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Original Paper

THE APPLICATION OF SILVOFISHERY ON TILAPIA (*Oreochromis niloticus)* AND MILKFISH *(Chanos chanos)* FATTENING WITHIN MANGROVE ECOSYSTEM OF THE NORTHERN COASTAL AREA OF SEMARANG CITY

Rini Budihastuti[1], Sutrisno Anggoro[2], Suradi W. Saputra[2]

[1)] Graduate School of Environmental Science Diponegoro University, Semarang, Central Java, Indonesia

[2)] Faculty of Fisheries and Marine Science Diponegoro University, Semarang, Central java, Indonesia

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ABSTRACT

The most influencing area on the preservation of the coastal environment is mangrove forest. Mangrove ecosystem is interface between land and sea ecosystem, thus this ecosystem possesses specific function in that its continuity depends on dynamics occurred in the land and sea ecosystem. Mangrove ecosystem is one of several ecosystems in that it has high productivity that produces food resource for most of shore biota. Besides, from fishery side, mangrove also possesses role as spawning and nursery grounds. Nevertheless, the condition of mangrove in Indonesia is experiencing damage and width shortening. To hold the degradation speed of mangrove forest, one appropriate effort could be silvofishery. Silvofishery in an integrated activity between brackish water fishery and mangrove forest cultivation at the same location. The research was completed in northern coastal area of Mangunharjo Sub-district, Tugu district, Semarang City. The purpose of the research was to review the most appropriate mangrove type and appropriate cultivated species for silvofishery for maximized result. The method of research action was completed upon multivariate experiment, consisted of 2 factors, which were mangrove vegetation (Avicenia marina and Rhizopora mucronata) and 2 types of cultivated species of tilapia (Orechromis niloticus) and milkfish (Chanos chanos) and with 2 times repetition. Based upon the data obtained, it can be concluded to develop optimal silvofishery were R. mucronata with milkfish cultivated species and A. marina with tilapia cultivated one.

Key words*:* silvofishery, *Avicenia marina*, *Rhizopora mucronata*, *Orechromis niloticus* and *Chanos chanos*

Correpondence *:* Phone: +62-24- 7474754; Fax: +62-24-76480690; E-mail: rini_puryono@yahoo.com

INTRODUCTION

Coastal area is transitional area where land and ocean possesses are mixed and various life resources are available. Coastal area proceeses play important role to their surrounding organisms. The coastal area consists of vital ecosystems such as coral reefs, sea grass beds and mangrove forests. Ecologically, high productivity within mangrove ecosystem should support the surrounding environment. The productivity within mangrove ecosystem was affected by its high litter production (Nagelkerken et al., 2008). The high productivity of mangrove ecosystem provide abundant feed for aquatic organisms such as fishes, crustaceans, bivalves and many other organisms and make it suitable for spawning, nursery and even feeding ground (Jamabo and Ibim, 2010).

Mangrove ecosystem in northern coast of Central Java was highly damaged. Puryono (2009) noted that the ecosystem damaged was about 96.65% of total mangrove coverage. From the identification, it was known that Semarang had also experienced mangrove damage. About 69.30% of mangrove coverage in Semarang had experieced severe damage while another 14.54%

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was categorized as light damage. Further effect of these damage was disturbance of pond cultures conducted along the coastal area. Hence, production of fish culture also decreased since pond productivity could not reach the optimum state.

Semarang coastal region degradation was caused by environment pressure resulted from caostal development and pollution resulted from upland activity such as farming, industries and homing. Another significant factor which caused mangrove degradation and coastal ecosystem as well was conversion of mangrove forests to fishponds (Primavera, 2006). Further effect of the conversion was the decrease of ecosystem support to aquatic organisms living caused by the low productivity of the ecosystem. Hence, its support for coastal activity including fishpond culture decrease either. Low production of fish culture lead to decrease of fish farmers income (Nautical and Fishery Institution of Central Java, 2009). Mangunharjo is a region in Semarang which experienced the same problem. Most farmers lost their ponds since protection of coastal ecosystem was weak followed by abrasion and flooding (Hedge, 2010).

In order to achieve sustainable fisheries management, especilly concerning pond culture, appropriate management should be conducted. Silvofishery is an integrated activity between brackish water fish culture and mangrove forest conservation within the same area. Silvofishery was arranged to provide sustainable fishery management. Silvofishery conducted fish culture with low input to achieve optimum result occupying ecosystem services. This system provide better chance to mangrove growth and better fish production as well. Hence, fish production could be increased without effecting further damage to mangrove and coastal ecosystem. Better economic profit should also be achieved since production cost could be lowered (Bengen, 1998).

The purpose of the research was to achieve appropriate information concerning the best combination of mangrove vegetation and fish species to provide optimal silvofishery application in Semarang northern coast area, especially in Mangunharjo. Hence, silvofishery would provide optimal fish production and reserve mangrove ecosystem as well so that both activity would be sustainable.

MATERIALS AND METHODS

Sampling Site

The research was conducted on Mangunharjo, of Semarang city, where most of the areas were utilized as fisponds. Research was held for 4 months periods.

Research Design

Research design used in this research was experimental. Clustered experimental design was conducted to observe the effect of silvofishery on the growth of Tilapia (*Oreochromis niloticus*) and Milkfish (*Chanos chanos*). The experiment was designed with 2 factors including mangrove vegetation and culture method as indenpendent variables, while the dependent variable was fish growth. Mangrove vegetation included were Avicennia and Rhizophora. Experiment was clustered by mangrove vegetation where Avicennia and Rhizophora plot were separated. While culture method included were monoculture and polyculture. To achieve better information, experiment were conducted with 2 replication.

Data Collection

Data collection was conducted in the 4th month when the experiment was finished. Data collection were including survival rate and weight growth of fish. Measurement of fish was conducted to several fish samples from each treatment.

Data Analysis

To obtain appropriate information concerning optimal combination of silvofishery in Mangunharjo, statistical data analysis was conducted. Analytical method used was ANOVA conducting mangrove vegetation and culture method as independent variables and fish growth as dependent variable.

RESULTS AND DISCUSSION

Results

Survival Rate (SR)

The survival rate of fish cultured in fishponds showed the succeess of aquaculture. Hence, fish survival rate between different mangrove species was observed. The survival rate of fish among

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treatments is shown in Table 1.

Table 1. Survival Rate of Tilapia and Milkfish Cultured in Different Mangrove Species

Fish Species	Mangrove Vegetation	
	Avicennia	Rhizophora
Tilapia	18%	20%
Milkfish	68%	71%
Tilapia + Milkfish	41%	47%

Table 1 showed the survival rate of Tilapia and Milkfish cultured for 4 months. The result showed that Milkfish cultured with Rhizophora had the highest survival rate compared to other treatments. While the lowest survival rate was achieved by Tilapia cultured in Avicennia. Table 1 also showed that Milkfish had the highest survival rate within each mangrove treatment, while Rhizophora provided better survival rate compared to Avicennia for all fish treatment. Hence, Rhizophora was the best mangrove species for fish survival while Milkfish cultured in monoculture method was provide the best survival. The survival of Tilapia was 18% in Avicennia and 20% in Rhizophora, while survival of Milkfish was 68% in Avicennia and 71% in Rhizophora. Both were cultured with monoculture method. While polyculture method combining Tilapia and Milkfish culture showed survival of 41% in Avicennia and 47% in Rhizophora.

Absolute Growth Speed (Biomass Growth)

Analysis of fish growth showed there were differences of fish growth among treatments. Detailed information concerning the growth of Tilapia and Milkfish in each treatment is shown in Table 2.

Table 2. Absolute Growth of Tilapia and Milkfish Cultured in Different Mangrove Species

Fish Species	Mangrove Vegetation	
	Avicennia	Rhizophora
Tilapia (gr)	151.83	91.17
Milkfish (gr)	111.67	111.67
Tilapia + Milkfish (gr)	141.84	75.25

Table 2 showed that average growth of fish culture within Avicennia plot was higher than in Rhizophora plot. Tilapi growth is higher in Avicennia plot than in Rhizophora plot, while te growth of Milkfish within Avicennia and Rhizophora plots were equal. Combination of Tilapia and Milkfish showed higher growth in Avicennia plot than in Rhizophora plot.

Growth of Tilapia cultured in Avicennia plot was 151,83 gr while in Rhizophora plotwas 91,17 gr. Milkfish growth was 111,67 gr at both plots, while combination of Tilapia and Milkfish in Avicennia plot was 141.84 gr and 75.25 gr in Rhizophora plot.

Statistical analysis showed a significant difference of fish growth among treatments. Partian analysis showed significant difference between vegetation species. Average growth of fish cultured in Avicennia plot was 135.11 gr while in Rhizophora plot was 92.70 gr. From the analysis, F statistic resulted was 82.517 with P value of 0.000. Average growth of Tilapia cultured in monoculture method was 121.50 gr, Milkfish in monoculture method was 111.67 gr and combination of both species cultured in polyculture method was 108.55 gr. Statistical analysis showed there was no significant difference among species growth.

F statistic resulted from the analysis on combination of vegetation and culture method was 33.122 with P value of 0.000. Most treatments showed significant difference of average growth, while treatments which did not have significant difference were between Milkfish cultured in Avicennia and Rhizophora and between Tilapia and Tilapia-Milkfish combination cultured in Avicennia.

Discussion

The analysis showed significant differences of fish growth in different vegetation and combination of vegetation and culture method. It means that culture method did not effect the growth of Tilapia and Milkfish significantly. Best fish growth was achieved by Tilapia cultured in Avicennia plot.

The analysis showed that Avicennia give better advantage to fish growth. It is because Avicennie provide better food resoures for aquatic organisms. Decomposition rate of Avicennia litter was faster than Rhizophora (Mahmudi et al., 2008). Litter decomposition is a process of nutrient transformation involving aquatic organisms. Avicennia litter was easier to

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decompose than Rhizophora. Hence, Avicennia should provide better food availability to fulfill the needs of cultivated fish.

The function of mangrove ecology was as the producer of O_2 and absorber of CO_2 (Gonneea et al., 2004). The availability of oxygen would support decomposition processes to produce food for aquatic organisms (Maie et al., 2008). The existence of mangrove also functioned to compile mud and increase the water purity. Mardiyati (2004) mentioned that management approach concerning mangrove conservation and utilization should preserve the ecosystem productivity. Mangrove ecosystem in Central Jawa was mostly distributed in the northern coast area where most of the soil texture was consisted of sandy loam (Setyawan et al., 2003).

Mangrove ecosystem is specific ecosystem in coastal area differed from marine and land. Natural processes and impact of human activity were cummulated in this area Gilman et al., 2008). Beside, mangrove vegetation had been exploited for such utilization such as timber, food, charcoal, firewood and medicine to many local communities world-wide (Walters, 2003)

The application of silvofishery system for aquaculture should provide better advantage on fish growth. David (2008) mentioned that the purpose of silvofishery application are:

- To provide facility / conservation method toward mangrove forest rehabilitation and protection of soil, marine and estuarine resources.
- To provide society economic establishment, by supporting pond culture activity. Hence, the pond fishery productvity could be sustaied and provide economic effect to the society, especially to the aquaculturists.
- To provide ecotourism facility and environmental friendly farming / fishery activity
- To provide mangrove ecosystem conservation along with the utilizaton of mangrove ecosystem services.

Silvofishery application need certain pattern to provide optimal combination of silviculture and fish culture. Nur (2002) conducted a research to figure the best composition of mangrove and pond ratio to provide the best ecology and economic advantages. The result showed the ratio of 50:50 and 60:40 for optimal utilization of mangrove forest in pond culture. The ratio would provide optmal activity fro litter decomposition which lead to nutrient availabilty to the cultivated organisms. In the application of silvofishery would increase and preserve function of biology and ecology of mangrove ecosystem, it needs to have rational approach in the usage by involving society. The application of silvofishery in mangrove ecosystem is one exact approach in the utilization and preservation of coastal area.

Food cycle within mangrove ecosytem started from mangrove litter production which then decomposed by certain decomposer organisms. Mwaluma (2002) mentioned that the role of mangrove vegetation within pond culture provide canopies for cultivated organisms beneath. Mangrove litter decomposition processes involving both arobic and anaerobic processes. This decomposition processes provide primary production which then enter the water system (Kristensen et al., 2008). In the case of silvofishery, primary production resulted from litter decompositions are cumulated in the pond. Hence, cultivated fish could directly utilize it. The closer a water to the mangrove means there should be more abundant nutrient. Which means there should be more food to the organisms.

From the result of tilapia fattening, it is shown that the best tilapia growth was achieved from the treatment in Avicennia plot, while milkfish growth were similar between Avicennia and Rhizophora. The growth of combinated culture of Tilapia and Milkfish showed higher growth on Avicennia either, which could be caused by the better Tilapia growth rather than Milkfish growth.

CONCLUSION

Based on the research result obtained, it can be concluded that there was significant difference on the growth of Tilapia and combination of Tilapia and Milkfish cultured in Avicennia and Rhizophora, while Milkfish did not show significant different. Factors which had significant effect to the growth of the fish were vegetation and combination of vegetation and culture method, while culture method did not have significant effect to the growth of Tilapia and Milkfish. The best combination for silvofishery would be Tilapia fish cultured in Avicennia vegetated pond. There was no relation

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between cultivation activity with *Avicennia marina* stand with *Rhizopora mucronata* in every cultivated species combination.

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