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DIREKTUR JENDERAL KEKAYAAN INTELEKTUAL

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PRODUCTIVITY IMPROVEMENT OF MILKFISH AND SEAWEED POLYCULTURE USING VERMICOMPOSTING FERTILIZER FROM DIFFERENT SOURCES OF WASTE

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ABSTRACT

Polyculture cultivation depends on the balance of several factors. Seaweed functions as a supplier of oxygen, protection for milkfish from predators, and an absorber of the dissolved CO_2 from the respiration of the milkfish. In turn, the milkfish waste was used as nutrients by the seaweed. This research was carried out in Ujungpangkah Pond, Gresik District, East Java. The objective of the study was to increase pond productivity using vermicompost fertilizer from different wastes in a seaweed and milkfish polyculture system. The treatment was using food waste, Alang-Alang waste, banana stems, and a combination of all wastes were used to produce the vermicompost. The polyculture system used milkfish and the seaweed *Gracilaria verrucosa* and was cultivated for 42 days. It was found that the highest carbon uptake (717.77 ppm/day) by*G. Verrucosa* was with no added organic waste; the highest nitrogen uptake (16.47 ppm/day) was with combined organic waste; and the highest phosphorus uptake (19.17 ppm/day) was with feed waste. The highest daily specific growth rate (6.21%/day) of the milkfish was with banana stem waste. The feed conversion ratio (FCR)was 1.04–1.26. This small FCR showed that seaweed could be used as an alternative feed source for milkfish within a polyculture system.

Keywords: polyculture, vermicompost, milkfish, seaweed, growth, nutrient uptake.

I. INTRODUCTION

Aquaculture can improve both the macro- and micro-economy. In the vast scope, aquaculture has the potential to contribute to the largest foreign exchange in the world export process. On a small scale, the aquaculture sector has an economic influence by providing experts, increasing the purchasing power of the local community, and increasing the income for the community by acting as fisheries entrepreneurs (Nugroho, 2013).

Seaweed is a water plant that requires a balance of several physical and chemical factors, such as water movement, temperature, salinity, carbon,the nutrients nitrogen andphosphorus, and sunlight. During the growth process, nutrients diffuse into the thallus, while the photosynthetic process takes place with the sunlight that penetrates the waters (Rahim et al., 2016).

The milkfish (*Chanos chanos*) is the only species in the Chanidae family. They live around the coast and islands in areas that have many coral reefs. After hatching they live in marine waters for three weeks and then move into mangrove, brackish or estuary waters or lakes. In adulthood, they return to the sea to reproduce (Sumawidjaja, 2002).

The polyculture cultivation system involves land use with more than one aquaculture organism in a cultivation medium. This kind of system can be used to increase pond efficiency and increase the farmers' income. The cultivation process of more than one aquaculture organism depends on a balance of factors in the cultivation system. Seaweed produces oxygen during photosynthesis, protects fish from predatory attacks, and absorbsthe CO_2 from the respiration of the milkfish.In return,the milkfish release feces, which contain nutrients for the seaweed (Mangampa and Burhanuddin, 2014).

Addition of nutrients to a polyculture medium of the seaweed *Gracilaria verucossa* and milkfish, in the form of macro elements such as carbon, nitrogen, and phosphorus, can maintain the fertility level of aquaculture ponds. Using waste such as residual feed waste or fertilizer, Alang-Alang waste, and banana stems to make vermicompost is a way of producing natural fertilizers that could increase production, in terms of the quality and quantity of milkfish and seaweed. This would reduce the use of synthetic or chemical fertilizers, which are relatively expensive and can cause a decrease in long-term productivity.

This study was carried out in Gresik District, East Java Province, Indonesia. It investigated the daily specific growth rate and the feed conversion ratio (FCR) of milkfish in a polyculture system with the seaweed *G. verrucosa*and vermicompost fertilizer. Different fertilizers were prepared from different organic wastes to increase pond productivity. The carbon, nitrogen, and phosphorus uptake by the seaweed were also measured.

II. METHODOLOGY

Time and Location The research was conducted from January to February 2019 for 42 days in the brackishof ponds of Banyu Urip Village, Ujungpangkah Sub-district, Gresik District, East Java Province, Indonesia; at the Fisheries Laboratory of Universitas Muhammadiyah Gresik; and the Soil Laboratory of Universitas Brawijaya Malang.

Fertilizer Production. Vermicompost fertilizers were made with different organic waste materials at the Aquaculture Laboratory of Universitas Muhammadiyah Gresik. Five plastic boxes (35 × 35 × 15 cm), with nine 3 mm holes in the bottom and covered with plastic, were used to make the vermicompost. The media used were cow dung (1.6 kg), as a starter, and soil (600 g). The cow dung and soil weremixed and placed in the base of each container. Alang-Alang (*Imperata)* and banana stems were roughly chopped to a thickness of 2–3 cm and then put into each container (300 g). The feed waste was aerated for seven days until the waste became moist. Adult earthworms (26 g/kg of vermicompost medium), were added and the resulting vermicompost medium stirred and sprayed with water every day. The fertilizer was harvested after twomonths, and the earthworms separated manually from the vermicompost (Rahim, 2018).

Seedstock Preparation. The seedstock was fresh, free from foreign material, hadmany branches with a slightly dark brown end, a young hard thallus, no white spots and exfoliated, and was least twoweeks old when collected. The mass of seaweed seedstock used was50 g for each treatment. The milkfish (5–7 cm) came from Tuban, North Coast of Java Island. The milkfish had passed the larval phase and were susceptible to disease. The milkfish were not fed for the three days of the acclimatization process.

Container Preparation. Fifteen styrofoam boxes (45 × 30 × 30 cm) were washed and dried. To make miniature ponds, each styrofoam box was filled to a thickness of 5 cm with mud taken from the bottom of the pond. Later, the cultivation container was filled with seawater.

Seedstock Spread. Seaweed seedstock from tissue culture (50g/container) (Rahim, 2018), and milkfish (30 heads/container) (Sumawidjaja, 2002) were added to each container. The containers were placed on top of the ponds and maintained for 42 days as a polyculture system.
Adding Fertilizer. Fertilizer was dissolved in sea water (450 ppm or 0.45 g/l of seawater) before use (Rahim et al., 2015).
Parameters. The parameters measured were the dissolved carbon, nitrogen, and phosphorus concentrations in the polyculture water, using UV-VIS spectroscopy methods at the Soil Laboratory of Universitas Brawijaya, Indonesia. The decline rates for carbon, nitrogen, and phosphorus (ppm/day) nutrients were calculated using the formula: final CNP nutrient concentration minus initial CNP nutrient concentration divided by the final observation time minus the initial observation time (Kurniawan, 2006). The milkfish daily growth rate was determined by weighing all the fish in each treatment once a week; the daily growth rate was calculated by the formula: (average weight of end cultivation) minus (average weight of initial cultivation) divided by the time of cultivation (Handajani and Widodo, 2010). The feed conversion ratio (FCR) of the milkfish was calculated using the formula from Directorate General of Fisheries Cultivation (2004):the feed given (g) divided by (final weight minus the initial weight of milkfish).

Research Design This study used a Completely Randomized Design (RAL) with five treatments and three replications so that there were 15 experimental units. The treatments were:
1. Treatment A: Vermicompost Fertilizer (without organic waste)
2. Treatment B: Vermicompost fertilizer (with feed waste)
3. Treatment C: Vermicompost Fertilizer (with alang-alang (*Imperata*) waste)
4. Treatment D: Vermicompost Fertilizer (with banana stem waste)
5. Treatment E: Vermicompost Fertilizer (with combined waste)

Data Analysis. The data obtained were analyzed using Analysis of Variance (ANOVA). If any vermicompost fertilizer was found to have a significant effect on the increasing growth of the milkfish and the milkfish FCR ($P < 0.05$), a Tukey test was used to identify any significant differences between each treatment. The decline rates in nitrogen, carbon and phosphorus concentrations were analyzed descriptively based on the seaweed's life needs.

III RESULTS AND DISCUSSION

1. Uptakeof Carbon by Seaweed

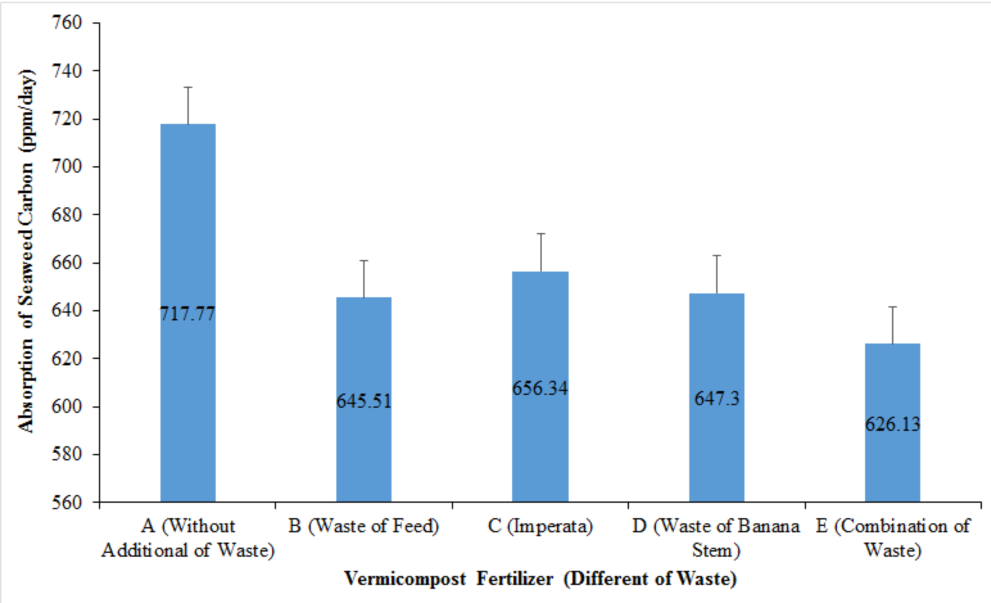

Figure 2. Uptakeof Carbon by Seaweed

The rate of uptake of carbon by the seaweed *G.verrucosa* was in the range 626.13–717.77 ppm/day. Treatment A hadthe highest rate of uptake(717.77 ppm/day), then treatment C (656.34 ppm/day), treatment D (647.3 ppm/day), treatment B (645.51ppm/day), and treatment E (626.13 ppm/day) had the lowest rate of uptake. Akmal et al. (2009) found that the rate of uptake of carbon that produced the best growth and quality of seaweed was in the range 100.89–202.79 ppm/day. Rahim (2016) found that the uptake rate of carbon by *G. Verrucosa* was in the range 112.38–114.17 ppm/day. According to Erlania et al., (2013), the large amounts of carbon taken up by *Gracilaria sp.*was because carbon was used in large quantities as the basic element in the formation of carbohydrates and sulfates.

2. Uptake of Nitrogen by Seaweed

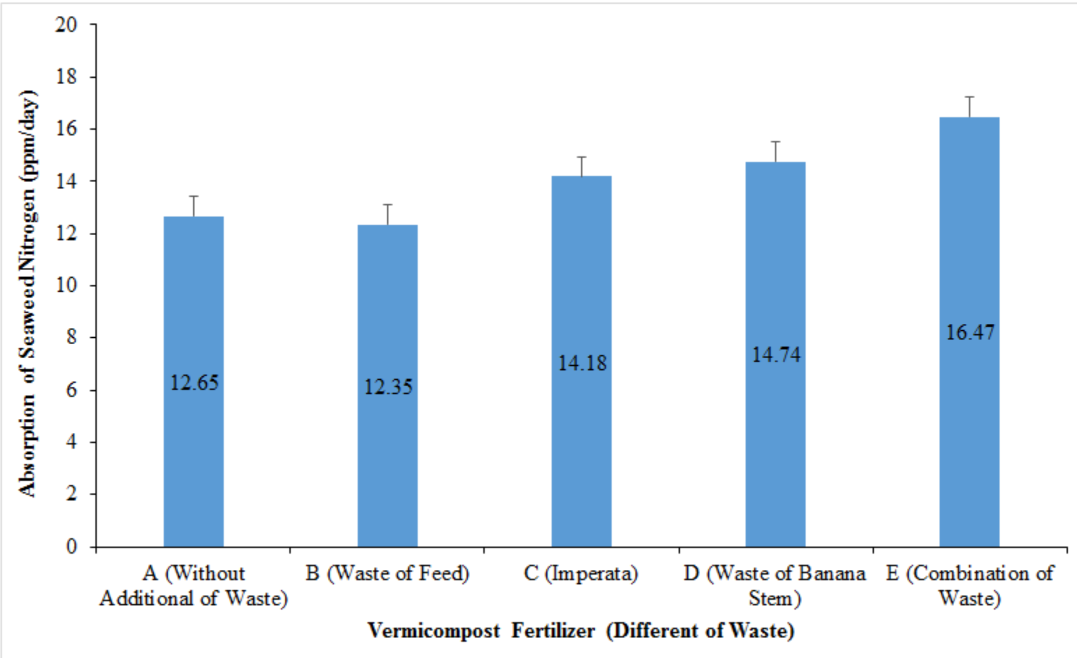

Figure 3. Uptake of Nitrogen by Seaweed (ppm/day)

Nitrogen uptake by the seaweed *G.verrucosa* ranged from 12.35–16.47 ppm/day. The rates of nitrogen uptake measured were: treatment E (16.47 ppm/day), treatment D (14.74 ppm/day), treatment C (14.18 ppm/day), treatment A (12.65 ppm/day), and treatment B (12.35 ppm/day). In a previous study, the highest nitrogen uptake for the *G. verucossa* was in the range 0.14–2.47 ppm/day (Kurniawan, 2006). According to Rahim (2016), the range of nitrogen uptake of *G. verrucose*, with a different ratio of vermicompost fertilizer to the one in this study, was 2.12–2.40 ppm/day. Syah et al. (2017) found that nitrogen (as nitrate and ammonia) was diffused by phytoplankton into much simpler form. The formation of nitrate and ammonia depends on the oxygen content of the water. If the oxygen concentration is low, nitrogen will be a dangerous element as ammonia is formed. If the oxygen concentration is high, the nitrogen will be in the form of nitrate, which can then be usedby the seaweed as a source of nutrition. As well as being important for photosynthesis, nitrogen assists in the formation of chlorophyll, protein, fat, and other organic compounds. Nitrogen is the most important element for increasing the size of seaweed. This is because nitrogenis a limiting factor for macro algal growth. It can also fertilize water plants leading to growth increases. (Salundik and Simamora, 2006)

3. Uptake of Phosphorus by Seaweed

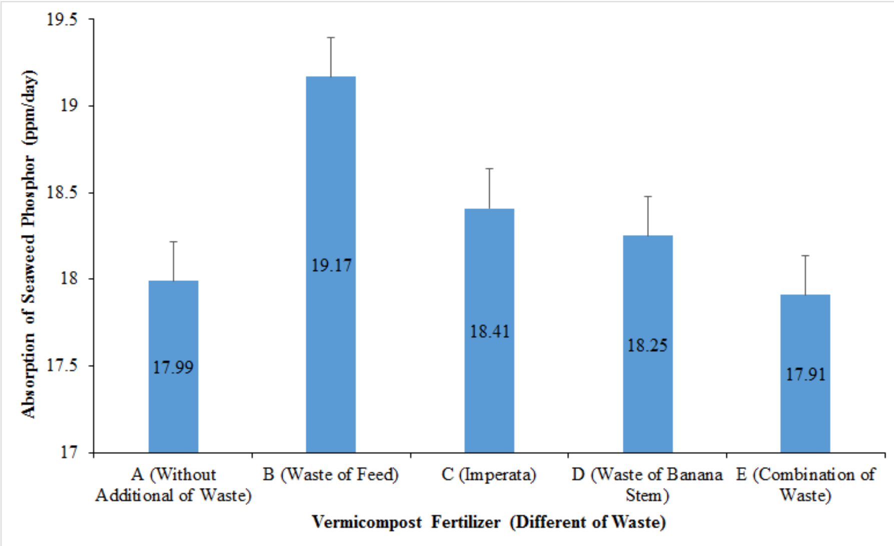

Figure 4. Uptake of Phosphorusby Seaweed (ppm/day)

Phosphorus uptake of *G. verrucosa* seaweed in this study ranged from 17.91 to 19.17 ppm/day. The highest absorption of phosphoruswas in treatment B (19.17 ppm/day), then treatment C (18.41 ppm/day), treatment D (18.25 ppm/day), treatment A (17.99 ppm/day) and treatment E (17.91 ppm/day). According to Kurniawan (2006), the range for *G. verrucosa* growth was 0.11–0.45 ppm/day. Whereas according to Rahim (2016), the range of phosphorus absorption,using vermicompost fertilizers with a different ratio to the one in this study, was 0.28–0.52 ppm/day. Lingga and Marsono (2007) stated that phosphate was a very important component for seaweed. Phosphate is easily decomposed and absorbed by plants and is a good nutrient source. Phosphorus stimulates growth and accelerates the formation of seaweed spores (Anam, 2007).

4. Daily Growth Rate of Milkfish

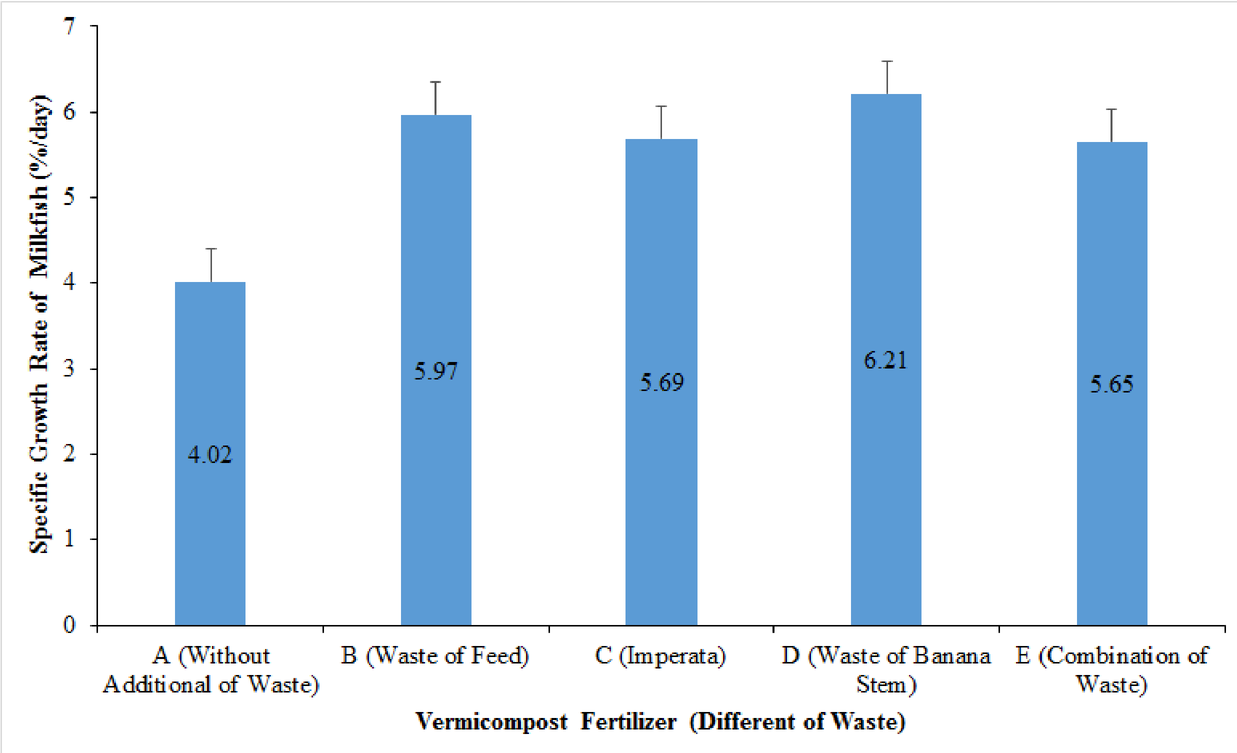

Figure 5. Daily Growth Rate of Milkfish (%/day)

The daily growth rate of the milkfish *Chanos chanos* was 4.02–6.21%/day. The highest daily growth rate was for treatment D (6.21%/day) while the lowest was for treatment A (control) (4.02%/day). According to Triyanto et al. (2014), the daily growth rate of cultivated milkfish in a reservoir was 0.26–1.1%/day. Mangampa and Burhanuddin (2014), found that milkfish cultivated together with *G. Verrucosa* had a daily growth rate of 4.8%/day. An important factor determining growth is the type and composition of feed according to the needs of the fish. The substances in the feed must be in accordance with the availability of endoenzymes in the digestive tract so that they can be processed properly and the remainder, that is energy, leads to weight gain (Spikadharaet al., 2012). According to Rahim (2018), the carbon content of *G. Verrucosa* was 23.53–29.47% and the nutrient content made it a good source of fish food for promoting development.

5. Milkfish Feed Conversion Ratio

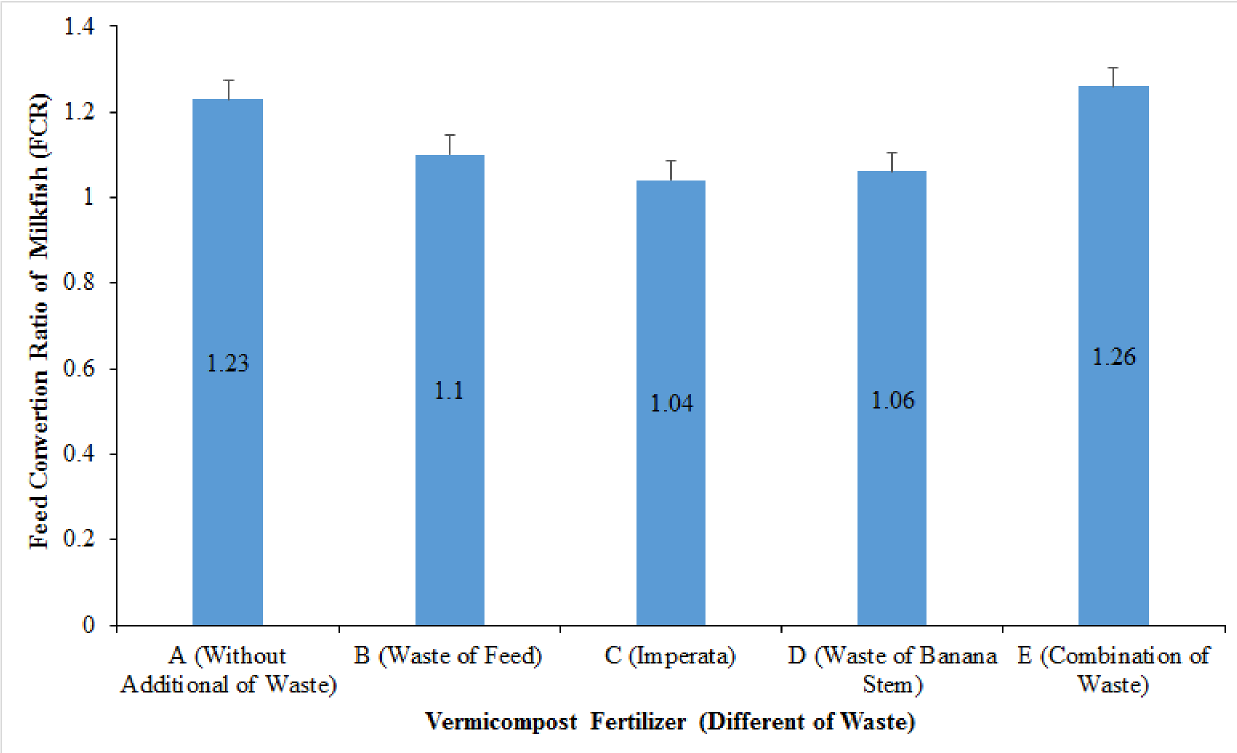

Figure 6. Milkfish Feed Conversion Ratio

Handajani (2011) stated that more efficient feeding can increase the weight of the fish. The efficiency of the feed can be determined by the feed conversion ratio (FCR). Serdiati et al. (2011) proposed that the lower the FCR, the less feed needed to produce each kilogram of fish. The FCRs determined for milkfish (*Chanos chanos*) were 1.04–1.26. The lowest FCR was for treatment C (1.04), and the highest was for treatment E (1.26).

IV. CONCLUSION

From the results of the study, the conclusions are as follows:

1. The highest carbon uptake of the seaweed *Gracilaria verrucosa* was 717.77 ppm/day, using vermicompost with no additional organic waste. The highest nitrogen uptake was 16.47 ppm/day, using vermicompost from combined waste, and the highest phosphorus uptake was 19.17 ppm/day, using vermicompost from feed waste.
2. The highest daily growth rate of milkfish *Chanos chanos* was 6.21%/day, using vermicompost from banana stem waste. The Feed Conversion Ratios (FCR) measured for milkfish were 1.04–1.26.
3. The FCR value was smaller than in previous studies. This showed that combined seaweed and milkfish production, usin gpolyculture technology and vermicomposting fertilizers from different wastes, was able to reduce the use of artificial feed, which is relatively expensive for milkfish,

V. ACKNOWLEDGMENTS

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