**Journal of Fish Health**
Volume 4, Issue 4, November 2024
https://doi.org/10.29303/jfh.v4i4.5959

# Evaluation of the Ca-Mg Mineral Ratio in the Media Cultivation on the Growth Performance of Freshwater Prawns (*Macrobrachium rosenbergii*)

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Received : 09-24-2024
Accepted : 10-28-2024

**Keywords**:
Ca-Mg Ratio, Growth, *Macrobrachium rosenbergii*

**ABSTRACT**

Freshwater prawn (*Macrobrachium rosenbergii*) is a freshwater species which intensively cultivated. Calcium (Ca) and magnesium (Mg) are crucial factors supporting the biological and physiological activities of freshwater prawns. The presence of calcium and magnesium minerals in the environment is utilized by the prawns, especially after the molting process. Calcium and magnesium play roles in osmoregulation and the formation of the prawn's carapace. This study aims to determine the optimal ratio of calcium and magnesium minerals to support molting frequency, specific growth rate, survival rate, and feed efficiency. The experimental design used in this research is a completely randomized design (CRD) with five treatments and three replicates. The treatment given consisted of increasing Ca-Mg in the media: A: 30 mg l-1 Ca + 0 mg l-1 Mg (1:0); B: 30 mg l-1 Ca + 15 mg l-1 Mg (1:0.5); C: 30 mg l-1 Ca + 30 mg l-1 Mg (1:1); D: 30 mg l-1 Ca + 45 mg l-1 Mg (1:1.5) and E: 30 mg l-1 Ca + 60 mg l-1 Mg (1:2). Based on the result, treatment C: 30 mg l-1 Ca + 30 mg l-1 Mg (1:1) was found to improve molting frequency, growth rate, feed efficiency and survival rate.

## INTRODUCTION

Freshwater prawn (*Macrobrachium rosenbergii*) is a high-value freshwater aquaculture commodity. The increasing market demand for giant freshwater prawns drives the development of effective and efficient aquaculture technologies. One important factor for the success of prawn farming is the quality of the rearing media, particularly the balance of minerals within it. Minerals such as calcium (Ca) and magnesium (Mg) play essential roles in supporting the physiology and growth of giant freshwater prawns (Truong *et al*., 2023). Calcium (Ca) is known as an essential mineral in the process of exoskeleton formation in prawns. This process is crucial because prawns undergo periodic molting to support their growth. On the other hand, magnesium (Mg) also plays a role in various physiological functions, such as energy synthesis through ATPase and maintaining osmotic balance in

aquatic organisms (Souza *et al*., 2023). Therefore, the optimal ratio of calcium and magnesium in the rearing media becomes a key factor influencing prawn growth and health.

Rearing media lacking a balanced Ca-Mg ratio can lead to disturbances in the molting process, osmoregulation, and nutrient absorption. Several studies have shown that excess calcium without sufficient magnesium can disrupt prawn metabolism (Kong *et al*., 2022). Conversely, magnesium deficiency can cause physiological disorders such as muscle weakness and reduced growth performance. Thus, evaluating the Ca-Mg ratio becomes an important step in optimizing rearing media. The ideal Ca-Mg ratio varies depending on the species and environmental conditions of the aquaculture system. In the case of giant freshwater prawns, previous research has suggested certain ratios, but results often differ depending on variables such as temperature, salinity, and other mineral concentrations (Tan & Wang, 2022). Therefore, further research is needed to determine the optimal ratio that can be applied at a commercial scale.

Studies on the effects of mineral ratios in rearing media have been conducted on various other aquatic species. For example, research on Nile tilapia (*Oreochromis niloticus*) has shown that the balance of Ca and Mg plays a role in improving feed efficiency and biomass growth (Aboseif *et al*., 2022). This research indicates the potential to apply similar principles to freshwater prawns while adjusting to their specific needs.

The evaluation of mineral ratios is also related to the sustainability of aquaculture. Excessive or unbalanced mineral use can increase production costs and pollute the surrounding environment. Therefore, an approach focused on efficient resource utilization is highly relevant to supporting the sustainability of giant freshwater prawn farming. This study aims to evaluate the effect of the Ca-Mg ratio in rearing media on the growth performance of freshwater prawns. Parameters observed include molting frequency, growth rate, feed efficiency and survival rate. This approach is expected to provide recommendations for the optimal mineral ratio for application at a commercial scale.

## METHODS

### Time and place

The research will be conducted over 3 months, covering preparation, prawn rearing, data collection, data analysis, and reporting. The research will occur at the Fisheries and Aquaculture Laboratory of the Faculty of Agriculture, University of Mataram.

### Research design

This study utilized a laboratory experimental method. The experimental design applied was a Completely Randomized Design (CRD) with five treatments and three replications. All treatments involved the addition of calcium at a concentration of 30 mg $L^{-1}$, based on Zaidy (2007). Meanwhile, magnesium was added at concentrations of 0, 15, 30, 45, and 60 mg $L^{-1}$ for each treatment. The Ca-Mg ratio levels tested in this experiment were as follows: A: Ca 30 mg $L^{-1}$ + Mg 0 mg $L^{-1}$ (1:0); B: Ca 30 mg $L^{-1}$ + Mg 15 mg $L^{-1}$ (1:0.5); C: Ca 30 mg $L^{-1}$ + Mg 30 mg $L^{-1}$ (1:1); D: Ca 30 mg $L^{-1}$ + Mg 45 mg $L^{-1}$ (1:1.5); and E: Ca 30 mg $L^{-1}$ + Mg 60 mg $L^{-1}$ (1:2).

The experimental setup included 15 glass aquariums measuring 50x30x30 cm, each equipped with an aeration system and a water heater. The aquariums were covered with black plastic to create a shaded environment, as prawns are nocturnal and highly active during the night. Additionally, each aquarium was fitted with shelters made of PVC pipe sections, matching the number of prawns stocked in each aquarium.

The maintenance medium for the giant freshwater prawns consisted of calcium-enriched water with magnesium added according to the specified treatments. The calcium ($CaOH_2$) and magnesium ($MgSO_4$) concentrations in the medium were achieved through dilution. Prior to dilution, calcium and magnesium levels were analyzed to determine the exact quantities required to meet the treatment concentrations. Strong aeration was applied during the dilution process to aid oxygen dissolution. Calcium and magnesium solutions were prepared weekly and stored in tanks, as water changes of 50% were performed weekly. The water volume for each aquarium was maintained at 30 liters.

The test animals used were giant freshwater prawns (*Macrobrachium rosenbergii*) with an initial body weight of 1±0.04 g and a length of 4.15±0.03 cm. The prawns were stocked at a density of 10 individuals per aquarium. Commercial feed containing 35% protein was provided ad libitum three times daily (morning, noon, and evening). The rearing period for this experiment lasted 35 days.

Sampling for water quality data was conducted every seven days, on days 0, 7, 14, 21, 28, and at the end of the experiment (day 35). A 300 ml water sample was collected from each aquarium using sampling bottles. These samples were analyzed to measure parameters such as temperature, pH, dissolved oxygen (DO), total ammonia nitrogen (TAN), hardness, and alkalinity. At the end of the study, observations were made on molting frequency, specific growth rate, feed efficiency and survival rate.

**Data Analysis**

Experimental data were analyzed using Mini Tab Version 16. Analysis of variance (ANOVA) with a 95% confidence interval, if there was a significant effect, a further Tukey test was carried out (Steel & Torrie, 1993). Data is presented in the form of tables and graphs.

## RESULTS

**Molting Frequency**

The results of analysis of variance (ANOVA) showed that the treatment had a significant effect on molting frequency of giant prawns ($P<0.05$).

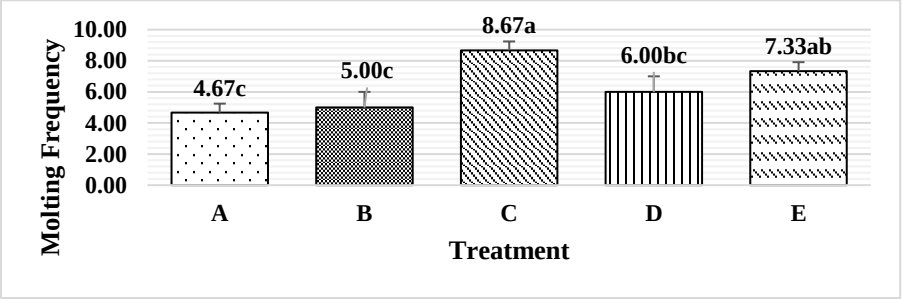


Figure 1. molting frequency of giant prawns for 35 days of cultivation.

**Feed Efficiency**

The results of analysis of variance (ANOVA) showed that the treatment had a significant effect on feed efficiency of giant prawns ($P<0.05$).

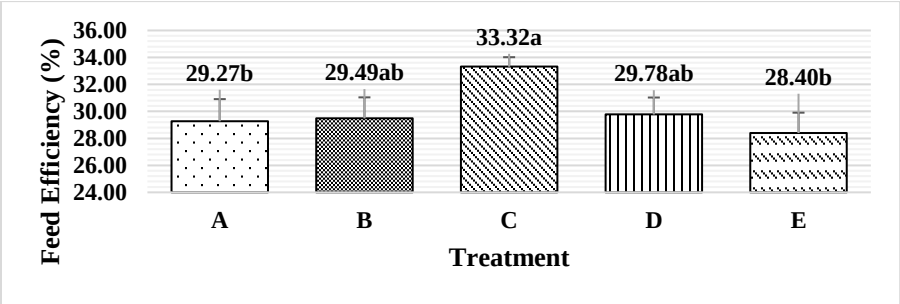


Figure 2. Feed efficiency of giant prawns for 35 days of cultivation.

**Specific Growth Rate**

The results of analysis of variance (ANOVA) showed that the treatment had a significant effect on specific growth rate of giant prawns (P<0.05).

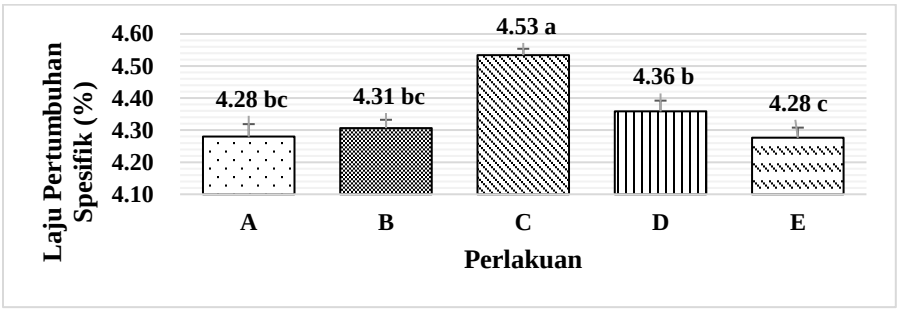


Figure 3. Specific growth rate of giant prawns for 35 days of cultivation.

**Survival Rate**

The results of analysis of variance (ANOVA) showed that the treatment had a significant effect on survival rate of giant prawns (P<0.05).

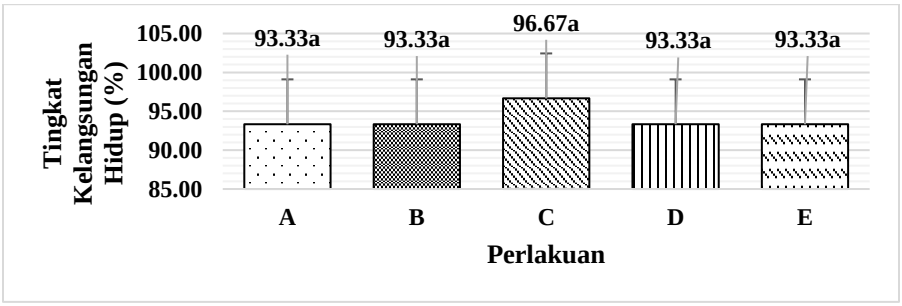


Figure 4. Survival rate of giant prawns for 35 days of cultivation.

**Water Quality During Rearing**

Table 1. Water quality during 35 days of cultivation

| Characteristic | Average |
|---|---|
| Temperature ($^0$C) | 27.32-28.41 |
| pH | 7.14-7.83 |
| $NH_3$ (mg/L) | 0.0093-0.0126 |
| Hardness (mg/L) | 315.04-397.20 |
| Alkalinity (mg/L) | 44.52-48.25 |
| DO (g $g^{-1}$) | 5.20-6.23 |

## DISCUSSION

Molting frequency is one of the key indicators of growth in giant freshwater prawns (*Macrobrachium rosenbergii*). The molting process is essential for growth as it allows prawns to increase their body size. In this study, the average number of molts obtained in treatment C (Ca 30 mg l-1 + Mg 30 mg l-1) was 8.67, not significantly different from treatment E (Ca 30 mg l-1 + Mg 60 mg l-1) the average number was 7 .33, but treatment C is relatively higher. Meanwhile, the lowest average number of molts was in treatment A (Ca 30 mg l-1 + Mg 0 mg l-1), namely 4.67. Molting triggered by two factors, internal factors including genetic characteristics and physiological conditions and external factors, related to the environment which is the maintenance cultivation (Jiang *et al*., 2020). These external factors include the chemical composition of the water, basic substrate, water temperature and food availability. This outcome is attributed to the role of calcium in carapace formation and magnesium in supporting osmoregulation during the molting process. Previous studies have also demonstrated that adequate calcium availability in the rearing media accelerates carapace recovery post-molting, while magnesium regulates electrolyte balance, ensuring the smooth progression of the process (Davis & Boyd, 2021).

Feed efficiency is a critical parameter for evaluating the success of aquaculture practices. Treatment C (Ca 30 mg l-1 + Mg 30 mg l-1) obtained a relatively better efficiency of 33.32% when compared to treatments in the second and third ranks, namely D (Ca 30 mg l-1 + Mg 45 mg l-1) of 29.78 and B (Ca 30 mg l-1 + Mg 15 mg l-1) of 29.49%. Meanwhile, there was a significant difference between treatment C and treatments A (Ca 30 mg l-1 + Mg 0 mg l-1) and E (Ca 30 mg l-1 + Mg 60 mg l-1). At a Treatment C (Ca 30 mg l-1 + Mg 30 mg l-1), feed efficiency exhibited the best results, indicating that prawns were able to convert feed into biomass more efficiently. Magnesium is known to play a vital role in energy metabolism, particularly through the activation of ATPase enzymes (Li *et al*., 2024). This activation supports optimal energy utilization, thereby enhancing prawn growth and feed efficiency (Mantoan *et al*., 2021). These findings align with studies on Nile tilapia (*Oreochromis niloticus*), where the balance of minerals such as Ca and Mg was shown to improve feed efficiency and biomass growth (El-Sayed *et al*., 2023).

Growth is defined as an increase in the number of cells, tissues, individuals, populations and communities. Based on the level of material, growth can be measured in the form of length, weight, volume or other physical dimensions. Furthermore, growth can be measured through the growth rate. Changes in the size or amount of body material, whether positive or negative, momentary or long term, wet or dry weight (Wootton, 2012). The specific growth rate (SGR) in this study also showed the best results at a Ca-Mg ratio of (Ca 30 mg l-1 + Mg 30 mg l-1). Based on weight measurement data each week, the highest specific growth rate value was obtained in treatment C (Ca 30 mg l-1 + Mg 30 mg l-1) of 4.53% and the lowest specific growth rate value was treatment E (Ca 30 mg l-1 + Mg 60 mg l-1) which is 4.28%. This indicates that the appropriate mineral balance provides optimal conditions for growth. Calcium directly contributes to the formation of exoskeletal tissue, while magnesium supports essential metabolic functions. Other studies on whiteleg shrimp (*Litopenaeus vannamei*) have also revealed that a balanced mineral ratio in the rearing media enhances SGR by promoting protein synthesis (Liu *et al*., 2014).

The survival rate (SR) is a key parameter that reflects the success of aquaculture practices. In this study, the survival rate results in this experiment were not significantly different across treatments. Based on the significance test ($P<0.05$), treatment C (Ca 30 mg l-

1 + Mg 30 mg l-1) occupied the top position in obtaining survival rates because it was relatively higher than the other treatments. Magnesium, through its role in osmoregulation, helps prawns withstand environmental stresses such as fluctuations in salinity and temperature. Additionally, adequate calcium availability prevents carapace deformities that could lead to mortality. These findings are consistent with the study by Bal *et al*., 2021 which highlights the importance of mineral balance in supporting the resilience of aquatic organisms against environmental stress. Based on the result rearing cultivations of prawn shown that physical and chemical water quality parameters still reasonable range for the survival of giant prawns (Boyd & Zimmermann, 2000).

## CONCLUSION

Based on the result, treatment C: 30 mg l-1 Ca + 30 mg l-1 Mg (1:1) was found to improve molting frequency, growth rate, feed efficiency and survival rate.

## ACKNOWLEDGEMENT

The author would like to thank to staff of Fisheries and Aquaculture Laboratory of the Faculty of Agriculture, University of Mataram and students involved for their assistance in completing this research.

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