*) di Lahan Pekarangan Kelurahan Pakis Kecematan Sawah Kota Surabaya. *Jurnal Pengabdian Masyarakat*. 04(02): 103-110.

Manurung. A. P, Indah. A, Rangga. B. K. H. (2018). Tingkat Pertumbuhan Dan Kelangsungan Hidup, Pada Pembesaran Udang Galah (*Macrobrachium rosenbergii* de Man 1879) Strain Siratu dan Strain Gimarco II. Jurnal Ilmu Perikanan dan Budidaya Perairan. Vol. 3 (1).

Nadhif, M. (2016). Pengaruh Pemberian Probiotik Pada Pakan Dalam Berbagai Konsentrasi Terhadap Pertumbuhan Dan Mortalitas Udang Vaname (*Litopenaeus vannamei).* Universitas Airlangga: Surabaya. [*Skripsi*].

Nur'aisyah, Agus, M., & Mardiana, T. Y. (2017). Analisis Pemanfaatan Dolomit dalam Pakan Terhadap Periode Molting Udang Vaname (*Litopenaeus vannamei*) di Tambak Unikal. *JurnPENA Akuatika*, *16*(1), 95–102.

Nurhasanah, N., Junaidi, M., & Azhar, F. (2021). Survival Rate And Growth Of Shirmp Vaname (*Litopanaeus vannamei*) At Salinity 0 Ppt With Multilevel Acclimatization Method Using Calsium CaCO3. *Jurnal Perikanan Unram*, *11* (2), 166–177. https://doi.org/10.29303/jp.v11i2.241.

Noviana, R., Muhammadar., & Hassanuddin. (2018). Penambahan Kalsium Dengan Dosis Yang

Berbeda Pada Terhadap Pertumbuhan Dan Kelangsungan Hidup Udang Galah (*Macrobrachium rosenbergii*) Stadia Tokolan. *Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah.* 3(1), 76-83

Putra, F. R., Abdul, M. (2014). Monitoring Kualitas Air Pada Tambak Pembesaran Udang Vannamei (*Litopenaeus vannamei*) Di Situbondo, Jawa Timur. *Jurnal Ilmiah Perikanan dan Kelautan*, *6* (2), 137-14.

Rakhfid, A., Baya, N., Bakri, M., & Fendi, F. (2019). Growth and survival rate of white shrimp (*Litopenaeus vannamei*) at different density. *Jurnal Akuakultur, Pesisir dan Pulau-Pulau Kecil*,3(1),23–29. https://doi.org/10.29239/j.akuatikisle.1.2.1-6.

Roshaliza. E. J., & Nurul. S. 2020. Pengaruh Penambahan Kapur (CaCO3) Pada Media Pemeliharaan Terhadap Pertumbuhan Udang Galah (*Macrobrachium rosenbergii*) de Man, 1879. *Bioma.* 9.(1).

Sahrijana. A., & Early. S. (2017). Variasi Waktu Kualitas Air Pada Tambak Budidaya Udang Dengan Teknologi Integrated Multitrophic Aquakulture (IMTA) di Mamuju Sulawesi Barat. *JUrnal Ilmu Alam dan Lingkungan.* 8(16),52-57.

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 Vaname (*Litopennaeus vannamei*). *Jurnal Perikanan Unram*, 11 (1), 35–49. https://doi.org/10.29303/jp.v11i1.250.

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., & 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: Jurnal Ilmu Perairan*, 10(1), 77-84 . https://doi.org/10.29103/aa.v1i2.9501

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., Cokrowati, N., & Fatimah, S. (2023). Pengaruh Pemberian Kalsium Hidroksida (Ca(OH)2) Pada Budidaya Udang Vaname (Litopenaeus vannamei) Air Tawar. *Jurnal Perikanan Tropis*, 10(2):43–55. https://doi.org/10.35308/jpt.v10i2.4049

Scabra, A. R., Cokrowati, N., & Wahyudi, R. (2023) Penambahan Kalsium Karbonat (CaCO3) pada Media Air Tawar Budidaya Udang Vaname (Litopenaeus Vannamei). *Samakia: Jurnal Ilmu Perikanan*, 14(2):129–40. https://doi.org/10.35316/jsapi.v14i2.1382

Sumeru, S. U., Anna, S. (1992). *Pakan Udang Windu.* Yogyakarta. Kanisius.

Syufi F. (2018). Pengaruh Pemberian Campuran Garan Dan Daun Kemangi Untuk Menghambat Ifeksi Bakteri *Aeromonas hydrophila* Yang Menyerang Ikan Lele Dumbo (*Clarias gariepinus*). Universitas Sanata Dharma: Yogyakarta. [Skripsi].

Taqwa, F. H., Sasanti, A. D., Haramain, K., Kusrini, E., & Gaffar, A. K. (2014). Penambahan Kalsium Pada Air Rawa Sebagai Pengencer Salinitas Media Pemeliharaan Pascalarva Udang Galah Terhadap Sintasan, Tingkat Kerja Osmotik, dan Konsumsi Oksigen. *Jurnal Riset Akuakultur*, 9 (2), 229-236. http://dx.doi.org/10.15578/jra.9.2.2014.

Taqwa, F. H., Mirna. F., & Rudi. P.(2021). Respons Fisiologis Benur Udang Vaname (*litopenaeus vannamei*) Terhadap Penambahan Kalsium Selama Adaptasi di Salinitas Rendah. *Aquatica Sciences Journal,* 8 (2), 112-1117.

Widodo, A. F., Pantjara, B., Adhiyudanto, N. B., & Rachmansyah. (2011). Performansi Fisiologis Udang Vaname (*Litopenaeus vannamei*) yang Dipelihara Pada Media Air

Tawar Dengan Aplikasi Kalium. *Jurnal Riset Akuakultur*, 6 (2), 225–241.

Wyban, N., Sweeney. (1991). *Prinsip-prinsip Budidaya Udang Vaname.* Jakarta. Gramedia Pustaka Utama.

Yuniarty, & Diana. P.R. (2022). Pertumbuhan Dan Kelangsungan Hidup Udang Vaname (*litopenaeus vannamei*) Secara Intensif Dengan Padat Tebar Berbeda. *Journal Of Fisheries And Marine Research.* 6(3), 1-5.

Yunus, R., Haris, A., & Hamsah. (2020). Pengaruh Penambahan Kapur Dolomite dan Kapur Tohor Dalam Media Pemeliharaan Terhadap Moulting, Pertumbuhan dan Sintasan Udang Vaname (*Litopenaeus vannamei*). *Jurnal Ilmu Perikanan,* 9 (1), 39–47. https://doi.org/10.26618/octopus.v9i1.4000.