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Study on culture of sea bass (*Latescalcarifer*, Bloch 1790) inhapa-in-pond environment

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Study on culture of sea bass (*Latescalcarifer*, Bloch 1790) inhapa-in-pond environment

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Abstract. The study on culture of sea bass (*Lates calcarifer*, Bloch 1790) was carried out to evaluate the potential of culturing sea bass in hapa-in-pond environment. The study made used of Completely Randomized Design (CRD) with four treatments at three replicates each randomly distributed using 12 units of 2.0m x 1.0m x 1.2m net cages. Results indicated that different stocking densities did not significantly affect the weight gain and survival over the ninety days culture period. Analysis of covariance (ANCOVA) for weight gain and feed given as covariate were determined. Results showed that growth of sea bass with respect to the feed given greatly affects its growth and survival rate. From the technical perspective, results showed that at lower stocking densities, higher weight gain can be realized, lower feed competition expected and more manageable to culture not to mention that it is also a high value species. Similar studies should be done at an on-farm level to assess the economics of sea bass farming on a commercial scale. It is also recommended that alternative source of feeds for the species and the practice of grading of the stocks to prevent cannibalism be explored.

1. Introduction

Sea bass is an economically important food fish in the tropical and sub-tropical regions of Asia and the Pacific. It is a highly carnivorous fish but can be trained to feed on formulated diets. It can tolerate a wide range of salinity from freshwater to full seawater. *Lates calcarifer*, known as sea bass in Asia and barramundi in Australia, is a large, euryhaline member of the family Centropomidae that is widely distributed in the Indo-West Pacific region from the Arabian Gulf to China, Taiwan Province of China, Papua New Guinea and northern Australia. Sea bass aquaculture commenced in the 1970s in Thailand, and rapidly spread throughout much of Southeast Asia. Among the various species of finfishes Asian sea bass, *Lates calcarifer* is considered as one of the most potential candidate species suitable for culture in marine ecosystems, freshwater and brackish water pond and cages [1- 3]. The global sea bass (*Lates calcarifer* Bloch, 1790) production from year 2009 to 2013 showed varied result in terms of tonnes. From 2009, sea bass production resulted to 49,172 tonnes. In year 2010, there were 67,094 tonnes of sea bass produced and in year 2011, a total of 68,949 tonnes of sea bass. For the year 2012, it showed a total of 77,538 tonnes, an increase of 2.80% compared to 75,370 tonnes in year 2013 [4]. Moreover, sea bass possesses fast growth rate, amenable for artificial feed or trash fish, and can be bred in captivity, makes it a candidate species for aquaculture [5]. This species is generally cultured in sea cages located in river mouths or estuaries [6].

With the above mentioned statistics and realities on the culture of sea bass, this study was designed to evaluate the potential culturing of sea bass in hapa-in-pond environment. At present, the culture of sea bass is not popular in the Philippines particularly in Bicol Region. Although it can be grown side by side with grouper and snapper in floating cages in other areas, fish growers rarely grow sea bass for market. This sea bass commands price in the local market, either fresh or frozen, and approximately ranges to a price market of 5.12 USD per kilogram. For the live fish, it commands a higher price of 15.17 USD to 18.96 USD per kilogram. Sea bass market showed that being a high value fish, sea bass consumption is limited to specialized restaurants and occasionally, the domestic users [7]. Cultured marine fish, especially sea bass, are sold in the local markets (in the provinces and in Bangkok). The product is also exported to neighbouring countries such as Malaysia, Singapore, Hongkong and Australia. The sea bass (*Lates calcarifer)* (bulgan, apahap in the Philippines) are high value fish occupying a market niche with the snappers (mangagat, maya-maya) and groupers (lapu-lapu). Recently, its skin has been found to be a suitable leather material with unexpected resiliency and durability, not to mention its attractiveness. In Central Philippines areas, sea bass is considered a delicacy and one of the major consumers for fish are the Chinese restaurants owners. Sea bass is noted for its large, thick flake and melt-in-your-mouth texture, this is why the Chinese like to eat this oil-rich fish that doesn't taste oily. It is marketed mostly in the Northeast and is popular as a steamed or fried dish in Chinese restaurants. Usually sold fresh and whole, and sometimes filleted, it can also be baked, broiled, or poached. As a whole, sea bass is domestically one of the favourite fish because it is easy to cook (baked, grilled, broiled or sautéed).

With the aforementioned information on the importance of sea bass as food and a potential species for rearing, there is no direct evidence yet, or case reported measuring the success of culturing sea bass in hapa-in-pond environment. Initiatives in the culture management of sea bass particularly in terms of growth performance at varying stocking densities, survival rate, production, type of feed given, protein efficiency and culture systems adopted [1, 8-11]. This study was designed to evaluate the potential of growing sea bass in hapa-in-pond environment.

2. Materials and Methods

2.1. Experimental design

The study was conducted in a 625 sq. m. private fish farm using 2.0m x 1.0m x 1.2m "hapa" net cages (Figure 1) as experimental unit. Four (4) treatments at different stocking densities (Table 1) with 3 replicates each were randomly distributed in the pond (Figure 1).The culture period lasted for 90 days. Growth, survival, feed performance, and cost analysis were determined at the end of the experiment.

Table 1. Experimental treatment.

Treatments	Stocking Density
T_1	10 pcs /m^3
T_2	15 pcs / m^3
T_3	20 pcs / m^3
T_4	25 pcs / m^3

Figure 1. Experimental set-up.

2.2. Experimental animal

The experimental fish came from a private hatchery in Southern Philippines. A total of 1000 sea bass fingerling with sizes of 38.10 mm were used in the study.

Sea bass fingerlings were stocked first at Bicol University Tabaco Campus (BUTC) Hatchery for acclimation procedure for two weeks before stocking. The tank was prepared and cleaned up for the filling of marine water and ready for stocking for acclimation. The acclimation was done by placing the water hose in the tank with minimum drop of water until it was finally range to freshwater salinity. Using a refractometer, the salinity was checked and to ensure that the stock was acclimatized into freshwater environment.

Figure 2. Photo of sea bass.

2.3. Stocking

Stocking was done in the late afternoon when temperature is low to avoid high percentage of mortalities. A total of 210 fingerlings weighing 3–5 g each were used in the study. The total weight of the stock in each cage was recorded to serve as basis for feeding ration.

2.4. Feeds and feeding

The fish were fed daily using commercial sinker feed diet (Prawn Feeds PO1, CP 39%) at 10% of their body weight during the 1st 60 days and 5% of their average body weight on the last 30 days. This type of feed was used to meet the protein requirement of sea bass which is also a carnivorous species requiring high protein diet. The fish were fed twice daily (7:00-8:00 A.M. and 3:00-4:00 P.M.) and the total amount of feed given was recorded to serve as basis for the computation of feed conversion ratio.

2.5 Experimental set up and water quality monitoring
The monitoring and cleaning of hapa was done every week, to prevent clogging. Nets are repaired as necessary. The water parameters monitored include water temperature, pH and dissolved oxygen (DO). The water temperature and DO was determined using Eutech PD 300meter and pH reading monitored by a pH meter and monitored done at weekly interval.

2.6 Data collection and sampling
Sampling was done every 15 days over ninety days by bulk weighing the fish using electronic balance. Growth and survival were recorded after every sampling.

2.6.1. Growth, survival, and feed performance
The growth, survival and feed performance were computed as follows:

Weight Gain (g) = Mean Final Weight – Mean Initial Weight
Length Increment (mm) = Mean Final Length – Mean Initial Length
Survival Rate (%) = (Number of Fish that Survive / Number of Initial Stock) x 100
Feed Conversion Ratio (FCR) = Total Feed Given (kg) / Weight Gained in a Feeding Period (kg)

2.6.2. Descriptive analysis of the cost and return of product / feed were based on the mathematical formula
The cost and return analysis was done to determine the viability and profitability of cultured sea bass at varying stocking densities in hapa-in-pond environment. It includes the total sales, operating cost, net income, return on investment and payback period of the four treatments.

2.6.3. Statistical Analysis
The data gathered were carefully recorded and analysed using appropriate statistical tools. For growth and survival, analysis of variance (ANOVA) was used to determine the significant difference among treatments. Descriptive statistics were used for the data on weight, length, survival rate, water temperature, FCR and FCE.

The ANCOVA was used to determine if the adjustment for body weight as a source of variation influences the growth and survival, thus determining the significant differences. If the result of ANCOVA is significant, further test using Duncan's Multiple Range Test (DMRT) at $P<0.05$ were used.

3. Results and Discussion

3.1. Growth performance of sea bass at varying stocking densities

3.1.1. Weight gain
The result showed that Treatment 1 obtained the highest weight gain increment of 148.80 g followed by Treatment 2 with (145.08 g) and lowest in Treatment 4 with (136.32 g) (Table 2). Based from the result obtained, those group stocked at 10 pcs/m^3 (T1) exhibited the highest mean daily increment of 1.65 g followed by T2 with 1.61 g and lowest in T4 with (1.51 g).

However, analysis of variance showed no significant interaction between different stocking densities among treatment means in terms of weight gained. These indicate that different stocking densities did not significantly affect weight gained of sea bass cultured in hapa-in-pond environment. The main effect of different stocking density among treatment means was not significant *(P=.123)*. The different levels of stocking density have relatively the same gain in weight. The average weight gained is 143.03 g. In general, the mean weight of fish decreased as stocking density increases.

The ANCOVA in terms of weight gained and feed given as covariate showed that there is a significant different among treatment mean at 5% level of significance. Data showed that out of six sampling periods, the results of ANCOVA at day 30 and day 60 are significantly different for feed given and treatments means with $P<0.001$ respectively. This means that growth of sea bass with respect to the feed given greatly affects its growth and survival rate. However, during the sampling period at day 15, 45, and day 75 only treatment means are significantly different with P<0.001 respectively. This means that the growth of sea bass was definitely affected by the adjustment of feed given and the number of sea bass that survived. Also, for final weight the treatment means was not significant while feed given as covariate was significantly different at (P=0.057).

Table 2 Weight increment of sea bass (*Lates calcarifer,* Bloch 1790) in Hapa-in-Pond in 90 days rearing period.

Treatment	Growth of Sea bass Initial Weight (g)	Final Weight (g)	Weight Gain (g)	Specific Growth Rate (SGR)
1	3.54±0.05	152.34±0.40	148.80	1.65
2	3.61±0.16	148.68±10.56	145.08	1.61
3	3.35±0.09	145.26±8.20	141.91	1.58
4	3.27±0.03	139.59±9.90	136.32	1.51

3.1.2. Length gain

Presented in Figure 3 is the length increment of sea bass at varying stocking densities over 90 days culture period. The result showed Treatment 1 had better length gain increment of 138.14 mm followed by Treatment 2 (135.32 mm) and lowest in Treatment 4 (113.91).

Also, the fish length is one of the indicators of growth that has a direct relation with weight gain. As the weight of the fish increases, its corresponding length also increases. Figure 3 below showed the result of the graph on growth pattern in length, it revealed that Treatment 2 has its highest length increment and the lowest was in Treatment 4. This result indicated that stocking densities has significant effect in terms of length increment.

The ANOVA results in terms of length gained showed a significant difference among treatment means at (*P<0.001*). Results only indicated that the group of sea bass stock at 10 pcs / hapa was significantly different to 25 pcs / hapa at *P=0.029* and 15 pcs / hapa also significantly different to 25 pcs / hapa at *P=0.014*. Data showed that with lower stocking density, larger size in terms of length can be obtained than in higher stocking densities. This result is opposite and significantly different to the other two groups stocked at 25 pcs / hapa to 10 pcs / hapa with *(P=.029)* and 25 pcs / hapa to 15 pcs / hapa with (*P=.029)*. Data showed that at higher stocking densities, more sea bass became larger in size compare to other groups, which among of them acted as shooter that can acquire larger in sizes than in lower stocking density, which their sizes are similar to one another since less competition observed.

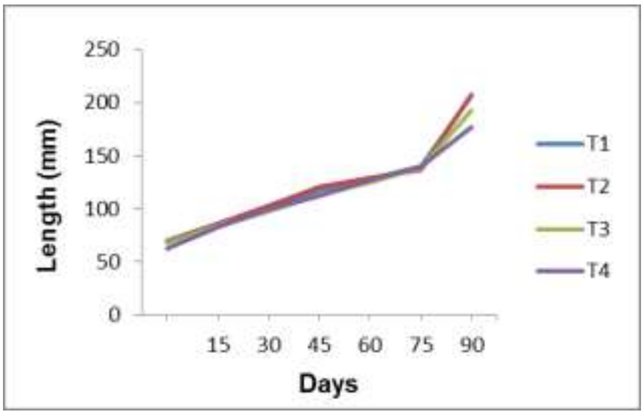

Figure 3. Growth pattern in length of sea bass (*Lates calcarifer*, Bloch 1790) in Hapa-in-Pond in 90 days rearing period.

3.1.3. Survival rate

Presented on Table 3 is the result of survival of the stock in all treatments fed with commercial feed for ninety days of culture period. Result showed that 10 pcs / m^3 obtained a survival of 87% which is significant different among the treatments. This was followed by 15 pcs / m^3 with 64% survival rate, 20 pcs / m^3 with 63%, and lowest in 25 pcs / m^3 with 47%.

Table 3. Survival of sea bass (*Latescalcarifer,* Bloch 1790) in Hapa-in-Pond in 90 days rearing period.

Treatment	Initial stock (pcs)	Mean and percentage survival of sea bass / sampling period (Days) [pcs (%)]					
		15 days 1st sampling	30 days 2nd sampling	45 days 3rd sampling	60 days 4th sampling	75 days 5th sampling	90 days 6th sampling
1 (10pcs/ m^3)	10^a	10±0.58^a	10 ±0.58^a	9±0.58^a	9 ±0.58^a	9 ±0.58^a	9 ±0.58^a
2 (15pcs/ m^3)	15^b	14±0.58^b	13 ±0.00^b	12±0.58^b	11 ±0.00^b	10 ±0.58^b	10 ±0.58^b
3 (20pcs/ m^3)	20 ^{b}	18 ±1.53^b	17 ±0.58^b	16±0.58^b	15 ±0.58^b	13 ±0.58^b	13 ±0.58^b
4 (25pcs/ m^3)	25^c	22±1.00^c	21 ±0.58^c	20±1.00^c	19 ±0.00^c	16±0.00^c	12 ±0.58^c

In the present investigation, fast growing individuals (shooters) were noticed at higher stocking densities of 20 pcs / m^3 and 25 pcs / m^3 at 15 days of rearing period. High mortality of sea bass was recorded on the 15 days for these treatments and further observation showed that the size of the fish varied from one another, with the tendency of the large fish to become aggressive. Thus, the presence of the shooters of large-sized fish, which preyed or attacked on the smaller ones, resulted to the low survival of the fish in groups having a stocking density of 20 pcs / m^3 a and 25 pcs / m^3. The overall mortality in all treatments was attributed to the cannibalistic instinct of sea bass. Mackinnon [12] and Paller et al. [13] observed stress in smaller-sized fry of sea bass with the presence of shooters that tend to cannibalize the smaller ones.

Data on stocking densities and survival indicates a direct proportional relationship. As the stocking density increases, mortality also increases (Table 3). The mortality was observed starting from the first to the last sampling period. The overall mortality in all treatments could be attributed mainly to cannibalism since some sea bass could be a shooter to others. Also, cannibalism was due to non-grading of the stocks in the hapa. Similar observation was reported by Imelda-Joseph [8] on the observed poor survival rate obtained at the end of the study mainly due to cannibalism. Other factors which could possibly contribute to low survival include space, presence of natural food to sustain the stock, feeding rate and food utilization and the feeding.

Analysis of Variance (ANOVA) in terms of survival rate showed a significant difference among treatment mean at $P<0.001$. This may be due to the variation in stocking density among treatments; hence, reduction of survival rate in higher stocking density could be attributed to the highly carnivorous and voracious feeding habit and development of fast-growing individuals (shooters) [1]. Cannibalism was also reported as a common problem and a major cause of mortalities and losses during culture at the juvenile and grow-out phases when sizes are greatly variable [14, 15]. DMRT results indicate that the mean survival rate of stocking densities between 15 pcs / m^3 and 25 pcs / m^3 revealed that they are both significantly different to each other. Also, treatment means having poor survival rate were in stocking densities of 25 pcs / m^3.

3.2 Feed conversion ratio (FCR)

Feed Conversion Ratio (FCR) was computed based on the total feed given to the fish divided by the weight gained of the stock over the rearing period. FCR usually shows the kilograms or amount of food needed to produce a kilogram of fish flesh. The lower the FCR value, the better is the feed utilization. Results of FCR and FCE are presented in Table 4.

Table 4 Feed conversion ratio (FCR) and feed conversion efficiency (FCE).

Treatment	Total Feed Given (g)	Weight Gain (g)	FCR	FCE (%)
10 pcs/ m^3	5054.25	148.80	33.97	2.94
15 pcs/ m^3	6080.25	145.08	41.97	2.38
20 pcs/ m^3	7224.44	141.91	50.91	1.96
25 pcs/ m^3	9072.23	136.32	66.55	1.50

On the overall, result obtained should higher FCR in all treatments and very poor FCE. This implies that the stock in all treatment will need 33.97 to 66.55 kgs of feed to produce a kg of fish. Moreover, given such FCRs, the FCEs showed very poor feeding efficiency ranging from 1.50 to 2.94%. Among the treatments, FCR is relatively higher in 25 pcs/ m^3 (66.55) with an FCE of 1.50 and lowest in 10 pcs/ m^3 (33.97) with an FCE of 2.94. The results for higher FCR for few fish or stocking density only showed that the feed given would be enough to sustain their needs compared to high stocking densities where the fish tend to compete just to get sufficient food to sustain their needs. Besides when fish compete in food getting, they consume more energy which needs to be replenished before growth can occur. In addition, the quality of the feed will ultimately depend on the level of available nutrients for fish. Because fish eat to satisfy their energy requirement, the energy value of the feed will affect its efficiency.

The ANOVA results in terms of feed given showed that there is a significant difference among treatment mean at P=0.001. FCR was significant in all treatments means and the value is significantly different at ($P<0.05$), this is possibly due to its stocking density. Data revealed that stocking density having 10 pcs/ m^3, 15 pcs/ m^3, 20 pcs/ m^3 and 25 pcs/ $m^3$are all significantly different among treatments means.

4. Conclusion

From the technical perspective, results showed that at lower stocking densities, higher weight gain can be realized, lower feed competition expected and more manageable to culture not to mention that it is also a high value species. Based on the information obtained from the study it is highly recommended that the future researcher should consider conducting a similar study at an on-farm level to assess the economics of sea bass farming on a commercial scale. Studies along alternative feed sources and stock grading to prevent cannibalism should also be explored.

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