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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 m^2 concrete ponds for 105 rearing period days and entailed the stocking density of 750-1,250 shrimp/m^2. The observation was carried out in the sediments on a wastewater treatment plant (WWTP) with 7,000 m^2. 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. P_2O_5. K_2O. pH, water content and C/N ratio. The results showed total sediment in the following stocking 750, 1000 and 1,250 vaname shrimp/m^2 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%. P_2O_5 by 3.33%. K_2O 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). Furthemore, 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/ m^2 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 9.8389-14.4260 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 environmental 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, environmental 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 m^2 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/m^2. 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 m^2 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. P_2O_5, K_2O, 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 vaname shrimp may be determined.

The total sediment analysis in solid stocking of 750, 1000 and 1.250 shrimps/m^2 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 m^2, 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 m^2, 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.

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Tabel.1: Nutrient load in vaname superintensive shrimp pond sediments

Variable	Stocking density (shrimp/m^2)		
	750	1.000	1.250
Shrimp production (tons)	7.86	10.70	12.16
Sedimentation rate (g/cm^2/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

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 / m^2 with the density of 1000 shrimp / m$_2$ each 325 kgTN; 253 kg and 2,042 kgC organic. The stocking densities was higher, 1,250 shrimp / m^2 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.

Muendo et al. (2014) estimated the potential of organic fertilizer from 16 plots of aquaculture ponds (200 m^2) 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 / m^2 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 / m^2 by 6.89 - 142.71 g / m^2 / 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%, P_2O_5 3.33%, K_2O 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.

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Table.2: Nutrient contents in solid waste from superintensive white shrimp *(Litopenaeus vannamei)* ponds

No	Parameters	Value	Quality Standard of Organic Fertilizer on the Minister of Agriculture Regulation No.70/Permentan/SR.140/10/2011
1	N-Total (%)	0.58	Hara Macro
2	P_2O_5 (%)	3.33	Min 4 % (N+ P_2O_5+ K_2O)
3	K_2O (%)	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

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 phosphorus 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 / kg; K 27,595 mg / kg; Ca 25,948 mg / kg; Mg 10.637 mg / kg; Cd 0.11 mg / kg; 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 1.9%. 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%; P_2O_5 total 0.53-0.63%; Total CaO 0.27-0.34%; MgO total is 0.26-0.27%; K_2O 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) ie are: C organic 30,670 g / 100 g; N total 8,842 g / 100 g; P_2O_5 12,700 g / 100 g; K_2O 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.

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Tabel.3: Comparison of macro nutrient content, C-Organic and the water content of several examples of organic fertilizers with solid waste of superintensive shrimp farm

No	Type of fertilizer	N-total (%)	P_2O_5 (%)	K_2O (%)	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 resdiues	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	-	Londhe and Bhosale (2015)
24	Compost	0.60	1.43	0.58	7.90	13.93	-	Jigme et al..

								(2015)
25	Spent Mushroom Compost (SMC)	0.98	0.80	0.28	14.7	15	-	Kwagyan and Odamtten (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**

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 Yakupitiyage. 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 population of Daphnia sp. According to Fitri (2012), the solid sediments from Maninjau Lake can be used as fertilizer to increase the production of natural feed (*Chlorella* sp.). The use of Lake Maninjau sediment fermentation as an organic fertilizer at a dose of 5 g / L gives the best growth 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 / m3) (Tangguda et al. (2015b). From Suwoyo et al. (2016), the use of solid waste as a single organic fertilezer 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 fertilezer. 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 lentiilifera* 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).

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Fig.1: Application of solid waste super-intensive shrimp ponds on chilli (a) and watermelon plants (b)

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%, P_2O_5 3.33%, K_2O 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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REFERENCES

[1] Abayomi. O.A.. and O.J. Adebayo., 2014. Effect of Fertilizer Types on the Growth and Yield of *Amaranthus caudatus* in Ilorin. Southern Guinea. Savanna Zone of Nigeria. *Advances in Agriculture* Volume 2014. Article ID 947062. 5 p . http://dx.doi.org/10.1155/2014/947062

[2] Akanni.D.I.. S. O. Ojeniyi. and M. A. Awodun., 2011.Soil properties. growth yield and nutrient content of Maize. Pepper and Amaranthus as influenced by organic and organomineral fertilizer. *Journal of Agricultural Science and Technology*. Vol. 1. 1074– 1078. 2011.

[3] Altindal. N and Altindal. D., 2015. Using facilities of spent mushroom compost (SMC) in potato (*Solanum tuberosum* L.) cultivation. *International Journal of Science and Knowledge* 4(1): 36–40.

[4] Avnimelech. Y.. Hargreaves. J.A. and Kochva. M.,1999. Sedimentation and Resuspensionin EarthenP onds.*J ournal o of World Aquaculture Society*. Vol. 30. pp.401-409.

[5] Avnimelech, Y., 2000. Nitrogen control and protein recycling: Activated suspension ponds. *Advocate*, 3(2), 23-24.

[6] Avnimelech, Y., Ritvo, G., 2001. Aeration, mixing and sludge control in shrimp ponds. *Glob. Aquac. Alliance Advocate* 4, 51– 53.

[7] Ayeni. L.S., 2008. Integrated application of cocoa pod ash and NPK fertilizer on soil chemical properties and yield of tomato. *American-Eurasian Journal of Sustainable Agriculture*. Vol. 2. (3) :333–337.

[8] Barg, U.C.,1992. *Guidelines for the promotion of environmental management of coastal aquaculture development*. FAO Fisheries Technical Paper 328, FAO, Rome, 122 pp.

[9] Boyd, C.E., 1992. Shrimp Pond Bottom Soil and Sediment Management . p 166 – 181. In Wyban, J. (Editor) : *Proceedings of the Special Session on Shrimp Farming*. Worl Aqaculture Society, Baton Rouge, L.A, U.S.A.

[10] Boyd. C.E. Wood. W. Philip L. C. and Julio. F.Q., 2010. Role of aquaculture pond sediments in sequestration of annual global carbon emissions. *Environmental Pollution* 158 (2010) 2537-2540.

[11] Babalola. O.O. M.O. Ilori. and S.A. Adegbite., 2012. Engineering economic analysis of organic fertilizer production in Nigeria. *International Journal of Engineering Research & Technology* (IJERT). Vol. 1 (9): 1-13.

[12] Badar. R and S.A. Qureshi. 2015. Utilization of composted agricultural waste as organic fertilizer for the growth promotion of sunflower plants. *Journal of Pharmacognosy and Phytochemistry* 2015; 3(5): 184-187.

[13] Barraza-Guardado, R.H., Arreola-Lizarraga, J.A.,Lopez-Torres, M.A., Casillas-Hernandez, R., Miranda-Baeza, A., Magallon-Barrajas, F., and Ibarra-Gamez, C., 2013. Effluent of shrimp farm and its influence on the coastal ecosystems of Bahia de Kino, Mexico. Hindawi Publishing Corporation. *The Scientific Journal* Volume 2013. Article ID 306370, 8 pages. http://dx.doi.org/10.1155/2013/ 306370.

[14] Birch. S.. R.Bell. J.Nair and C.V.Phung., 2010. *Feasibility of vermicomposting aquaculture solifd waste the mekong Delta*. vietnam: A.Pilot Study. Dynamic Soil. Dynamic Plant. Vol 4(1): 127-134.

[15] Bui, T.D., Luong-Van, J., and Austin, C.M.,2012. Impact of shrimp farm effluent on water quality in coastal areas of the World Herritage-Listed Ha Long Bay. *American Journal of Environmental Sciences*, 8(2): 104-116.

[16] Chongrak. P., 1996. *Organic waste Recycling*: Technology and Management. Chapter 3. John Wiley & Sons Ltd.. Baffins Lane. Chichester. West Sussex PO19 lUD. England. 412 pp.

[17] Dela Cruz. N.E.. C. P. Aganon. M.G. Patricio. E.S. Romero. S.A. Lindain and J.L. Galindez., 2006. *Production Of Organic Fertilizer From Solid Waste And Its Utilization In Intensive Organic-Based Vegetable Production And For Sustaining Soil Health And Productivity*. International Workshop on Sustained Management of the Soil-Rhizosphere System for Efficient Crop Production and Fertilizer Use 16 – 20 October 2006. Land Development Department. Bangkok 10900 Thailand. 16 pp.

[18] Elfrida. 2012. Analysis of Organic and Inorganic Compounds from KJA Waste Sediments on Lake Maninjau. Proceedings of the National Fisheries Seminar. Padang. Hal 60-71.

[19] Fadlil,A., L.Deswati dan Y.Basri. 2013. Effects of Lake Sediment Sediment Fermentation on Growth of *Daphnia* Sp. Department of Aquaculture, Faculty of Fisheries and Marine Sciences Bung Hatta University, Padang.

[20] Fitri, B. 2012. Utilization of Sediment in Maninjau Lake as Fertilizer in Increasing Natural Feed Production *(Chlorella* sp.). Skripsi. Department of Aquaculture, Faculty of Fisheries and Marine Sciences Bung Hatta University. Padang.

[21] Hazarika, M.K., Samarakoon, L., Honda, K., Thanwa, J., Pongthanapanich, T., & Boongsong, K., 2000. Monitoring and impact assessment of shrimp farming in the east coast of Thailand using remote sensing and SIG. *International Archives of Photogrammetry and Remote Sensing*. Vol. XXXIII, Part B7. Amsterdam 2000, p. 504-510.

[22] Jayathilakan. K.. K. Sultana. K. Radhakrishna and A. S. Bawa., 2012. Utilization of byproducts and waste materials from meat. poultry and fish processing industries: a review. *J Food Sci Technol* (May–June 2012) 49(3):278–293. DOI.10.1007/s13197-011-0290-7

[23] Janakiram. T and K. Sridev., 2010. Conversion of waste into wealth: A study in solid waste management. *Journal of Chemistry*. **7**(4). 1340-1345.

[24] Jigme. N.Jayamangkala. P. Sutigoolabud. J. Inthasan2 and Sakhonwasee. S., 2015. The effect of organic fertilizers on growth and yield of broccoli (*Brassica oleracea* L. var. *italica* Plenck cv. Top Green). *Journal of Organic Systems*. 10(1) : 9-14

[25] Joardar. J.C and Rahman. M.M., 2018. Poultry feather waste management and effects on plant growth. *International Journal of Recycling of Organic Waste in Agriculture*.pp 1-6. https://doi.org/10.1007/s40093-018-0204-z

[26] Joesting, H.M., R. Blaylock, P. Biber, and A. Ray., 2016. The use of marine aquaculture solid waste for nursery production ofthe salt marsh plants *Spartina alterniflora* and *Juncus roemerianus*. *Aquaculture Reports* 3 (2016) 108–114. http://dx.doi.org/10.1016/j.aqrep.2016.01.004

[27] Kadir. A.A.. N.W.Azhari. and S.N. Jamaludin., 2016. *An overview of organic waste in Composting*. MATEC Web of Conferences. 47. 05025 (2016). : 1-6.

[28] Kamrunnahar,K., Anisuzzaman Md, U.C. Jeong, S.J. Kang., 2019. Mass culture of Moina macrocopa using organic waste and its feeding effects on the performance of Pagrus major larvae. *Egyptian Journal of Aquatic Research*. https://doi.org/10.1016/j.ejar.2019.02.001

[29] Karabcova. H.. L. Pospisilova. K. Fiala. P.Skarpa and M. Bjelkova., 2015. Effect of organic fertilizers on soil organic carbon and risk trace elements content in soil under permanent grassland. *Soil & Water Res*.. 10. 2015 (4): 228–235. doi: 10.17221/5/2015-SWR

[30] Khairuddin. Md.N.. A.J. Zakaria. I.Md. Isa. H. Jol. W.A.R. Wan-Mohd-Nazri and Md.K.S. Salleh., 2016. The potential of treated palm oil mill effluent (POME) sludge as an organic fertilizer. *AGRIVITA Journal of Agricultural Science*. 38(2): 142-154. Doi: 10.17503/agrivita.v38i2.753

[31] Khater. E.S.G., 2015. Some Physical and Chemical Properties of compost. 2015. *International Journal of Waste Resources* 5.(172):1-5.

[32] Komarayati. S., 2007. Karakteristik Pupuk Organik Limbah Padat Industri Pulp Plus Arang Serbuk Gergaji.. Pusat Penelitian dan Pengembangan Hasil Hutan. Bogor.

[33] Komarayati. S.. dan R.A. Pasaribu., 2007. Pembuatan pupuk organik dari limbah padat industri kertas. *Jurnal Penelitian Hasil Hutan*. 23 (1) : 35 - 41.

[34] Kwagyan. W. M and Odamtten G T., 2018. Use of *Pleurotus eous* Strain P-31 Spent Mushroom Compost (SMC) as Soil Conditioner on the Growth and Yield Performance of *Capsicum annuum* L. and *Solanum lycopersicon* L. Seedlings under Greenhouse Conditions in Ghana. *Tropical Life Sciences Research*. 29(1). 173–194.

[35] Lacerda, L.D., A.G. Vaisman, L.P. Maia, C.A.R. de Silva, E.M.S. Cunha., 2006. Relative importance of nitrogen and phosphorus emmisions from shrimp farming and other anthropogenic sources of six estuaries along the NE Brazilian coast. *Aquaculture*. 253. 433-446.

[36] Latt. U. Win., 2002., Shrimp pond waste management. *Aquaculture Asia* 2002 . Vol. 7 No. 3:12-16

[37] Londhe.P.B and S.M.Bhosale., 2015. Recycling of solid wastes into organic fertilizers using low cost treatment: vermicomposting. *International Journal of Innovations In Engineering Research And Technology* [IJIERT]. Vol 2 (6) : 1-11.

[38] Lorenzen, K., Struve, J., and Cowan, V.J., 1997. Impact of farming intensity and water management on nitrogen dynamics in intensive pond culture: a mathematical model applied to Thai commercial shrimp farms.*Aquaculture Research*, 28, 493-507.

[39] Manohara. B and S.L. Belagali., 2014. Characterization of essential nutrients and heavy metals during municipal solid waste composting. Int. J. of Innovative Research in Science. *Engineering and Technology*. 3(2) . 9664-9672.

[40] Muendo.P.N. M. C J Verdegem. J. J Stoorvogel. A Milstein. E.N.Gamal. P. M Duc and J. A.J. Verreth., 20014. Sediment Accumulation in Fish Ponds; Its Potential for Agricultural Use. *International Journal of Fisheries and Aquatic Studies* 2014; 1(5): 228-241

[41] Nagasaki, T., Chapin, C.J., Gundersen, G.G., 1992. Distribution of detyrosinated microtubules in motile NRK fibroblasts is rapidly altered upon cell. Cell contact: Implications for contact inhibition of locomotion. Cell Motil. Cytoskel. 23(1), 45-60.

[42] Naveed. S.. A. Rehim. M. Imran. M. A.Bashir. M.F. Anwar. and F. Ahmad., 2018. Organic manures: an efficient move towards maize grain Biofortification. *International Journal of Recycling of Organic Waste in Agriculture*. https://doi.org/10.1007/s40093-018-0205-y: pp 1-9.

[43] Nino. A.. A.Rivera and A. Ramírez., 2012. Production of organic fertilizer with Macro-Micronutrients from the solid waste generated at home. *European Journal of Experimental Biology*. 2012. 2 (1):199-205

[44] Nur, A., 2011. Shrimp cultivation management of Vaname. General Directorate of Fisheries Culture, BBPBAP Jepara. Center of Fisheries and Marine. Jakarta.

[45] Ogunlade. M. O.. Ogunlade. E. A. Adeyemi. D. O. Ogunleti. and P. S. Ibiyomi., 2011. Effect of cocoa pod husk. urea fortified cocoa pod husk and NPK fertilizers on the growth and yield of *Solanum macrocarpon* cultivation. *International Journal of*

Organic Agriculture Research and Development. Vol. 3: 1–8.

[46] Okareh. OT.. S.A. Oyewole. and L.B.Taiwo., 2014. Conversion of food wastes to organic fertilizer: Astrategy for promoting food security and institutional waste management in Nigeria. *Journal of Research in Environmental Science and Toxicology*. Vol. 3(4): 066-072

[47] Oreopoulou, V., Russ, W., 2007. Utilization of By-products and Treatment of Waste in the Food Industry. Food & Nutrition Series, Springer-Verlag US.

[48] Polat E. Uzun H I. Topcuoglu B. Onal K. Onus A N. and Karaca M., 2009. Effects of spent mushroom compost on quality and productivity of cucumber (*Cucumis sativus* L) grown in greenhouses. *African Journal of Biotechnology* 8(2): 176–180.

[49] Preston. N.P.. Jackson. C.J.. Thompson. P.. Austin. M.. Burford. M.A. and Rothlisberg. P., 2001. *Prawn farm effluent: composition. origin and treatment.* Project No. 95/162. Fisheries Reaserach and Development Corporation. Cleveland. OH.

[50] Rahman. M. M.. Yakupitiyage. A. and Ranamukhaarachchi. S. L., 2002. *European Commission funded POND LIVE Project*. Aquaculture and Aquatic Resource Management Field of Study. Asian Institute of Technology. Thailand.

[51] Rahman. M. M. and Ranamukhaarachchi. S. L., 2003. Fertility status and possible Environmental consequences of Tista Floodplain Soils in Bangladesh. *Thammasat International Journal of Science and Technology*. 8. 11-19.

[52] Rahman. M. M.. Yakupitiyage. A. and Ranamukhaarachchi. S. L., 2004. Agricultural Use of Fishpond Sediment for Environmental Amelioration. *Thammasat International Journal. Science*. Technology..Vol. 9. No. 4: 1-10.

[53] Rawat. M.. . A.L. Ramanathan and T. Kuriakose.,2013. Characteristics of municipal solid waste compost (MSWC) from selected Indian cities - a case study for its sustainable utilisation. *J. Of Environmental Protection*. 4.163-171.

[54] Rina. S. Soetopo ; S. Purwati ; H. Hardiani dan A. Surachman., 2002. Effect of compost from waste from WWTP paper industry on plants and soil. *Prosiding Seminar Teknologi Selulosa.* 24 Oktober 2002. Balai Besar Penelitian dan Pengembangan Industri Selulosa. Bandung.

[55] Rosen. C.J.. Halbach T.R and Swanson. B.T., 1993. Horticultural uses of municipal solid waste components. *Hortic Technol* 3:167-173.

[56] Roy S. B Shibu. U Chakraborty and B Chakraborty., 2015. Evaluation of spent mushroom substrate as bio-fertilizer for growth improvement of *Capsicum annuum* L. *Journal of Applied Biology and Biotechnology* 3(3):22–27

[57] Sabiiti EN., 2011. Utilising Agricultural waste to enhance food security and conserve the environment. *Afric J Food Agric Nutri Develop* 2011; 11(6):1-9

[58] Saputra.. N.R.M. Sukoso and H. Kartikaningsih., 2017. A Solid Waste Pond Tiger Shrimp (*Peneaus monodon*) as Fertilizer for *Caulerpa lentillifera*. *J.Exp. Life Sci.* Vol. 7 No. 1: 17-21.

[59] Sharma, A., Chetani.R., 2017. A Review on the effect of organic and chemical fertilizer on plants. *International Journal for Research in Applied Science & Engineering Technology* (IJRASET), Volume 5 Issue II, February 2017: 677-680.

[60] Suwoyo, H.S., Gunarto, dan Rachmansyah., 2009. Studi sedimentasi dan kualitas substrat dasar tambak intensif udang vaname (*Litopenaeus vannamei*). *Prosiding Seminar Nasional Tahun VI Hasil Penelitian Perikanan dan Kelautan Tahun 2009, Jilid I Budidaya Perikanan*. Jurusan Perikanan dan Kelautan, Fakultas Pertanian UGM, Yogyakarta, 25 Juli 2009, hlm. RB-04, 1-16.

[61] Suwoyo, H.S., Tahe.S and Fahrur.M., 2015. Characterization of Sediment Waste of Vaname Shrimp Pond (*Litopenaeus vannamei*) Super Intensive with different Stocking Density. In Sugama, K., Kristanto, A.H.,Radiarta, I.N., Lusiastuti., A.M., Kusdiarti., Priono,B., Insan, I., Dewi., R.R.S.P.S., dan Gardenia, L (eds). *Prosiding Forum Inovasi Teknologi Akuakultur 2015*. Hal 901-913.

[62] Suwoyo, H.S., M.Fahrur., Makmur and R. Syah., 2016. The utilization of superintensive shrimp pond waste as organic fertilizer for klekap and milkfish growth. *Media Akuakultur*, 11 (2), 2016, 97-110

[63] Syah.R., H.S. Suwoyo. M.C. Undu dan Makmur., 2006. Estimation nutrient budget of white shrimp *Litopenaeus vannamei*. *Jurnal Riset Akuakultur*. Vol 1 (2) : 181 -202.

[64] Syah,R., Makmur, and M.C.Undu., 2014., The estimation of loading feed nutrient waste and carrying capacity of coastal area for superintensive shrimp vanamei pond aquaculture. *Jurnal. Riset Akuakultur* Vol. 9 No. 3 Tahun 2014: 439-448.

[65] Syah, R., Makmur, dan Fahrur, M., 2017a. The *Litopenaeus vanamei* aquaculture under high stocking density.. *Media Akuakultur*, 12(1), 19-26.

[66] Syah, R., Fahrur, M., H.S. Suwoyo dan Makmur., 2017b. The performance of wastewater treatment

http://dx.doi.org/10.22161/ijeab/4.2.24 *ISSN: 2456-1878*

plant in superintensive *Litopenaeus vannamei* shrimp aquaculture. *Media Akuakultur*, 12(2), 95-103.

[68] Taleb. R.A. Z.. R.A. Ta'any and A. R. Arabiyyat., 2014. Changes in compost physical and chemical properties during aerobic decomposition. *Int. J. of Current Microbiology and Applied Sciences*. 3(10). 479-486.

[69] Tangguda. S. Arfiati. D and Wilujeng. E.A., 2015a. Characterization of Sediment Waste of Vaname Shrimp Pond (*Litopenaeus vannamei*) for culture *Chlorella* sp. Proceedings Seminar Nasional FMIPA Universitas Pendidikan Ganesha V Tahun 2015: 381-386

[70] Tangguda. S.. A. Diana. W.E. Arning., 2015b. Utilization of solid waste from White Shrimp (*Litopenaeus vannamei*) farm on the growth and Chlorophyll content in *Chlorella* sp. *J. Life Sci. Biomed*. 5(3). 81-85.

[71] Wan Razali. W.A.. A.S. Baharuddin. A.T. Talib. A. Sulaiman. M.N. Naim. M.A. Hassan and Y. Shirai., 2012. Degradation of oil palm empty fruit bunches (OPEFB) fibre during composting process using in-vessel composter. *BioResources* 7 (4): 4786-4805.

[72] Wudtisin and Boyd.C.E., 2006. Physical and chemical characteristics of sediments in catfish. freshwater prawn and carp ponds in Thailand. *Aquaculture Research*. 2006. 37. 1202-1214

[72] Zahidah. 2012. Population Growth of *Daphnia* spp Given Fertilizer with Floating Net Cage Cultivation Waste in Cirata, Fermented using EM4. Akuatika Journal. Vol 2 (1). Hal 84-94.