Potential, Characteristics and Utilization of Shrimp Pond Solid Waste as Organic Fertilizer
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Abstract—The study aimed at determining the potential, characterization and utilization of super-intensive shrimp pond solid waste as a raw material for organic fertilizer, and its application in fisheries and agriculture. It was conducted at Experimental Pond Installation, Research Institute for Coastal Aquaculture and Fisheries Extension located in Punaga Village in South Sulawesi. The research involved 3 of 1,000 m2 concrete ponds for 105 rearing period days and entailed the stocking density of 750-1,250 shrimp/m2. The observation was carried out in the sediments on a wastewater treatment plant (WWTP) with 7,000 m2. The variables observed in this study included sedimentation rate, total sediment, and estimation of total nutrient in the contents of solid waste such as C-organic N total, P2O5, K2O, pH, water content and C/N ratio. The results showed total sediment in the following stocking 750, 1000 and 1,250 vaname shrimp/m² weighed 18.2, 20.3 and 21.9 tons respectively. During the shrimp cultivation, TN, TP and C accumulated in sediments increased, resulting to an upsurge in stocking density. Therefore, the solid waste may potentially be used as organic fertilizer because it has a fairly high nutrient content such as N total of 0.58%, P2O5 by 3.33%, K2O by 0.8%. C-organic by 9.94%, pH 6.73, water content of 16.36% and C/N ratio by 17.14%.

Keywords—solid waste, organic fertilizer, super intensive, pond.

I. INTRODUCTION
The intensive and super-intensive cultivation of shrimp decreases the quality of coastal waters in several countries, including Thailand (Hazarika et al. 2000, Lorenzen et al. 1997), Vietnam (Bui et al. 2012) and Mexico (Barraza-Guardado et al. 2013). Furthermore, it produces large amounts of waste. The waste is often in form of stool, leftover feed and dead organisms accumulating discharged directly into the water without treatment. One problem frequently faced by shrimp farmers is the low sources of nutrients. Furthermore, the waste leads to the eutrophication, oxygen depletion, and precipitation (Saputra et al. 2017). The aquaculture waste produced was also pollute the aquatic environment and should be addressed immediately. It can be in form of digestive remnants at the bottom of the pond, and this may cause problems such as high amount of nitrogen and phosphorus discharged into the water (Lacerda et al., 2006). These elements may be consumed and retained in fish meat at about 25%-30%, and the remaining amount released in the aquatic environment (Avnimelech, 2000).

The high stocking density used in the super-intensive shrimp culture system was expected to be followed by an increase in production, proportional to the aquaculture waste produced. According to Syah et al. (2017), the main problem in the super-intensive pond wastewater is the large number of particles of organic matter. It consists of shrimps’ feces, non-inedible feed, shrimp palm oil, and dead plankton which settles at the bottom of the pond, along with high N and P content which potentially increase the fertility of waters. The wastewater with stocking density of 750-1,250 shrimps/m² contains a total suspended solid (TSS) average of 798-924 mg/L, the dissolved organic matter by 81,227-88,641 mg/L, the total nitrogen (TN) of 9,838-14,426 mg/L, and total phosphate (TP) by 7.8770-11,8720 mg/L (Fahrur et al. 2015). These values have exceeded the permitted standards and therefore has the potential to negatively impact the quality of the water bodies. According to Preston et al. (2001) the sludge formed during the cultivation process may reach 35-60 t/ha/shrimp production cycle. Furthermore, Boyd (1992) also reported the organic materials accumulating in form of sediments increase with age. In the end, the thickness of the organic material obtained was 6.4 - 8.5 cm. According to Avnimelech and Rivto (2003), the pond sediments are rich in nutrients and organic matter. The solid waste of shrimp ponds contain 1.92% C organic materials, 0.54% N total and 1.70% P (Tungguda et al. 2015). The high content of nitrogen and phosphorus makes the sediments effective materials for organic fertilizers.
The production of organic fertilizers from solid waste and their subsequent use for crop production as well as land rehabilitation are highly recommended. They help in reducing volumes and environmental degradation, apart from increasing the agricultural land productivity (dela Cruz et al. 2006). Further, it is environmentally friendly since it is an organic source (Guardian, 2004; Fadare et al. 2009; Adeoye et al. 2005). The, organic fertilizers also improve soil texture, water retention and erosion resistance. Besides, they provide nitrogen in a usable form, which help to increase the plants growth, and cannot cause the death of the beneficial microorganisms in the soil (Sharma and Chetani, 2017). Moreover, the production of organic fertilizers provides the agronomic effectiveness, it is affordable to farmers, environmentally friendly, and increases food production and security (Babalolaa et al. 2012).

The research on composting various types of organic waste shows different performances depending on the processes used. Composting is a treatment which significantly reduce the volume of the existing leftover. Besides, it can provide suitable nutrients for agriculture and fisheries as well as being used as substitutes for chemical fertilizers. Furthermore, it may be used as a land amendment, environmentally friendly, hygienic, economical and free of toxic materials (Kadir et al. 2016). For the reason, this study aimed at evaluating the potential, characteristics and utilization of solid waste of super-intensive shrimp cultures.

II. METHODS AND MATERIAL

The research was conducted at the Experimental Pond Installation, Research Institute for Coastal Aquaculture and Fisheries Extension, located in Punaga Village, Mangarabombang District in South Sulawesi. The observation of sedimentation rate, total sediment count and estimation of total nutrient load made reference to the study by Suwoyo et al. (2015). The reference study was carried out on the 3 plots of 1,000 m² of super-intensive ponds, the Post Larva size (PL-10) scattered with the vaname shrimp (L. vannamei) and a stocking density by 750-1,250 shrimp/m². The measurement of the sedimentation rate and the amount of sediment at the bottom of the pond was carried out by installing the sediment traps made of 4 inch paralon pipes with a length of 40 cm. The deposit collection was carried out once a week and the sedimentation rates was calculated based on the equation by Syah et al., (2004). Estimating the total nutrient load (TN, TP and C) in the sediment referred to the method developed by Ackefors & Enell (1990) in Barg (1992) and Syah et al. (2014).

The observation of solid waste characterization from the cultures was conducted on a wastewater treatment plant (WWTP), ± 7,000 m² by collecting the pond left-over sediments. The collection was carried out at the end of the rearing period. The variables observed include the macro-nutrient content such as C-organic. N total. P2O5, K2O, pH water content and C/N ratio. The results of the nutrients’ observation were tabulated and analyzed descriptively and compared to the quality requirements of organic fertilizers on the Minister of Agriculture Regulation No.70 / Permentan / SR.140 / 10/2011. To obtain more information on the potential utilization of shrimp pond solid waste, the results of several previous studies were analyzed descriptively.

III. RESULTS AND DISCUSSION

Potential of super-intensive shrimp ponds solid waste

Sedimentation in ponds occur due to the deposition process of organic particles, both stemming from the remaining feed, shrimp stool, plankton or other dead organisms, and mud particles carried to the sea. According to Hopkins et al. (1994), the sources of sediment accumulation in shrimp ponds include non-inedible feed, feces, and dead and decaying plankton/diatom. Furthermore, the erosion of pond soil and microorganisms is part of the sediment. According to Syah et al. (2006), based on the estimated sedimentation rate from the installation of sediment traps, the amount of residues during rearing period of vanname shrimp may be determined.

The total sediment analysis in solid stocking of 750, 1000 and 1,250 shrimps/m² were 18.2, 20.3 and 21.9 tons for 105 days rearing period (Table 1). The solid waste may potentially be used as organic fertilizer. From the results of Lacerda et al. (2006), shrimp farming in Australia estimated the number of N and P produced to 290 and 16 kg / ha / year. Other estimates include: California with N and P produced being 112 and 32 kg / ha, and Indonesia where N and P produced from the intensive and traditional ponds reached 399 and 37 kg / ha / year (Nur, 2011). According to Syah et al. (2014), at the farm productivity level of 6,376 kg / 1000 m², the TN, TP, and C organic waste loads amount to 50.12 gTN / kg of shrimp respectively; 15.73 gTP / kg shrimp and 126.85 g C organic / kg shrimp. Whereas in the pond productivity of 8,407kg / 1000 m², TN, TP and C organic waste loads are 43.09 gTN / kg shrimp respectively; 14.21 gTP / kg shrimp; and 112.85 gC organic / kg shrimp.
During cultivation, TN, TP and C organic accumulated in each sediment of 303 kgTN; 263 kgTP and 2,082 kgC for solid stocking 750 shrimp / m² with the density of 1000 shrimp / m² each 325 kgTN; 253 kg and 2,042 kgC organic. The stocking densities was higher, 1,250 shrimp / m² each 362 kgTN; 299 kgTP and 2,334 kgC organic (Table 1). From the table, it is evident the increase in nutrients in the sediment is in line with the rise in the density of the stocked shrimp, the amount of feed given, and the total quantity of sediment produced. This is also in agreement with Lemonnier & Brizard (2001) who reported a correlation between the level of sediment accumulation and the shrimp density at 13 pond plots in New Caledonia. According to Suwoyo et al. (2009), there is a positive correlation between the amount of sediment and the final density of vaname shrimp and the total amount of feed. Shrimp density and the amount of feed contributed 58.3% in determining the amount of sediment in the intensive shrimp vaname ponds. The remaining 41.7% was attributed to other factors.

TN, TP and C are the wastes found in form of organic particles. Most of them are part of the load of waste originating from feed and organic matter formed during the cultivation process. According to Chien et al. (1989) sediment plays an important role in the balance of aquaculture systems, functioning as a buffer in the concentration of water nutrients. The sedimentation process plays an important role in the mechanism of P loss in ponds because mud is known to have a strong affinity for phosphorus (Shrestha and Lin. 1996). The high organic matter content, nitrogen and phosphorus in the sediment making are potential organic materials for fertilizer, where previously it was necessary to reduce salinity in the dredge itself.

Mueno et al. (2014) estimated the potential of organic fertilizer from 16 plots of aquaculture ponds (200 m²) in semi-intensive tilapia to be 173 tons of sediment / ha / cycle. It has nutrients with the potential to meet the needs of nitrogenous fertilizers for 0.35-1.2 hectares and potassium fertilizers for 0.7-1.5 hectares. Besides, the accumulation of sediments containing 1.8-5 tons of organic matter with a high potential to improve soil quality. It is rich in nitrogen, potassium and organic ingredients with high potential for nitrogen and potassium fertilizers and serve as a soil conditioner. According to Rahman et al. (2002), the value of sediment fertilizers from one hectare of tilapia production ponds is equivalent to 6.26 tons of urea and 1.96 tons of TSP. Rahman et al. (2004) show the high content of organic sediment ponds may play a major role in obtaining information on soil aggregates. Therefore, it will improve the soil quality, physical and chemical conditions, and facilitate crop production.

From Syah et al. (2006), based on the estimated sedimentation rate obtained from the installation of sediment traps, the amount of deposit during the rearing period of vaname shrimp may be determined. The quantity of sediment obtained in vaname shrimp cultivation with a density of 50 / m² and the treatment of 2, 3 and 4 paddle wheel are 2,829 kg; 3,120 kg and 3,154 kg. Suwoyo et al. (2009) obtained a sedimentation rate in vaname shrimp farming ponds with a density of 50 shrimp / m² by 6.89 - 142.71 g / m² / day with sediment counts ranging from 676.39 - 1262 kg / plot / cycle. Preston et al. (2001) states that the increase in solid waste in the cultivation system must be prevented since it can cause a decrease in dissolved oxygen and increase ammonia levels due to the decomposition of organic matter which is toxic. Therefore, the formed disposal of the sludge needs to be carried out periodically.

**Macro and micro nutrients contents of super-intensive ponds solid waste**

From the results, both macro and micro nutrients from the solid waste may possibly be used as organic fertilizers. They have high for example: total N 0.58%, P₂O₅ 3.33%, K₂O 0.82%, C-organic 9.94%, pH 6.73, water content 16.36%, and C/N ratio 17.14 (Table 2). They have contents which meet the requirements of organic fertilizer on the Minister of Agriculture Regulation No.70 / Permentan / SR.140 /10/2011, and therefore the solid waste may be used as organic fertilizer.

**Table 1: Nutrient load in vaname superintensive shrimp pond sediments**

| Variable                        | Stocking density (shrimp/m²) |
|---------------------------------|------------------------------|
|                                 | 750                          | 1,000                        | 1,250                        |
| Shrimp production (tons)        | 7.86                         | 10.70                        | 12.16                        |
| Sedimentation rate (g/cm²/day)  | 1.62                         | 1.81                         | 1.96                         |
| Total sediment (tons) dry weight| 18.2                         | 20.3                         | 21.9                         |
| TN sediment (kg)               | 303                          | 325                          | 362                          |
| TP sediment (kg)               | 263                          | 253                          | 299                          |
| C organic sediment (kg)        | 2.082                        | 2.042                        | 2.334                        |

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The results of the analysis were not different from previous studies. For instance, according to Latt et al. (2002), shrimps’ waste have high value of organic matter, total nitrogen, and phosphorous compared to normal soil. The pond waste has high biological and chemical oxygen requirements. The condition shows the high loading of nutrients which require treatment right before they are disposed. The characteristics of sludge depend on a number of factors including: the design and type of pond cultural system, farm management, and inputs used. The assertion is in line with Muendo et al. (2014) that pond solid waste is rich in nitrogen, potassium, and organic matter.

The sludge compost contains the organic matter 530 g / kg. N 25.8 g / kg. P 7.3 g / kg and K 4.8 g / kg. pH 7.2, water content 23.86% (Chongrak. 1996; Rahman et al. 2004). Whereas the fish pond sediments contain C 49.81-62.0 g / kg; N 2.80 g / kg; P 0.07-0.011 g / kg and K 0.51 g / kg; pH 7.2-8.2; water content of 47-50%. (Rahman et al. 2002; Avnimelech et al. 1999). From Karabcova et al. (2015), the average macro concentration and micro elements in sludge or solid waste organic fertilizer is P 6.447 mg / g; K 27.595 mg / g; Ca 25.948 mg / g; Mg 10.637 mg / g; Cd 0.11 mg / g; Zn 295 mg / kg; Co 2.35 mg / kg; Cu 36.3 mg / kg and C 35% and C / N in the ratio around 8.2-8.5. Meanwhile, compost organic fertilizer contains P 2.535 mg / kg; K 4.120 mg / kg; Ca 21.387 mg / kg; Mg 3.687 mg / kg; Cd 0.24 mg / kg; Zn 195 mg / kg; Co 1.19 mg / kg; Cu 20.4 mg / kg and C 52% and C / N in ratio ranging from 8.1-8.2. The results of the research conducted by Komarayati and Pasaribu (2005) showed the organic fertilizers have nutrient contents as follows: Water 29.5%; pH 6.70; CEC 31.74 meq / gr; C / N 32.00 ratio; C 23.6%; N 0.9%; P 0.4%; K 0.5%; Mg 0.6% and Ca 19%. Texture was in form of 0.10% sand; 59.6% dust and clay 40.2%. Komarayati (2007) further reported the characteristics of organic fertilizer plus sawdust charcoal as follows: moisture content 32.90-39.40%; pH 6.70-6.90; C/N ratio of 18.70-23.70; Organic C 24.17-28.26%; N 1.19-1.29%; P2O5 total 0.53-0.63%; Total CaO 0.27-0.34%; MgO total is 0.26-0.27%; K2O total 0.63-0.68% and CEC 29.34-32.44 meq / 100 g. Rina et al. (2002) showed the characteristics of the physical properties of IPAL sludge in the paper industry having a clay texture of 64% and a dust texture of only 20%.

The macro and micro nutrient content in solid waste of vaname shrimp ponds according to Tangguda et al. (2015a) are: C organic 30.670 g / 100 g; N total 8,842 g / 100 g; P2O5 12,700 g / 100 g; K2O 7,730 g / 100 g; Fe 166.93 mg / 100 g; Cu 25.92 mg / 100 g; Zn 55.37 mg / 100 g; Mn 63.30 mg / 100 g; B 29.41 mg / 100 g; Co 22.43 mg / 100 g; and Mo 53.53 mg / 100 g.

The results of the C / N analysis of the ratio of pond waste obtained were 26. According to Rosen et al. (1993), the C / N ratio of around 15-20 is ideal for compost ready for use. Mature compost has a C / N ratio of less than or equal to 25 (Oreopoulou and Russ 2007). Nagasaki et al. (1992) proposed a C / N ratio for composting should be in the range of 16 to 21. The macro nutrients, C organic, and moisture content of some organic fertilizers compared to super-intensive pond organic fertilizer are presented in Table 3. It is evident the nutrient content of super-intensive organic fertilizer waste is not much different from other organic fertilizer.

| No | Parameters   | Value | Quality Standard of Organic Fertilizer on the Minister of Agriculture Regulation No.70/Permentan/SR.14010/10/2011 |
|----|--------------|-------|--------------------------------------------------------------------------------------|
| 1  | N-Total (%)  | 0.58  | Hara Macro                                                                           |
| 2  | P2O5 (%)     | 3.33  | Min 4 % (N+ P2O5+ K2O)                                                               |
| 3  | K2O (%)      | 0.82  |                                                                                     |
| 4  | pH           | 6.73  | 4.9                                                                                 |
| 5  | C/Organic (%)| 9.94  | Min 15                                                                               |
| 6  | Water content (%) | 16.36 | 15-25                                                                                 |
| 7  | C/N ratio    | 17.14 | 15-25                                                                                |
| 8  | Fe (ppm)     | 7736  | Maximum 9000                                                                         |
| 9  | Mn (ppm)     | 836   | Maximum 5000                                                                         |
| 10 | Cu (ppm)     | 20.60 | Maksimum 5000                                                                        |
| 11 | Zn (ppm)     | 84.00 | Maximum 9000                                                                         |
| 12 | Pb (ppm)     | 43.81 | Maximum 50                                                                           |
| 13 | Cd (ppm)     | 2.11  | Maximum 2                                                                            |
| 14 | Co (ppm)     | 26.98 | Maximum 700                                                                          |

Table 2: Nutrient contents in solid waste from super-intensive white shrimp (Litopenaeus vannamei) ponds

The following table shows the nutrient contents as follows: Water 29.5%; pH 6.70; CEC 31.74 meq / gr; C / N 32.00 ratio; C 23.6%; N 0.9%; P 0.4%; K 0.5%; Mg 0.6% and Ca 19%. Texture was in form of 0.10% sand; 59.6% dust and clay 40.2%. Komarayati (2007) further reported the characteristics of organic fertilizer plus sawdust charcoal as follows: moisture content 32.90-39.40%; pH 6.70-6.90; C/N ratio of 18.70-23.70; Organic C 24.17-28.26%; N 1.19-1.29%; P2O5 total 0.53-0.63%; Total CaO 0.27-0.34%; MgO total is 0.26-0.27%; K2O total 0.63-0.68% and CEC 29.34-32.44 meq / 100 g. Rina et al. (2002) showed the characteristics of the physical properties of IPAL sludge in the paper industry having a clay texture of 64% and a dust texture of only 20%.

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| No | Type of fertilizer                                      | N-total (%) | P₂O₅ (%) | K₂O (%) | C-organic (%) | C/N ratio | Water content (%) | References                                      |
|----|--------------------------------------------------------|-------------|----------|---------|---------------|-----------|-------------------|------------------------------------------------|
| 1  | Chicken manure                                         | 1.17        | 2.08     | 8.58    | 7.16          | 6.1       | 13.01             | Suriadikarta and Setyorini. (2005)              |
| 2  | Fine compost                                            | 0.68        | 0.77     | 0.06    | 5.04          | 7.4       | 46.43             | Suriadikarta and Setyorini. (2005)              |
| 3  | Bokasi                                                  | 0.73        | 6.13     | 3.25    | 9.39          | 12.9      | 43.86             | Suriadikarta and Setyorini. (2005)              |
| 4  | Compost                                                 | 0.37        | 0.09     | 8.95    | 8.95          | 14        | 62.86             | Suriadikarta and Setyorini. (2005)              |
| 5  | Organic fertilizer from Pulp-Mill Sludge                | 1.19        | 0.53     | 0.63    | 24.17         | 18.70     | 32.90             | Komarayati. (2007)                              |
| 6  | Compost of succulent plant                             | 1.22        | 0.32     | 1.70    | 12.2          | 10        | 12.3              | Janakiram and Sridevi (2010)                    |
| 7  | Aquaculture sludge                                     | 0.49        | 0.44     | 1.53    | 21.9          | 25.67     | -                 | Birch et al. (2010)                            |
| 8  | Compost oil palm empty fruit bunches                   | 2.7         | -        | 0.03    | 38.5          | 13.8      | 49.3              | Wan Razali et al. (2012)                       |
| 9  | Organic Household Waste                                | 1.9         | 0.95     | 1.2     | 11.7          | 14        | 2.78              | Nino et al. (2012)                             |
| 10 | Compost of pineapple leaves                            | 2.3         | 0.46     | 2.67    | 45.8          | 19.8      | 53.3              | Ch'ng et al. (2013)                            |
| 11 | Municipal solid waste compost                          | 0.85        | 2.52     | -       | 15.95         | 18.99     | 23.83             | Rawat et al. (2013)                            |
| 12 | Solid waste compost                                    | 1.75        | 2.4      | 0.57    | 25.5          | 14.67     | 44                | Manohara. and Belagali. (2014)                  |
| 13 | Food wastes compost                                    | 3.56        | 1.12     | 2.03    | 40            | 11.23     | -                 | Okareh et al. (2014)                           |
| 14 | Compost of plant residues                              | 0.65        | 0.003    | 0.36    | -             | -         | -                 | Taleb et al. (2014)                            |
| 15 | Cattle manure                                           | 0.95        | 0.31     | 0.27    | 16.6          | 17.47     | 58.3              | Khater. (2015)                                 |
| 16 | Herbal plant residues                                  | 1.13        | 0.32     | 0.51    | 20.93         | 18.52     | 16.20             | Khater. (2015)                                 |
| 17 | Sugar cane plant residues                              | 1.68        | 1.13     | 2.11    | 23.89         | 14.22     | 36.20             | Khater. (2015)                                 |
| 18 | Treated POME sludge                                    | 4.21        | 0.08     | 0.03    | 25.53         | 6.35      | 68.46             | Khairuddin et al. (2016)                       |
| 19 | Solid waste from White Shrimp                          | 0.54        | 1.70     | -       | 1.92          | 3.55      | -                 | Tangguda et al. 2015                           |
| 20 | Solid waste from Freshwater prawn                      | 0.14        | 5        | -       | 1.38          | 9.9       | -                 | Wudtisin & Boyd (2006)                         |
| 21 | The compost leachate                                   | 1.72        | 2.60     | 1.75    | 32            | 18.60     | -                 | dela Cruz et al (2006)                         |
| 22 | Shrimp pond solid waste                                | 0.46        | 6.25     | 0.25    | 6.36          | 13.82     | -                 | Rachman et al. 2015                            |
| 23 | Solid waste using vermicomposting                      | 0.99        | 0.24     | 0.45    | 16.3          | 16.46     | -                 | Londe and Bhosale (2015)                       |
| 24 | Compost                                                | 0.60        | 1.43     | 0.58    | 7.90          | 13.93     | -                 | Jigme et al.                                   |
Potential use of waste as organic fertilizer

The use of solid waste as organic fertilizer has been analyzed in several studies. This is because the sediment accumulating in the ponds are rich in nitrogen, potassium and organic ingredients. (Rahman and Yakupityage. 2006: Muendo et al. 2014)

In fisheries, pond solid waste can be used for growing mangroves, for natural food growth and clumps, and for seaweed growth fertilizers. According to Latt et al. (2002), the waste has a positive effect on the growth of several mangrove species. For example, mixing soil and pond waste in a ratio of 75% of farm waste and 25% of land may increase the growth of Rhizophora mucronata, Rhizophora apiculata and Bruguiera cylindrica. From Elfrida (2012), the content of N, P and K may be used as an input for plankton growth, basing his argument on the analysis of the content of organic and inorganic compounds from solid waste floating net cage cultivation in Maninjau Lake. Zahidah. (2012) show the application of solid waste fertilizer from Floating Net Cages at a dose of 10 g / L resulted in the highest populatio
tion of Daphnia sp. compared to other treatments (Fadlil et al. 2013). According to Tangguda et al. (2015a), solid waste shrimp ponds contain macro and micro nutrients needed for the growth of Chlorella sp, and using them at a dose of 2 g / L showed the highest cell density (2,333 cells / ml), rapid specific growth rate (0.7677) and high chlorophyll content (89.0568 mg / ml) (Tangguda et al. 2015b). From Suwoyo et al. (2016), the use of solid waste as a single organic fertilizer at the dosage of 2,000 kg / ha and its combination with inorganic fertilizer resulted in the production of lab-lab biomass and the survival of milkfish fingerling, which were not very different from commercial organic fertilizer. Joesting et al. (2016) used solid waste from aquaculture in the production of Spartina alterniflora and Juncus roemerianus seedlings. The results of this study indicate that J. roemerian is a suitable plant species which can be used for remedy purpose on solid waste from marine aquaculture activities. Additionally, Saputra et al. (2017) show solid waste shrimp farms may be used as fertilizer for macro algae growth of Caulerpa lentillifera type to support the development of C. lentillifera by 6 g / L. In addition, from Kamrunnahar et al. (2019), organic wastes from food provides higher growth of Moina macrocopa density than manure from chicken, pig and cattle farms. Moina macrocopa may be used as a larval feed for Pagrus major fish, red sea bream and as a substitute for Artemia.

According to Yeasmin (2011), the use of pond sediments to produce high number of leaf strands in maize plant showed better results than normal soil or its combination with pond sediments (ratio 1: 1). The use of pond sediments will reduce the cost of fertilizer and improve farmland conditions. Pond sediments include stable organic matter which is easily biodegradable and have a high potential to provide N, P, K. These are macro and micro elements which may be used well when combined with inorganic fertilizers. Therefore, the sediment should not be removed but analyzed and utilize its nutritional content.

The results of the study showed chili and watermelon planted in growing media with an additional 20% of pond waste (a ratio of 80% of land and 20% of pond waste) grew in a normal way (Figure a). The addition of 10% of pond waste (comparison of 90% of soil and 10% of pond waste) led to a better growth of chili plants (Treatment 100%: 0%). Interestingly, the same observation was made on watermelons which gave a relatively better growth response to the growing media when added a solid waste of about 30% (ratio of 70% soil and 30% pond waste) (Figure b).

| Potential use of waste as organic fertilizer | 25 | Spent Mushroom Compost (SMC) | 0.98 | 0.80 | 0.28 | 14.7 | 15 | - | Kwagyan and Odamten (2018) |
|---|---|---|---|---|---|---|---|---|---|
| | 26 | Poultry feather waste (PFW) | 4.0 | 0.50 | 0.40 | 20.82 | 5.21 | - | Joardar and Rahman (2018) |
| | 27 | Solid waste from Superintensive Shrimp pond | 0.58 | 3.33 | 0.8 | 9.94 | 17.14 | 16.36 | This Research |
The use of agricultural and other organic wastes has been analyzed by several studies. For instance, Dela Cruz et al. (2006) suggested the use of organic matter show enormous potential in the production of sandy vegetables such as lettuce, eggplant and tomatoes. According to Abayomi and Adebayo (2014), the use of organomineral fertilizers (organic fertilizers combined with minerals) have a significant effect on the parameters (Amaranthus sp) such as height, number of stalks, and higher production in spinach plant compared to the use of NPK fertilizer and compost manure (without fertilizer).

The results obtained are the same as those of Akanni et al. (2011), Ayeni (2008), and Ogunlade et al. (2011), which established a combination of organic fertilizers and minerals provided better production performance in tomato plants, corn and eggplant (Solanum macrocarpon). According to Jigme et al (2015), the use of a combination of compost and 200 mL of dung (CMT) provides the best manure which facilitates vegetative growth of broccoli (Brassica oleracea). Similarly, Naveed et al. (2018) reported that the use of organic waste from the agricultural industry may support the growth and bioavailability of Zn in corn plants. According to Kwagyan and Odamtten (2018), the use of mushroom waste compost with a ratio of 10% SMC and 90% soil was the best medium for supporting optimum vegetative growth in tomato and pepper plants. It was also (Spent Mushroom Compost. SMC) reported by Polat et al. (2009) for cucumber cultivation (Cucumis sativus L), Altindal, and Altindal (2015) for the growth of potatoes (Solanum tuberosum L) and large chili (Capsicum annuum) (Roy et al. 2015). It showed the best growth performance in plant height, number of branches, production results and overall development. Besides, SMC is thought to play an important role in mobilizing phosphate from the soil through roots to the leaves.

IV. CONCLUSIONS

From the results, it was concluded that solid waste of super-intensive shrimp culture has a high potential to be used as a raw material for organic fertilizer. It has a high nutrient content, such as total N 0.58%, P₂O₅ 3.33%, K₂O 0.8%, C-organic 9.94 %, pH 6.73, water content 16.36%, and C/N ratio 17.14. Therefore, it may be applied as an organic fertilizer in fisheries and agriculture.

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