Development of water and nutrient management models to improve multitrophic seafarming productivity

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Abstract. The cultivation of more than one species needs to be done to improve land use efficiency. Multitrophic seafarming has been practiced in several countries and involves two important components in its development. The first is the choice of aquatic plants and animals that can be cultivated together in one cultivation area and the second is water quality management through water replacement techniques. The purpose of this study was to determine the cultivation techniques and weight gain of seaweed and aquatic animals. The cultivated seaweed was Eucheuma cotonii, while the cultivated aquatic animals were milkfish and sea cucumbers. The treatments tested were the replacement of the water in a 10-ton culture tank consisting of daily water circulation, water changes every two days and a complete turnover every 3 days. The seaweed was done in a cultivation pond equipped with water flow manipulation. The water flow manipulation was achieved by adding a water pump to rotate the water flow. The variables observed were the growth of the cultivated biota and water quality. The preliminary research results showed that the weight gain of the seaweed after 18 days reached 3 times the initial weight.

1. Introduction

Marine aquaculture is an alternative option for coastal communities. Referring to the development of cultivation technology, aquaculture is not only intended to cultivate one type of species, but more than one species in the same unit of cultivation volume. Today, multi-species cultivation has developed into a multi-tropic culture. Multi-tropical cultivation is meant to maintain the biological resources of the fisheries which occupy the tropical liver as producers, consumers and filters.

The initial consideration of choosing to cultivate these three types of biological resources is in order to improve the efficiency of commercial feeding to spur the growth of the fish and liquid fertilizer to, in turn, stimulate the growth of the seaweed. The rationale for this cultivation is that the remaining food and fish feces will be filtered by the sea cucumbers, while the liquid fertilizer and the remaining fish and sea cucumber waste will be used as nutrients for the growth of seaweed. The collaboration of these three types of biological resources in the cultivation container results in the addition of weight and helps in the management of aquatic quality.

In order to improve the effectiveness and efficiency of cultivation, the choice of the biological resources that will be cultivated is important. In this study, the biological resources cultivated in one unit of cultivation volume were seaweed (Eucheuma cotonii), milkfish and sea cucumbers. In this study, feeding, substitution and the provision of nutrients were the treatments tested. The final result of the study is where the researcher expected to obtain the most effective and efficient water quality management that has an influence on the growth of the seaweed, milkfish and sea cucumbers.
2. Methodology

The research study used an experimental methods with the variables observed being the growth of the seaweed, milkfish and sea cucumber respectively. The three biological resources that were maintained in the three tanks were all of the same volume. The volume of the cultivation plants was 10 tons. Each tub was filled with 450 fish, 100 sea cucumbers, and seaweed with a spacing of 20 cm and an initial weight of 100 grams. Feeding was done using commercial feed with a weight of 2% of the weight of the milkfish cultivated.

The seaweed was cultivated with the basic loose method (tub A), surface (tub C) and mid (tub B) in the cultivation medium. The seaweed was cultivated by binding a string of seaweed seeds to a raft. The rafts were made of paralon pipes which were equipped with a rope with a distance of 20 cm. The water quality management developed in this study included changing the water every 1 day (tub A), every 2 days (tub B) and with a constant circulation of the water (tub C). The water quality parameter observed every day was salinity.

The seawater that was loaded into the culture tank was the seawater around the research location taken using a seawater pump. Before entering the cultivation container, the water was filtered using a filterbag. Filtering the seawater aimed to prevent organisms and / or impurities from entering with the seawater into the cultivation container.

3. Results

The preliminary research results showed that the weight gain of the seaweed at 18 days reached 3 times the initial weight. However, there were indications of ice-ice (white spots), which are the symptoms of some white talus. Meanwhile, the weight gain of the fish and sea cucumbers did not show as being any different from their initial weight. The appearance of ice-ice on the seaweed is caused by thalus partial closure caused by the remaining food and fish feces. Indications of the appearance of ice-ice were only found in seaweed cultivated on the surface and mid-cultivation medium.

In connection with the sea farming model, results were obtained related to the need for the manipulation of the cultivation media. Referring to the appearance of ice-ice in the seaweed, it is necessary to develop water pumps to form currents such that the remaining feed and the remaining fish and sea cucumber waste has a shorter residence time (settling) on the thalus surface of the seaweed. In addition, the basic loose method produces the best seaweed performance compared to the middle method and when it is on the surface of the cultivation medium. The best seaweed performance is because seaweed requires a certain level of brightness to spur its growth. Based on the results of these studies, this cultivation method is feasible to develop as an alternative livelihood for coastal communities. The visualization of the research activities has been presented in Figure 1, while the results of the research have been presented in Figure 2.
Figure 1. Visualization of the research activities

Figure 2. Visualization of the research results
This research is the first of two research stages. This first study aims to determine the optimal multi-tropic seafarming model that produces growth in the seaweed, milkfish and sea cucumber. The results of the first study will be implemented in the second research study by adding one type of biological resource. One type, as an example, is mangrove crabs. In addition to the addition of mangrove crabs as a cultivated biological resource, replacing the size of the milkfish stock will also be carried out.

In the first phase of the study, the milkfish were cultivated at a size of 10-11 cm, while in the second phase of the research; we will use 2 - 3 cm milkfish. In terms of cultivation, the maintenance of the milkfish of this size to encourage them to reach a size of 10 - 11 cm is known as weaving. The basis of this classification consideration is to provide the milkfish as live bait for tuna fishing.

4. References
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