Effects of Vinegars on the Growth Performance and Survival Rate of Juvenile Giant Freshwater Prawn (*Macrobrachium rosenbergii*)

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Abstract

Giant Freshwater Prawn (*Macrobrachium rosenbergii*) is cultivated in various countries, including Philippines, due to its high market value, contribution to rural livelihoods, and ensuring food security. This study aimed to investigate the impact of vinegars on the growth performance and survival rate of juvenile Giant Freshwater Prawn. The experiment was conducted over a period of sixty days and involved three treatment groups: T_0 - control diet , T_1 - 2% (w/w) coconut sap vinegar (CSV), and T_2 -2% (w/w) apple cider vinegar (ACV), with each treatment replicated three times. The growth in terms of length and weight, as well as survival rate, were measured and subjected to statistical analysis using Analysis of Variance at a significance level of p=0.05. The findings revealed that juvenile prawns fed with diets containing CSV exhibited the highest weight gain (WG), length gain (LG) and specific growth rate (SGR). All of the treatment groups achieved a 100% survival rate. Results demonstrated that diets supplemented with vinegars lead to significantly greater growth increments and specific growth rates compared to the control diet, and these differences were statistically significant ($p<0.05$). Furthermore, diets supplemented with CSV showed remarkably excellent growth performance among all diets and can be recommended for inclusion in commercial feeds to enhance the growth and survival of Giant Freshwater Prawns.

Keywords: *Giant Freshwater Prawn, growth increment, Macrobrachium rosenbergii, specific growth rate, survival*

Introduction

The Giant Freshwater Prawn, scientifically known as *Macrobrachium rosenbergii*, is a species of freshwater prawn that thrives in various inland water bodies such as lakes, rivers, swamps, estuaries, irrigation canals, and upstream areas of rivers (Rosario and Tayamen, 2004). It is cultivated for economic purposes in inland aquaculture in countries like South America, Bangladesh, China, Taiwan, Vietnam, and Thailand (New and Nair, 2012). In the Philippines, it is locally referred to as "ulang" or "udang" and holds significant economic value due to its resilient nature, rapid growth, ability to thrive in freshwater and slightly brackishwater conditions, as well as its numerous biological advantages for commercial cultivation, including its large size and fast growth rate. The freshwater prawn industry in the country aims to diversify the

commodities utilized in freshwater aquaculture, which are currently dominated by tilapia. This prawn species plays a vital role in supporting rural livelihoods and contributing to food security. Furthermore, it commands high market value, fetching substantial prices in seafood markets throughout Asia (Yan and Beijin, 2019), and its cultivation has the potential to yield impressive results.

Prawn and shrimp aquaculture has emerged as a rapidly growing sector not only in Asia but also in various parts of the world. This industry has experienced rapid development, providing employment opportunities on a global scale and generating billions of dollars in annual trade, thereby making significant contributions to the economies of respective countries. However, surging global demand for shrimps and prawns in the trade market has led to intensified production systems. Unfortunately, this intensification has resulted in several challenges, including inadequate growth performance, increased stress levels, and poor welfare among farmed prawns and shrimps (dela Calzada et al., 2020). In an effort to enhance the nutritional value and growth of aquatic organisms, there has been growing interest in the utilization of organic acids as feed additives (Hoseinifar et al., 2017; Ng and Koh, 2017). This interest stems from the ability of organic acids and their salts to chelate minerals or facilitate the dephosphorylation of phytic acid, thereby improving mineral digestion and absorption (Baruah et al., 2005). Furthermore, they have been found to enhance the fish's capacity to assimilate copper, zinc, calcium, phosphorus, and lipids, thereby promoting overall growth (Lin and Cheng, 2017).

The application of vinegars, which contain organic acids, can offer significant benefits to important shrimp species in aquaculture by acting as growth stimulators and preventing the proliferation of harmful bacteria. Various have been explored the use of vinegars and have found positive effects on the growth of commercially valuable shrimps. For example, research on black tiger shrimp revealed that coconut sap vinegar, sugar cane vinegar, and their combination enhanced the growth of these shrimp species (dela Calzada et al., 2020). Similarly, Pacific white shrimp fed with diets containing apple cider vinegar, coconut sap vinegar, and sugar cane vinegar at a 2% inclusion rate exhibited notably higher final average body weight, weight, gain, and specific growth rate (Jamis et al., 2018).

However, most studies on vinegar as a growth enhancer have focused on shrimp species cultivated in saltwater conditions. Therefore, further research should be conducted to determine if similar effects can be observed in other commercially important prawns, such as freshwater prawns. The aim of this study was to assess the growth and survival rate of juvenile giant freshwater prawns fed with diets supplemented with vinegar. It is anticipated that the findings of this study will contribute to the advancement of freshwater aquaculture in the country by promoting the growth and production of Giant Freshwater Prawns.

MATERIALS AND METHODS

Research Design

The study employed a single-factor design implemented using the Randomized Complete Block Design (RCBD) in circular freshwater tanks. There were three experimental treatments in total: T_0- control diet (no vinegar added), T_1 involved the

addition of 2% (w/w) coconut sap vinegar (CSV), and T_2 included 2% (w/w) apple cider vinegar (ACV). Each treatment was replicated three times to ensure robustness and reliability of the results. The entire study was conducted over a period of sixty (60) days, allowing for observations and data collection within this culture duration.

Tank Preparation

The study took place at the Bureau of Fisheries and Aquatic Resources - Region VII (BFAR 7) Clarin Freshwater Fish Farm, situated in Caluwasan, Clarin, Bohol, Philippines. The experiment was carried out within the confines of sheltered circular freshwater tanks for a duration of sixty days. In total, nine circular freshwater tanks were utilized, each with dimensions of 1.5 meters in diameter and 1.2 meters in height. To ensure proper oxygenation, each tank was equipped with one aerator.

Stock Securement and Stocking

Ninety (90) healthy juvenile Giant Freshwater Prawns were obtained from BFAR Clarin Freshwater Fish Farm for the study. The prawns were carefully secured and transported to the research facility. Stocking of the prawns into the circular freshwater tanks took place in the early morning. To ensure their well-being and minimize any potential harm or mortalities due to thermal shock, acclimatization procedures were implemented. This involved gradually adjusting the prawns to the water temperature and conditions of the tanks. In each circular freshwater tank, a total of ten (10) prawns were stocked. To gather data on the prawns' weight and length during the stocking process, a digital weighing scale and Vernier caliper were utilized. These measurement tools helped to accurately determine the weight and length of the juvenile prawns as part of the initial assessment.

Feeding and Feed Preparation

The giant freshwater prawns in the study were provided with commercial feeds, specifically prawn feeds with a crude protein of 42%. There were three experimental treatments involving the addition of different vinegars: coconut sap vinegar (CSV) and apple cider vinegar (ACV). The control diet (T_0) did not contain any vinegar, while T_1 and T_2 included 2% (w/w) CSV and 2% (w/w) ACV, respectively. To prepare the diets, the commercial feeds were mixed with the vinegars at a concentration of 2%. The prepared diets were air-dried at room temperature overnight before being fed to the cultured prawns. The average body weight (ABW) of the juvenile giant freshwater prawns was carefully measured serving as the basis for determining the feeding rate used in the feed preparation. Feeding was conducted three times a day, early in the morning, noon, and late in the afternoon, using the broadcasting method.

Data Gathering

The initial weight (g) and length (cm) of the cultured juvenile freshwater prawns were collected prior to stocking. Subsequent sampling was conducted at fifteen-day intervals throughout the duration of the study. Data was recorded at each sampling period to observe the effects of the diets on the growth performance and survival rate of the prawns. Daily monitoring of water parameters, including pH level and temperature (^{0} C), was carried out to ensure optimal conditions for the prawns' cultivation.

During the sampling, the cultured juvenile giant freshwater prawns were individually counted, and their weight and length were measured. The 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 of cultured prawns at the conclusion of the experiment. Similarly, the length main (LG) was calculated using the formula $LG = L_2-L_1$, where L_1 represents the initial mean length and L_2 represents the final mean length of cultured prawns at the end of the experiment. To determine the specific growth rate (SGR), the formula SGR = {(In final weight – In initial weight)/days} x 100 was utilized. Here, In refers to the natural logarithm of final and initial weight. The survival rate (SR) was calculated using the formula used was SR = (number of survived stocks/total number of stocks) x 100. The data collected throughout the study period were then analyzed and interpreted to draw conclusions about the effects of the diets on the growth performance and survival rate of the cultured prawns.

Statistical Analysis

The collected data were analyzed using a One-Way ANOVA at a significance level (α) of 0.05 to determine if there were significant differences among the treatments. If the ANOVA result indicates significant difference, a post hoc analysis using Tukey's HDS test was performed to identify specific differences between independent factors.

Results and Discussion

Table 1 presents the data on weight gain (WG), length gain (LG), specific growth rate (SGR), survival rate (SR), and mean water quality parameters. The results indicate that diets containing vinegars resulted higher WG, SGR, and SR compared to the control diet. Among the cultured juvenile prawns, those fed diets with 2% (w/w) CSV exhibited the highest WG of 12.11 g, LG of 6.14 cm and SGR of 40.36 % day^{-1}. On the other hand, the prawns fed with control diets had the lowest WG of 7.11 g and SG of 23.69% day^{-1}, while those fed with diets containing 2% (w/w) ACV showed the lowest LG of 3.48 cm. All of the cultured juvenile giant freshwater prawn successfully survived throughout the entire culture period. The water quality parameters, including pH level and temperature (^{0} C), remained within acceptable ranges throughout the study, with no notable fluctuations recorded.

Table 1. Growth, Survival, and Mean Water Quality Parameters of 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)	60	60	60
Weight Gain (g)	7.11	12.11	7.46
Length Gain (cm)	3.77	6.14	3.48
SGR (% BW day^{-1})	23.69	40.36	24.86

Survival Rate (%)	100	100	100
pH Level (mean)	7.06	7.06	7.04
Temperature ^{0} C (mean)	26.62	26.59	26.64

Additionally, there was a notable distinction among the four treatments regarding weight gain, length gain, and specific growth rate. However, there was no significant difference observed in terms of survival rate. These finding indicate that diets containing vinegars have a significant impact on the growth, both in terms of weight and length, as well as the specific growth rate of the prawns. However, the vinegars did not have significant effect on the survival rate of the prawns. This information is summarized in Table 2.

Table 2. One-Way Analysis of Variance for Growth Increment (Weight and Length), Specific Growth Rate, and Survival Rate of Giant Freshwater Prawn (*Macrobrachium rosenbergii*) Fed with Vinegar Enhanced Diets.

Source of Variation	SS	DF	MS	F-Value	F-Critical Value	Decision
Growth Increment (Weight)						
Between Groups	46.745	2	23.373	5.738587	5.143253	Reject H_O
Within Groups	24.437	6	4.0729			
Growth Increment (Length)						
Between Groups	12.7766	2	6.3883	7.056296	5.143253	Accept H_O
Within Groups	5.432	6	0.905333			
Specific Growth Rate						
Between Groups	544.4023	2	272.2011	6.446347	5.143253	Reject H_O
Within Groups	253.3539	6	42.22564			
Survival Rate						
Between Groups	0	2	0	-	5.143253	Accept H_O
Within Groups	0	6	0			

Results of the study indicated that diets enriched with vinegars greatly enhanced the growth of giant freshwater prawns. These results align with previous studies conducted 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*, where diets containing 2% (w/w) vinegar lead to higher weight gain and specific growth rate. In addition, Jamis et al. (2018) reported that shrimps fed with diets containing coconut sap vinegar exhibited best growth performance among all the treatments. According to Ozturk et al. (2015), the acetic acid content in vinegars contributes to their strong aroma, unique flavor and serves as precursor for the formation of other volatile compounds such as aldehydes, esters, ketones, and organic acids. These compounds enhances the organoleptic properties of vinegars. It is also believed that the species were attracted to diets containing coconut sap vinegar, as observed by Jamis et al. (2018) and dela Calzada et al. (2020). In a volatile analysis conducted by dela Calzada et al. (2020) using Gas Chromatography, numerous detectable volatile compounds were found in coconut sap vinegar that were noticeable. Besides, these aroma compounds detected in the coconut

sap vinegar. These aroma compounds may have contributed to a significantly higher proportion of shrimps being attracted to the diet containing coconut sap vinegar CSV (dela Calzada et al., 2020).

Conclusion

Incorporating various vinegars into the diet of juvenile Giant Freshwater Prawn (*Macrobrachium rosenbergii*) demonstrated positive effects on their growth performance and survival rate. Specifically, diets containing 2% (w/w) coconut sap vinegar showed 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 for enhanced growth performance and survival in prawn culture.

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