



RESEARCH PAPER

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Impact of vinegar-supplemented diets on the survival and growth performance of juvenile giant freshwater prawn (*Macrobrachium rosenbergii*) in a 30-day culture period

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Abstract

The giant freshwater prawn (*Macrobrachium rosenbergii*) is extensively cultivated in the Philippines and other countries due to its high market value, contribution to rural livelihoods, and potential role in ensuring food security. This study examined the tolerability and growth performance of juvenile giant freshwater prawns fed diets supplemented with different types of vinegar. A 30-day experiment was conducted with three dietary treatments: To (control diet), T1 (2% coconut sap vinegar [CSV]), and T2 (2% apple cider vinegar [ACV]), each replicated three times. Key parameters, including weight gain (WG), length gain (LG), specific growth rate (SGR), and survival rate, were analyzed statistically using Analysis of Variance (ANOVA) at a significance level of $p = 0.05$. The results revealed that prawns fed with CSV-enhanced diets exhibited the highest WG (8.33 g), LG (4.37 cm), and SGR (27.77% day⁻¹), significantly outperforming the control group ($p < 0.05$). Additionally, a 100% survival rate was observed across all treatment groups, demonstrating the prawns' tolerability to vinegar-supplemented diets. These findings suggest that incorporating coconut sap vinegar into commercial prawn feeds can enhance growth performance while maintaining high survival rates, offering a sustainable strategy for improving aquaculture productivity.

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Introduction

Prawn farming has become a vital and rapidly expanding segment of global aquaculture due to its high economic value, significant contribution to food security, and ability to support rural livelihoods. In the Philippines, prawn farming, particularly of the Giant Freshwater Prawn (*Macrobrachium rosenbergii*), locally known as "ulang," holds immense potential for boosting freshwater aquaculture. This species is highly valued for its rapid growth, adaptability to freshwater and slightly brackish environments, and ability to command premium prices in both local and international markets. Despite these advantages, prawn farming in the Philippines remains underdeveloped compared to other sectors, such as tilapia farming, which currently dominates the country's freshwater aquaculture. Expanding and optimizing prawn farming practices could significantly diversify aquaculture production, providing greater economic benefits and sustainable livelihood opportunities for rural communities.

The global aquaculture industry, including prawn and shrimp farming, has experienced rapid growth, driven by rising demand and the potential for high returns. However, intensified production to meet this demand has introduced several challenges, such as suboptimal growth performance, increased stress levels, and reduced welfare of farmed species (dela Calzada *et al.*, 2020). Addressing these issues requires innovative solutions, such as the incorporation of organic acids in feed formulations. Organic acids have been shown to improve mineral digestion and absorption, enhance nutrient assimilation, and promote growth in aquatic species (Baruah *et al.*, 2005; Lin and Cheng, 2017). Vinegars, which are rich in organic acids, have demonstrated promising results in aquaculture, particularly in enhancing the growth and health of shrimp species. For instance, studies have shown that coconut sap vinegar and sugar cane vinegar improve the growth performance of black tiger shrimp (dela Calzada *et al.*, 2020), while Pacific white shrimp fed diets containing apple cider vinegar or other vinegars exhibit higher weight gain and specific growth rates (Jamis *et al.*, 2018).

Despite these advancements, most studies on vinegar-enhanced diets have focused on saltwater shrimp species, with limited research on freshwater prawns. This gap underscores the need to investigate whether similar benefits can be observed in freshwater prawn farming. This study aims to address this gap by evaluating the tolerability, growth performance, and survival rates of juvenile giant freshwater prawns fed vinegar-supplemented diets. The findings of this research are expected to provide valuable insights for optimizing feed strategies and improving the productivity of freshwater aquaculture in the Philippines, ultimately contributing to food security and economic development.

Materials and methods

Research design

The study employed a single-factor design using a Randomized Complete Block Design (RCBD) in circular freshwater tanks to assess the impact of vinegar-supplemented diets. Three experimental diets were prepared: T₀, prawn feeds (a control diet without vinegar); T₁, a diet supplemented with 2% (w/w) coconut sap vinegar (CSV); and T₂, a diet containing 2% (w/w) apple cider vinegar (ACV). Each dietary treatment was replicated three times. The experiment was conducted over a 30-day period, allowing consistent observation and data collection throughout the culture duration.

Research environment

The study was carried out at the Bureau of Fisheries and Aquatic Resources - Region VII (BFAR 7) Clarin Freshwater Fish Farm, located in Caluwasan, Clarin, Bohol, Philippines. The experiment took place over a 30-day period in sheltered circular freshwater tanks. Nine tanks, each measuring 1.5 meters in diameter and 1.2 meters in height, were used for the study. To ensure proper oxygenation, each tank was equipped with a single aerator.

Stock procurement and stocking

Ninety (90) healthy juvenile giant freshwater prawns were obtained from the BFAR Clarin Freshwater Fish Farm for the study. They were carefully transported

to the research facility to ensure their safety during transit. In the early morning, the prawns were stocked into the circular freshwater tanks. To prevent stress or mortality caused by sudden temperature changes, the prawns were gradually acclimatized to the water temperature and tank conditions. Ten (10) prawns were placed in each tank. A digital weighing scale and Vernier caliper were used to measure and record the prawns' weight and length at the time of stocking for initial assessment.

Feed preparation and feeding

The juvenile giant freshwater prawns in this study were fed commercial prawn feeds with a crude protein content of 42%. Three experimental treatments were applied, involving the addition of different vinegars: coconut sap vinegar (CSV) and apple cider vinegar (ACV). The control diet (To) contained no vinegar, while T1 and T2 included 2% (w/w) CSV and 2% (w/w) ACV, respectively. To prepare the diets, the commercial feed was mixed with the respective vinegars at a 2% concentration. The mixtures were air-dried at room temperature overnight before being fed to the prawns. The average body weight (ABW) of the juvenile prawns was measured to determine the appropriate feeding rate. Feeding was conducted three times daily—early in the morning, at noon, and late in the afternoon—using the broadcasting method.

Data collection

Before stocking, the initial weight (in grams) and length (in centimeters) of the juvenile giant freshwater prawns were recorded. Sampling was conducted at fifteen-day intervals throughout the study to assess the impact of the diets on the prawns' growth performance and survival rate. At each sampling point, the prawns were individually counted, and their weight and length were measured. Additionally, daily monitoring of water parameters, including pH level and temperature (°C), was carried out to maintain optimal conditions for prawn cultivation. Weight gain (WG) was calculated using the formula: $WG = W_2 - W_1$, where W_1 represents the initial mean weight and W_2 represents the final mean weight at the end of the experiment. Length gain

(LG) was calculated using the formula: $LG = L_2 - L_1$, where L_1 is the initial mean length and L_2 is the final mean length of the prawns. The specific growth rate (SGR) was determined using the formula: $SGR = \{(\ln \text{ final weight} - \ln \text{ initial weight}) / \text{days} \} \times 100$, where "ln" refers to the natural logarithm of the final and initial weights. The survival rate (SR) was calculated using the formula: $SR = (\text{number of survived prawns} / \text{total number of prawns stocked}) \times 100$. The data collected during the study period were analyzed and interpreted to evaluate the effects of the different diets on the growth performance and survival rate of the cultured prawns.

Statistical analysis

The collected data were analyzed using a One-Way ANOVA with a significance level (α) of 0.05 to determine if there were significant differences among the experimental diets. If the ANOVA results showed a significant difference, a post hoc analysis using Tukey's Honest Significant Difference (HSD) test was performed to identify specific differences between the experimental groups.

Results and Discussion

Table 1 provides an overview of the data on weight gain (WG), length gain (LG), specific growth rate (SGR), survival rate (SR), and mean water quality parameters. The findings indicate that diets supplemented with vinegars resulted in significantly higher growth (weight and length), SGR, and SR values compared to the control diet. Among the experimental groups, juvenile prawns fed a diet containing 2% (w/w) CSV achieved the highest WG (8.33 g), LG (4.37 cm), and SGR (27.77% day⁻¹). In contrast, prawns on the control diet exhibited the lowest growth performance, with WG of 4.29 g, LG of 1.84 cm, and SGR of 14.30% day⁻¹. In addition, 100% survival was observed across all treatments throughout the culture period. This indicates that the cultured giant freshwater prawns can tolerate diets supplemented with vinegars, resulting 100% survival rate and notable improvements in terms of growth. Also, water quality parameters, such as pH level and temperature (°C), remained stable and within optimal ranges throughout the study.

Table 1. Growth, survival, and mean water quality parameters of juvenile giant freshwater prawn (*Macrobrachium rosenbergii*) fed with vinegar enhanced diets

Parameters	Protein diet sources		
	T ₀ Control diet (no vinegars added)	T ₁ 2% (w/w) CSV	T ₂ 2% (w/w) ACV
Rearing period (Days)	30	30	30
Survival rate (%)	100	100	100
Weight gain (g)	4.29	8.33	5.16
Length gain (cm)	1.84	4.37	2.67
SGR (% BW day ⁻¹)	14.3	27.77	17.2
pH level (mean)	7.02	7.02	6.90
Temperature °C (mean)	27.46	27.38	27.12

Table 2. One-way analysis of variance for growth increment (weight and length), specific growth rate, and survival rate of juvenile giant freshwater prawn (*Macrobrachium rosenbergii*) fed with vinegar-enhanced diets

Source of variation	SS	DF	MS	F-Value	p-value	F-Critical value	Decision
Growth increment (Weight)							
Between groups	8.649622	2	4.324811	12.11281	0.007822	5.143253	Reject Ho
Within groups	2.142267	6	0.357044				
Growth increment (Length)							
Between groups	17.25936	2	8.629678	26.34927	0.001068	5.143253	Reject Ho
Within groups	1.965067	6	0.327511				
Specific growth rate							
Between groups	163.5314	2	81.76568	31.90842	0.000635	5.143253	Reject Ho
Within groups	15.37507	6	2.562511				
Survival rate							
Between groups	0	2	0	-	-	5.143253	Accept Ho
Within groups	0	6	0				

A significant difference was observed among the three treatments in terms of weight gain, length gain, and specific growth rate, while no significant differences were identified for the survival rate. These findings suggest that diets supplemented with vinegars substantially enhance the growth performance of juvenile prawns, particularly in weight, length, and specific growth rate. However, the inclusion of vinegars did not have a notable effect on their survival rate. A comprehensive summary of these results is presented in Table 2.

The study demonstrated that diets supplemented with vinegars significantly improved the growth performance of giant freshwater prawns. These findings align with previous studies by Dela Calzada *et al.* (2020) on Black Tiger Post-larvae Shrimp (*Penaeus monodon*) and Jamis *et al.* (2018) on Pacific White Shrimp (*Penaeus vannamei*), which reported increased weight gain and specific growth rates in diets containing 2% (w/w) vinegar. Notably, Jamis *et al.* (2018) observed that shrimps fed diets

with coconut sap vinegar exhibited the best growth performance among all treatments. Ozturk *et al.* (2015) attributed the efficacy of vinegars to their acetic acid content, which contributes to their strong aroma and distinct flavor, serving as a precursor for volatile compounds such as aldehydes, esters, ketones, and organic acids. These compounds enhance the organoleptic properties of the vinegar. It is suggested that coconut sap vinegar diets attracted the prawns, as similarly observed by Jamis *et al.* (2018) and Dela Calzada *et al.* (2020). Additionally, a volatile analysis by Dela Calzada *et al.* (2020) using Gas Chromatography identified numerous detectable volatile compounds in coconut sap vinegar, which likely contributed to a higher attraction rate of shrimps to diets containing CSV.

Conclusion

Incorporating various vinegars in the diet of juvenile giant freshwater prawn (*Macrobrachium rosenbergii*) has proven beneficial for their growth performance and survival rate. Notably, diets

supplemented with 2% (w/w) coconut sap vinegar showed the most significant improvements in growth (both weight and length) and specific growth rate compared to other treatments. Therefore, it is highly recommended to supplement commercial feeds with coconut sap vinegar to enhance growth performance and ensure better survival rates in prawn farming.

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