Pretreatment of Sludge Milk Waste as Source Of Composting using Microbes

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Abstract—***Anorganic fertilizer application in high concentration causes damaging in agriculture field. An alternative way to protect the soil, is using organic fertilizer (compost). Sludge milk waste as souce of composting can be used, but it has high lipid content and causes hardening on composting process. Using combination microbes such as Rhizopus oligosporous (R. oligosporous) and Aspergillus niger (A. niger) in pretreatment of sludge milk waste can cause reducing of lipid content.Objective of this research is to know the influence of Rhizopus oligosporous (R. oligosporous) as anaerobic fermentation microorganism and Aspergillus niger (A.niger) as aerobic fermentation microorganism of sludge milk waste pre-treatment for further composting process, and to compare composting products against technical requirement organic compost used. The research method used is the anaerobic fermentation with addition of Rhizopus oligosporous and aerobic fermentation with Aspergillus niger. Process variables were 100 ml R. oligosporous and A. niger /3 kg sludge waste (3,33% v/w), 200 ml R.oligosporous and A. niger /3 kg sludge waste (6,67%v/w), and 300 ml R.oligosporous and A. niger /3 kg sludge waste (10%v/w) during incubation period of 72 and 96 hours. Process was continued through composted the pretreatment sludge by adding the biofertilizer and bone powder. After composting of pretreatment waste then Carbon, kalium, lipid, nitrogen, phosphate and water content were analyzed. Temperature and pH were also monitored. Results of this research shows that R. oligosporous and A. niger can reduce lipid content of sludge milk waste. The best variable is A. niger 6,67 % v/w with incubation period of 96 hours and can be proved with the lipid content of 10,44 % and reducing of lipid content per cell of microorganism as 0,00036 ppm. Composting process has enhanced 1,57 % N, 5,16 % P and 1,2% K. This compost were in accordance with the technical requirements of organic fertilizer in Indonesia.***

Keywords— Aspergillus Niger, Rhizopus Oligosporous, Compost, Sludge Milk Waste, Lipid.

I. Introduction

The land is an important part in the growth of a plant. Environmental biology damage can be increasingly felt as a result of industrial pollution. The increasing industrial growth followed with increasing consequences of the resulting waste. On dairy processing industry, the resulting waste is no different with other industrial waste, but for milk industrial waste has susceptibility to microbial attack, or in other words quickly experienced decomposite. Solid waste milk plant as sludge containing organic matter (C, N, P and K) are very useful for the improvement of soil fertility. Composting is the process by which organic materials decomposted especially by microbes that utilize organic matter as an energy source. Compost is the result of partial decomposition / incomplete, artificially accelerated from a mixture of organic materials by a variety of microbial populations in environmental conditions of warm, moist, and aerobic or anaerobic (JH Crawford, 2003). Composting technology is becoming very important, especially to overcome the problem of organic waste which is one of the sludge waste of dairy processing industry. Oil content and high lipids in the composting process can lead to clotting in the compost. Preatreatment is needed to reduce lipid content before the composting process to make the process of fermentation using microorganisms that can remodel lipids and produce enzymes such as lipase from Rhizopus oligosporous and Aspergillus niger. The main nutrients that plants need a lot but the amount or the availability is often lacking or insufficient in the soil is N, P, and K. Therefore these three elements need to be added in the form of fertilizer. To increase the nutrients in the fertilizer can be obtained through the addition of biofertilizer. Biofertilizer used was Azotobacter chroococcum and Aspergillus niger, where the role of Azotobacter chroococcum as microorganisms capable of converting nitrogen (N2) in the atmosphere into ammonia (NH4 +) through the process of nitrogen fixation in which ammonia was converted into proteins needed by plants (Saribay, 2003). Aspergillus niger while acting as a microorganism capable of secreting organic acids that function to parse the phosphate required by plants (Diamond, 2007)..

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II. Method

A. Microorganisms

First, microorganisms (Aspergillus niger, Azotobacter chroococcum and Rhizopus oligosporous) was cultured until reaching log phase growth and ready to be fed to the process of fermentation or composting. Prior to fermented, dairy processing industry sludge was analyzed first levels of N, P, K, C, lipid, and water content. After that then it was fermented using microorganism of Aspergillus niger or Rhizopus oligosporous. The purpose of fermentation is to reduce the lipid content of sewage sludge contained in the milk processing industry using lipase-producing microorganisms with solid state fermentation. 3 kg mass of solid waste was fermented by Aspergillus niger and Rhizopus oligosporous (used separately or combined) at fermentation temperature of 25-40oC, pH was kept of 6.5 to 8 and incubation time was 72 and 96 hours. The number of microorganisms added was 100 ml / 3 kg of waste sludge (3.33% v / w), 200 ml / 3 kg of waste sludge (6.67% v / w) and 300 ml / 3 kg of waste sludge (10% v / w) in the log phase conditions. After fermentation was complete, the result of the fermentation process was analyzed for levels of N, P, K, C, lipid, and water content; whereby the best results with the highest

lipid levels decreasing of each combination of the microorganisms was continued to the next process of composting.

B. Composting

The next process was the composting process where added biofertilizer (Azotobacter chroococcum and Aspergillus niger) and bone meal into the mixture. The addition of Azotobacter chroococcum by 10 ml / kg of solid waste (1% v / w), Aspergillus niger at 5 ml / kg of solid waste (0.5% v / w) and bone meal of 0.6 kg / 3 kg of waste. The aeration rate of 1.15 m3 air/day.kg. was added in the composting process, and was carried out for 17 days with stirring in 3 times a day. Once the composting process was complete, then it was analyzed the levels of N, P, K, C, lipid and water content.

III. Result and Discussion

Solid waste used as raw material in this study is a dairy factory waste. Results of analysis of dairy processing sludge waste are shown in Table 1.

The fermentation process is expected to reduce lipid levels, due to solid waste dairy industry has a high lipid content which can cause hardening of the compost produced. Microorganisms used were Aspergillus niger and Rhizopus oligosporous. The microorganisms can produce lipase with solid state fermentation. The lipase enzyme derived from a microorganism added to the fermentation process. Microorganisms were added in liquid form is Aspergillus niger and Rhizopus oligosporous.

Variable addition of Aspergillus niger and Rhizopus oligosporous in the fermentation process was the number of cells in phase log/100 ml (3.33% v / w), the number of cells in phase log/200 ml (6.67% v / w) and the number of cells in phase log/300 ml (10% v / w) with a fermentation time of 72 hours and 96 hours. The operating conditions as follows: the temperature of incubation was 25-40oC, pH incubation was 6.5 to 8 and 3 kg mass of solid waste. In the fermentation process occured lipid reduction as shown in figure 1. The highest lipid reduction per cell was reached by Aspergillus niger of 6.67% V / W, and then 10% V/W was acchieved by Rhizopus oligosporous 10% V / W with 96 hours incubation time was 3.6 X 10-4 and 2.6 X 10 -4 (ppm. Lipid / cell of microorganism) respectively . This has been in accordance with Nrkamini, 1997. Biofertilizer (Azotobacter chroococcum and Aspergillus niger) was added in the process of composting . The addition of Azotobacter chroococcum was 10 ml / kg of solid waste (1% v / w) and Aspergillus niger was 5 ml / kg of solid waste (0.5% v / w) with a concentration of between 1.425 x 108 to 4.175 x 108 cells / ml and bone meal was 0.6 kg / 3 kg of waste. The addition of biofertilizer on composting influenced on the content generated.

Bacteria Azotobacter chroococcum role in nitrogen fixation by utilizing the carbon in the waste as an energy source. These bacteria produced nitrogenase enzyme that functions bind nitrogen from the air and converted into ammonia, then changed again to N that can be absorbed by the soil and plants that NH4 + and NO3-(Fekete et al, 1988).

Fungus Aspergillus niger role in the decomposition of phosphorus to secrete a number of low molecular weight organic acids such as oxalic acid, succinic, citric, acetic, formic, and others. Furthermore these organic acids will react with phosphorus binders, in these experiments Ca 2+ from bone flour to form a stable organic compounds that are able to release ions bound phosphorus that will be absorbed by plants (Ginting et al, 2006).

Every day, stirring 3 times that of microorganisms and air can be spread evenly. Composting process is done until the mature compost that lasted for 17 days. Composting final temperature near room temperature in this study area was about 31^{o}C, indicating compost was at the stage of maturation with compost final pH of 7.6 for *Aspergillus niger* and *Rhizopus oligosporous* of 7.1. Composting results showed friable texture, dark brown and smells like the smell of the soil. Decreased lipid levels in waste composting processes by fermentation using *Aspergillus niger* by 64.23% and waste composting process by fermentation using *Rhizopus oligosporous* amounted to 75.42%. As shown in Figure 3. Water levels were also measured as one of the environmental factors that affect the activity of microorganisms decompose organic matter. Water leached of nutrients and cell protoplasm. By SNI 19-7030-2004, mature compost has a moisture content of less than 50%, and all variables in this study were accordance with these criteria.

Based on Figure 4 was known that nitrogen levels in the second variable was higher than the market compost. *Rhizopus oligosporous* highest value in this variable was equal to 1.74% . Increased nitrogen was due to the nitrification process, whereby biological ammonia decomposition oxidized to nitrite (NO_2) and nitrate (NO_3).

In Figure 5 was known that phosphorus levels in the two different variables were higher than compost market, and the highest value on *Rhizopus oligosporous* variable was equal to 5.78%. Phosphorus levels in the compost with *Aspergillus niger* variable increased from 1.29% to 5.16% and for variable *Rhizopus oligosporous* increased from 2.58% to 5.78%. Results of this study showed that the composting process by the addition of *Aspergillus niger* microbes can increase levels of phosphorus. Potassium levels in each variable composting showed almost the same results, shown in Figure 6. Highest potassium levels found in compost with variable *Aspergillus niger*, which was 1.20%. From Figure 7 was shown that two images of composting variables containing carbon more than the minimum levels of the Minister of Agriculture Regulation No. 28/Permentan/SR.1305/2009, which was 12% (Permentan, 2009). The amount of carbon content in both variables derived from the decomposition of organic matter such as residual plant and bacterial respiration. In the aerobic composting process approximately 2/3 the element carbon into CO_2 evaporated and the remaining third part reacted with nitrogen in living cells. If viewed from the agriculture minister rules No.28/Permentan / SR.1305/5/2009, both fertilizer is compliant with the government as an organic fertilizer, seen from Table 2.

CONCLUSION

1. Microorganism Aspergillus niger and Rhizopus oligosporous could reduce lipid levels in the dairy industry sludge fermentation processes respectively 3.6 x 10-4 and 2.6 x 10-4 (ppm lipid / cell microorganisms) with lipid reducing by 32 percent % (Aspergillus niger) and 34.95% (Rhizopus oligosporous). The best results in this study was the use of variable fermentation using Aspergillus niger 6.67% v / w with a 96-hour incubation period.
2. Results of all the variables are technically qualified organic fertilizer from Permentan. For variable Aspergillus niger 6.67% v / w resulted C-Organic of 28.75%, C / N ratio of 18.37, 1.57% N content, P content of 5.16% and K content of 1.2%. For variable Rhizopus oligosporous 10% v / w resulted C-Organic of 27.31%, C/N ratio of 15.7, N content of 1.74%, P content of 5.78% and K content of 1, 18%.

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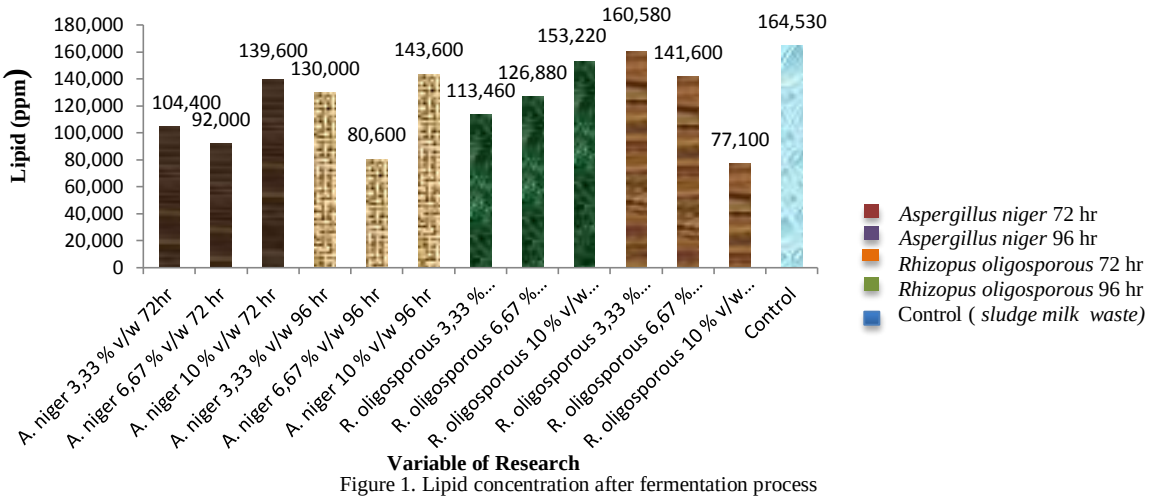

Figure 1. Lipid concentration after fermentation process

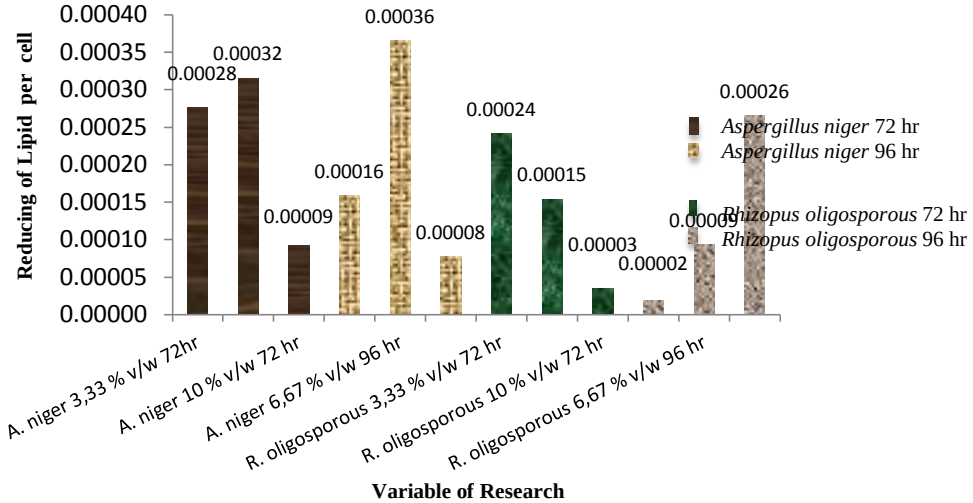

Figure 2. Reducing of Lipid Content after Fermentasion

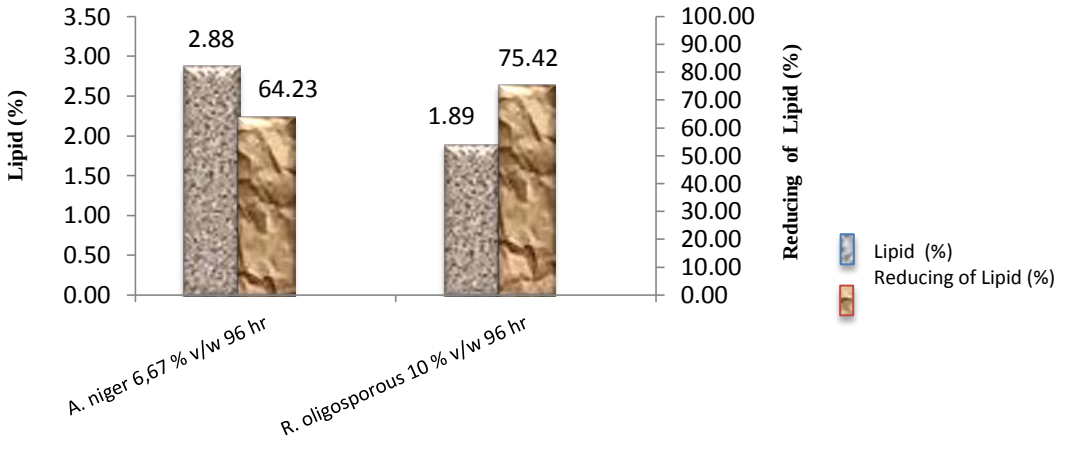

Figure 3. Lipid and Reducing of Lipid after Composting

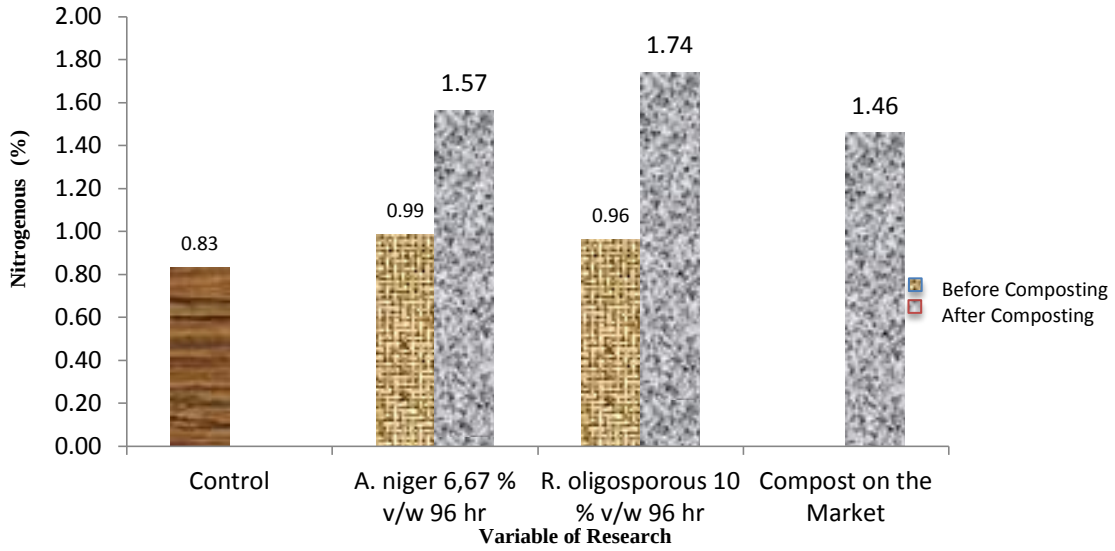

Figure 4. Nitrogenous in various variable at before and after composting

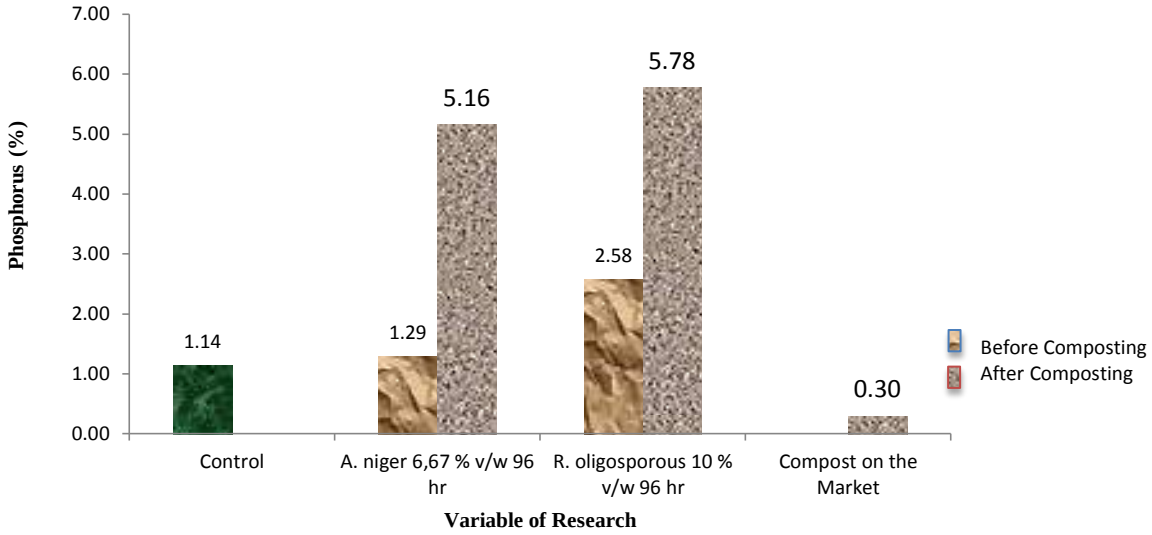

Figure 5. Phosphorus in various variable at before and after composting

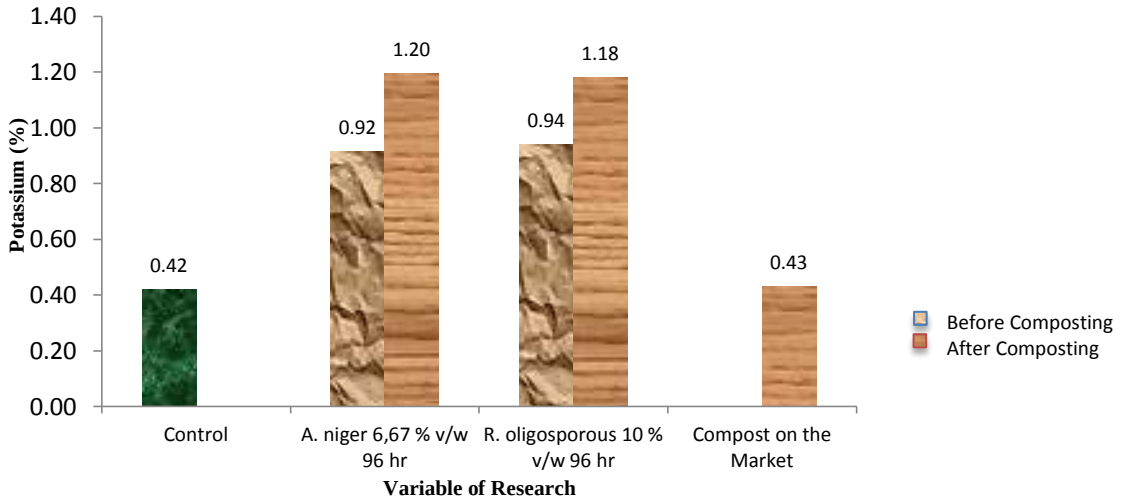

Figure 6. Potassium in various variable at before and after composting

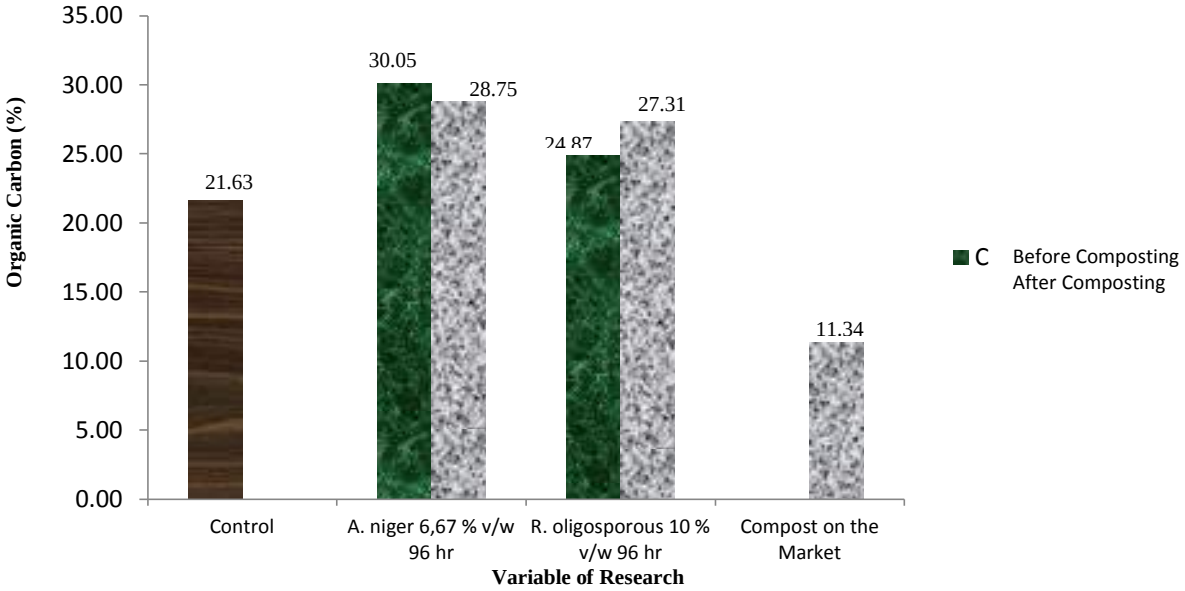

Figure 7. Organic Carbon in various variable at before and after composting

TABLE 1.
CONTENT OF DAIRY PROCESSING SLUDGE WASTE

NO.	Compounds	Concentration (%)
1	Nitrogen	0,83
2	Phosphor	1,14
3	Potassium	0,42
4	Organic Carbon	21,63
5	Lipid	16,45
6	Water	83,57

TABLE 2.
COMPARISON BETWEEN RESEARCH COMPOST AND ORGANIC COMPOST BASED ON THE AGRICULTURE MINISTER RULES NO.28/PERMENTAN / SR.1305/5/2009

No	Parameter	Organic Compost by Permentan	Variable *Aspergillus niger* 6,67 % v/w	Variablel *Rhizopus oligosporous* 10 % v/w
1.	C-Organik (%)	>12	28,75	27,31
2.	C/N Ratio	15-25	18,37	15,7
3.	Kadar N (%)	< 6	1,57	1,74
4.	Kadar P (%)	< 6	5,16	5,78
5.	Kadar K (%)	< 6	1,2	1,18