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Growth and protein content of mud crabs *(Scylla serrata)* fed with different natural feeds

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Abstract

Mud crab (*Scylla serrata)* farming is one of the main sources of livelihood in Calauag, Quezon. Commonly, they use trash fish as their major source of feeds for mud crabs. However, fluctuation on its prices happen because of supply and demand, thus the use of other natural feeds were conceptualized. This aimed to determine if there are significant differences on the weight, protein content and meat characteristics of mud crabs fed with different natural feeds. It also aimed to assess the profitability of mud crab farming in plastic cages using different natural feeds. The experiment was laid out in Complete Randomized Design with three treatments replicated thrice: T1 - trash fish, T2 - horn snail meat and T3 - yellow corn. Results revealed that mud crabs fed with horn snail had the highest weight and protein content as compared to the other treatments. Hence, had the highest ROI. While, in the sensory analysis of its meat characteristics, mud crabs fed with yellow corn had the highest mean which was rated as very much juicy, flavorful and very much acceptable.

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Introduction

Mud crab aquaculture has been practiced for many years in Southeast Asia, including the Philippines. It is based predominantly on capture and fattening of juvenile crabs from the wild. However, nowadays, mud crab farmers resort to culture of crablets also to be sold to other farmers. It is available in brackish coastal waters and estuaries and has a great potential for aquaculture. Crab culture and fattening are nevertheless, still in the trial stage in South Asia (Samarasinghe *et al*., 1992). However, some parts of the Philippines are into mud crab farming since they have experienced it to be profitable. Its prominence as an export commodity has also unlocked great opportunities for crab farming. The mud crab remains species with good potential for aquaculture due to its fast growth and good market acceptability and price. There have been rise in demand for the live mud crabs than the supply in the world market. Because of their delicacy and larger size, the live mud crabs are always in greater demand and fetch a higher price (Kathirvel, 1993). The high price of mud crabs provides a strong incentive for mud crabs fishing as it can be among the major source of income for the coastal people and contributes to the national income.

Mud crabs or 'alimango' in Filipino is considered one of the most important foods from the sea. Commonly, mud crab is fed with trash fish - marine fish having little or no market value as human food but used sometimes in the production of fish meal. Another type of feed is the telescope snail meat which is locally known as bagongon. Yellow corn, on the other hand, is sometimes used as feed which has the greater contribution in the growth and survival of different fishery products (Rabia, 2015). Since mud crabs in the locality uses only trash feeds as source of feeds and because of its fluctuating price in the market, the idea of using other natural feeds was conceptualized. Thus, this study aimed to determine the effects of different natural feeds on the weight, protein content and meat characteristics of mud crabs. Profitability using those natural feeds were also assessed.

This study would greatly benefit mud crab farmers since they will have now an option on what to give to the crabs to increase growth and eventually profit or to make their crabs more palatable and meaty. Moreover, consumers can be assured that the mud crabs are free from synthetic chemicals. The scope of the study was only limited to one growing period. The study was conducted from June 2019 to September 2019 at Calauag, Quezon.

Materials and methods

Species of Mud Crabs Used in the Study

Mud crabs used in the study was *Scylla serrata*. The identification was based on the description given by Department of Fisheries (2013), the mud crab species *S. serrata* can grow up to 300 millimetres in shell width and 2.5 kilograms. Its elbow has more than one prominent sharp spine. Its claws is dark green with purple color and claw spines are large and distinct. It has also long narrow lobes between the eyes.

Location of the Study

The study was conducted in Brgy, Biyan,Calauag ,Quezon. The fishpond was 2000 m^2 with brackish water, which is best suited for mud crab farming as they are highly tolerant to varying salinity conditions. The water depth of the pond is about 5 feet (1.5 meters). Water exchange in the pond is carried through tidal water and sluice gates were used for the purpose. The gates can regulate the inflow and outflow of the tidal water.

Source of Mud Crabs

Crablets were obtained from Yngente Fish Farm in Calauag, Quezon. The crablets were approximately 50 g each and about a month old. The gender is still unidentifiable when it was put in the pond.

Collection of Mud Crab Feeds

Trash fish and yellow corn were purchased from the market. While telescope snails were collected from fishpond and in the river near the area. It was pounded to extract the meat.

Treatments and Layout of the Experiment

The study was composed of 3 treatments with 10 mudcrabs on each cages. The treatments were the following: T1- Trash fish; T2-Telescope Snail meat

and; T3- Yellow corn. The cages were laid out in Randomized Complete Block Design (RCBD) replicated 3 times.

Water Quality

Water quality was tested everyday. Salinity and temperature were determined using EC meter (E3 Portable TDS and EC Meter) and pH was determined using pH meter (UOTO Water Quality Tester). The average salinity was 20 ppt, the average temperature was 27°C and the average pH was 8.0. The optimum salinity for mud crab farming is 15-25 ppt and the water temperature should be kept below 32°C to avoid water quality problems and above 20°C as growth is greatly reduced at temperatures below this level (https://www.business.qld.gov.au /industries /mud-crab/growing). Water pH should be 8.0 to 8.5 (www.fisheriesjournal.com).

Stocking and Feeding of Mud Crabs in Cages

Three plastic cages measuring 252x252x162 cm^2 were used in the study. Each plastic cage has 30 compartments which accommodated one crab. One crab was put in each of the plastic cages. Trash fish, horn snail meat and yellow corn were given to the crab twice or thrice a day at a rate of 5-8 percent of body weight for the entire duration of the study. It is given twice a day if it is low tide and thrice a day if it is high tide. The difference in tides is due to the phases of the moon.

Pond Management

In the pond, water is replaced twice a day during high tide and during low tide. When it is low tide, the water is removed from the pond and when it is high tide, the water is allowed to go into the pond and enclosed by the sluice gates.

Crab Harvesting

Harvesting was done early in the morning, on its 3rd month after putting in the crab pond. It was weighed and claws were tied with a plastic straw to avoid damage to the handler.

Sensory Evaluation of Mud Crab Meat Characteristics

For the sensory evaluation of its meat characteristics, mudcrabs meat were removed from its body and steamed. Then it was presented to the 30-member taste panel for the evaluation of its meat characteristics. For every sample they taste, they drink water, eat crackers and drink water again to remove the taste of the previous sample.

Data Gathered

Mud crab weight

The weight (g) of the mud crab was gathered every 2nd week using digital weighing scale.

Mortality

Number of dead mud crabs were counted

Meat Characteristics

Sensory evaluation of the mud crab's meat was determined by a 30-member taste panel. They were instructed to rate the taste on a 1-9 scale based on Hedonic scale developed by Peryams and Pilgrims (1957). The sensory attributes included juiciness, taste and general acceptability.

Crude protein (%)

It was analyzed at SGS (Standard Global Services) company in Makati City using Kjeldahl method. The researchers used rating and free tasting technique as an instrument in evaluating the acceptability of the mud crab meat. Rating included blanks provided for respondent's profile including name, age, gender and name of organizations. The next part includes the sensory attributes of the mud crab meat such as juiciness, taste and general acceptability. The respondents answers based on their perception were tallied.

Statistical Analysis

Analysis of variance (ANOVA) was used in analyzing if there were significant differences on the weight and organoleptic properties of mud crabs fed with different natural feeds. Further test used was Scheffes to test the significance between means. For the sensory analysis of the meat of mud crabs, the data gathered were interpreted using mean and ANOVA. Statistical Analysis for Agricultural Research (STAR) was the software used in the study.

Results and discussion

Growth of Mud Crabs Fed with Different Natural Feeds

Mudcrabs which are fattened are feed twice or thrice a day depending on its body weight. A crab fattening cycle typically takes from 14 to 60 days (if they started at 500g), during which time their protein content can increase from 8 to 15 percent (Shelley and Lovatelli, 2011). However, young crabs can also be grown for a period of 5 to 6 months till they attain desirable size (www.vikaspedia.in). As shown in Table 1, mud crabs fed with horn snail meat had the highest weight and significantly different from those fed with trash fish and yellow corn. During the initial and final week of weighing the mud crabs, the weight pattern remained still, and those fed with Telescope snail meat had the highest weight (Fig. 2).

Table 1. Mean Weight of Mud Crab Fed with Different Natural Feeds.

Treatment	2 week (g)	4 week (g)	6 week (g)	8 week (g)	10 week (g)	12 week (g)
Trash Fish	47.87 b	103.74 b	150.35 b	166.60 b	201.94 b	233.62 b
Telescope Snail Meat	72.00 a	132.05 a	174.68 a	207.04 a	248.02 a	278.05 a
Yellow Corn	50.05 b	89.14 b	145.05 b	170.94 b	184.15 b	219.94 b
CV (%)	7.82	12.53	4.79	9.09	9.07	8.07

**Mean with the same letter are not significantly different at 0.05 level of significance*

Fig. 1. Feeds Given to Mud Crab A) Trash Fishes B) Telescope Snail Meat and C) Yellow Corn.

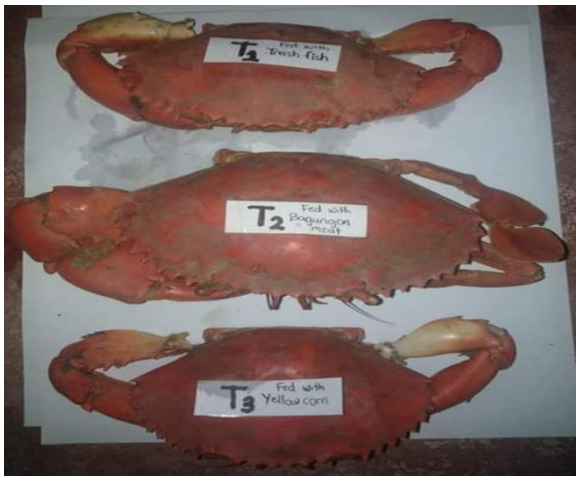

Fig. 2. Mud crabs fed with A) trash fish B) telescope snail meat C) yellow corn.

Telescope snail meat are rich in protein. It contains 52-63% protein (DM), ash varies from 11 and 27% DM, 3-4% calcium, 0.4-1.2% phosphorus, carbohydrate is 15.3% and fat content is generally less than 5% (Tran, 2016). Trash fish on the other hand contains 10.4 to 20.22% protein, ash is 0.7 to 3.3%, carbohydrates range from 0.00 to 0.34% and fats range from 0.3 to 4.2% (Azmat, 2008). Yellow corn contains 8.30% protein, ash is 1.20%, carbohydrate content is 70.80% and fat content is 4.20%. (http://www.fao.org/3/w6928e/w6928e1l.htm).

Horn snail has higher protein content than trash fish and yellow corn, thus might be the reason for the higher weight of crab fed with telescope snail meat. As reported by Unnikrishnan & Paulrajs (2010), dietary protein levels suggested that 46.9^47.03% dietary protein is required for the best growth response and protein deposition in *S. serrata*. Moreover, its abundance makes it a readily available feed source (Alber, 2003).

The study is similar with the study of Rabia (2015), where those mud crabs fed with golden apple snail had higher weight gain than those fed with trash fish. Furthermore, in a study of Alber (2003) on mud crabs fed with telescope snail and fish meal, those fed with snail meat had higher weight gain compared to those fed with fish meal alone or combination of fish meal and telescope snail. Furthermore, Severo *et al.* (2016) reported that apple snail (*Pomacea canaliculata*) is a potential feed source for mud crabs or it could be administered in combination with by-catch fish. Similarly, Muchlisin Z.A. and Azizah (2013) reported that both the golden snail and chicken intestine are possible alternative feeds for mud crab culture as they showed no significant differences compared to the conventional trash fish feed. However, in study done by Das *et al.* (2019), those mud crabs fed with chicken intestine had higher growth rate as compared to those fed with trash fish and golden apple snail.

Mortality of Mud Crab

There are several factors affecting the survival in crab culture such as cannibalism, molting, salinity and temperature fluctuations, feed, shelter and stocking density (Ruscoe *et al.,* 2004; Holme *et al.,* 2007; Mann *et al.,* 2007; Rodriguez *et al.,* 2007; Mirera 2009; Quinitio & Estepa 2011). Most of the time the mortality could be attributed to environmental conditions. As shown in Table 2, highest mortality was recorded in those fed with trash fish as compared to those fed with horn snail meat and yellow corn. According to Unnikrishnan and Paulraj (2010), the higher the protein content of the feeds, the lower the mortality rate which can be seen on the mortality exhibited by mud crabs fed with telescope snail meat.

Table 2. Mortality (%) of Mud Crab Fed with Different Natural Feeds.

Treatment	Mortality (%)
Trash Fish	16.00 a
Horn Snail Meat	3.33 b
Yellow Corn	6.67 c
CV (%)	7.82

*Mean with the same letter are not significantly different at 0.05 level of significance

The findings of the study coincides with the study of Unnikrishnan and Paulraj (2010) where the crabs fed with 15% and 20% dietary protein levels showed 100% and 12.5% of mortalities respectively. The mortalities observed in the above treatments were associated with the prolonged intermoult duration (46 and 32 days respectively). All other treatments recorded 100% survival. The best growth performance as well as the nutrient turn-over was recorded in crabs fed with 45% crude protein in the diet. Second-order polynomial regression of specific growth rate (SGR) as well as body protein gain vs. dietary protein levels suggested that 46.9–47.03% dietary protein is required for the best growth response and protein deposition in juvenile *S. serrata.*

Protein Content of Mud Crabs

Crab is said to be a complete source of protein, which supplies each of the 20 amino acids the body needs to make new proteins. https://healthyeating.sfgate.com /crab-meat-healthy-3614.html. It is also extremely low in fat and carbohydrates. In general, a 3-oz cooked serving has around 80 calories, 20gms of protein, 1gm of fat, and less than 1gm of carbohydrate (www.sharecare.com). As shown in Table 3, mud crab fed with telescope snail meat had the highest crude protein content (18%), followed by yellow corn (16.76%) and trash fish (16.44%). The high amount of protein present in those mud crabs fed with telescope snail could be attributed to the high protein content of snails (52-63%).

Table 3. Protein Content of Mud Crabs Fed with Different Natural Feeds.

Treatment	Crude Protein
Fed with Trash Fish	16.44%
Fed with Horn Snail	18.00%
Fed with Yellow Corn	16.76%

As reported by Sreelakshmi *et al.* (2016), the protein content of mud crab meat range from 12.22% to 16.42%. While, in a study done by Severo *et al.* (2016), crude protein of mud crabs fed with apple snail meat had 15.40% and those fed with trash fish had a protein content of 19%. Moreover, Ali *et al.* (2011) reported a protein content of 12.10 to 13.64%

on mud crab meat which were fed with a combination of fish meal, squid meal, shrimp meal, mantis shrimp meal, soyabean meal, bread flour and other additives which contains 41.6% crude protein.

Sensory Evaluation of Mud Crab's Meat Characteristics

Mud crabs are praise for their impressive size and delicious taste. It has been reported by Pitogo and Dela Peña (2004) that the meat characteristics of the crab are usually affected by parasite that causes sterility and alteration of taste. Tang *et al.* (2020) also reported that temperature is one of the factors affecting the taste of mud crabs.

No significant differences were reported in terms of mud crab's sensory attributes such as juiciness, taste and overall acceptability (Table 4). However, those fed with yellow corn were the juiciest, most flavorful and very much acceptable to the respondents. According to Nozowitz (2013), if some component of feed, like corn, makes up the majority of an animal's diet throughout its life, that will definitely flavor the meat. Yellow corn given to the crabs were sweet, offering flavors of almond and sugar and the kernels were succulent. Thus, it could be the reason for the juiciness and flavorful taste of the meat.

Table 4. Sensory Attributes of Mud Crab Meat as Perceived by the Respondents.

Treatment	Juiciness	Taste	Overall Acceptability
Trash fish	7.38 (VMJ)	7.03 (VMF)	7.31 (VMA)
Telescope Snail Meat	7.26 (VMJ)	6.87 (VMF)	7.05 (VMA)
Yellow corn	7.47 (VMJ)	7.88 (VMF)	7.68 (VMA)
CV (%)	2.73	31	4.72

Legend: VMJ – Very Much Juicy; VMF – Very Much Flavorful; VMA – Very Much Acceptable

A similar study was done by Lampe *et al.* (2004) where meat of those animals fed with yellow corn and with higher ratio in mixed feed were most flavorful as compared to those without yellow corn in the diet. In addition, Mandell *et al.* (2013) reported a corn-fed meat had significantly more intense flavor and higher flavor desirability than forage-finished meat. However, in a study done by Muir *et al.* (1998) comparing the meat characteristics of those fed with different grains and forages, results showed that the type of feeding system had no effect per se on tenderness, juiciness, lean meat colour, marbling, and flavor.

Profitability

Mud crab farming is a very lucrative business with a 1.54 M return on investment in only 60 days (Rabia, 2016). There has been a huge interest in the aquaculture of this species due to its high demand and price, high flesh content and rapid growth rates in captivity. For a three month period in cages, Table 5 shows the cost and return analysis in the production of mud crab for each treatment. The data presented is the average yield for the 10 crablets on each replicate for each treatment. Since, those crabs fed with telescope snail meat had the highest weight, it also gained the highest profit and return on investment.

Table 5. Profitability of Mud crab Farming Fed with Different Natural Feeds.

Cost of Materials	Treatment		
	Trash Fish	Telescope Snail Meat	Yellow corn
Plastic cages	100.00	100.00	100.00
Synthetic rope	115.00	115.00	115.00
Crablets	300.00	300.00	300.00
Feeds	625.00	750.00	500.00
Transportation	100.00	100.00	100.00
Total expense	1,240.00	1,365.00	1,115.00
Total harvest(kg)	3.00	4.00	2.40
Income(Php 500/kg)	1,500.00	2,000.00	1,200.00
Profit	260.00	635.00	85.00
ROI(%)	20%	46.52%	7.62%

Conclusions

Mud crab fed with telescope snail meat had the highest protein content and weight, thus higher profit. While, those fed with trash fish had the highest mortality as compared with other treatments. In terms of its sensory attributes, those fed with yellow corn had the highest rating in terms of juiciness, taste and overall acceptability.

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