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Evaluating different diets on the growth performance of mud crab *(Scylla serrata)*

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ABSTRACT

The purpose of this study was to assess the potential of natural feeds for the sustainable grow-out aquaculture of mud crabs as an alternative to commercially available mud crab feeds. This study employed a completely randomized design that includes five feed treatments including trash fish, African land snail, horn snail, edible frog, and mud snail. There were three replicates for each treatment with three cages each located in a concrete tank with an area of 12m^2. Each cage contained one lean crab. The crabs were fed twice a day, at 7 a.m. and 8 p.m. with an amount adjusted to 7% of the crab's body weight. After the first 21 days, all the crabs were harvested by draining out the tank water and the pincers of the crab were tied with a string to enable handling. The results showed that the highest growth performance in weight gain and condition factor was seen in African land snail feed with a feed conversion ratio of 1.38, indicating a high-quality feed. It also showed an impressive ROI of 96.8% which can be confirmed that this kind of feed might be a viable mud crab feed for both commercial scale and industry.

1. INTRODUCTION

In the Philippines, mud crab fattening is a relatively new practice. In both the domestic and foreign markets, and primarily to meet the short-term demand from culturing crab, research in crab farming and fattening methods is severely lacking. Attempts to develop diets for the culture of mud crabs have resulted in developing a variety of feeds. The absence of suitable feeds, either pellets or live feed that are both economical and natural feasible feeds, promoting growth, is considered an essential aspect in the cultivation of mud crabs.

The majority of mud crab producers in Southeast Asia currently feed their crabs with waste fish, bivalve meats, or animal byproducts. This traditional feeding method is currently seen as unsustainable, and the formulation of low-cost grow-out diets is regarded as a top priority in mud crab aquaculture (Christensen et al., 2004; Edward et al., 2004; Fielder, 2004; Tuan et al., 2006; Richardson et al., 2010; William & Abdullah, 1999). Consideration of each feed item for inclusion in aquafeeds requires data on the target species' ability to digest and absorb it. Several recent investigations have revealed that the mud crab species *Scylla serrata* has a substantial potential to utilize feed ingredients derived from a variety of terrestrial animal and plant sources. For example, Tuan et al. (2006) reported that the digestibility values for soybean meal in diets formulated for *S. serrata*, which were not significantly different from those obtained using fishmeal.

Most Southeast Asian farms have used trash fish, clam meat, or animal by-products as feeds (Baliao & de los Santos, 1998; Dau, 1998; Marichamy and

Rajapckkiam, 1998; William and FitzGerald, 2002), which are not readily available for use in east Africa. Millamena and Quinitio (2000) showed that S. serrata broodstock fed with mussel meat, squid, and trash fish produced better broodstock survival than a mixed diet or a formulated diet. The majority of mud crab producers in Southeast Asia currently feed their crabs with waste fish, bivalve meats, or animal byproducts. This traditional feeding practice cannot sustain its demand, and the Australian Centre for International Agricultural Research (ACIAR) views the development of low-cost, formulated diets for growing out as a priority research issue (Richardson et al., 2010). Most of the studies dealt with the effect of the feeds on the mud crab, which had a similar bearing on the scientific investigation. Its difference was also on the application of the different feeds. This study investigates the most effective feeds to increase the weight of a mud crab using the African land snail, horn snail, edible frog, and mud snail, which so far have not been studied as feed for mud crabs.

The main backdrop to this study is low survival rate of cultured crabs because of the shortage of seed supply and feeds. Consequently, the research attempted to assess the potential for sustainable grow-out aquaculture of mud crabs by assessing the growth rate of mud crabs under a drive-in cage culture system and comparing the growth rate of mud crabs using locally accessible and inexpensive organic feedstuff. This study focuses on a direct evaluation of growth performance, specifically the efforts of one of these farmers, in addition to offering information on other easy-to-apply techniques utilized in the Philippines to fatten mud crabs.

2. MATERIALS AND METHODS

2.1. Research design

This study was to understand the effect of the different feed and experiments were the only way to obtain convincing evidence for causation. This study used experimental research in a completely randomized design (CRD). It incorporated the simplest form of control, namely comparing the effects of the different treatments given to the mud crabs.

Using the CRD, the mud crabs were divided into five groups subjected to five treatments with three replications for each treatment. There were three cages with one crablet placed into every cage in every replication, making a total of forty-five mud crab cages.

2.2. Cage preparation and setting in the tank

The preparation of the cage and the setting of the tank was done in the institution's hatchery. As per the experimental design, 6 pairs of PVC pipes of 5.50 m length were prepared for the five treatments in a concrete tank with an area of 12 m^2. Forty-five mud crab cages of 21.5 cm (L) x 16 cm (W) x 16 cm (H) each were tied to these pipes with nine cages for each treatment using a straw with a distance of 0.28 m for each replication. The depth of the water was about 80–100 cm. Each cage was provided with a lid to prevent the crabs escaping. The cage was designed to have twelve holes at the top of the cage and small holes at the sides to enable the free movement of water and air through the cages, but no gap was provided at the bottom to enable easy movement of the crabs. In addition, each experimental unit was provided with a fishing net inside to prevent the stock's escape through the holes provided for in the cage.

2.3. Stocking

The initial weights of the crabs ranged from 53 grams to 75 grams. One crablet was individually placed into every mud crab cage. In total there were 45 crablets under study. Each replication has three cages totaling nine cages for every treatment. Each cage has a stocking density of one lean crab.

2.4. Experimental feed preparation

The crabs were fed twice a day, at 7 a.m. and 8 p.m. at 7% of the stocked crab's body weight. The mean initial weight of the mud crabs was 73.3 grams; mean initial weight for T1 was 74.6 grams, 87.4 grams for T2, 84.2 grams for T3, 67.1 grams for T4, and 53.2 grams for T5. For the Treatment 1 (Control), the crabs were fed with trash fish, *Sardinella longiceps;* for Treatment 2 with African snail, *Achatina fulica;* Treatment 3 with horn snail, *Telescopium telescompium*, Treatment 4 with edible frog, *Rana catesbieana;* and Treatment 5 with mud snail, *Batellaria attramentaria.*

The periodic checking was carried out every seven days. In addition, there was a removal of drifting seaweeds and other debris to facilitate easy water circulation and prevent damage to the cages. Water was changed with tidal water every 15 days throughout the experimental period. The tank water level was kept within the range of 80–100 cm throughout the duration of the experiment.

2.5. Sampling for weight measurement

After the initial weighing, the mud crabs were placed individually in forty-five (45) cages. The following were recorded at each weighing interval, the days of culture, body length, body weight, the crab's weight after each feeding time, and the amount of feed consumed. The feeding time was uniform, that is every 7 a.m. and every 8:00 p.m. There was feeding in the evening since mud crabs are nocturnal animals. The weighing was also done every seven days. The data obtained were tabulated, interpreted, and analyzed to find the absolute growth, absolute growth rate, biomass, total feed consumed, days of culture, condition factor, food conversion ratio, and return of investment for every treatment.

The growth performance was measured by the following indicators; such as Absolute Growth (AG), Absolute Growth Rate (AGR), and Condition Factor (K). While, feed conversion ratio (FCR) or feed conversion rate is a measure of an animal's efficiency in converting feed mass into increases of the fish's mass. Specifically, FCR is the biomass divided by the total feed consumed. Biomass is the product of the total body weight multiplied by the total feed consumed. In some sectors, feed efficiency, which is the output divided by the input (the inverse of FCR). Moreover, the condition factor (K) is used to compare the condition or well-being of any species and is based on the hypothesis that the higher weight at a given length is in better condition. The higher the K, the healthier is the mud crab.

2.6. Harvesting

After the fattening period of 21 days, all the crabs were harvested by draining the pond water and individually caught by hand in the cages. The pincers of the crab were bound with straw or string to enable easy handling.

2.7. Data analysis

The statistical measures applied were the means for each treatment for all the measured variables and the one-way Analysis of Variance (ANOVA) was used to determine the significance of the five treatments.

3. RESULTS

There was a measurement on the growth performance through the following indicators; such as Absolute Growth (AG), Absolute Growth Rate (AGR), and Condition Factor (K). In addition, Table 1 presents the growth increment of mud crab fed with the different diets.

The mean initial weight of the mud crabs was 73.3 grams and resulted to a mean final length of 5.3 cm and mean final weight of 78.36 grams. The mean absolute growth was 4.92 with a mean absolute growth rate of 0.234. The mean condition factor was 0.514. Lastly, all treatments had a 100% survival.

Results showed that the highest average growth increment was found in Treatment 2 (African Land Snail). The findings also show that Treatment 2 had the highest condition factor with a value of 0.55, while the lowest condition factor was seen in Treatment 5.

Table 1. Growth Increments of Mud Crabs Fed with Different Diets

Treatment	Mean Initial Weight (gm)	Mean Final Length (cm)	Mean Final Weight (gm)	AG	AGR	Survival (%)	K
Trash Fish (Control)	74.6	5.3	78.7	4.1	0.19	100	0.51
African snail	87.4	5.6	96.4	8.3	0.40	100	0.55
Horn snail	84.2	5.6	88.1	3.9	0.19	100	0.52
Edible frog	67.1	5.2	73.0	5.9	0.28	100	0.50
Mud snail	53.2	4.8	55.6	2.4	0.11	100	0.49
Means	73.3	5.3	78.36	4.92	0.234	100	0.514

The findings show that the five treatments were significantly different in terms of absolute growth and absolute growth rate at a 0.01 level of significance with values 12.046 and 12.263, respectively. This implies that the five treatments exhibit a different effect on the absolute growth and absolute growth rate of mud crab. However, the treatments did not differ significantly in terms of its condition factor meaning, the condition factor were comparable among treatments.

Implemented in this study was the post hoc analysis on absolute growth using the Duncan's test. Results show that Treatment 2 was significantly different from the rest of the Treatments, while Treatment 1 (Trash fish) is not significantly different from Treatments 3 and 5; however, Treatment 5 was significantly lower than Treatment 3. According to

the findings of other research, the crude protein content of *Achatina fulica* is on average 19.27%±0.29% (Fagbuaro et al., 2006) and 17.29g/100g of fresh meat (Babalola and Akinsoyuni, 2009), which could have provided the appropriate amount of nutrients needed for the experimental animals' growth.

Among the treatments, the highest average absolute growth rate was found in Treatment 2 (African land snail) at 0.40g/day, while the lowest was seen in Treatment 5 (mud snail) at 0.11/day. The statistical analysis results showed that Treatment 2 was significantly different from all other Treatments. As Treatment 2 had the higher absolute growth and the growth rate per day values.

The feed conversion ratio (FCR) is a measure of an animal's efficiency in converting feed mass into increases in the crab mass. Specifically, the calculation of FCR is by obtaining the total weight of feed given divided by the weight gain (final weight minus starting weight) to obtain the feed conversion (USAID-Harvest, 2011). In comparison, the calculation of the biomass was to determine weight gain.

Results show that there was a significant difference among the five treatments at 0.01 level of significance in regards to the feed conversion ratio with p-value<0.000. The calculated Duncan test findings highlight is that Treatments 2, 3, and 5 differ from the other treatments, while Treatments 1 and 4 do not differ in terms of feed conversion ratio.

Table 2, shows that the highest return of investment (ROI) was established in Treatment 2 (96.8%), and the lowest return was seen in Treatment 5 (12.9%). Therefore, it implies that it is more profitable to feed mud crab with African snails.

Table 2. Simple Cost Analysis of the Different Treatments in Growing Mud crab in Cages

Treatment	Production Cost (P)	Biomass of mud crab (kg)	Gross Sale (Php)	Net income (Php)	ROI (%)
1	332.10	2.1	525.0	192.9	58.1
2	317.04	2.5	623.9	306.86	96.8
3	330.50	2.4	600	269.50	81.5
4	330.53	1.9	475	144.47	43.7
5	332.17	1.5	375	42.83	12.9
Sum	1,642.3		2,598.9	956.6	293

Assumptions:

1.Input

-Price of crablet @ P10.72 each

-Feeds @ average price of P15.00/k

-Growing unit @ P36.00/crop

-Concrete tank rental @ 33.00/crop

-Labor cost @ P87.50/crop

- Electric power @ P3.50/crop

2. Output

-Farm gate price of mud crab P 250.00/kl

As reflected in Table 2, gross income was highest in Treatment 2 than the rest of the Treatments. This is because the ideal market size of mud crab for local demand was smaller than mud crab shipped to Manila for export purposes.

The return of investment is an indicator to identify the feasibility and viability of the investment. Therefore, the investment with an ROI higher than the inflation rate is an indicator of feasibility.

4. DISCUSSION

Although Treatments 1 and 4, were fed with trash fish and edible frog meat, which have a protein content of 18.7% and 20%, respectively (Baygar and Ozgur, 2010), both showed significantly lower growth. The reason most likely was the food preference of mud crab, since they prefer gastropod meat. According to the results of the study by Mireral and Mtile (2009), the absolute growth rate of mud crab was higher when fed with gastropod

meat at 1.29g/day. compared to fish offal at 0.97g/day. Hence, the finding of this study are consistent with the study of Mireral and Mtile (2009).

However, the growth rates of all experimental animals across all Treatments were lower compared to the reported findings of Mirera and Mtile (2009). The experimental animals' slow growth rate can be attributed to culture, the initial weight of the crablets, and the culture medium. This study believed that experimental animals had adjusted themselves to their growing medium being an artificial body of water (polyethylene cages in Tank system). Likewise, the length of culture was only 21 days, with an initial weight of less than 100 g among the experimental animals.

However, the condition factor of all Treatments falls within a reasonable range for mud crab. According to Das Mohapatra et al. (2009), the mean condition factor of *S. serrata* ranges from 0.031-0.071 for males and 0.039 to 0.62 for females. Therefore, the computed condition factor of the mud crab in this study falls within the acceptable level as reported.

The findings show that the low feed conversion ratio in Treatment 2 (African snail) of 1.38, which implies that the feed is of high quality, and the highest feed conversion ratio was in Treatment 5 (Mud snail) with 2.57 meaning is a lower-quality feed.

In this study, all Treatments' ROI values were much higher than the Philippines' present inflation rate per a report from the *Trading Economics on Philippines Inflation Rate* of 2.5%. Therefore, it can be deduced from its ROI values (Table 2) that all Treatments using a different type of feedstuff is a viable investment. However, it appeared that Treatment 1 produced the greatest return considering that African land snail commands a low market price, considered pest among rice farmers. Furthermore, African land snail as feed for mud crab may render maximum utilization of this resource from rice paddies instead of just treating them as pests or nuisance by the farmers.

5. CONCLUSION

Based on the study's findings, we conclude that the highest growth performance in weight gain and condition factor was in Treatment 2 – using African snail as feed. Further, African snail (*Achatina fulica)* feed for mud crab exhibited the highest feed efficiency with an FCR of 1.38 and highest ROI of 96.8%, making it comfortable to conclude that African snail may offer a viable and feasible option as mud crab feed for industry success.

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