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Protein diet sources on the growth and survival rate of blue swimming crab *(Portunus pelagicus)* cultured in fattening cages

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Abstract

Blue Swimming Crab (*Portunus pelagicus*) is a highly nutritious food and an important commercial species of crabs. This study aimed to determine the growth and survival rate of Blue Swimming Crab fed with different treatments. The researchers used experimental method of research to determine the growth and survival rate of blue swimming crab cultured in fattening cages. The experiment was lain out in Randomized Complete Block Design (RCBD) using four treatments namely: T_0-Commercial Feeds, T_1-Low Valued Fish (Indian Sardine), T_2-Ragworm, and T_3-50% low valued fish + 50% ragworm. Kruskal Wallis Test was used to test the significant difference among the four treatments. Results showed that among all the treatments, T_1 got the highest growth increment in terms of weight and width with 22.79 g and 16.1 cm respectively and obtained the highest specific growth rate with 75.97 % day^{-1}. In terms of length, T_3 got the highest growth increment with 13.58 cm. Moreover, all treatments got 100% survival rate. Results revealed that there was a significant difference on the growth in terms of weight, length, and width on the four treatments but not significantly different in terms of survival rate. It can be concluded that use of ragworm alone or combination of low valued fish such as Indian sardines and ragworm can be a potential feed for it exhibits best growth in culturing blue swimming crab.

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Introduction

Aquaculture has emerged as one of the fastest-growing sectors in global food production, providing substantial societal benefits as a source of livelihood, trade, and sustainable seafood. Mariculture, a specialized branch of aquaculture, focuses on cultivating marine organisms in marine environments, including open oceans and enclosed coastal areas. Among the species cultured through mariculture, the blue swimming crab (*Portunus pelagicus*) holds significant commercial value.

The blue swimming crab, a bottom-dwelling species, inhabits estuaries, coastal lagoons, and underwater grasses in both shallow brackish and deeper saline waters. It is an omnivorous species, feeding on clams, mussels, small crustaceans, fish, and detritus, making it highly adaptable to cultivation in fish cages, ponds, and reservoirs. In the Philippines, this crab is one of the most commercially vital seafood commodities. According to Germano (1994), it constitutes a crucial component of local fisheries production. Its importance is further underscored by export data; the Philippines ranked as a major source of crab meat for the USA in 2011, accounting for 23% of the supply. By 2013, it became the third leading fishery export in terms of value, contributing ₱2.89 billion. In 2016, it generated $55 million USD in revenue, with a total export volume of 4,200 metric tons (PSA, 2016). Despite this, the growing demand for blue swimming crab in both local and international markets has resulted in supply shortages, emphasizing the need for improved aquaculture practices.

One significant challenge in blue swimming crab aquaculture is the escalating cost of commercial feeds, which hinders cost-efficient production. Protein, a critical nutrient for the growth and survival of crabs, is often sourced from expensive commercial diets. To address this, researchers are investigating alternative, locally available protein sources that are cost-effective and nutritionally beneficial. Indian sardines are highly valued as aquaculture feed due to their rich protein content (up to 71%) and abundance of polyunsaturated fatty acids, including essential omega-3s like EPA and DHA, which support growth and health in aquatic species (Jamila *et al.*, 2021). Their excellent digestibility and nutritional efficiency make them an economical and sustainable option for aquaculture diets. Ragworms (*Hediste diversicolor*), on the other hand, are a valuable feed source in aquaculture due to their high nutritional content, including approximately 71% crude protein and essential fatty acids such as omega-3s like EPA and DHA. These nutrients are critical for the growth and health of marine organisms. Their high digestibility further enhances their potential as a sustainable and efficient feed option in aquaculture systems (Marques *et al.*, 2017).

This study aims to assess the growth and survival rates of blue swimming crabs cultured in fattening cages and fed with different protein diet sources. By identifying sustainable and cost-efficient feeding strategies, the research addresses the existing gap in aquaculture practices. It is anticipated that the findings will serve as the foundation for a feeding management program for blue swimming crabs, promoting improved growth and production. This research holds the potential to advance the crab aquaculture industry in the Philippines, contributing to food security and economic development while reducing reliance on expensive commercial feeds.

Materials and methods

Research design

The study employed a single-factor design implemented using the Randomized Complete Block Design (RCBD) in a crab fattening cage. There were four experimental treatments in total: T_0 - commercial feeds, T_1 – low valued fish, T_2 - ragworms, and T_3 – low valued fish (50%) + ragworm (50%). 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.

Cage preparation

The study took place at the marine environment located at Mocpoc Norte, Loon, Bohol, Philippines that is six kilometers away from the national road. The said area has an excellent water quality and is away from any disturbances and pollution ideal for culturing blue swimming crab (BSC). The experiment was carried out first by preparing the materials in making crab fattening cages such as bamboo poles, nets, and nylon. The cage was constructed in rectangular shape with a measurement of 4.5m × 6m with twelve equally divided compartments wherein every compartment has a measurement of 1.5m by 1.5m.

Research materials

Various materials were used in the experiment, including 120 healthy juvenile blue swimming crab (BSC) samples, which were sourced from the municipality of Ubay, Bohol. The samples were transported to the research area using styrofoam containers. Prawn feeds served as the control diet, while low-value fish such as Indian sardines and ragworms were used as feed for the different treatments. A basin with a diameter of 16 inches was used as a container for transferring the crabs during sampling. Bamboo, nets, and nylon were utilized for constructing the crab cages. A caliper was employed to measure the length and width of the samples, while a digital weighing scale was used to determine their weight. Water parameters, including pH, temperature, and salinity, were measured using a pH meter, thermometer, and refractometer, respectively. Additionally, recording sheets and pens were used to document the data gathered during the study.

Feeding and feed preparation

The blue swimming crab in the study was provided with commercial feeds or the control diet with a crude protein of 37% (T_0). Other experimental treatments include: T_1 – low valued fish (Indian sardines), T_2 - ragworms, and T_3 – low valued fish (50%) + ragworm (50%). Indian sardines and ragworms were cleaned first and chopped into smaller pieces prior to feeding so that these could be easily eaten by the cultured BSC. The average body weight (ABW) of the juvenile BSC was carefully measured serving as the basis for determining the feeding rate used in the feed preparation. Furthermore, feeding was conducted two times a day during early in the morning and late in the afternoon.

Data gathering

The initial weight (g) and length (cm) of the cultured juvenile BSC were gathered 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 blue swimming crabs. Daily monitoring of water parameters, including pH level, temperature (°C), and salinity level were carried out to ensure optimal conditions for the culture of BSC.

During the sampling, the cultured BSC were individually counted, and their weight, length, and width 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 BSC at the conclusion of the experiment. Similarly, the length gain (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 BSC at the end of the experiment. Also, the width gain (VG) was calculated using the formula $VG = V_2 - V_1$, where V_1 represents the initial mean width and V_2 represents the final mean width of cultured BSC at the point 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) × 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 BSC.

Statistical analysis

The collected data were analyzed using a Kruskal Wallis Test at a significance level (α) of 0.05 to determine if there were significant differences among the treatments. If the Kruskal Wallis Test 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), width gain (VG), specific growth rate (SGR), survival rate (SR), and mean water quality parameters. The results indicate that among the cultured BSC, those fed with low valued fish (T_2) exhibited the highest WG of 22.79 g, VG of 16.10 cm and SGR of 75.97 % day^{-1}. Those fed with combination of low valued fish and ragworm exhibited highest LG of 13.58 cm. However, those fed with commercial feeds (T_0) gained the lowest WG of 10.02 g, LG of 9.12 cm, and SGR of 34.54% day^{-1}. Also, those fed with combination of low valued fish and ragworm (T_3) showed the lowest WG of 7.7 cm. All of the cultured BSC successfully survived throughout the entire culture period. The water quality parameters, including pH level and temperature (⁰C), remained within acceptable ranges throughout the study, with no notable fluctuations recorded.

Table 1. Growth, survival, and mean water quality parameters of blue swimming crab (*Portunus pelagicus*) fed with different protein diet sources

Parameters	Protein diet sources			
	T_0 Commercial Feeds	T_1 Low Valued Fish	T_2 Ragworm	T_3 50% low valued fish + 50% ragworm
Rearing period (Days)	60	60	60	60
Weight gain (g)	10.02	22.79	18.67	17.22
Length gain (cm)	9.12	13.03	9.26	13.58
Width gain (cm)	10.23	16.10	12.88	7.70
SGR (% BW day^{-1})	34.54	75.97	60.24	59.07
Survival rate (%)	100	100	100	100
pH level (mean)	7.7	7.7	7.7	7.7
Temperature °C (mean)	30.4	30.4	30.4	30.4
Salinity level (mean)	30.8	30.8	30.8	30.8

Table 2. Kruskal Wallis test on the growth increment (weight, length, and width) and survival rate of blue swimming crab (*Portunus pelagicus*) fed with different protein diet sources

Treatments	Mean rank	F-value	P-value	α	Decision	Interpretation
Growth increment (Weight)						
0	1.37767	38.109	0.000	0.05	Reject Ho	Significant
1	2.27900					
2	1.77767					
3	1.82267					
Growth increment (Length)						
0	0.93667	19.871	0.000	0.05	Reject Ho	Significant
1	1.25333					
2	0.92667					
3	1.28667					
Growth increment (Width)						
0	1.02667	92.991	0.000	0.05	Reject Ho	Significant
1	1.64000					
2	0.89667					
3	0.77333					
Survival rate						
0	-	-	0.000	0.05	Accept Ho	Not-significant
1						
2						
3						

In addition, there was a significant among difference among the four treatments in terms of weight, length, width, and specific growth rate. However, there was no significant difference observed in terms of survival rate. These findings indicate that the following treatments significantly affect the growth of BSC in terms of weight, length, width, as well as the specific growth rate. However, the treatments did not have significantly affected the survival rate of the cultured BSC. This information is summarized in Table 2.

The study showed that feeding blue swimming crabs with low-value fish (Indian sardines) and ragworms significantly enhanced their growth. These findings are consistent with Manjappa *et al.* (2002), who reported that common carp fed low-value fish like Indian sardines achieved higher specific growth rates compared to other treatments. Additionally, Indian sardine meal was found to fully replace a 100% protein diet for common carp. Jamila *et al.* (2021) noted that Indian sardines are highly valued as aquaculture feed due to their rich protein content (up to 71%) and abundance of polyunsaturated fatty acids, including essential omega-3s like EPA and DHA, which support growth and health in aquatic species. Likewise, Marques *et al.* (2017) highlighted that ragworms are an excellent aquaculture feed due to their high protein content (about 71%) and essential fatty acids, such as omega-3s like EPA and DHA, which are vital for marine organism health and growth. Their high digestibility also makes them a sustainable feed option. These attributes likely explain why blue swimming crabs fed with low-value fish and a combination of low-value fish and ragworms showed the highest growth and specific growth rates.

Conclusion

In conclusion, the study demonstrates that feeding treatments significantly influence the growth of blue swimming crabs (*Portunus pelagicus*) in terms of weight, length, width, and specific growth rate, with low valued fish (Indian sardines) yielding the best results in the growth of BSC in terms of weight, width, and survival rate and a combination of low valued fish and ragworm in terms of length. However, survival rates remained unaffected by the treatments, and all crabs successfully survived throughout the culture period. These findings highlight the potential of using low valued fish and a combination of both low valued fish and ragworm as an effective and sustainable feed option for blue swimming crab aquaculture.

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