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Utilization of vinegar-enriched diets in the growth and survival rate of giant freshwater prawn (*Macrobrachium rosenbergii)*

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Abstract

Acetic acid on vinegars has the capability to act as growth enhancers and prevents pathogenic bacteria. This study aimed to determine the growth and survival rate of Giant Freshwater Prawn (*Macrobrachium rosenbergii*) fed with vinegar-enriched diets. It was conducted within three trials with four experimental diets formulated: T0- control diet, T1- 2% (w/w) coconut sap vinegar(CSV), T2- 2% (w/w) apple cider vinegar (ACV) , and T3 - 2% (w/w) coconut sap vinegar + apple cider (CSV+ACV) with three replications each. Weight gain (WG), length gain (LG), specific growth rate (SGR), and survival rate (SR) were measured and data were analyzed using Analysis of Variance at p=0.05. Results demonstrated that individuals fed with diets containing CSV got the highest WG, LG and SGR. In terms of survival rate, those fed with diets containing CSV(T1) and ACV(T2) got 100% SR. Results showed that vinegar-enriched diets gained higher WG, LG, SGR, and SR compared with the control diet and were significantly different ($p<0.05$). In addition, diets supplemented with CSV resulted significantly the best growth among all diets and can be recommended to be supplemented into commercial feeds for better growth and survival of Giant Freshwater Prawn.

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Introduction

Freshwater Aquaculture plays a major role in the country's economic development and in the sustenance of the needs of individuals as source of food consumption and livelihood. Along with Mariculture and Brackishwater Aquaculture, it is one of the rapidly developing fishery sectors not just only in Asia but also in some other parts of the world. Several freshwater species including Giant Freshwater Prawn scientifically known as *Macrobrachium rosenbergii*, which have great potential for aquaculture, are widely cultured nowadays because it is hardy and easily farmed (Pañares, 2022). This freshwater species of prawn is locally known as "ulang" in the Philippines and is economically important species due to its faster growth and market demand which fetches excellent prices in seafood markets across Asia (Yan and Beijin, 2019).

Shrimp industries, which has grown rapidly and generates billions of dollars every year in trade and employs millions of people globally contribute significantly in the country's economy. However, the intensification of production system is triggered due to the rapid demand of shrimps and prawns in the global trade market. This led to increased stress, limited growth performance and poor welfare in farmed shrimps (dela Calzada *et al.*, 2020) and prawns. The use of organic acids as feed additives has gained much attention to increase the nutritive value and growth of aquatic organism (Hoseinifar *et al.*, 2017: Ng and Koh, 2017) especially aquaculture animals (Pourmozaffar *et al.*, 2017). The reason of this could be organic acids and their salts have the capacity to chelate minerals or improve the dephosphylation of phytic acid, leading to improved mineral digestion and absorption (Baruah *et al.*, 2005) and increase digestibility of dry matter, lipid, copper, zinc, calcium, and phosphorous in fish (Lin and Cheng, 2017) and other aquatic species.

Acetic acid in vinegars becomes so much useful for important shrimp species in aquaculture. Vinegars and their salts have the capability to act as growth promoters and prophylactics against pathogenic bacteria. Research studies about the use of vinegars as source of organic acid were also found to enhance the growth of shrimps. Pacific white shrimp fed with apple cider, coconut sap, and sugar cane vinegars at 2 % inclusion shown significantly higher final average body weight, weight gain and specific growth rate (Jamis *et al.*, 2018). In addition, black tiger shrimp fed with coconut sap vinegar, sugar cane vinegar, and the combination of two, result demonstrated that the vinegars tested enhanced the growth of black tiger shrimp (dela Calzada *et al.*, 2020). Recent research studies about the use of vinegars were focused only on shrimp species cultured in saltwater environments. To determine if it has the same effects with other commercially important prawns such as freshwater prawns, another study should be conducted. Thus, this study aimed at determining the growth and survival rate of Giant Freshwater Prawn feed with vinegar-enriched diets. It is believed that this study could contribute to the country's freshwater aquaculture industry in order to promote better growth and production of Giant Freshwater Prawn.

Materials and methods

Research design

This study utilized a single factor design laid out in Complete Randomized Design (CRD) in circular freshwater tanks with four (4) experimental diets: T_0- no vinegar added (control), T_1 - 2% (w/w) coconut sap vinegar (CSV), T_2- 2% (w/w) apple cider vinegar (ACV), and T_3- 2% (w/w) 1:1, coconut sap vinegar + apple cider vinegar (CSV+ACV) with three (3) corresponding replications. The study was done within three trials with 30 days per trial for a total of ninety (90) days culture period.

Tank preparation

This study was conducted in the shaded circular freshwater tanks for three (3) months at Bureau of Fisheries and Aquatic Resources - Region 7 (BFAR 7) Clarin Freshwater Fish Farm located at Caluwasan, Clarin, Bohol, Philippines. Twelve circular freshwater tanks were used in this study with a dimension of 1.5 meters (diameter) and 1.2 meters (height). Each tank had an aerator and an 18 inches length PVC pipe that served as the hiding place of the cultured species.

Stock procurement and stocking

The 120 healthy Giant Freshwater Prawn juveniles were procured from BFAR Clarin, Bohol, Philippines. Stocking was done early in the morning and acclimatization was done to avoid thermal shock of the individuals that might cause them harm or sudden mortalities. There were ten (10) individuals in each tank. Digital weighing scale and Vernier caliper were used to measure the weight and length respectively during stocking.

Feeding preparation and feeding

Giant Freshwater Prawns were fed with commercial feeds such as prawn feeds containing 42% crude protein with four (4) different experimental diets. Various vinegars such as coconut sap vinegar (CSV) and apple cider vinegar (ACV) served as different treatments. T_0 served as control diet (no vinegar) while T_1, T_2, and T_3 contained 2% (w/w) CSV, 2% (w/w) ACV, and 2% (w/w) CSV+ACV (1:1) respectively. In preparing the feeds, vinegars were mixed on the commercial feeds at 2% concentration. The treatments were air dried at room temperature overnight before they were given to the cultured species. Prawns were carefully weighed to determine the average body weight (ABW) of the individuals which served as the basis in determining feeding rate to be used in preparing the feeds. Feeding was done by broadcasting method thrice a day at early in the morning, noon, and late in the afternoon.

Data collection

Initial weight (g) and length (cm) of the cultured individuals were gathered prior to stocking. Sampling was done every fifteen (15) days. Data were recorded from initial measurement to every fifteen (15) days interval until the end of the duration of the study to determine the effects of those diets on the growth and survival of the cultured individuals. Water parameters such as pH level and temperature (^{0}C) were monitored daily.

The cultured individuals were harvested every after 30 days per trial for three (3) months, counted individually and measured using digital weighing scale (weight) and Vernier caliper (length). In computing the weight gain (WG), the formula used was $WG = W_2-W_1$, wherein W_1 is the initial mean weight and W_2 is the final mean weight of cultured prawns at the end of the experiment. In computing the length main (LG), the formula used was $LG = L_2-L_1$, wherein L_1 is the initial mean length and L_2 is the final mean length of cultured prawns at the end of the experiment at the end of the experiment. In getting the specific growth rate (SGR) and survival rate (SR), the following formulas were used: SGR = {(In final weight – In initial weight)/days} x 100 wherein In = natural logarithm of final and initial weight and SR = (number of survived stocks/total number of stocks) x 100. Collected data were used as the basis for the analysis and interpretation.

Statistical analysis

Data were subjected to One-Way ANOVA at α=0.05 to test if there is a significant difference among the following treatments. Post hoc Analysis was done using Tukey's HDS Test to identify the differences between independent factors once the result is significant.

Results and discussion

The weight gain (WG), length gain (LG), specific growth rate (SGR), survival rate (SR), and mean water quality parameters are presented in Table 1. Results showed that vinegar-enriched diets gained higher WG, LG, SGR, and SR compared with the control diet. WG and LG were highest in prawns fed with diets containing 2% (w/w) CSV with 5.42 g and 2.49 cm respectively and also obtained the highest SGR with 18.05 % day^{-1}. In terms of survival rate, prawns fed with diets containing 2% (w/w) CSV and 2% (w/w) ACV got the highest SR of 100 %. Causes of mortalities from other treatments are due to stress during sampling especially when individuals are in molting stage where their status are vulnerable and molting individuals are being attacked by the other individuals which caused the death of the attacked individuals. According to Saravan and Kamalam (2008), moulted species are more vulnerable to attack and consumption by hard inter-moult prawns.

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

Parameters	Experimental diets			
	T_0 Control diet (no vinegar)	T_1 2% (w/w) CSV	T_2 2% (w/w) ACV	T_3 2% (w/w) CSV+ACV
Mean weight gain (g)	3.50	5.42	3.66	4.19
Mean length gain (l)	1.50	2.49	1.46	1.88
SGR (% BW day^{-1})	11.68	18.05	12.01	13.95
Survival Rate (%)	92.22	100	100	97.78
pH Level (mean)	7.08	7.04	7.04	7.05
Temperature ^{0}C (mean)	26.65	26.62	26.67	26.58

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-enriched diets.

Source of variation	SS	DF	MS	F-value	F-critical value	Decision
Growth increment (Weight)						
Between groups	20.2685	3	6.756	3.778445	2.90112	Reject H_O
Within groups	57.2186	32	1.788			
Growth increment (Length)						
Between groups	68.2523	3	22.751	2.658175	2.90112	Accept H_O
Within groups	273.8814	32	8.559			
Specific growth rate						
Between groups	232.0534	3	77.351	3.871821	2.90112	Reject H_O
Within groups	639.2951	32	19.978			
Survival rate						
Between groups	363.89	3	121.296	7.594203	2.90112	Reject H_O
Within groups	511.11	32	15.972			

They are cannibalistic and territorial to some degree and exhibits aggressive and social behavior. In terms of water quality parameters, it was observed that water parameters such as pH level and temperature (^{0}C) were in tolerable range during the whole culture period. Thus, there were no recorded fluctuations throughout the conduct of the study.

Furthermore, there was a significant difference among the four treatments in terms of weight gain, specific growth rate, and survival rate but not significant in terms of length gain. Thus, the vinegar-enriched diets significantly affect the growth (weight), specific growth rate, and survival rate but did not significantly affect the growth in terms length (Table 2).

Results of the study demonstrated that vinegar-enriched diets substantially improved the growth of Giant Freshwater Prawns. This agreed with the results in those of Black Tiger Post-larvae shrimp *Penaeus monodon* (dela Calzada *et al.*, 2020) and Pacific White Shrimp *Penaeus vannamei* (Jamis *et al.*, 2018) in which feeding diets containing 2% (w/w) vinegars results higher weight gain and SGR. Moreover, it agreed also with the study of Jamis *et al.* (2018) wherein species fed with diets containing CSV exhibited significantly best growth performance among all the treatments. Several contributing factors held to improve the growth of shrimp fed with organic acids in way that it enhanced protein, dry matter, and/or phosphorus digestibility (da Silva *et al.*, 2013). The acetic acid content in vinegars provides the strong aroma, unique flavor and act as precursor for the formation of other volatile compounds such as aldehydes, esters, ketones, and organic acids that contribute to the organoleptic properties of vinegars (Ozturk *et al.*, 2015). In addition, it is believed that species were being attracted to diets containing CSV. According to Jamis *et al.* (2018) and dela Calzada *et al.* (2020), diets containing CSV attracted the most number of their cultured shrimps. In a volatile analysis conducted by dela Calzada *et al.* (2020) using Gas Chromatography, results showed that a number of volatile compounds were detected in CSV that were prominent. In line with, these aroma compounds

detected in the CSV could have attributed the significantly higher proportion of shrimps attracted to the diet, which contained CSV (dela Calzada *et al*., 2020).

Conclusion

In conclusion, the inclusion of different vinegars in the diet enhanced growth performance and survival rate of Giant Freshwater Prawn (*Macrobrachium rosenbergii*). Among the following treatments, diets with coconut sap vinegar resulted significantly highest growth and exhibits best survival rate along with apple cider vinegar. For better growth and survival in prawn culture, supplementation of commercial feeds with coconut sap vinegar is highly recommended.

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