



Analysis of glucose and amino acid combination for *Cherax quadricarinatus* growth and characteristics

Nurul Mutmainnah^{1*}, Lidya², Zulfiani³, Fitri Indah Yani¹, Mayasari Yamin⁴

¹Aquaculture, Faculty of Agriculture, Animal Husbandry, and Fisheries, Universitas Muhammadiyah Parepare, Indonesia.

²Fish Hatchery Technology Study Program, Bombana Polytechnic, Indonesia.

³Aquaculture Study Program, Faculty of Animal Husbandry and Fisheries, Universitas Sulawesi Barat, Indonesia.

⁴Department of Agrotechnology, Faculty of Agriculture, State University of Gorontalo, Indonesia

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ABSTRACT

Freshwater crayfish (*Cherax quadricarinatus*) is a valuable aquaculture commodity with relatively easy cultivation. However, low larval survival during early developmental stages remains a major challenge in its farming. This study aims to evaluate the effects of dissolved glucose and amino acid combinations on growth characteristics, molting frequency, and survival rate. The research was conducted in the Greenhouse of the Faculty of Agriculture, Animal Husbandry, and Fisheries, Universitas Muhammadiyah Parepare, using hatchery-produced crayfish larvae. Four dosage combinations were tested: A) 100 ppm glucose + 250 ppm amino acids, B) 150 ppm glucose + 200 ppm amino acids, C) 200 ppm glucose + 150 ppm amino acids, and D) 250 ppm glucose + 100 ppm amino acids, each replicated three times. The results showed that glucose and amino acid combinations significantly affected crayfish length growth. The highest absolute length growth was observed in the 250 ppm glucose + 100 ppm amino acid group. Meanwhile, the 150 ppm glucose + 200 ppm amino acid combination showed the best performance in molting frequency, number of molting crayfish, survival rate, and percentage of surviving crayfish. The optimal treatment for supporting freshwater crayfish growth and development was the 150 ppm glucose + 200 ppm amino acid combination.

Introduction

Freshwater lobster *Cherax quadricarinatus* is a fishery commodity with great potential due to its advantages, such as ease of cultivation and high economic value. Although hatchery activities for freshwater lobsters have been widely conducted, several major challenges remain that affect the survival rate of larvae (juvenile lobsters). One of the biggest challenges is the high cannibalistic behavior during the larval stage, which often leads to mortality. In addition to cannibalism, other factors influencing the growth and survival of lobster larvae include frequent molting cycles or shell shedding (Putri, 2019; Syaharudin, 2021; Yudhistira, 2022; and Badjuka *et al.*, 2024). Slow growth may also result from inadequate nutrition or suboptimal environmental conditions.

This issue poses a significant challenge in freshwater lobster hatchery practices, necessitating special treatments such as providing optimal feed to suppress cannibalistic behavior and improve the survival and growth of lobster larvae. The most influential factor affecting the performance of freshwater lobster larvae is the availability of nutrients and their utilization for energy (Mutmainnah, 2019; Mutmainnah *et al.*, 2019; Mutmainnah *et al.*, 2024). The incomplete development of the larvae's digestive system results in suboptimal feed utilization. Therefore, it is essential to provide feed materials that can be directly utilized without undergoing complex digestive processes. One organic material that can be directly utilized is dissolved glucose and essential amino acids.

* Corresponding author.

Email address: nurulmutmainnah383@gmail.com

Dissolved glucose is a type of simple carbohydrate capable of providing rapid energy for freshwater lobster larvae. Unlike complex nutrients, dissolved glucose can be directly absorbed by the body without undergoing complex digestion processes. Its role as an energy source and energy reserve in the form of glycogen has been supported by various studies (Montung *et al.*, 2015; Mutmainnah *et al.*, 2019). The administration of dissolved glucose has been shown to improve survival rates and enhance growth in various species. Mutmainnah *et al.*, (2019) demonstrated that dissolved glucose plays a role in improving the survival and growth of crab larvae, where dissolved glucose contributes positively to their development and survival.

Essential amino acids are key components in protein formation, playing a critical role in the growth and development of tissues in freshwater lobster larvae. Insufficient protein in the diet will reduce growth or cause weight loss, as protein is taken from less important tissues to maintain more vital ones. Amino acids are divided into two types: essential amino acids and non-essential amino acids. Essential amino acids cannot be synthesized by the body (Sari *et al.*, 2017; Rahayu *et al.*, 2020; Umar, 2023). Given the underdeveloped digestive system of larvae, providing essential amino acids in an easily absorbable form is crucial. Amino acids support muscle development, tissue regeneration, and strengthen the immune system of the larvae. By offering nutrients that are readily absorbed, such as essential amino acids, larvae can maximize their growth during this critical early stage. Proper administration of amino acids can accelerate growth, reduce mortality rates, and enhance resistance to stress and diseases. Research indicates that the provision of amino acids improves survival rates and promotes growth in crab larvae (Mutmainnah *et al.*, 2024), vannamei shrimp (Rachmawati *et al.*, 2021), and Nile tilapia (Rahayu *et al.*, 2024).

Several studies have explored the individual benefits of dissolved glucose and amino acids; however, research on their combination as a supplement to support the survival and growth of freshwater lobster larvae has yet to be thoroughly examined. Therefore, this study was conducted to evaluate the effects of the combination of dissolved glucose and amino acids on growth characteristics, the number of lobsters undergoing molting, molting frequency, and the survival rate of freshwater lobsters.

Materials and Methods

This study was conducted in the Green House of the Faculty of Agriculture, Livestock, and Fisheries, Universitas Muhammadiyah Parepare. The freshwater lobster larvae used in this study were sourced from a previous cultivation process. The rearing media consisted of 12 black plastic basins, each with a capacity of 15 liters. Before use, each container was cleaned with detergent and chlorine to eliminate any potential bacteria. After rinsing with running water, the containers were dried for 12 hours. Each container was then filled with 15 liters of water and equipped with an aeration system to ensure proper oxygenation.

In this study, the stocking density was set at 30 larvae per container. The larvae were stocked in the morning, followed by an acclimatization process to adjust the larvae to the new rearing conditions. The feed provided in this study was a combination of essential amino acids and dissolved glucose. Water quality was monitored daily, and water changes were carried out weekly.

Research Design and Parameters

This study was designed using a Completely Randomized Design (CRD) consisting of 4 treatment doses, each with 3 replications. Thus, the study comprised 12 experimental units. The layout of the experimental containers will be randomized. The treatments to be tested are combinations of dissolved glucose and multiple amino acids. The application of amino acid and dissolved glucose combinations will be conducted once every 2 days. The treatment doses are as follows:

- A = 100 ppm glucose + 250 ppm amino acids
- B = 150 ppm glucose + 200 ppm amino acids
- C = 200 ppm glucose + 150 ppm amino acids
- D = 250 ppm glucose + 100 ppm amino acids

The parameters analyzed in this study are the growth characteristics of freshwater lobsters:

- PP = Length growth (cm);
- PB = Absolute weight growth (g);
- JUG = Number of molting events (times);
- JYM = Number of lobsters undergoing molting (individuals);
- FM = Molting frequency;
- NT = Number of lobsters alive at the end of the study (individuals);
- SR = Lobster survival rate (%).

Results

Growth Characteristics of Freshwater Lobster

Table 1. Recapitulation of the Analysis of Variance (ANOVA) for the effect of several combinations of glucose and amino acids on the growth of freshwater lobsters

Observational Character	Mean Square	R-Square	Mean	Coefficient of Variation (%)
PP	0.077*	0.829	1.983	6.001
PB	0.048 ^{tn}	0.608	1.677	20.905
JUG	4.083 ^{tn}	0.436	11.250	0.436
JYM	2.305 ^{tn}	1.435	6.750	42.695
FM	0.045 ^{tn}	0.401	0.613	30.931
NT	6.188 ^{tn}	0.775	12.625	12.782
SR	105.836 ^{tn}	0.668	55.372	15.064

Explanation: (*) = significant at α 5%; ^{tn} = not significant at both α 5% and 1%; PP = Absolute Length Growth; PB = Absolute Weight Growth; JUG = Number of Moulting Events (times); JYM = Number of Lobsters Undergoing Moulting (individuals); FM = Moulting Frequency; NT = Number of Lobsters Alive at the End of the Study; SR = Survival Rate (%)

Table 2. Absolute Length Growth Characteristics in Response to the Combination of Glucose and Amino Acids in Freshwater Lobster

Treatment	Length Growth
100 ppm glucose + 250 ppm amino acids	1.80 ^b
150 ppm glucose + 200 ppm amino acids	2.10 ^a
200 ppm glucose + 150 ppm amino acids	1.90 ^{ab}
250 ppm glucose + 100 ppm amino acids	2.13 ^a

Explanation: Numbers followed by the same letter are not significantly different at α = 5%.

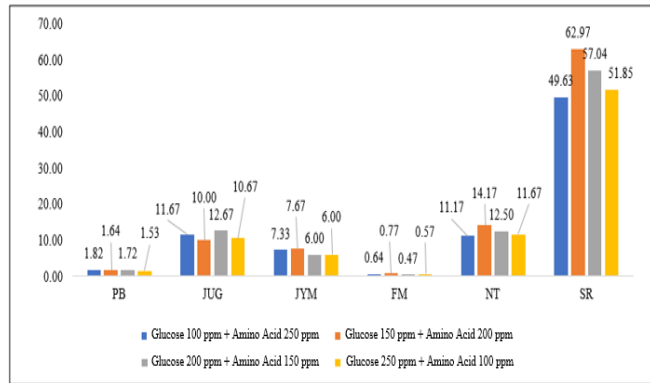


Figure 1. Administration of Glucose and Amino Acid Combinations at Different Concentrations on the Following Characteristics: PB = Absolute Weight Growth; JUG = Number of Moulting Events (times); JYM = Number of Lobsters Undergoing Moulting (individuals); FM = Moulting Frequency; NT = Number of Lobsters Alive at the End of the Study; and SR = Survival Rate Percentage.

Table 3. Correlation Matrix of Freshwater Lobster Growth Characteristics in Response to Glucose and Amino Acid Combinations

Karakter Amatan (Xi)	PP	PB	JUG	JYM	FM	NT
PB	-0,498 ^{tn}					
JUG	0,053 ^{tn}	-0,484 ^{tn}				
JYM	0,234 ^{tn}	-0,593*	0,667*			
FM	0,214 ^{tn}	-0,231 ^{tn}	-0,229 ^{tn}	0,571 ^{tn}		
NT	0,149 ^{tn}	0,118 ^{tn}	-0,559 ^{tn}	-0,378 ^{tn}	0,107 ^{tn}	
SR	0,221 ^{tn}	0,12 ^{tn}	-0,579 ^{tn}	-0,375 ^{tn}	0,138 ^{tn}	0,973**

Explanation: * = significant at α 5%; ^{tn} = not significant at both α 5% and 1%.

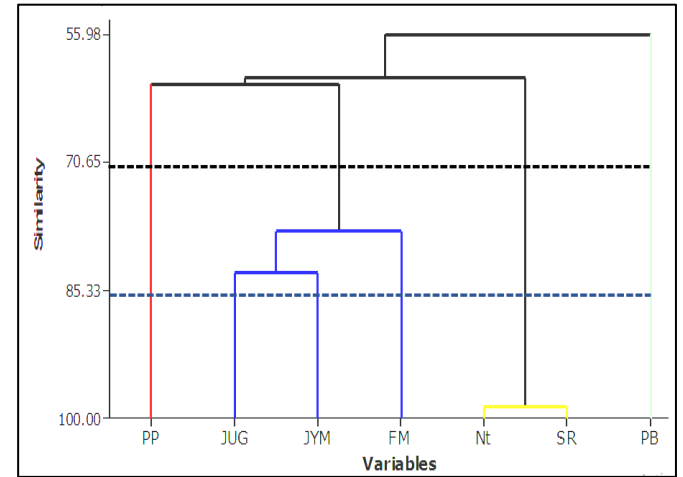


Figure 2. Dendrogram of Lobster Growth Characteristics Based on Phenotypic Similarity Constructed Using UPGMA with Jaccard's Coefficient.

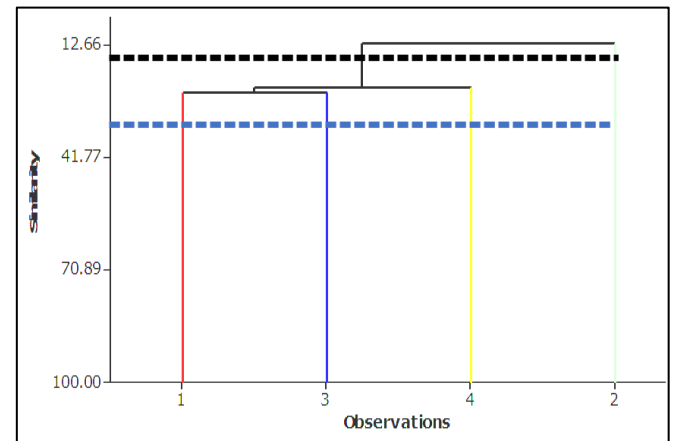


Figure 3. Dendrogram of Glucose and Amino Acid Combination Treatments for Enhancing Lobster Growth Based on Phenotypic Similarity Constructed Using UPGMA with Jaccard's Coefficient. 1 = Glucose 100 ppm + Amino Acid 250 ppm; 2 = Glucose 150 ppm + Amino Acid 200 ppm; 3 = Glucose 200 ppm + Amino Acid 150 ppm; and 4 = Glucose 250 ppm + Amino Acid 100 ppm.

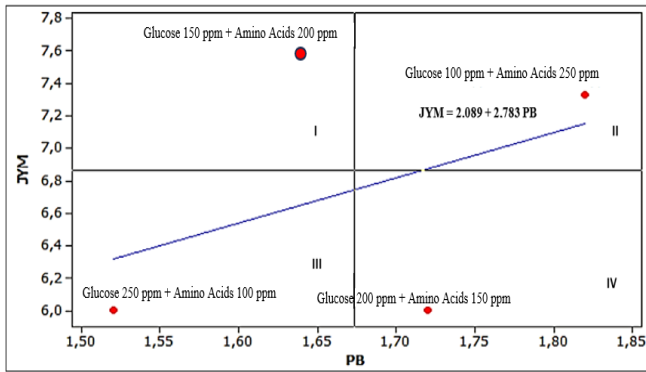
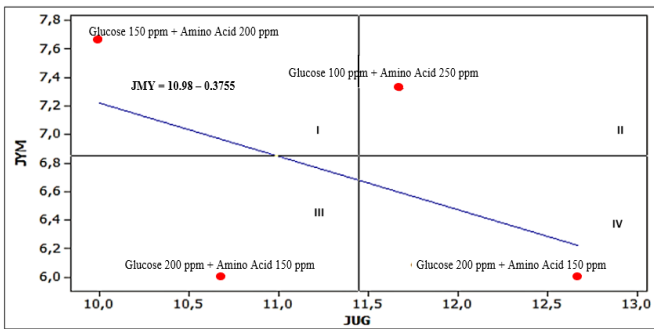


Figure 4. Distribution of Glucose and Amino Acid Combination Treatments to Enhance Freshwater Lobster Growth for JYM and PB Characteristics.



Discussion

Table 1 shows that out of the seven observed research parameters, only length growth exhibited a significant difference at $\alpha = 5\%$. This indicates that the combination of glucose and amino acids affects the length growth of lobsters, while the other parameters did not show significant differences. It is suspected that other factors, such as environmental conditions, may have had a more dominant influence compared to the effects of the given supplementation Yamin et al., (2018). Growth can also be influenced by genetic factors, environmental factors, and the interaction between the two Yamin & Qadri, (2023).

The coefficient of variation (CV) in Table 1 shows that the number of lobsters undergoing molting has a CV value of 42.695%, which falls into the moderate category. This indicates that the uniformity of data in this parameter is relatively low (Yamin et al., 2023; Yamin & Qadri, 2023; Dely et al., 2024; Qadri et al., 2024). This means that the molting process in lobsters is influenced by the combination of glucose and amino acids. The higher the CV value, the greater the data variation. This high variation is suspected to be influenced by environmental factors and the applied treatment.

Growth in lobsters is defined as an increase in weight and length during the rearing population (Prariska et al., 2020; Lubis et al., 2023). Table 2 shows that this parameter is significantly influenced

Figure 5. Distribution of Glucose and Amino Acid Combination Treatments to Enhance Freshwater Lobster Growth for JYM and JUG Characteristics.

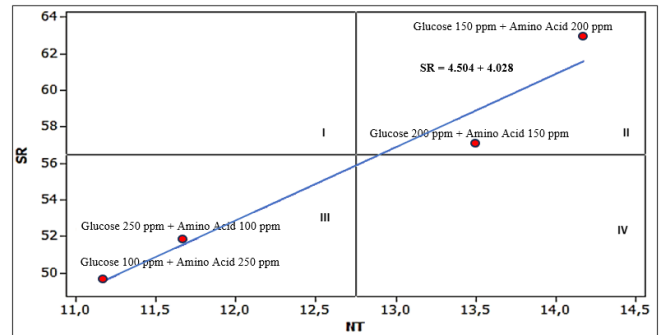


Figure 6. Distribution of Glucose and Amino Acid Combination Treatments to Enhance Freshwater Lobster Growth for SR and NT Characteristics

by the combination of glucose and amino acids at $\alpha = 5\%$. The best combination for length growth was achieved with a glucose dose of 250 ppm + amino acids at 100 ppm, resulting in an average growth of 2.13 cm. Conversely, the combination of 100 ppm glucose + 250 ppm amino acids produced the lowest length growth, at 1.80 cm. This indicates that glucose plays a crucial role in lobster length growth, although amino acids also contribute. Tian et al., (2024) Limited glucose availability in aquatic environments can reduce growth rates and increase mortality. Chen et al., (2023). Additionally, amino acids function as biosynthetic precursors that support lobster growth.

Figure 1 illustrates various aspects of lobster growth, including weight gain, number of molting events, molting frequency, number of surviving lobsters, and survival rate. The combination of 100 ppm glucose + 250 ppm amino acids resulted in the highest weight gain, with an average of 1.82 g. This increase occurs because amino acids support weight growth as well as the lobster's immune system, allowing them to grow more (Mutmainnah, 2019; Lu et al., 2020; Kurnia et al., 2024; Saputra, 2024).

According to Saputra (2024), the availability of amino acids is crucial for the growth and development of lobsters. (Nankervis & Jones, 2022) further stated that the minimum essential amino acid requirements for lobsters consist of nine main types. Thus, the combination of glucose and amino acids

has a significant effect on lobster length and weight growth, with the best results observed at 250 ppm glucose and 100 ppm amino acids. However, environmental factors also play a significant role in influencing the final growth outcomes of lobsters.

The highest moulting frequency was observed in the combination of 200 ppm glucose + 150 ppm amino acids, with an average of 12.67 times. This indicates that the administration of glucose and amino acids plays an important role in metabolism, specifically for cell proliferation. [Sacristán *et al.*, \(2020\)](#); [Goncalves *et al.*, \(2024\)](#) glucose plays an important role in metabolism, where carbohydrates trigger proliferation, while proteins serve as an energy reserve during the differentiation (cell regeneration) process in lobsters.

The combination of glucose and amino acids at concentrations of 150 ppm and 200 ppm resulted in the highest values for the number of lobsters undergoing moulting, moulting frequency, number of lobsters alive, and survival rate, with averages of 7.67 individuals, 0.77, 14.17 individuals, and 62.97%, respectively. This indicates that this concentration combination provides energy to enhance lobster growth, moulting frequency, the number of lobsters undergoing moulting, as well as the survival rate of the lobsters. [Menu-Courey *et al.*, \(2019\)](#); [Wang *et al.*, \(2021\)](#) The metabolic process in the body and appropriate energy can enhance lobster growth, which is accompanied by an increase in its weight. Sufficient energy availability, one of which is sourced from glucose, plays a crucial role. ([Mutmainnah *et al.*, \(2019\)](#) a ([Mutmainnah *et al.*, \(2019\)](#)) It is essential for organisms to achieve high levels of survival and growth [Rono *et al.*, \(2018\)](#); [Yousif *et al.*, \(2019\)](#) essential and non-essential amino acids, when provided in the appropriate amounts, can stimulate molting hormones. Amino acids in the rearing medium can accelerate the transition rate of larval stages in crabs ([Mutmainnah *et al.*, \(2024\)](#)).

Some of the observed characters described above do not adequately represent selection traits for obtaining the best treatment. Therefore, character selection is needed based on the correlation values obtained, as presented in ([Table 3](#)). The correlation coefficient is a measure or index that indicates the relationship between two variables, with coefficient values ranging from +1 to -1 ([Hairuddin *et al.*, \(2020\)](#)).

[Table 3](#) shows that the character of the number of lobsters undergoing moulting has a strong and significant negative correlation (-0.593) with the absolute weight growth. This means that each lobster undergoing moulting results in a decrease in absolute weight. The number of lobsters undergoing moulting

has a strong, significant, and positive correlation (0.667) with the number of moulting events in the lobsters. Meanwhile, the survival rate is strongly, significantly, and positively correlated with the number of lobsters alive at the end of the study (0.973). [RS *et al.*, \(2022\)](#) It produces six characters out of the 16 observed characters that have a significant and positive correlation with production, so these characters can be used as selection traits to obtain the best lobster phenotype. However, a clustering analysis of the observed lobster traits is necessary, as shown in [Figure 2](#).

The results of the dendrogram show several groups of lobster traits obtained from genetic similarity using Euclidean distance. The degree of relatedness of the traits ranges from 55% to 85%. At a similarity distance of 70.65%, there are four groups of traits: Group I, which includes the absolute length growth trait; Group II, which includes the number of moulting events, number of lobsters undergoing moulting, and moulting frequency; Group III, which includes the number of lobsters alive until the end of the study and the survival rate percentage; and Group IV, which includes the absolute weight growth trait. However, when the similarity distance is increased to 85%, the lobster traits are divided into six groups. This indicates that as the percentage of similarity increases, the similarity between traits decreases. [Illahi, \(2020\)](#); [Makhziah, \(2022\)](#) the dissimilarity and/or similarity between the observed traits can be determined based on clustering, which is based on their Euclidean distance. Meanwhile, the clustering performed based on the combination of treatments is presented in [Figure 3](#).

[Figure 3](#) shows the dendrogram results using Euclidean distance with a character similarity range of 12.66% - 20%. Both the 12.66% and 20% similarities form four clusters, with each treatment in a different group. Therefore, the Euclidean distance analysis is not able to predict the best treatment. As a result, a scatterplot analysis based on the selected observed characteristics from the correlation values ([Figure 4](#)) was performed.

[Figure 4](#) shows the division into four quadrants of the distribution of treatment combinations of glucose and amino acids based on the characteristics of the number of lobsters undergoing moulting and absolute weight growth. Quadrant I represents the treatment combination of glucose 150 ppm + amino acids 200 ppm, which increases the number of lobsters undergoing moulting but decreases absolute weight growth. Quadrant II represents the treatment combination of glucose 100 ppm + amino acids 250 ppm, which increases both the number of lobsters

undergoing moulting and absolute weight growth. Quadrant III represents the treatment combination of glucose 250 ppm + amino acids 100 ppm, which decreases both the number of lobsters undergoing moulting and absolute weight growth. Meanwhile, Quadrant IV represents the treatment combination of glucose 200 ppm + amino acids 150 ppm, which reduces the number of lobsters undergoing moulting but increases absolute weight growth.

Figure 5 shows the division into four quadrants of the distribution of treatment combinations of glucose and amino acids based on the characteristics of the number of lobsters undergoing moulting and the number of moulting events in lobsters. Quadrant I represents the treatment combination of glucose 150 ppm + amino acids 200 ppm, which increases the number of lobsters undergoing moulting but decreases the number of moulting events in the lobsters. Quadrant II represents the treatment combination of glucose 100 ppm + amino acids 250 ppm, which increases both the number of lobsters undergoing moulting and the number of moulting events in the lobsters. Quadrant III represents the treatment combination of glucose 250 ppm + amino acids 100 ppm, which decreases both the number of lobsters undergoing moulting and the number of moulting events in the lobsters. Meanwhile, Quadrant IV represents the treatment combination of glucose 200 ppm + amino acids 150 ppm, which reduces the number of lobsters undergoing moulting but increases the number of moulting events in the lobsters.

Figure 6 shows the division into four quadrants of the distribution of treatment combinations of glucose and amino acids based on the characteristics of the number of lobsters alive at the end of the study and the survival rate percentage of lobsters. Quadrant I shows no distribution of glucose and amino acid treatment combinations. Quadrant II includes the treatment combinations of glucose 150 ppm + amino acids 200 ppm and glucose 200 ppm + amino acids 150 ppm, both of which are capable of increasing the number of lobsters alive at the end of the study and the survival rate percentage. Quadrant III includes the treatment combinations of glucose 100 ppm + amino acids 250 ppm and glucose 250 ppm + amino acids 100 ppm, both of which are able to decrease the number of lobsters alive at the end of the study and the survival rate percentage. Meanwhile, Quadrant IV, like Quadrant I, also shows no distribution of glucose and amino acid treatment combinations. Based on Figures 4–6, it indicates that appropriate glucose and amino acid requirements are essential for the growth and development of lobsters.

Conclusion

The combination of glucose and amino acid treatments has a significant effect on the absolute length growth characteristic. However, the number of lobsters that molt and the molt frequency have a moderate coefficient of variation, indicating that these characteristics exhibit a varied data distribution. The combination of glucose 250 ppm + amino acid 100 ppm was able to increase absolute length growth compared to other treatments. Meanwhile, the combination of glucose 150 ppm + amino acid 200 ppm produced the highest performance in terms of the number of lobsters that molted, molt frequency, number of lobsters alive at the end of the study, and the survival percentage of lobsters. The number of lobsters that molted had a strong and significant negative correlation (-0.593) with the absolute weight growth characteristic. The survival percentage showed a strong positive and significant correlation (0.973) with the number of lobsters alive at the end of the study. At a similarity distance of 70.65%, four groups of characteristics were formed. Meanwhile, the treatment clustering based on similarity distances of 12.66% - 20% resulted in four different groups. The treatment combinations that can be used to improve growth and development in freshwater lobsters are glucose 100 ppm + amino acid 250 ppm and glucose 150 ppm + amino acid 200 ppm.

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References

- Badjuka, D. A., Y. Koniyo, A. Lamadi. 2024. The addition of vitamin C in feed with different doses on growth and survival of freshwater lobster (*Cherax quadricarinatus*). *Journal Ilmu Kelautan dan Perikanan Papua*, 7(1): 65–74.
- Chen, J., S. Yang, Y. Li, X. Ziwen, P. Zhang, Q. Song, Y. Yao, H. Pei. 2023. *De novo* nucleotide biosynthetic pathway and cancer. *Genes and Diseases*, 10(6): 2331–2338.
- Dely, A., S. Sukmawati, M. Yamin, M. A. Akib, S. Suherman. 2024. The morphological characterization of hybrid corn (*Zea mays* L.) under various slow-release biochar-based fertilizer applications on clayey soil. *Journal of Sustainable Agriculture*, 12(1): 104–113.
- Goncalves, R., T. Pfalzgraff, I. Lund. 2024. Impact of live feed substitution with formulated diets on the development, digestive capacity, biochemical composition, and rearing water quality of

- European lobster (*Homarus gammarus*, L.) larvae. *Aquaculture*, 586: 740776.
- Hairuddin, R., M. Yamin, S. Hama. 2020. Selection and correlations of character agronomy of onion (*Allium cepa* L.) var. Bima in salinity and drought condition *in vivo*. *Proceedings of the 1st International Conference of Research on Education, Applied Science, Science, and Technology (1st ICREAST)*: 479–487.
- Illahi, A. K. 2020. Phenotypic diversity and morphological similarity of hanjeli (*Coix lacryma-jobi* L.) in Lima Puluh Kota Regency. *Journal of Indonesian Agricultural Sciences*, 22(2): 129–135.
- Kurnia, A., W. H. Muskita, M. Hamzah, L. O. B. Abidin, R. Ruslaini, S. Suaida, R. Amanda. 2024. Amino acid profiles and growth performance of spiny lobster *Panulirus ornatus* fed on combination of three mollusk meals. *Aceh Journal of Animal Science*, 9(1): 10–17.
- Lu, X., D. Peng, X. Chen, F. Wu, M. Jiang, J. Tian, W. Liu, L. Yu, H. Wen, K. Wei. 2020. Effects of dietary protein levels on growth, muscle composition, digestive enzymes activities, hemolymph biochemical indices and ovary development of pre-adult red swamp crayfish (*Procambarus darkii*). *Aquaculture Reports*, 18: 100542.
- Lubis, A. S., E. Efrizal, S. Syaifullah, R. Rusnam, N. Nurmia, A. T. Puari. 2023. Growth performance and survival rate of spiny lobster *Panulirus homarus* (Linnaeus, 1758) with formulated feeding enriched by spinach extract. *Biodiversitas Journal of Biological Diversity*, 24(11).
- Makziah, M. 2022. Characterization and morphological similarity analysis of local bird's eye chili (*Capsicum frutescens*) from East Java and South Kalimantan. *Buletin Plasma Nutfah*, 28(2): 193–204.
- Menu-Courey, K., F. Noisette, S. Piedalue, D. Daoud, T. Blair, P. U. Blier, K. Azetsu-Scott, P. Calosi. 2019. Energy metabolism and survival of the juvenile recruits of the American lobster (*Homarus americanus*) exposed to a gradient of elevated seawater pCO₂. *Marine Environmental Research*, 143: 111–123.
- Montung, L. J. A., M. E. Paruntu, M. Tiho. 2015. Comparison of serum sodium levels before and after high-intensity physical activity. *Jurnal E-Biomedik*, 3(3): 1–5.
- Mutmainnah, N. 2019. The effect of dissolved glucose administration on the survival and performance of blue swimming crab larvae (*Portunus pelagicus*) from Zoea to Megalopa stages. Hasanuddin University.
- Mutmainnah, N., M. Y. Karim, S. Aslamyah. 2019. The effect of dissolved glucose on survival rate and performance of swimming crab larvae *Portunus pelagicus* from zoea stadia to megalopa. *International Journal of Fisheries and Aquatic Studies*, 7(6): 85–88.
- Mutmainnah, N., Z. Zulfiani, Y. E. Yunus, F. Faidar, M. Y. Karim, F. I. Yani. 2024. The addition of multi amino acids to the rearing media of blue swimming crab larvae (*Portunus pelagicus*) to accelerate metamorphosis from zoea to megalopa stages. *Jurnal Galung Tropika*, 13(1): 1–10.
- Nankervis, L., C. Jones. 2022. Recent advances and future directions in practical diet formulation and adoption in tropical Palinurid lobster aquaculture. *Reviews in Aquaculture*, 14(4): 1830–1842.
- Prariska, D., E. Supriyono, D. T. Soelistiyowati, R. E. Puteri, S. R. Sari, R. Sa'adah, G. Guttifera. 2020. Survival of sand lobster (*Panulirus homarus*) cultured in a recirculating system. *Clarias: Jurnal Perikanan Air Tawar*, 1(1): 1–7.
- Putri, D. U. 2019. Growth and survival of freshwater lobster juveniles (*Cherax quadricarinatus* Von Martens) fed with different doses of earthworms (*Lumbricus rubellus*). *Jurnal Riset*, 1(1): 1–6.
- Qadri, S. N., M. Yamin, D. Darwis. 2024. Viability and vigor testing of seeds from various tobacco plant (*Nicotiana tabacum* L.) varieties. *PERBAL: Jurnal Pertanian Berkelanjutan*, 12(1): 128–136.
- Rachmawati, D., J. Hutabarat, A. I. Fiat, T. Elfitasari, S. Windarto, E. Nur, C. Dewi. 2021. Addition of tryptophan amino acid in feed on cannibalism rate and growth of *Litopenaeus vannamei*. *Jurnal Perikanan*, 24(11): 343–352.
- Rahayu, W. S., P. I. Utami, F. Haryadin. 2020. Amino acid analysis using HPLC method and ninhydrin derivatizing agent. *National Seminar on Research and Community Service Results*.
- Rono, K., J. Manyala, D. Manguya-Lusega, J. A. Sabwa. 2018. Growth performance of spinach (*Spinacia oleracea*) on diets supplemented with iron-amino acid complex in aquaponic system in Kenya. *International Journal of Research Science & Management*, 5(7): 117–127.
- RS, T. H., M. Marjani, N. Nurindah, M. R. Ridho, C. L. Hertianti, W. Patriasari. 2022. Secondary characters based selection of Indonesian kenaf (*Hibiscus cannabinus* L.) germplasm for developing superior varieties. *AIP Conference Proceedings*, 2462(March): 1–7.
- Sacristán, H. J., J. R. Mufari, R. A. Lorenzo, C. C. Boy, G. A. Lovrich. 2020. Ontogenetic changes in energetic reserves, digestive enzymes, amino acid and energy content of *Lithodes santolla* (Anomura: Lithodidae): Baseline for culture. *PLoS ONE*, 15(5): e0232880.
- Saputra, I. 2024. Physiological changes of post-puerulii spiny lobster (*Panulirus ornatus* Fabricius, 1798) fed low protein to energy ratio diets supplemented with black soldier fly (*Hermetia illucens*) meal. *Curtin University*.
- Sari, E. M., M. Nurilmala, M. A. Abdullah. 2017. Amino acid profile and bioactive compounds of seahorse *Hippocampus comes*. *Jurnal Ilmu dan Teknologi Kelautan Tropis*, 9(2): 605–618.
- Syahrudin. 2021. Effect of addition of calcium carbonate (CaCO₃) on the survival rate of freshwater crayfish (*Cherax quadricarinatus*) seeds. *Agrokompleks*, 21(2): 48–52.
- Tian, Y., D. Zheng, H. Xu, Z. Xu, T. Zhou, Y. Huang. 2024. Effects of intermittent fasting on growth, metabolism and stress resistance in freshwater crayfish (*Procambarus darkii*). *Aquaculture Reports*, 38: 102275.
- Umar, C. B. P. 2023. Extension on the importance of the role of protein and amino acids for the body in Negeri Lima Village. *Jurnal Pengabdian Ilmu Kesehatan*, 1(3): 52–56.
- Wang, S., C. G. Carter, Q. P. Fitzgibbon, B. M. Codabaccus, G. G. Smith. 2021. Effect of dietary protein on energy metabolism including protein synthesis in the spiny lobster *Sagmariasus verreauxi*. *Scientific Reports*, 11(1): 1–12.
- Yamin, M., S. Hama, R. S. T. Hidayat. 2018. Agronomic characters of wheat (*Triticum aestivum* L.) grown using two cropping systems in medium land of Palopo City. *Agrotech Journal*, 3(1): 1–7.
- Yamin, M., S. N. Qadri. 2023. Estimation of variance components and gene action of agronomic traits in cotton population. *Perbal: Journal of Sustainable Agriculture*, 11(2): 238–245.
- Yamin, M., S. N. Qadri, A. Dely, S. Sukardi. 2023. Application of hydropriming technique to enhance seed invigoration of brown cotton at the germination stage. *Perbal: Journal of Sustainable Agriculture*, 11(3): 399–407.
- Yousif, R. A., O. Abdullah, A. M. Ahmed, M. I. Adam, F. A. M. Ahmed, O. A. Idam. 2019. Effect of replacing fishmeal with water spinach (*Ipomoea aquatica*) on growth, feed conversion and carcass composition for Nile tilapia fry (*Oreochromis niloticus*). *Journal of Aquatic Science and Marine Biology*, 2(4): 13–20.
- Yudhistira, D. I. 2022. Growth and survival of freshwater lobster (*Cherax quadricarinatus*) at different salinities. *Sciline (Scientific Timeline)*, 2(2): 65–74.

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