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Applying Organic Fertilizer from Solid Waste of Super Intensive Shrimp Pond on Production of Milkfish Fingerlings *Chanos chanos (Forsskal, 1775)*

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***Abstract*— The cultivation of super-intensive shrimp with high density has consequences on the burden in the form of waste as the aquaculture activities product affecting the habitat feasibility for the aquatic organisms and the environment of fisheries. Super intensive shrimp in the form of solid waste has the potency to use as the raw material of organic fertilizer. Hence, this research is subject to assess the growth response of live feed and milkfish nursery, which are given super intensive pond solid waste through organic fertilizer compared to commercial organic fertilizers. The research used a completely randomized design (CRD) by three times of treatment and repetitions, respectively. The treatment applied in the experimental group was Urea plus SP-36 plus organic fertilizer originated as of best quality concentrated pond solid waste (A), Urea plus SP-36 plus commercial fertilizer (B), Urea plus SP-36 plus chicken farm waste organic fertilizer (C), and the controls group was Urea plus SP-36) (D). The Urea fertilizer dosage was 200 kg/ha, SP-36 as much as 100 kg/ha, and organic fertilizer each as much as 2,000 kg/ha. The parameters observed were components and a large quantity of plankton, the growth and survival rate of the juvenile milkfish, and the quality of water. The results of this research showed that the number of plankton species obtained during nursery of milkfish was 43 genera consisting of 27 genera of phytoplankton and 16 genera of zooplankton. The most dominant plankton found was from the classes Bacillariophyceae as much as 41.86%. The abundance of plankton obtained ranges of 1.330-1.915 ind/L. The super-intensive shrimp pond solid waste was applied as organic fertilizer along with inorganic fertilizer produced abandon plankton along with growth and survival juvenile milkfish produced by the application of commercial organic fertilizer was better than the components in the control group. This research also found that water quality measurement results during the experiment were suitable for the growth of live feed and milkfish.**

***Keywords*— extensive; milkfish; life feed; organic fertilizer; solid waste.**

I. INTRODUCTION

The cultivation of super-intensive shrimp with high density has developed in several countries, including in Indonesia. Since 2011, in Indonesia developed super-intensive *vaname shrimp* cultivation in 1,000 m^2 ponds with stocking densities of 312-1,000 per m^2 [1]. The cultivation of shrimp with high stocking densities uses a raceway system of 271 m^2 in stocking densities of 300-810 ind/m^2 [2]; 658-1602 ind/m^3 [3]; raceway system of 40-100 m^3 in stocking densities of 390-500 ind/ m^3 [4]; and the shrimp farming in 1,000 m^2 concrete ponds with a density of 500-1,250 ind/ m^2 [5], [6]. This cultivation system has the consequences on the burden in the form of waste as the aquaculture activities product that can modify the habitat feasibility for the aquatic organisms and the environment of fisheries. One of the causes of the decline in the quality of coastal waters is the discharge of aquaculture waste during operations, which contain high concentrations of organic matter and nutrients as a consequence of putting aqua input in the cultivation that produces dissolved waste and feces in surrounding waters [7].

Pond wastes have higher values of organic matter. It has a higher amount of nitrogen and phosphorus than typical soils [8]–[10]. The amount of sediment waste from shrimp ponds produced with a density of 750-1,250 per m2 is 18.2-21.9 tons. The solid waste can be an opportunity as well as the potential negative impact if it is managed inappropriately. Super intensive shrimp pond sediment solid waste is possible to use as organic fertilizer since it contains high nutrients such as 0.67% N, 4.78% P_2O_5, 1% K2O, 17.84% C-organic, 6.25 pH, and 15.60% water content [11]. The rate of sediment fertilizer for one hectare of *Tilapia* ponds production was equal to 6.26 tons of Urea and 1.96 tons of TSP [12]. The potency of organic fertilizer is derived from sixteen plots of aquaculture ponds, which are about 200 m^2. In semi-intensive Tilapia with one hundred and seventy-three tons of sediment/ha/cycle has nutrients that have the potency to meet nitrogen fertilizer requirements for 0.35-1.2 ha and potassium fertilizer for 0.7-1.5 ha [13]. Besides, the sediment accumulation contains 1.8-5 tons of organic material that has high potency as an ingredient to enhance the quality of the soil. In China, Thailand, and Vietnam, pond sediments have been used to fertilize crops and have higher production yields. The use of pond sediments in agriculture has a positive impact and increases crop yields in Asia [14].

One effort that can be done to increase the production of fish or shrimp ponds or farming is fertilization. In principle, water fertilization is adding nutrients that are needed by water plants so that the production of natural fish or shrimp feed can be increased. Fertilizers used are usually organic fertilizers, such as urea and TSP or organic fertilizers such as bran and chicken manure [15]. Organic and inorganic fertilizers each have their strengths and weaknesses, but their use together will be complementary. The use of organic fertilizers provides several advantages including increasing the activity of microorganisms in the soil, the ability to exchange anions and cations, increasing organic matter and soil carbon content and therefore improving the quality and production of crops in the same way as inorganic fertilizers [16], without causing environmental pollution.

Some important advantages of organic fertilizers include improving soil surface, water preservation, and erosion endurance. Organic fertilizer provides nitrogen in the form that can be used, which will help increase plant growth without causing root death or destroying strategic microorganisms in soil [17]. Fertilization is crucial in fish farming because it provides phytoplankton as a food source and oxygen in the water [18]. The type of fertilizer used for milkfish farming is TSP, Urea, and organic fertilizer. These types of fertilizer allow life feed (plankton and microbenthic biological complex like algae) to grow. This is in line with the main function of fertilization, which is to provide nutrients needed for life feed growth, improve soil structure, and inhibit water absorption in porous soil. The use of these types of fertilizer is to fertilize the soil on which the pond is suitable because it contains essential minerals and the main organic acids for soil fertility and the growth of life feed[19], Those are algae, plankton and basic organisms (benthos).

Based on the description above, it can be informed that the solid waste in the form of super-intensive shrimp pond could be used using organic fertilizer aimed at the nursery of milkfish in traditional ponds. This research is subject to assess the growth response of live feed and milkfish nursery, which are given super intensive pond solid organic fertilizer compared to commercial organic fertilizers and combinations with inorganic fertilizers that have been circulating in the market.

II. Materials and Methods

A. Research Setting

This research was conducted in Maros regency, South Sulawesi, Indonesia. This research applied in an Experimental Pond Installation. This research was officially administered in Research Institute for Coastal Aquaculture and Fisheries Extension in Manrimisi Lompo Village, Maros Baru Subdistrict.

B. Research Design

This study used 12 plots of ponds measuring 500 $m^{2,}$ which were equipped with a channel system for the entry and discharge of water. The study used a completely randomized design (CRD) with four times treatment and three times of repetition. The treatment experimented was Urea+SP-36+organic fertilizer of best quality concentrated pond solid waste (A), Urea + SP-36 + commercial fertilizer (B), Urea + SP-36 + chicken farm waste organic fertilizer (C), and the controls, (Urea + SP-36) (D). The dosage of Urea fertilizer was 200 kg/ha, SP-36 as much as 100 kg/ha, and organic fertilizer each as much as 2,000 kg/ha [15]. Before the juvenile fish were stocked into rearing ponds, the pond was prepared first by drying, removing the mud, eradicating pests, and growing life feed using organic and inorganic fertilizers. Before applying the fertilizer treatment, the pond was prepared to grow a life feed (plankton and algae). The life feed growth started from making the soil dry for 7-10 days until it is cracked adhere to the basic fertilizer implementation based on the treatment and filling of brackish water as high as 5 cm. All through the process of life feed growth, the water height was raised to 15 cm until 60 cm [20], [21]. After the growth of life feed lasted for 2-3 weeks, the juvenile milkfish weighed about 0.1200 ± 0.0609 g, stocked with a stocking density of 10 ind/m2. This research was conducted for six weeks.

C. Observed Variable

The variables observed in this research include the identification of plankton carried out at the genera level [22], [23]. This research also covered the abundance of life feed composition bodies calculated using a microscope equipped with SRC (Sedgwick Rafter Counter cell) through modification [24]. This research observed the growth and survival rate of the juvenile milkfish [25], and water quality including dissolved oxygen and temperature (DO meter model YSI650), salinity (hand refractometer), pH (pH meter), BOT (Titrimetry), total nitrogen ammonia - TAN (Phenate method), nitrate (Cadmium reduction method), and phosphate (Ascorbic acid method).

D. Data Analysis

The data collected data based on the growth and survival rate of the juvenile milkfish were analyzed by Analysis of Variance (ANOVA). The analysis of this research applied SPSS program version 21.00 with a Tukey test at a 95% level of confidence. This research also applied descriptive statistics for the composition and the abundance of plankton and water quality data.

III. Result and Discussion

A. Composition and Abundance of Plankton

The number of plankton species obtained during the nursery of milkfish was 43 genera consisting of 27 genera of phytoplankton and 16 genera of zooplankton. The number of species and individuals of phytoplankton is greater than zooplankton. Treatment B and C resulted in 21 genera, respective, as the highest number of phytoplankton species in this research. The phytoplankton resulted in treatment were 20 genera, and the lowest was in treatment D resulted in 17 genera. The highest number of zooplankton genera were obtained in treatment D, as many as 14 genera, then treatment C as many as 13 genera. The lowest was in treatment A and B; they resulted in 12 genera, respectively.

The identified phytoplankton during the rearing of milkfish was *Biddulphia* sp, *Chaetoceros* sp, *Coscinodiscus* sp, *Cyclotella* sp, *Dactyliosolen* sp, *Dinophysis* sp, *Gymnodinium* sp, *Gyrosigma* sp, *Gleotrichia* sp, *Globigerina* sp, *Guinardia* sp, *Gonyaulax* sp, *Hemiaulus* sp, *Leptocylindricus* sp, *Licmophora* sp, *Navicula* sp, *Nitzschia* sp, *Oscillatoria* sp, *Plagiodiscus* sp *Pleurosigma* sp, *Protoperidinium* sp, *Prorocentrum* sp, *Rhizosolenia* sp, *Spirulina sp*, *Thallasionema* sp, *Thallassiorira* sp. While identified zooplankton was *Acartia* sp, Apocyclops sp, *Brachionus* sp, *Colurella* sp, *Echinocamptus* sp, *Euplotes* sp, Nauplii copepod, *Labidocera* sp, *Microsetella* sp, *Oithona* sp, *Polychaeta*, *Temora* sp, *Tortanus* sp, *Tintinnopsis* sp, *Strombidium* sp, dan *Schmackeria* sp.

Here is described the percentages of plankton composition based on the class obtained during the rearing of milkfish. There were 41.86% (18 genera) *Bacillariophyceae* class, 23.26% (10 genera) *Crustacea*, 11.63% (5 genera) *Chromonadea*, 6.98% (3 genera) *Cyanophycean*, 6.98% (3 genera) Ciliata, 4.65% (2 genera) *Rotatoria*, and 2.33% (1 genera) each of *Sarcodina* and *Polychaeta* classes which were the lowest in amount. The dominant type of phytoplankton was *Nitzschia* sp., while the type of zooplankton was dominated by Nauplii copepod as a type of life feed favored by fish. The abundance of phytoplankton genera from the *Bacillariophyceae* and *Chlorophyceae* classes at each observation was because the phytoplankton of the two classes were the main members of phytoplankton found in all waters, both in coastal waters and sea waters [26]. *Bacillariophyceae* class often dominates waters because it is easy to adapt to its environment, resistant to extreme conditions, cosmopolitan, and able to develop rapidly [27]. The crustacean class, especially the copepod group, is the main constituent of the zooplankton community [28]. The application of fertilization affected the abundance of zooplankton in ponds [29]. *Copepod* plays an imperative role in aquatic life since it functions as a primary consumer and a link between phytoplankton and higher trophic levels. Copepod is the main food source for all pelagic fish species. Its abundance and distribution are influenced by physical conditions of waters such as temperature, salinity, and availability of feed, so that its abundance is very volatile according to season and location, and often associated with aquatic fertility [30].

Phytoplankton composition in milkfish ponds consists of 5 classes and 17 genera of phytoplankton, namely *Chlorophyceae* (2 genera), *Cyanophycean* (6 genera), *Bacillariophyceae* (5 genera), *Dinophyceae* (3 genera) and *Euglenophycin* (1 genera) [31]. The composition of plankton found in 2 ponds and lakes as source water [32]. There were 7 classes of phytoplankton, namely *Chlorophyceae*, *Bacillariophyceae*, *Cyanophycean*, *Euglenophycin*, *Conjugatophyceae*, *Dinophyceae*, and *Cryptophyceae*. The leading three sets were phytoplankton, which was dominantly found, each consisting of 17, 9, and 5 genera. Phytoplankton and zooplankton genera obtained in the rearing of milkfish were the Chlorophyceae (6 genera), Bacillariophyceae (7 genera), and Cyanophyceae (1 genera) classes [33]. The Zooplankton consisted of Rotifera (2 genera) and Copepoda (2 genera). The composition of algae found in ponds in Banggi Village, Rembang, consisting of 6 classes [34]. Nineteen genera were consisting of Chlorophyceae (3 genera), Bacillariophyceae (9 genera), Cyanophyceae (4 genera), Desmidiacea (1 genera), Ciliata (1 genera) and Dynophyceae (1 genera).

The results of observations on the peak quantity of individual phytoplankton were resulted in treatment C ranging from 20 to 638 ind/L. This range was followed by treatment A ranging from 6 to 624 ind/L, treatment D ranging from 7 to 587 ind/L, and the minimum number was found in treatment B ranging from 7to419 ind/L (Figure 1). Whereas the highest number of zooplankton was found in treatment A ranging from 34 to 326 ind/L. This number was followed by treatment C ranging from 16 to 239 ind/L, treatment B ranging from 33 to 138 ind/L, and treatment D ranging from 19 to 170 ind/L (Figure 2). The maximum total number of individual plankton gained in treatment A was 1,915 ind/L. This number was followed by treatment C ranging from 1,730 ind/L, treatment D ranging from 1,598 ind/L, and the last amount was found in treatment B ranging from 1,330 ind/L.

The number of individual planktons found in treatment A encompasses a combination of inorganic fertilizers and pond organic solid fertilizer. The composition of nutrients caused this case consist of macronutrients and micronutrients. It is derived from the used fertilizer, which is more comprehensive to strengthen the life feed growth in milkfish ponds. The highest plankton abundance in milkfish ponds in Banggi Rembang Village at 1,600 ind/L was found in the 4th week [34]. The highest phytoplankton abundance using Liquid organic fertilizer with a fertilizer dose of 2 mL/m^3 was equal to 21,667 ind/L, and the peak of abundance occurred on the 12th day [35]. The phytoplankton abundance in the water is inclined by various aspects, for instance, temperature, nutrients, sunlight, pH, dissolved oxygen, and free carbon dioxide. The highest phytoplankton abundance in milkfish ponds in Gresik was equal to 8,425 individuals/L with the application of 8.6 kg N and 2.3 kg P fertilizers [31]. Some plankton genera are abundant in brackish waters, while other genera are abundant in waters with higher salinity. Several circumstances influence these fluctuations, consist of temperature, nutrient concentration, pH, light, weather, disease, fish predation and zooplankton, and competition between species and algal toxins [36].

It was reported that observations of plankton during the intensive rearing of milkfish obtained 28 plankton species consisting of 18 phytoplankton species and ten zooplankton species [37]. Plankton abundance ranges from 10 to 387 ind/L with an average of 54 to 81 ind/L. It was argued that the good or bad growth of phytoplankton bodies in enlargement ponds is controlled by the pond's preparation environment [38]. Fertilizing subgrade will produce the pond base designate fertile to facilitate water plants, primarily blue algae, which could grow well. Fertility will decline by the length of rearing. Therefore, the pond's water fertility ought to be watched to catch on the right time to do re to fertilization. Several factors influence the low plankton abundance because the research takes place in the rainy season to facilitate the intensity of sunlight decreases, and turbidity of pond water is high. This is in line with the opinion of [39] that if the intensity of sunlight is lacking and turbidity occurs in the water, then phytoplankton may not be able to grow well.

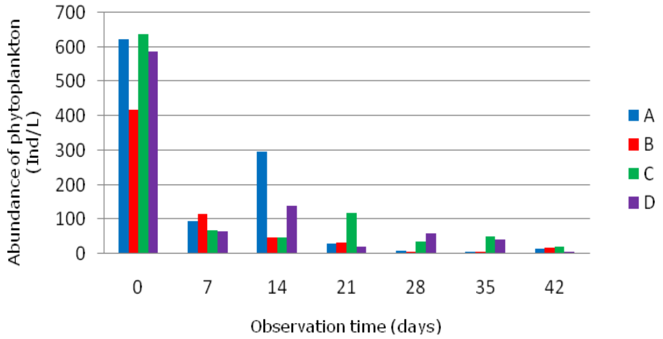

Fig. 1 Phytoplankton abundance of each treatment during 42 days of rearing

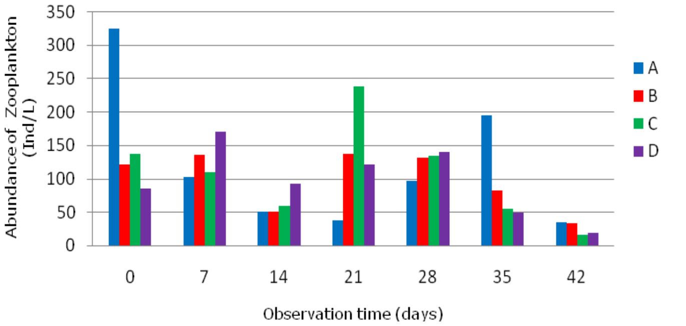

Fig. 2 Zooplankton abundance of each treatment during 42 days of rearing.

B. The Growth Rate of the Juvenile Milkfish

The results of observations on the growth of the final average weight of the juvenile milkfish in day 42 of treatment A was 5.68 g/ind. This number was followed by treatment C reached the 5.25 g/ind, treatment B gained 4.97 g/ind, and the lowest was treatment D that achieved 4.65 g/ind (Figure 3). The ANOVA found that the treatment of different types of fertilizers presented a significant effect ($p<0.05$) on juvenile milkfish growth. The addition analysis (Tukey Test) exposed that milkfish growth in treatment A was in insignificantly different ($p> 0.05$) among treatments B and C. However, the research presented the significant differences resulted in treatment D ($p <0.05$). The higher growth of milkfish in treatment A was caused by the composition of nutrients from the applied fertilizer, which was more wide to ranging (macro and micronutrient) so that it could sustain the life feed growth in a rearing pond.

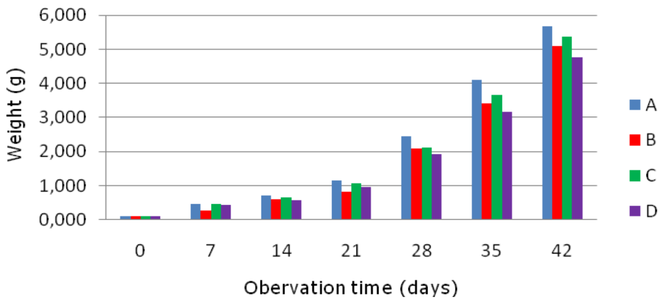

Fig. 3 The growth pattern of the milkfish weight during 42 days of rearing

The absolute growth and daily growth rate of juvenile milkfish that were increased in all treatments showed that life feed grown had been useful for the juvenile milkfish. The amount of life feed gradually decreases with the length of the rearing time. This turned out since the abundance of life feed after the initial stocking until the end of the rearing of milkfish showed a decrease in density as the juvenile milkfish used it as food. Life feed performs a constraint role all through the preliminary rearing period of milkfish as fish are highly dependent on the bodies of the constituent of food [40]. The intestinal contents of milkfish showed that milkfish ate life feed consisting of green algae, green-blue algae, benthic and planktonic organisms, and crustacean larvae [41]. The foremost composition of live feed in milkfish ponds is in unicellular green algae and crustaceans [42]. Some types of life feed that are favored by milkfish include plankton, benthic algae, moss (filamentous algae) with complex community structures [43]–[45]. The level of life feed abundance, especially periphyton concentration in milkfish ponds, steadily decreased once the first month of rearing [46]. The abundant life feed and good quality in nursery ponds is an important factor determining the good growth of juvenile milkfish [47]. Therefore, there are three types of nurseries based on food sources, namely 1) algae, 2) plankton with supplementary feeding, and (3) direct giving of artificial food. The first two are nursery operations that rely on life feed grown on ponds and supplementary feeding; the third only rely on formulated artificial feed.

The growth of the average final weight of the juvenile milkfish obtained in this study ranging from 4.77 to 5.68 g/ind with a growth rate of 0.11 to 0.13 g/day (Table 1). This result was higher than the growth rate of juvenile milkfish from the hatchery ranged from 0.02 to 0.06 g/day with an average of 0.034 g/day [48]. Whereas, the growth rate of juvenile milkfish in nature ranging from 0.02 to 0.05 g/day with an average of 0.03 g/day for 45 to 60 days of rearing. A range of final weight of juvenile milkfish of 2.59 to 4.63 g with growth rates in the nursery phase ranging from 0.07 to 0.13 g/day for 34 to 38 days of rearing [49]. The juvenile milkfish growth rates of 0.06 to 0.10 g/day during 56 days of rearing [50]. The growth rate of juvenile milkfish after 30 days of rearing reaching 0.14 g/day with a density of 5,000 ind/m^2 [51]. The growth rate of juvenile milkfish ranging from 0.20 to 0.42 g/day, which was maintained for 63 days [52]. The high density and rearing system can affect the growth and survival of juvenile milkfish. The growth of juvenile milkfish which were maintained in a tub with a combination of the substrate (soil) and organic fertilizer of chicken manure (0.22 g/day) not significantly different from fish raised on the substrate (soil) and urea fertilizer (0.19 g/day), but significantly different from the control treatment is given artificial feed (0.16 g/day) [53]. This is because the initial stage of milkfish rearing is very dependent on the body of the life feed constituent.

C. Juvenile Milkfish Survival Rate

The juvenile milkfish survival rate in different fertilizer application treatments ranging from 67.9 to 87.66%. The highest survival rate was obtained in treatment A (87.66%, followed by treatment C (86.69%), then treatment B and D, respectively 77.08% and 67.90% (see Table 1). The ANOVA showed that the different treatment types of fertilizers were significantly different ($p<0.05$) on the juvenile milkfish survival rate. The results of further analysis, Tukey Test, it showed that the milkfish survival rate in treatment A was insignificantly different ($p> 0.05$) among treatment B and C, but was significantly different on treatment D ($p<0.05$). The survival of milkfish was the higher rate in treatment A compared to treatment D because of the sufficient life feed to support the life of milkfish during the rearing period.

TABLE I
GROWTH AND SURVIVAL RATE OF MILKFISH FOR EACH TREATMENT DURING 42 DAYS OF REARING

Variable	*Fertilizer treatment types*			
	(A)	(B)	(C)	(D)
Rearing period (days)	42	42	42	42
Density (ind/m2)	10	10	10	10
Initial weight (g/ind.)	0.1200±0.0609	0.1200±0.0609	0.1200±0.0609	0.1200±0.0609
Final weight (g/ind.)	5.6767±0.0903^{a}	5.0853±0.1328^{bc}	5.3720±0.2493^{ab}	4.7670±0.2307^{b}
Absolut growth (g/ind.)	5.5557±0.0903^{a}	4.9653±0.1328^{bc}	5.2520±0.2493^{ab}	4.6470±0.2307^{b}
Daily growth rate (g/day)	0.1323±0.0022^{a}	0.1182±0.0032^{bc}	0.1250±0.0059^{ab}	0.1106±0.0045^{b}
Survival rate (%)	87.66 ±8.9784^{a}	77.08 ±8.1336^{ab}	86.69 ±5,7654^{ab}	67.90 ±5.5007^{b}

Note: The average values in a row go after the same superscript letter indicated are insignificantly different ($P>0.05$)

The survival rate of juvenile milkfish observed in this research was indifferent from some previous research. The average of juvenile milkfish survival rate from hatchery was 61.5%. Whereas, the average survival rate of juvenile milkfish was 62.9% for 45 to 60 days of rearing[48]. The survival rate of milkfish in the nursery phase were ranging from 50 to 60%, with a density of 25 to 50 ind/m^2 [54]. The high survival rate of 71.5% was produced from a density of 75 ind/m^2 by giving the bran feed, and the survival rate of 51.7% was obtained at a density of 50 ind/m2 without the provision of bran feed supplements. There was a 70 to 80% survival of juvenile milkfish in Gresik [55].

Furthermore, it is said that the survival of the juvenile milkfish that provide benefits must be higher than 60% or at least 70%. The juvenile milkfish survival rate was within 68.6% to 81.0% in the nursery phase for 34 to 38 days of rearing [49]. The survival of juvenile milkfish of around 75.5 to 89.2% was maintained at different densities for six weeks of rearing [56]. The survival of juvenile milkfish nursery with different recirculation and circulation systems for one month and obtained survival rates ranging from 89.67 to 94.23% [57]. There was 21% survival of juvenile milkfish, which were grown in a floating net with an average fish weight of 1.7 g/ind for 30 days of rearing with a density of 200ind/m^3 [58]. The juvenile milkfish survival of 78 to 85% for 56 days of rearing [50]. The survival of juvenile milkfish of 80.1 to 80.6% for 120 days of rearing [53]. The survival of juvenile milkfish which were maintained by giving different feeds ranging from 75 to 85% for 92 days of rearing [59]. The survival of juvenile milkfish ranging from 77.5 to 87.5%, which were fed with different protein content for 63 days of rearing [52]. The excessive application of organic fertilizers (chicken manure and fertilizers from agricultural/industrial waste) could cause the death of milkfish due to the accumulation of organic matter at the pond bottom which caused the death of benthic algal communities, dissolution of oxygen and the presence of hydrogen sulfide [60].

Therefore, it is recommended that a lower dose of organic fertilizer should be applied in the pond, especially during the rainy season. Several factors that influence the growth and survival of milkfish in the nursery phase in the pond are 1) life feed (plankton and algae), 2) juvenile density; 3) predation; and 4) sudden changes in environmental conditions [61].

The application of organic fertilizer (pond solid waste and manure) combined with inorganic fertilizers resulted in relatively similar growth response of the biomass of life feed and juvenile milkfish. This is thought to be due to the balance of nutrient content (N, P, K, and organic matter) from the applied fertilizer which could support the growth of live feed, which in the end could be used by milkfish for its growth, especially in the early stages of the rearing. Organic fertilizers are one of the critical components that determine the fertility and productivity of pond waters. Fertilization in the pond aims to grow life feed in the pond. Solid waste of shrimp ponds contains macronutrients and micronutrients required for the *Chlorella* sp growth [62]. The application of fertilizer to aquaculture ponds was carried out to grow life feed in the form of phytoplankton [31]. The use of fertilizers with different N and P ratios for each treatment influenced the abundance and composition of phytoplankton. Fertilized ponds will produce higher phytoplankton abundance compared to ponds that are not fertilized [63]–[65] The abundance of phytoplankton in water is inclined through the content of nutrient of phytoplankton growth, for instance, nitrate, phosphorus, and organic matter [66]. The diversity and loads of phytoplankton in pond water are affected by the content of nutrients if there are no other limiting factors. One of the primary demands of phytoplankton to grow is sufficient nutrients [67], [68].

D. The Quality of Water

The quality of water is crucial since it is one of the sustaining issues on milkfish and life feed growth in ponds. The observation results of water quality parameters during this research were still within the range that was suitable for the growth of live feed and juvenile milkfish (see Table 2). The measurement results of water temperature in each pond through the research ranging from 27.2 to 30.3°C. The range of this temperature was entirely feasible for plankton and milkfish growth. The optimum temperature range for phytoplankton growth is 20 to 30°C [69]. The optimum temperature for milkfish cultivation ranged from 20–43°C [61]. The pond water temperatures during the rearing of juvenile milkfish ranged from 23.9 to 32°C [48]. Water temperatures during the rearing of juvenile milkfish in the ponds ranged from 26.8 to 29.2°C [49]. The water temperatures during the rearing of juvenile milkfish ranged from 26–32°C [50].

TABLE II
RANGE OF WATER QUALITY VARIABLE'S VALUES MEASURED DURING THE EXPERIMENT

Variable	***Different types of fertilizers application***			
	A	**B**	**C**	**D**
Temperature (°C)	28.1 to 29.8	28.3 to 29.7	27.2 to 30.3	28.1 to 30.0
Salinity (ppt)	17 to 27	19 to 27	17 to 27	18 to 27
pH	8.0 to 9.5	8.0 to 9.5	8.0 to 9.5	8.0 to 9.0
DO (mg/L)	2.44 to 5.46	2.09 to 6.71	1.19 to 4.07	2.19 to 5.88
TAN (mg/L)	0.0662 to 0.4283	0.1294 to 0.3026	0.0709 to 0.8301	0.0791 to 0.5814
NO_2-N (mg/L)	0.0010 to 1.4508	0.0010 to 0.2088	0.0010 to 0.3132	0.0010 to 1.5221
NO_3 - N (mg/L)	0.0020 to 1.0329	0.0014 to 0.4602	0.0021 to 0.5925	0.0017 to 0.8291
PO_4 -P (mg/L)	0.0021 to 2.7555	0.0021 to 1.6139	0.0021 to 3.4353	0.0021 to 1.7605
BOT (mg/L)	25.65 to 65.06	30.65 to 65.69	28.15 to 64.44	25.65 to 63.81

The salinity value measured during the study ranged from 17 to 27 ppt. The salinity value was still feasible and able to support the growth of milkfish. Pond water salinity during the rearing of milkfish ranged from 8 to 48 ppt [48]. The temperature, pH, and dissolved oxygen did not significantly influence planktonic (phytoplankton and zooplankton) and phytobenthic (algal) loads at 40 cm of pond depth [70] whereas salinity has a significant effect on loads of phytoplankton and zooplankton. Zooplankton loads peak (rotifer) occurs through the rainy season at the salinity of 27 to 42 ppt.

In contrast, *protozoa* and *copepods* are ample in the dry season, at a maximum salinity of 70 ppt. The water salinity during the rearing of juvenile milkfish in ponds ranged from 27 to 45 ppt [49]. The salinity of milkfish nursery media ranged from 17 to 35 ppt [11]. Milkfish are tolerant to wide salinity (*euryhaline*), ranging from 0 to 158 ppt [71], [45]. The pH value measured during the study ranged from 8.0 to 9.5. The pH values in all treatments were relatively the same. The range of pH values was still feasible and sustainable for the growth of milkfish and live feed. Water with a pH between 6–9 has high fertility, and it is categorized as productive since it could nurture the organic dismantling process into minerals for phytoplankton growth [72]. The pond water pH during the rearing of juvenile milkfish ranged from 5.20 to 8.15 [48]. Water pH during the rearing of juvenile milkfish ranged from 7.4 to 8.2 [50]. The final weight, growth rate, total production, and survival of milkfish, which were better at 15 ppt salinity, compared to 10 ppt and 20 ppt salinity [73]. The pH during the rearing of milkfish ranged from 7.7 to 8.3 [52].

The content of dissolved oxygen gained throughout the research was ranging from 1.01–6.71 mg/L. The dissolved oxygen plays an essential part in milkfish life sustainability in ponds [74]. Milkfish can live at a concentration of oxygen for 1 mg/L, but then milkfish discontinue eating at this point. However, these fish will eat again when the dissolved oxygen is no less than 3 mg/L in water [75]. The dissolved oxygen during the rearing of juvenile milkfish in ponds was ranging from 2.84 to 10.71 mg/L [48]. Milkfish could grow well in dissolved oxygen ranging from 3 to 8 mg/L [53]. The dissolved oxygen level during the rearing of juvenile milkfish in ponds ranged from 2.7 to 4.4 mg/L [49]. The dissolved oxygen point during the rearing of milkfish ranged from 0.8 to 3.9 mg/L [53]

The results of the observation of ammonia content in pond water showed that it was ranging from 0.067 to 0.83 mg/L, the nitrate content was ranging from 0.002 to 1.033 mg/L, and nitrite was ranging from 0.001 to 1.522 mg/L (Table 2). This value could still stand the live feed and milkfish growth. The content of nitrate, phosphate, and chlorophyll increased every week [34]. The nitrate content was ranging from 1.53 to 1.83 mg/L, phosphate was ranging from 0.01 to 0.091 mg/L, and chlorophyll to a was ranging from 3.12 to 5.33 ug/g. The optimum growth for algae was ranging from 0.900 to 3.500 mg/L [76]. The water quality during the rearing of milkfish needed ammonia levels were ranging from 0.1 to 0.97 mg/L; nitrite was ranging from 0.05 to 1.4 mg/L, and nitrates were ranging from 6 to 12.2 mg/L [53]. The ammonia level obtained during the rearing of milkfish ranged from 2.19 to 2.62 mg/L, whereas nitrates were ranging from 0.50 to 0.61 mg/L and nitrate was ranging from 0.69 to 0.74 mg/L [33]. The ammonia levels during the rearing of milkfish were ranging from 0.127 to 0.128 mg/L; nitrite was ranging from 0.138 to 0.193 mg/L, nitrate was ranging from 0.017 to 0.058 mg/L [59]. Ammonia toxicity to milkfish was 21 mg/L [77]. The ammonia levels obtained during the rearing of milkfish was ranging from 0.01 to 0.25 mg/L, while nitrates were ranging from 0.01 to 0.03 mg/L, and nitrite was ranging from 2.15 to 3 to 20 mg/L [52].

The measurement results of phosphate throughout milkfish rearing was ranging from 0.002 to 3.435 mg / L. The p for overall value in brackish water ponds were ranging from 0.62 to 5.88 mg/L [31]. Phosphorus content in water is inclined since phosphorus contains some materials, for instance, phosphorus fertilization (SP fertilizer). The least limit of phosphate concentration for optimal algae growth was ranging from 0.018 to 0.090 mg/L P-PO_4, and the uppermost limit was ranging from 8.90 to 17.8 mg/L P-PO_4, if nitrogen is in the form of nitrate. If N is in the form of ammonium, the maximum limit is 1.78 mg /L P-PO_4 [15]. The more materials containing phosphorus in the waters, the higher the phosphorus content in the waters. Phosphorus content in the water will be reduced due to the use of phosphorus by phytoplankton and aquatic plants. Phosphorus content in waters is relatively small because most of the ponds are absorbed by sediment [72]. The suitable environmental elements are required for the algae optimal growth, such as nitrate and phosphate content, temperature, water depth, brightness, salinity, acidity, and soil texture [34]. If the environmental elements/ conditions are not appropriate, the growth of the algae and milkfish will be hampered.

Based on the measurement results, the total organic matter in the ponds during the nursery of milkfish ranged from 25.65 to 65.69 mg/L. This value can still be tolerated by milkfish. The content of organic matter in water during the rearing of milkfish can reach 37.30±6.592 mg/L in the application of non-commercial organic fertilizers [78]. It seems that this result is not much different from the use of commercial organic fertilizers, which reached 39.68±6.846 mg / L. Furthermore, it is stated that waters with dissolved organic matter above 26 mg/L belong to fertile waters.

IV. CONCLUSION

This research focused on the application of super-intensive solid waste of shrimp pond as organic fertilizer merged with inorganic fertilizer made plankton loads, growth, and survival rate of juvenile milkfish. What is produced in this research was better than what is produced by the application of commercial organic fertilizer. The solid waste of super-intensive shrimp ponds is the potential as a substitute for organic fertilizer in ponds with an extensive setting.

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