Utilization of shrimp pond solid waste into organic fertilizer

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ABSTRACT

Cultivation of shrimp ponds in Bantul Poncosari D.I. Yogyakarta causes some issues. There are water pollution because of wastewater effluent pond and also the residual solid precipitates from the residual activities of the pond that is not utilized. The residual solids in shrimp ponds contained nutrient including nitrate (NO_3), phosphorus (P_2O_5) and potassium (K_2O) which usefull for plantatiton. The purpose of this study are to analyze the content of macro nutrients in waste shrimp ponds and utilized it as fertilizer. Manufacture of solid organic fertilizer is done by the anaerobic process and utilizing a variation of the 3 reactors with addition of leaf compost, cow manure and EM4 (Effective Microorganism 4). The test results of macronutrient content of the third reactor near with to the quality standard for solid organic fertilizer and only on the reactor with a mixture of solid waste ponds and EM4 that meet quality standards with a total of 6.96% of macro nutrients. Salinity of this material is still classified as saline although it has decreased the salinity of the content of the starting material. At the salinity conditions plants can grow but the crops is limited. So we can conclude solid organic fertilizer from solid wastes vannamei shrimp farms still not yet be an effective organic fertilizer for agriculture but can be organic compost with continue its efforts further decrease in salinity.

Keywords: waste, shrimp ponds, solid residues, solid organic fertilizer, salinity

1. INTRODUCTION

In Indonesia where shrimp always increase in line with market demand continues grow as well, because shrimp is one of the animals that contain high protein and other nutrients that are very good for humans . With the increasing number of shrimp in the pond will increase the amount of waste. Data from the Directorate General of the Ministry of Maritime Affairs and Fisheries (2005) mentions that in Indonesia of 170 shrimp processing business has a production capacity of about 500,000 tons per year. Total of shrimp production its about 80-90 % where is exported as frozen shrimps without heads and skins. The weight of the head and the skin has reached 60-70 % of the weight. So that the volume of waste shrimp heads and skins produced reaches 203.403-325.000 tons per year.

The higher demand for shrimp, the more places for shrimp ponds where shrimp farmed. The rise of shrimp aquaculture in the Poncosari village, Bantul D.I.Yogyakarta cause some problems in between the river pollution , coastal pollution and also the presence of solid waste such as leftover sediment pond activities that are not utilized. Shrimp farms across the region still don't have a good treatment for waste from the activities of shrimp ponds.

In addition to shrimp, the agricultural sector has also become a commodity market into economic input source community because Indonesia has a fertile soil landless majority. Agricultural activities require fertilizer to support agriculture. Given this, fertilizer demand is also growing and needed more economical source of fertilizer to be processed and utilized.

Waste from shrimp farms has potential to become fertilizer because based on the research, the waste ponds containing CaCO3. Calcium (Ca) is one of the macro nutrients for plants. The sediment of shrimp ponds activity also contains nutrients, especially nitrates, phosphorous and potassium that are beneficial to plants. Utilized of shrimp waste as an organic fertilizer can solve the problems existing fertilizer scarcity due to the increasing demand of fertilizers. In addition, it can also overcome the problem (smelly, dirty, disease, and others) that may be caused by the presence of the waste in the neighborhood. With the main source of raw material waste, the organic fertilizer is expected to be very less or economical than manure - fertilizer sold in the market.

With the events as above can be interconnected, it is necessary to study or analyze the potential of shrimp farm waste into organic fertilizer

2. METHODE

This study is an organic fertilizer production using anaerobic reactor (10 liter jerry can) as much as 3 reactor. Solid waste taken from vannamei shrimp farms in the village of Poncosari Bantul, Yogyakarta.

Picture 2.1 Reactors from Jerry Can

The first reactor containing 2 Kg solid waste vannamei shrimp farms and 1 Kg compost leaves, the second reactor containing solid waste vannamei shrimp ponds 2 kg and 1 kg of cow dung and the third contains solid waste vannamei shrimp farms 2 Kg and 0.5 Liter EM4 (Effective Microorganism 4). Fertilizer production using anaerobic process for 4 weeks incubation in a closed jerry cans. During incubation of 4 weeks, every 3 days checked the pH and temperature of each reactor. Before the incubation process performed on the reactor, testing the content of C, N, P, K and salinity of solid waste to determine the content of the beginning of the waste. Then after 4 weeks of incubation testing the content of C, N, P, K and salinity back to determine the content after the incubation process. Testing C, N, P, K and salinity using references presented in Table 2.1.

After testing, the results of the data were compared with the standard quality organic fertilizer PERMENTAN No 70 of 2011 Organic Fertilizer, Fertilizers and Pembenah Soil Conservation. Vannamei shrimp farms solid waste into organic fertilizer is said to be effective if it conforms to the standard quality organic fertilizer and salinity conditions allow for the plant can grow up. The quality standard of SNI 19-7030-2004 Compost compost from domestic organic waste is also used to compare the content of the fertilizer from solid wastes this vannamei shrimp farms

Table 2.1 Analysis Method

No	**Parameter**	**Analysis method**
1	N (ppm)	SNI 2803 - 2010
2	C (ppm)	Determination of ash content AOAC 2005
2	P (ppm)	SNI 2803 - 2010
3	K (ppm)	SNI 2803 - 2010
5	pH	Analysis with pH meter (SNI 06-6989.11-2004)
6	Salinity (DHL)	Electrometry & Conductometry
7	Temperature	Analysis with Thermometer

3. RESULT

Research the content of C, N, P, K and salinity are twice. At the start time of a new waste taken from ponds and then after the incubation period of the reactor. Anaerobic process in each reactor is for 4 weeks. Every 3 days check pH and temperature to ensure the process in the reactor and also keep the temperature from getting too high or low that can cause microbe death in the reactor. The result of the initial content of solid waste vannamei shrimp farms can be seen in Table 4.1

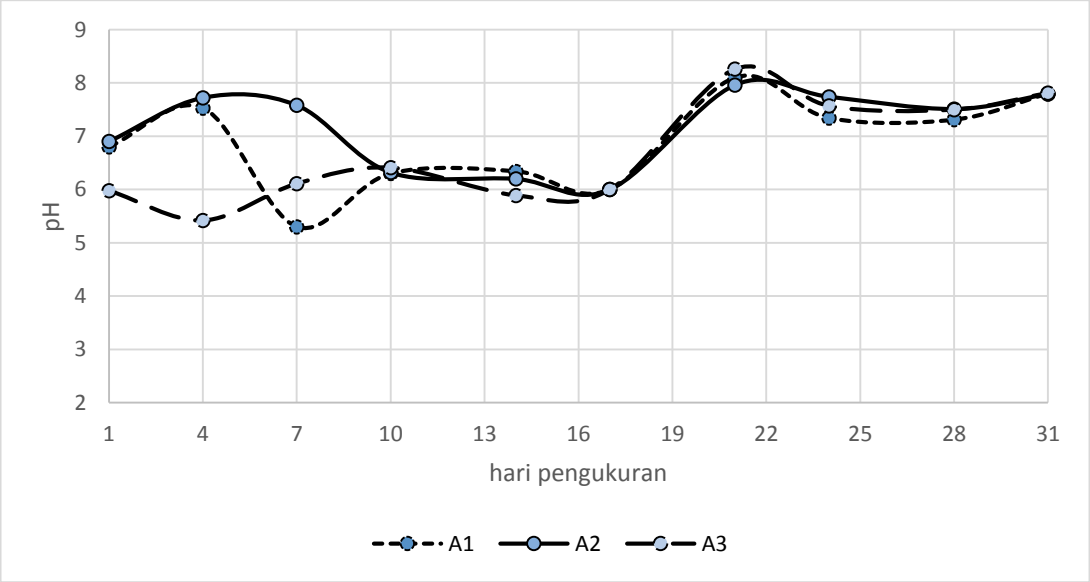
Table 4.1 Solid waste content Test Results

No	Parameter	Unit	Total
1	C organic	%	10,58
2	N total	%	0,49
3	C/N	-	21,59
4	P_2O_5	%	1,37
5	K_2O	%	0,27
6	DHL (salinitas)	mS/cm	34,3
7	NaCl (salinitas)	%	10,81

Results of testing the content of solid waste vannamei shrimp farms have obtained data that has been shown in Table 4.1. Seen organic C in the initial conditions or when solid waste is taken is 10.58%. It is not yet meet the requirements of the quality standards PERMENTAN Permentan No 70 solid organic fertilizer that is at least 15%. The Nitrogen is 0.49%, 1.37% of P_2O_5 and K_2O is 0.27%.

These three macro nutrients that if you add up was 2.13% and the nutrients are still not meet the quality standards PERMENTAN No 70 organic fertilizer which contains the required minimum is 4%. Salinity conditions in the solid waste is high which in these conditions many plants are difficult to grow life.

After research the content of solid waste, the process of making organic fertilizer from anaerobic starting by entering the solid waste vannamei shrimp farms are added into the reactor and addition of other materials such as compost leaves in the reactor A1, cow dung on the A2 reactor and addition of EM4 in the reactor A3. Then every three days check the pH and temperature. PH test results can be seen in Table 4.2 and a temperature test results in Table 4.3

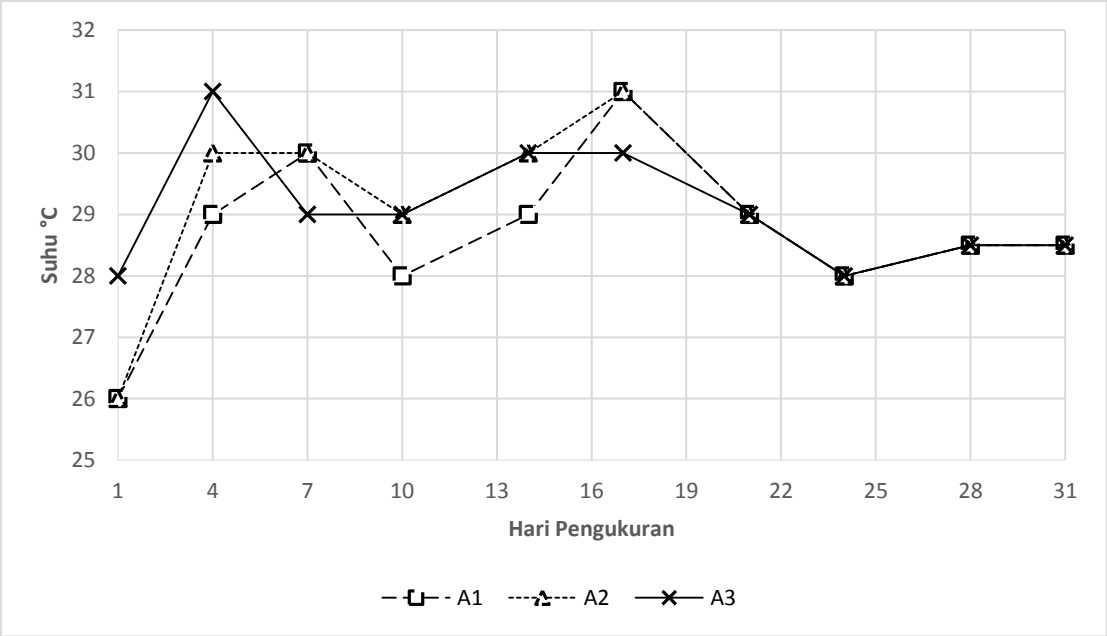


Picture 4.1 pH test result

On the first reactor A1 showed pH 6.8; A2 is 6.9 and pH 5.9 indicated by A3. On the first day the pH is tend to acidic because organic material is decomposed into organic acids, but for the next several days it will be back in a neutral pH (Mulyono, 2014).

Then on days 24 to 31, the third reactor show the number of pH between 7 and 8 or on the atmosphere of a neutral pH. In the process of incubation is the highest pH was 8.26 at day 21 on A3 or waste are added EM4 and lowest pH also on A3 is 5.98 on the first day. Changes in pH is unstable because it is influenced activities of microorganisms break down organic material into simpler organic acids.

The average pH of the end of the decomposition of waste in all treated almost same, at around pH 7.79 and 7.81. Anaerobic decomposition ideal pH between 6.0 to 8.0, because the degree of microbes can grow and organize activities in decomposing organic matter (Hadisumarno, 1992).



Picture 4.2 Temperature test result

On the first day, the third reactor showed the same temperature at 27 °C. Then on day 4 increased temperature. A1 temperature of 29 oC, 30 ^{o}C A2 and A3 31 ^{o}C. On day 7 shows a third reactor temperature 29 °C and 30 °C. Days 10 A2 and A3 show the temperature 29 ^{o}C and A1 down to 28 ^{o}C. Later in the day - the next day anjd the temperature increases at day 17 A3 and A1 are at a temperature of 31 °C and A3 at 30 °C. Day 21 third reactor showed the same temperature is 29 ^{o}C and then on day 24, all three fell to 28 ^{o}C and then on days 28 and 31 showed the same temperature again is 29 ^{o}C. In accordance Mulyono opinion in his research, the temperature controlled composting process is very important for the purposes of microorganisms do the rendering, the optimum temperature is 30 - 40 ^{o}C. If the temperature is too low or too high, the bacteria in composting will die.

The heat generated from microbial activity. There is a direct relationship between the increase in temperature with oxygen consumption. The higher temperature it causes by the more consumption of oxygen and will sooner decomposition. Increased temperatures can occur rapidly in the compost heap. Temperatures ranging from 30 °C to 60 °C showed activity in rapid decomposition. A temperature higher than 60 °C will kill most microbes and only thermophilic microbes who will survive. High temperatures will kill microbes - pathogens of plants and seeds of weeds (IBRIEC 2008).

The process used in this research using anaerobic process that does not require oxygen. Then the temperature that occurs in the reactor is not very high and the maximum temperature in the incubation process is 31 ^{o}C. In addition, because less material pile height can also affect the lower temperature. Low pile resulted in lower accumulated heat.

Piles of compost material that is too short causes heat quickly evaporates, because no materials used to withstand the heat and avoid heat loss. In less than optimum temperature conditions resulting in bacteria bacteria love hot temperatures do not proliferate well and give effect to the long period of composting (Komarayati 2007).

After 4 weeks the process of anaerobic reactor, it testing the content again. The second test is to determine changes in the value of the content of C, N, P, K and salinity after the process in each reactor. Test results on the content of the reactor A1 can be seen in Table 4.2, in Table 4.3 of the reactor A2 and A3 reactor in table 4.4

Table 4.2 The reactor A1 content test results (solid waste shrimp ponds and compost leaves)

No	Parameter	Unit	Total
1	C organic	%	9,15
2	N total	%	0,41
3	C/N	-	22,31
4	P_2O_5	%	0,61
5	K_2O	%	0,31
6	DHL (salinitas)	mS/cm	6,1
7	NaCl (salinitas)	%	4,20

On the A1 reactor that containing solid waste and leaf compost, it change the amount of the nutrient content of macro and salinity. Organic C content decreased from baseline to 9.15%. The number is still not meet the standard of solid organic fertilizer that is at least 15%. N total produced 0,41%; 0.61% P_2O_5 and K_2O 0.31%. The sum of 3 parameters is 1.33% which not qualified with the quality standards required of organic fertilizer. But the numbers of total N content, P_2O_5 and K_2O have met the requirements of the standard quality compost. C / N increased from the initial amount of content became 22.31. Conditions that shows C / N has met the quality standards required by manure and compost is between 15-25% on quality standard solid organic fertilizer and 10-20 % in the compost. DHL declined to 6.1% which in these conditions the plant can grow but the crops is limited. NaCl percentage of 4.20%, which indicates the condition of the saline.

A2 reactor containing waste and cow dung to show changes in the amount of content of macro nutrients and salinity. Organic C increased to 14.6 7% and is nearing the standard quality organic fertilizer that is at least C content is 15% and the qualified standard quality compost is 9.8% minimum. N total rise to 0.55%. P_2O_2 Fell to 0.59% and K_2O rise to 1.07%. The sum of N, P and K was 2.21% and the amount is not yet eligible quality standard solid organic fertilizer that is equal to 4%. They meet the standard of quality compost. C / N in this reactor was 26.5 which shows the increase of the content from the initial test results. C / N in the reactor is still too high and exceeds the quality standard requirements of solid organic fertilizer and compost quality standards. DHL decreased significantly to 4.13% and the percentage of NaCl is 4.45%. On the condition that the plant can grow but the crops are limited. And the condition is still classified as saline.

Table 4.3 The reactor A2 content test results (solid waste shrimp farms and cow dung)

No	Parameter	Unit	Total
1	C organic	%	14,67
2	N total	%	0,55
3	C/N	-	26,5
4	P_2O_5	%	0,59
5	K_2O	%	1,07
6	DHL (salinity)	mS/cm	4,13
7	NaCl (salinity)	%	4,45

The test results of A3 reactor presented in Table 4.2. This last reactor containing solid waste and EM4. Organic C in the reactor was 6.36% and this rate does not qualify quality standard solid organic fertilizer and compost quality standards.

Tabel 4.4 The reactor A3 content test result (solid waste shrimp ponds and EM4)

No	Parameter	Unit	Total
1	C organic	%	6,36
2	N total	%	0,46
3	C/N	-	13,82
4	P_2O_5	%	6,25
5	K_2O_2	%	0,25
6	DHL (salinity)	mS/cm	7,12
7	NaCl (salinity)	%	4,86

N total result is 0.46%. P_2O_5 content increased from baseline to 6.25% and K_2O is 0.25%. If the three macro nutrients is summed, the result is 6.96% which has been pass quality standard solid organic fertilizer and compost quality standards. C / N of 13.82 and the figure does not qualify quality standard solid organic fertilizer but has been pass compost quality standards. DHL declined to 7.12%. Under such conditions the plant can grow but the crops are limited. And like the other reactor, the conditions on the A3 also saline which indicated of the percentage figure of 4.86% NaCl.

4. DISCUSSION

The results of manufacture fertilizer from solid wastes vannamei shrimp farms that had 3 reactor only on A3 reactor (solid waste & EM4) have the amount of macro nutrients that pass the quality standards solid organic fertilizer. But almost all of the nutrient content of macro in this test has met quality standards in accordance with SNI 19-7030-2004 about Compost from domestic organic waste. Results conformity with quality standard parameter data can be seen in table 4.5, table 4.6 and table 4.7.

Tabel 4.5 Suitability of data parameter A1 with Quality standar

Parameter	Quality Standard of Organic Fertilizer PERMENTAN NO 70 Tentang Pupuk Organik, hayati dan Pembenah tanah	Quality Standard of Compost SNI 19-7030-2004	A1			
			Composition		Fertilizer	Compost
C organik	Min 15 %	Min 9,8 %	9,15	Total	X	X
N total	Sum of macro nutrient = Min 4 %	0,40 %	0,41 %	2,33%	X	V
P_2O_5		0,10 %	0,61 %			V
K_2O		0,20 %	0,31 %			V
C/N	15 - 25	10 -20	22,31 %		V	V

Tabel 4.6 Suitability of data parameter A2 with Quality standar

Parameter	Quality Standard of Organic Fertilizer PERMENTAN NO 70 Tentang Pupuk Organik, hayati dan Pembenah tanah	Quality Standard of Compost SNI 19-7030-2004	A2			
			Composition		Fertilizer	Compost
C organik	Min 15 %	Min 9,8 %	14,67 %	Total	X	V
N total	Sum of macro nutrient = Min 4 %	0,40 %	0,55 %	2,21%	X	V
P_2O_5		0,10 %	0,59 %			V
K_2O		0,20 %	1,07 %			V
C/N	15 - 25	10 -20	26,5		V	V

This resulted in salinity conditions fertilizer plants can be grown, but the harvest is limited. So we can say that this fertilizer still can't be an effective solid organic fertilizer for agriculture and still less marketable. But it has the advantage besides fertilizer made from natural organic also uses inexpensive base materials. This fertilizer also has the advantage of high P_2O_5 content on the A4 treatment is 6.25%. The need for further treatment in order to improve the content of the fertilizer from solid wastes this vannamei shrimp farms. Further lowering the salinity by dilution with salt-free water or water containing a little bit of salt and gypsum can also conversions that add gypsum.

Tabel 4.7 Suitability of data parameter A3 with Quality standar

Parameter	Quality Standard of Organic Fertilizer PERMENTAN NO 70 Tentang Pupuk Organik, hayati dan Pembenah tanah	Quality Standard of Compost SNI 19-7030-2004	A3			
			Composition		Fertilizer	Compost
C organik	Min 15 %	Min 9,8 %	6,36 %	Total	X	X
N total	Sum of macro nutrient = Min 4 %	0,40 %	0,46 %	6,96%	V	V
P_2O_5		0,10 %	6,25 %			V
K_2O		0,20 %	0,25 %			V
C/N	15 - 25	10 -20	13,82		X	X

V = Pass The Quality Standard

X = Not yet Pass The Quality Standard

5. CONCLUSION

In this research, we can conclude: (1) The highest content of C organic is in the reactor A3 (solid waste shrimp ponds and Cow dung), for N total in A3 reactor, the highest P_2O_5 in the reactor

A4 (solid waste shrimp ponds and EM4) and for K_2O is on the A3 reactor. C/N of the better ones in accordance with quality standard solid organic fertilizer is in the reactor A2 (solid waste shrimp ponds and compost leaves). (2) DHL or salinity is best for use as a fertilizer in this experiment is in the reactor A2 (solid waste shrimp ponds and compost leaves). (3) Not all the parameters tested in this research pass the quality standards of solid organic fertilizer pursuant to PERMENTAN No. 70 of the Organic Fertilizer, Fertilizers biological and ground improver. But it pass the quality standards in accordance with SNI 19-7030-2004 compost Compos from domestic organic waste. (4) Solid waste shrimp ponds used as an organic fertilizer less effective because not all of the parameters of macro nutrients pass the standard of solid organic fertilizer and the salinity conditions result causes not all plants can grow well if the fertilizer from the vannamei shrimp pond solid waste utilized it.. However, vannamei shrimp farms solid waste is worthy of being an organic compost when viewed from the parameters that meet the quality standards of organic compost through constant attention to salinity that needs to be lowered again.

Based on the conclusion that has been described above, then the advice that can be given are: (1) On further research is necessary to add other organic materials that can add to the content of the fertilizer in order to meet quality standards. (2) Require the research content of macro and micro nutrients else and also treatments to further lower salinity. (3) Time incubation or composting organic fertilizer needs to be added in order to be more mature and good. (4) Should be carried out experimental use of fertilizers from waste vannamei shrimp ponds on the plant directly

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