

ANALYSIS OF FRESHWATER LOBSTER GROWTH AND SURVIVAL (*Cherax quadricarinatus*) FED WITH NATURAL FEED AND CALCIUM CARBONATE SUPPLEMENTATION

Muh. Hasbir¹, Nursyahran^{1*}

¹Institut Teknologi dan Bisnis Maritim Balik Diwa, Indonesia

Email*: nursyahran00@gmail.com

ABSTRACT

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Feed quality and mineral availability play important roles in determining the growth and survival of freshwater lobster (*Cherax quadricarinatus*). This study aimed to analyze the effects of natural feed supplemented with calcium carbonate on the growth and survival performance of freshwater lobster. The experiment was conducted from March to April 2025 at the Freshwater Hatchery of Pangkep State Polytechnic of Agriculture using a completely randomized design with three treatments and three replications. The treatments consisted of commercial shrimp pellets (control), *Tubifex* sp. supplemented with 10% CaCO₃, and earthworms supplemented with 10% CaCO₃. Lobsters were reared for 42 days and fed daily at 3% of biomass. Absolute growth and survival rate were used as response variables, and the data were analyzed using one-way ANOVA followed by Tukey's HSD test. The results showed that dietary treatments significantly affected both growth and survival ($p < 0.05$). The highest absolute growth (0.29 ± 0.005 g) and survival rate ($88.89 \pm 5.55\%$) were obtained in lobsters fed *Tubifex* sp. supplemented with 10% CaCO₃, whereas the control treatment produced the lowest values. Water quality parameters remained within acceptable ranges for freshwater lobster culture throughout the study. These findings indicate that the combination of natural feed and calcium carbonate supplementation can enhance growth performance and improve survival in freshwater lobster culture.



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INTRODUCTION

Freshwater lobster (*Cherax quadricarinatus*), commonly known as redclaw crayfish, is one of the most economically important freshwater crustaceans cultivated worldwide. The species has gained increasing attention due to its rapid growth, high market value, attractive appearance, and strong adaptability to a wide range of environmental conditions. According to Fleming et al. (2019), the demand for freshwater lobster has continued to increase in both domestic and international markets, creating promising opportunities for aquaculture development. Similarly, Jones et al. (2021) emphasized that *C. quadricarinatus* possesses several biological advantages over marine lobsters, including a shorter production cycle, easier husbandry practices, and greater tolerance to environmental fluctuations. These characteristics have made freshwater lobster culture increasingly popular among small-scale farmers and commercial producers.

The expansion of freshwater lobster farming has also been encouraged by advances in aquaculture technologies and diversification of culture systems. Recent studies have shown that *C. quadricarinatus* can be successfully reared in earthen ponds, concrete tanks, recirculating aquaculture systems, and aquaponic systems integrating aquatic animals with horticultural crops (Rahman et al., 2022). Such flexibility provides opportunities for

sustainable aquaculture development while enhancing resource utilization efficiency. Furthermore, freshwater lobster farming contributes to food security and income generation, particularly in developing countries where aquaculture has become an important economic sector (FAO, 2024).

Despite its economic potential, the sustainability of freshwater lobster production largely depends on appropriate nutritional management. Feed represents one of the major operational costs in aquaculture and directly influences growth performance, feed utilization, survival rate, and product quality. According to Nguyen et al. (2020), nutritional inadequacies frequently result in reduced growth, prolonged culture periods, and increased susceptibility to disease. Consequently, improving feed quality has become one of the primary strategies for enhancing production efficiency and profitability in freshwater lobster farming.

Natural feeds have attracted considerable interest because of their high nutritional value and their ability to stimulate feeding responses. Among the commonly utilized natural feeds, *Tubifex* worms and earthworms possess high levels of protein, essential amino acids, and lipids required for crustacean growth. Previous studies have demonstrated that these organisms provide highly digestible nutrients and contribute positively to growth performance and feed conversion efficiency (Mubarak et al., 2019; Pratiwi et al., 2021). According to Hasan et al. (2023), the use of natural feed sources may improve palatability and reduce the dependence on commercial diets, thereby lowering production costs. However, although natural feeds are rich in protein, their mineral composition, particularly calcium content, is often insufficient to fully support the physiological requirements of crustaceans.

Minerals play essential roles in numerous metabolic processes in aquatic organisms. Among these minerals, calcium is particularly important for crustaceans because it is directly involved in exoskeleton formation, muscle contraction, enzymatic activity, osmoregulation, and molting processes. García-Guerrero et al. (2017) reported that calcium deficiency may impair shell hardening and delay molting frequency, ultimately reducing growth performance and survival. In decapod crustaceans, molting represents a critical physiological process that enables body enlargement and tissue regeneration. Since the exoskeleton is periodically shed and rebuilt, sufficient calcium availability becomes indispensable for successful molting and overall development.

As explained by Fotedar and Evans (2018), calcium requirements in crustaceans can be fulfilled through both environmental absorption and dietary intake. Nevertheless, dietary calcium supplementation becomes particularly important when the calcium concentration in natural feed or culture water is insufficient. Inadequate calcium supply may result in incomplete exoskeleton calcification, increased vulnerability to stress, and higher mortality rates. Therefore, optimizing calcium availability through feed supplementation is considered an effective strategy to improve growth and survival in freshwater crustaceans.

Calcium carbonate (CaCO_3) has been widely used as a dietary supplement because of its high calcium content, low cost, and easy availability. Previous studies have demonstrated that calcium carbonate supplementation enhances mineral metabolism and contributes to improved shell quality and growth performance in crustaceans. According to Kumar et al. (2020), dietary calcium supplementation positively influences molting frequency and body weight gain in freshwater crayfish. Similar findings were reported by Li et al. (2021), who observed that calcium-enriched diets significantly increased growth performance and reduced mortality rates in cultured decapods. More recently, Wang et al. (2023) indicated that balanced mineral supplementation improves nutrient utilization efficiency and enhances physiological functions associated with exoskeleton formation.

Although the beneficial effects of calcium supplementation have been extensively documented, studies investigating the combined use of natural feeds and calcium carbonate supplementation in freshwater lobster remain limited. Most previous studies have focused either on artificial diets or mineral supplementation alone, while information regarding the interaction between natural feed sources and additional calcium supply is still scarce.

Furthermore, differences in nutrient composition among natural feeds may influence the effectiveness of calcium supplementation, leading to variations in growth performance and survival. According to Ahmed et al. (2022), understanding the synergistic effects of protein-rich natural feeds and mineral supplementation is essential for developing cost-effective and environmentally sustainable feeding strategies.

Survival rate is another important indicator of cultural success because it reflects the ability of cultured organisms to adapt to environmental conditions and nutritional adequacy. High survival rates are generally associated with balanced nutrition and effective physiological functioning. As noted by Chen et al. (2021), nutritional deficiencies may compromise immune responses and increase susceptibility to stress and disease. Consequently, evaluating both growth and survival is necessary to assess the effectiveness of dietary treatments comprehensively.

Given the importance of calcium in molting and exoskeleton development, as well as the high nutritional value of natural feeds, the combination of natural feed and calcium carbonate supplementation may provide a practical approach for improving freshwater lobster production. However, information regarding its effects on the growth and survival of *Cherax quadricarinatus* remains limited, particularly under culture conditions commonly applied by farmers. Therefore, this study aimed to analyze the growth and survival performance of freshwater lobster (*Cherax quadricarinatus*) fed natural feed supplemented with calcium carbonate. The findings of this study are expected to provide scientific information for optimizing feeding management and contribute to the development of sustainable freshwater lobster aquaculture.

METHOD

This study was conducted from March to April 2025 at the Freshwater Hatchery of Pangkep State Polytechnic of Agriculture. An experimental approach employing a completely randomized design (CRD) with three treatments and three replications was used to evaluate the effects of natural feed supplemented with calcium carbonate on the growth and survival of freshwater lobster (*Cherax quadricarinatus*). The treatments consisted of A: commercial shrimp pellets (control), B: *Tubifex* sp. supplemented with 10% CaCO₃, and C: earthworms supplemented with 10% CaCO₃. Lobsters were cultured for 42 days and fed daily at 3% of total biomass. Freshwater lobster culture is highly influenced by nutritional quality and mineral availability, particularly calcium, which plays a fundamental role in molting and exoskeleton formation (Fotedar & Evans, 2018; Kumar et al., 2020). Previous studies have demonstrated that the use of natural feeds can improve feed acceptance and growth performance because of their high protein content and digestibility (Mubarak et al., 2019; Hasan et al., 2023). Accordingly, the present study examined the potential benefits of combining natural feed sources with calcium carbonate supplementation in improving lobster performance.

Experimental units consisted of container boxes equipped with aeration systems, while water quality parameters, including temperature, pH, and dissolved oxygen, were monitored using a thermometer, pH meter, and dissolved oxygen meter, respectively. The materials used included earthworms, *Tubifex* sp., calcium carbonate, commercial shrimp pellets, and freshwater. Growth performance was evaluated based on absolute growth, calculated as the difference between final weight (Wt) and initial weight (W0) according to Jobling (1994), whereas survival rate was expressed as the percentage of surviving individuals at the end of the culture period. Similar growth and survival indicators have been widely applied in crustacean aquaculture studies (Jones et al., 2021; Chen et al., 2021). Data on growth and survival were analyzed using one-way analysis of variance (ANOVA), followed by Tukey's honestly significant difference (HSD) test to determine significant differences among treatments. Meanwhile, water quality variables were analyzed descriptively by comparing

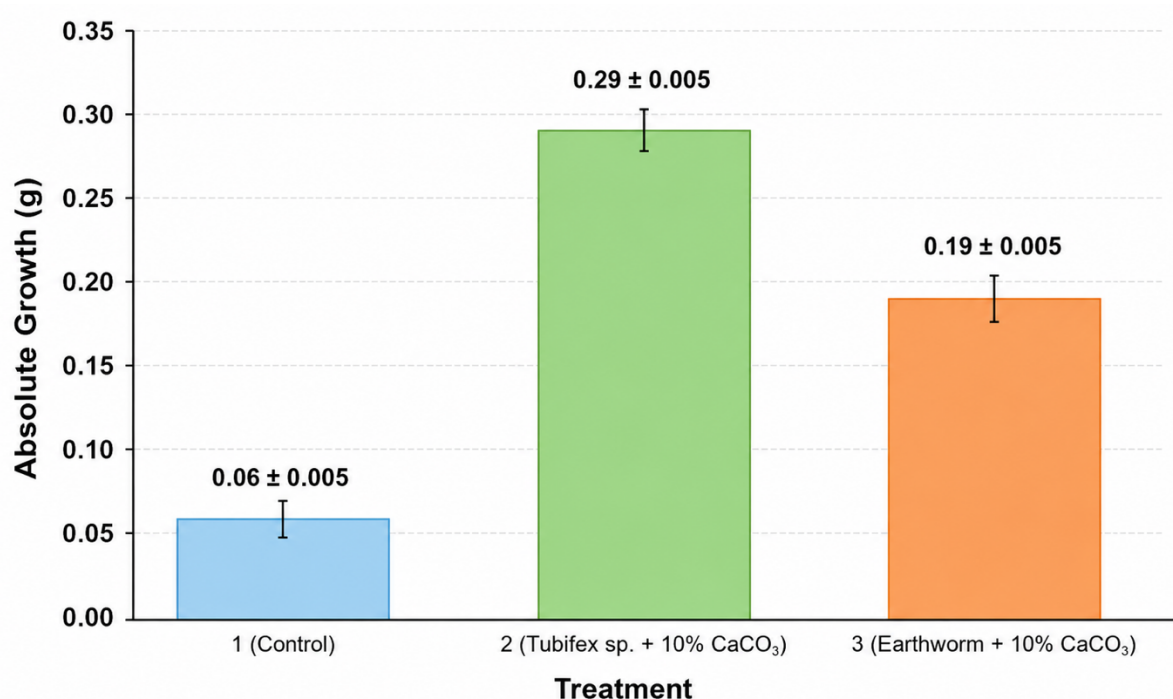
the observed values with the optimum ranges recommended for freshwater lobster culture (Nguyen et al., 2020; FAO, 2024).

RESULT AND DISCUSSION

Absolute Growth of Freshwater Lobster (*Cherax quadricarinatus*)

Absolute growth is one of the most important indicators used to evaluate the effectiveness of feed treatments in supporting biomass accumulation during the culture period. Variations in growth performance among treatments reflect differences in nutrient utilization efficiency and physiological responses of freshwater lobster to the diets provided. The changes in absolute growth of *C. quadricarinatus* during the 42-day rearing period are presented in Figure 1.

Figure 1.
Absolute growth of freshwater lobster (*Cherax quadricarinatus*) under different dietary treatments



Source: data processing results, 2025

As shown in Figure 1, freshwater lobsters fed *Tubifex* sp. supplemented with 10% CaCO₃ (Treatment B) exhibited the highest absolute growth, with an average weight gain of 0.29 g. This value was followed by Treatment C, consisting of earthworms supplemented with 10% CaCO₃, which produced an average weight gain of 0.19 g. The lowest growth was observed in Treatment A (commercial shrimp pellets), with an average gain of only 0.06 g. Analysis of variance (ANOVA) revealed that dietary treatments significantly affected absolute growth ($p < 0.05$), while Tukey's HSD test indicated significant differences among all treatments ($p < 0.05$).

The superior growth observed in Treatment B indicates that the combination of *Tubifex* sp. and calcium carbonate provided a more balanced nutritional composition and sufficient mineral supply for tissue development and exoskeleton formation. Calcium is an essential component involved in biomineralization and molting, processes that are fundamental for growth in crustaceans (García-Guerrero et al., 2017). According to Kumar et al. (2020),

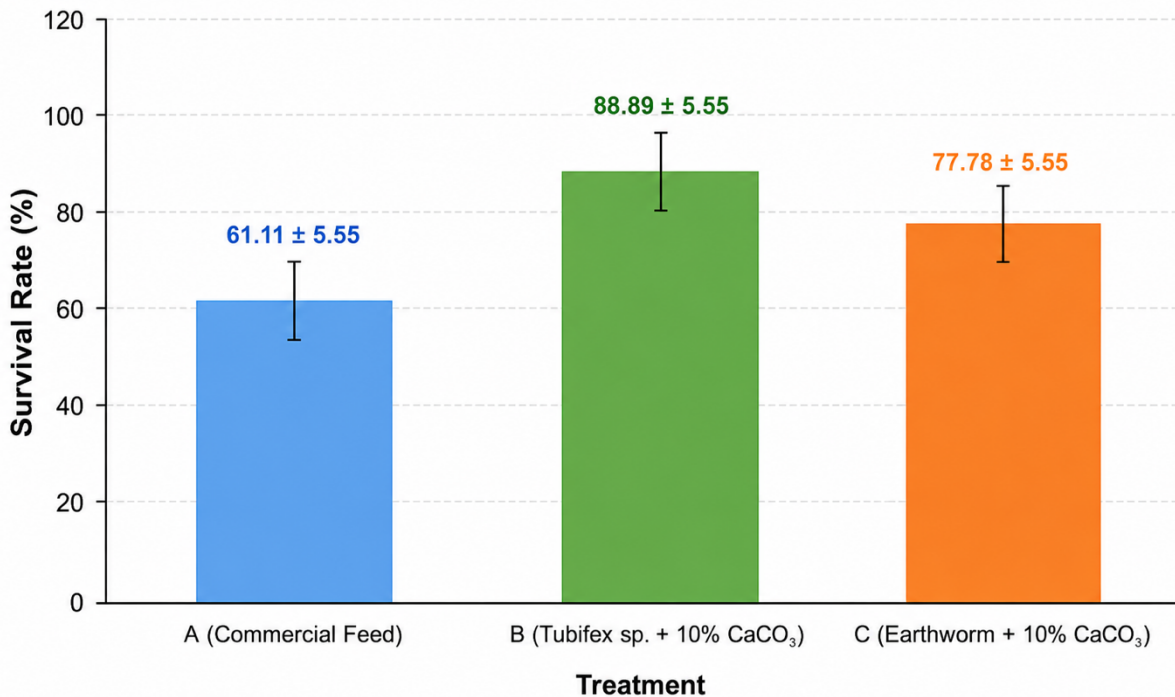
adequate calcium availability facilitates exoskeleton calcification and improves physiological functions associated with growth. In addition, *Tubifex* worms are highly digestible and rich in protein and essential amino acids, thereby supporting protein synthesis and tissue accretion (Hasan et al., 2023). The relatively high body protein content observed in Treatment B (38.19%) further confirms the positive contribution of natural feed quality to growth performance. As emphasized by Jobling (1994), growth in aquatic organisms is largely determined by nutrient intake, particularly dietary protein and essential minerals. Therefore, the synergistic effects of high-quality protein and calcium supplementation likely explain the enhanced growth achieved in Treatment B.

Survival Rate of Freshwater Lobster (*Cherax quadricarinatus*)

Survival rate represents an important parameter for assessing the success of culture practices because it reflects the ability of cultured organisms to adapt to environmental conditions and utilize available nutrients efficiently. Differences in survival among treatments may indicate variations in feed quality and mineral availability that influence physiological stability and resistance to stress. The survival rates of freshwater lobster during the 42-day culture period are presented in Figure 2.

Figure 2.

Survival rate of freshwater lobster (*Cherax quadricarinatus*) under different dietary treatments



Source: data processing results, 2025

Figure 2 shows that the highest survival rate was obtained in Treatment B, reaching 88.89%, followed by Treatment C with 77.78%, whereas the lowest survival was recorded in Treatment A with 61.11%. Statistical analysis revealed significant differences among treatments ($p < 0.05$). Tukey’s HSD test showed that Treatment A differed significantly from Treatment B, whereas no significant differences were observed between Treatments A and C or between Treatments B and C.

The higher survival observed in Treatment B highlights the importance of adequate nutrition and mineral availability in maintaining physiological stability. In crustaceans, mortality frequently occurs during or immediately after molting because incomplete shell hardening increases vulnerability to stress and cannibalism. Calcium deficiency is recognized as one of the major causes of molting failure and mortality (García-Guerrero et al., 2017). Thus,

supplementation with calcium carbonate likely increased calcium availability and accelerated exoskeleton mineralization, thereby reducing mortality risks. Furthermore, *Tubifex* sp. possesses high protein content and soft body tissues, making it highly digestible and palatable for juvenile crustaceans. Hasan et al. (2023) reported that natural feeds improve nutrient utilization and stimulate feeding activity, thereby enhancing survival. Hoseinifar et al. (2018) further demonstrated that natural feed sources and beneficial microorganisms contribute to improved digestive health and immune responses in aquatic animals. Consequently, the combination of high nutritional value and calcium supplementation may explain the superior survival performance observed in Treatment B.

Water Quality Conditions

Water quality is one of the key environmental factors affecting the growth and survival of freshwater lobster. Appropriate water conditions ensure optimal metabolic activity and minimize physiological stress during the culture period. Therefore, monitoring water quality parameters is essential for evaluating whether differences in growth and survival are primarily influenced by dietary treatments rather than environmental conditions. The ranges of water quality parameters recorded during the experiment are presented in Table 3.

Table 3.

Water quality parameters during the culture period of freshwater lobster (*Cherax quadricarinatus*)

Table 3. Water Quality Parameters During the Culture Period of Freshwater Lobster (*Cherax quadricarinatus*)

Treatment	Temperature (°C)	pH	Dissolved Oxygen (mg L ⁻¹)	Ammonia (mg L ⁻¹)
A (Commercial Feed)	26–28	7.0	2.22–3.14	0.01–0.25
B (<i>Tubifex</i> sp. + 10% CaCO ₃)	26–28	7.0	3.13–3.35	0.01–0.25
C (Earthworm + 10% CaCO ₃)	26–28	7.0	3.12–3.34	0.01–0.25

Source: Research data, 2025

The results indicate that water temperature ranged from 26 to 28°C, pH remained stable at 7, dissolved oxygen varied between 2.22 and 3.35 mg L⁻¹, and ammonia concentrations ranged from 0.01 to 0.25 mg L⁻¹. Overall, these values were within acceptable ranges for freshwater lobster culture and therefore did not appear to impose significant stress on the experimental animals.

The temperature range recorded during the study was considered suitable for freshwater lobster growth. Boyd (2017) reported that *C. quadricarinatus* grows optimally within temperatures ranging from 24 to 30°C, whereas temperatures below 20°C may reduce metabolic activity and molting frequency. Similarly, King et al. (2021) noted that excessively high temperatures increase oxygen demand and induce stress responses. Consequently, the temperature conditions observed in the present study likely supported normal physiological activities and contributed to satisfactory growth performance.

The pH remained constant at approximately 7 throughout the culture period, indicating a neutral environment favorable for freshwater lobster. Satyani (2001) reported that freshwater lobster grows optimally within a pH range of 7–8.5. Neutral pH conditions facilitate osmoregulation and maintain physiological homeostasis, thereby supporting growth and survival.

Dissolved oxygen concentrations ranged from 2.22 to 3.35 mg L⁻¹. Although these values were slightly lower than the ideal range of 4–5 mg L⁻¹ recommended for crustacean culture (Foster & Harper, 2006; FAO, 2023), no severe negative effects on survival were observed. This condition may be attributed to the relatively low stocking density and continuous aeration

provided during the experiment. Nevertheless, low dissolved oxygen concentrations may reduce feeding activity and metabolic efficiency, potentially limiting growth performance.

Ammonia concentrations remained between 0.01 and 0.25 mg L⁻¹, which is below the threshold considered harmful for freshwater lobster. According to Boyd (2017) and Kusman (2006), ammonia concentrations exceeding 0.3 mg L⁻¹ may become toxic by damaging gill tissues and interfering with nitrogen excretion processes. The relatively low ammonia concentrations observed in this study indicate that feed residues and metabolic wastes were adequately controlled. Although hardness and alkalinity were not measured directly, previous studies have suggested that hardness values between 100 and 200 mg L⁻¹ CaCO₃ and alkalinity values between 50 and 200 mg L⁻¹ CaCO₃ are favorable for freshwater lobster culture because they provide sufficient calcium reserves for exoskeleton formation and help stabilize pH fluctuations (Boyd, 2017; Jones et al., 2021). Overall, the water quality conditions recorded during the study were conducive to freshwater lobster culture and likely contributed to the relatively high growth and survival performance, particularly in Treatment B.

CONCLUSION

The present study demonstrated that dietary treatments significantly influenced the growth and survival of freshwater lobster (*Cherax quadricarinatus*). Freshwater lobsters fed *Tubifex* sp. supplemented with 10% calcium carbonate (Treatment B) exhibited the best performance, achieving the highest absolute growth (0.29 ± 0.005 g) and survival rate (88.89 ± 5.55%). In contrast, the control treatment fed commercial shrimp pellets produced the lowest growth and survival values. The superior performance observed in Treatment B indicates that the combination of highly digestible natural feed and calcium supplementation effectively supported tissue development, molting, and exoskeleton mineralization. Water quality parameters remained within acceptable ranges throughout the experimental period and were considered suitable for freshwater lobster culture. Overall, the results suggest that supplementation of natural feed with calcium carbonate, particularly *Tubifex* sp. combined with 10% CaCO₃, represents a promising feeding strategy for improving the productivity and sustainability of freshwater lobster farming.

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