Waste Engineering
and Management

Proceeding

SIBE-2009

The 1st International Conference on Sustainable Infrastructure and Built Environment in Developing Countries

SABUGA ITB, Bandung - Indonesia
2nd - 3rd November 2009

Published by
Faculty of Civil and Environmental Engineering
Institut Teknologi Bandung - Indonesia

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SIBE 2009 published eight (8) volumes of proceeding as following :

Volume A : Structure and Material
Volume B : Transportation System and Engineering
Volume C : Water Engineering and Management
Volume D : Waste Engineering and Management
Volume E : Ocean Engineering
Volume F : Construction Management
Volume G : Geotechnical Engineering
Volume H : Environmental Protection and Management

PREFACE

The 1st International Conference on Sustainable Infrastructure and Built Environment in Developing Countries (SIBE) 2009 is aimed to provide a forum to discuss and disseminate recent advance in scientific research, technology, and management approach to obtain better environment quality.

Infrastructure that provides the basic need of a society and sustainable infrastructure system are essential for the survival, health and well-being of a society. In developing countries, civil and environmental engineers are at the epicenter in seeking means to enhance the quality of human life through modernization of infrastructure as evidenced by provision of shelters, water, and transport, amongst others. The current rate of urbanization and industrialization raises a number of environmental issues, often resulting in environmental mismanagement, especially in developing countries. The problems are further aggravated by environmental degradation such as soil erosion, depletion of water resources, etc. In order to meet these multifaceted challenges, proper planning followed by implementation and verification must be exercised, via an integrated, multi disciplinary and holistic approach.

The conference will provide an opportunity for professionals and researchers to learn, share and exchange about the latest development and research in civil and environmental engineering. The scope of the conference covers all aspect of civil and environmental engineering practices.

Participants of the conference include researchers, academic staffs, students, industries, public and local governments. The keynote presentations during the conference are as follows:

Keynote speakers:
- **Indonesian Government Representative**
  Minister of Public Works, Indonesia
- **Dr. Puti Farida Marzuki**
  Dean of the Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung, Indonesia
- **Dr. Tony Liu**
  National Taiwan University, Taiwan
- **Prof. Shunji Kanie**
  Hokkaido University, Japan
- **Prof. Syunsuke Ikeda**
  Tokyo Institute of Technology (AUN/SEED-Net), Japan.

Invited speakers:
- **Dr. Setiawan Wangsaatmaja**
  Environmental Protection Agency of West Java Province, Indonesia
- **Dr. Edwan Kardena**
  Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung, Indonesia
- **Prof. Harianto Rahardjo, Ph.D.**
  School of Civil and Environmental Engineering, Nanyang Technological University, Singapore
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- **Prof. Nakasaki Kiyohiko**
  Tokyo Institute of Technology, Japan.

The objectives of this conference are:

1. To provide a platform for exchange of ideas, information and experiences among academics, researchers, consultants, engineers, manufacturers and post graduate scholars in civil and environmental engineering.
2. To discuss and evaluate the latest approaches, innovative technologies, policies and new directions in infrastructure development, pollution prevention and eco-friendly technologies adapted to developing countries.
3. To promote cooperation and networking amongst practitioners and researchers involved in addressing infrastructure and built environment issues.

The oral and poster presentations are subdivided into 8 major sections, as following:

A. Structure and material
B. Transportation system and engineering
C. Water engineering and management
D. Waste engineering and management
E. Ocean engineering
F. Construction management
G. Geotechnical engineering
H. Environmental protection and management.

There are 174 contributors in oral presentation and 36 contributors for poster presentation.

Finaly, the Organizing Committee wishes that this conference is able to provide beneficial scientific information to the participants and other concerned readers.

Bandung, November 2009
Organizing Committee

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Composting Process of Sludge From Dairy Industry's Waste Water Treatment Plant

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Abstract

Food processing industries produce solid waste with high organic contents. Therefore, composting is an option to be considered in managing this waste. Dairy industry produces solid waste in the form of sludge. This study aims to assess the composting process of dairy processing sludge with rice straw as a bulking agent, on a small-scale. The composting process was done using aerobic treatment in a rotary composter and windrow for 30 days. During the process, daily monitoring was done to evaluate the changes on several parameters. These parameters are temperature, water content, pH, oxygen level, and weight reduction. Laboratory analysis was conducted on samples T0, T3, T5, T9, T15, T20, and T30. The results obtain were compared to the standard compost quality by the USEPA, WHO, and SNI 19-7030-2004. The highest temperature recorded was 38°C at 14d. The oxygen level during the process was between 20.3-20.9%. pH number never went below 6.9 and the highest number was 7.1. The moisture content ranged between 40% and 100%. The weight reduction ratio was 24%. The results from the monitoring showed that the only parameter that did not meet the requirement is the temperature. Water content on both experiment decreased which shows that heat was produced during the process. C-organic level increased on both experiment because straw was not degraded properly. Nitrogen content decreased which means that the sludge was degraded. From these results, it can be concluded that sludge from dairy industry's WWTP can be composted.

Keywords: dairy processing sludge, rice straw, rotary composter, windrow.

1. Introduction

The dairy industry located in Cikampek is a food industry that produces milk products particularly powdered milk. This industry produces liquid waste that is treated in the wastewater treatment plant (WWTP). This plant generates side product in the form of sludge which according to Peraturan Pemerintah (PP) No. 18/1999 Jo PP No. 85/1999 is categorized as hazardous waste. According to the initial survey, this industry produces about 25 tons of sludge every month which is treated by a third party with high cost. Therefore, the industry is considering composting as an option to treat this sludge.

According to Schaub et al. (1996) many food processor industries are faced with problems in managing solid wastes, which can constitute up to 30% of incoming raw material. Traditionally, most of this waste has been landfilled but environmental regulations, closure of landfill sites and higher tipping fees are forcing the consideration of other options. One of these options is composting. Composting is viewed as the best treatment alternative because it does not harm the environment and it will create a useful product with relatively low-cost infestation (Roca-Perez et al., 2009).

Composting is a biological process for treating solid or semisolid organic materials to produce a stable, soil like end product. The process requires a mixture of materials with suitable physical and chemical properties, and adequate management to ensure that suitable process conditions are maintained. When carried out properly, the process results in temperatures that are sufficiently high to destroy pathogens and weed seeds while, at the same time, reducing the volume of material by up to 40%. In addition to the economic value of the product, the process is generally perceived as being environmentally friendly and, therefore, can have significant 'value' from the point of view of public relations. However, if the process is mismanaged, offensive odours can result, which have a distinctly negative public relations value (Schaub et al., 1996).

The characteristics of the dairy processing sludge are shown in Table 1. It can be seen that water is the most dominant content of the sludge. Meanwhile, the heavy metals content shows that only zinc (Zn) is high in concentration. The C/N ratio of the sludge is 9. The sludge also consists mainly of organic material. From these characteristics, it can be concluded that dairy processing sludge can be composted.

The dairy processing sludge characteristic is water-absorbent. Consequently, there will be very little air holes when the sludge is stacked in the composting process. This condition will disturb the composting process so another material needs to be added to solve the problem. In this experiment rice straw will be used as bulking agent.

The role of rice straw as a bulking agent was to increase C/N ratio and to provide degradable organic carbon (Petric et al., 2009). Adding rice straw to dairy processing sludge gave higher carbon content and therefore C/N ratio was higher. Rice straw exerted a great influence on composting performance since appropriate conditions of the physical environment for air distribution must be maintained during the process (Petric et al., 2009). The addition of rice straw for dairy processing sludge optimized substrate properties such as air space, moisture content, C/N ratio, and pH, affecting positively the decomposition rate.

Table 1 Characteristics of Dairy Processing Sludge

No.	Parameter	Unit	Analysis
1	Kadar Air	%	84.12
2	C – Organik	% DW*	40.83
3	NTK	% DW	4.55
4	Phospat	gr/kg DW	3.495
5	Arsen (As)	mg/kg DW	Nd**
6	Barium (Ba)	mg/kg DW	14.80
7	Cadmium (Cd)	mg/kg DW	Nd
8	Chromium (Cr)	mg/kg DW	12.79
9	Copper (Cu)	mg/kg DW	62.96
10	Cobalt (Co)	mg/kg DW	1.51
11	Lead (Pb)	mg/kg DW	3.01
12	Mercury (Hg)	mg/kg DW	Nd
13	Molybdenum (Mo)	mg/kg DW	Nd
14	Nickel (Ni)	mg/kg DW	2.51
15	Tin (Sn)	mg/kg DW	Nd
16	Selenium (Se)	mg/kg DW	Nd
17	Silver (Ag)	mg/kg DW	2.01
18	Zinc (Zn)	mg/kg DW	541.34

*DW = Dry Weight
**Nd = Not detected

Therefore, the objective of the present study is to assess the composting process of dairy processing sludge with rice straw on a small-scale and to identify the ability of the sludge to be composted.

2. Methodology

The composting process was done in the Greenhouse Solid and Hazardous Waste Laboratory at Bandung Institute of Technology. The process was conducted for 30 days. Dairy processing sludge as raw material for compost was collected from a dairy industry located at Indotaisei Industrial Region, Cikampek. This sludge was produced from the industry's wastewater treatment plant. Rice straw was obtained from a rice field located at Awiligar, North Bandung.

2.1. Mixing dairy processing sludge with rice straw

The C/N ratio of the sludge is 10 and rice straw is 70. The moisture content of the sludge is 86% and rice straw is 7%. The optimum conditions for composting are C/N ratio in the range of between 20 and 30 (Li et al., 2006) and moisture content of 50% (Roca-Perez et al., 2005). Therefore, to achieve these conditions, sludge and rice straw had to be mixed at a ratio of 5:1 (w/w fresh weight). Rice straw was shredded before mixing.

2.2. Composting process

The composting process was conducted by two composting methods; rotary drum and stockpile. The process was done aerobically. During the process, daily monitoring and laboratory analysis were conducted.

The rotary composter was made of plastic with diameter of 39 cm and height of 74 cm. The composter has two covers on top and at the bottom to ease the turning of the compost. There are eight air holes equipped with air hose connected to an air pump to ensure adequate air circulation because the process was done aerobically. The composter also has rotating blades in the middle to mix the compost. The compost was turned and mixed every day during the process. Water was added if the pile was too dry. The stockpile process was done by piling the *sludge* and straw on a tarp. The pile got oxygen supply from a blower, also from mixing and turning of the pile once every three days.

2.3. Daily monitoring

Daily monitoring was done every day during the composting process. The parameters measured were temperature, O_2 level, pH, water content, and weight reduction. The temperature was measured in two points, in the middle of the top of the compost and the bottom part (when the rotary composter is turned). O_2 level was measured at eight points from the air holes spread throughout the rotary composter. The O_2 level was measured using oxygen analyzer. pH and water content was measured using soil tester in one point, in the middle of the compost pile. The weight was measured before the turning and mixing of the compost.

2.4. Laboratory Analysis

The analysis was done by taking two samples from the process on day (T) T0, T3, T5, T9, T15, T20, and T30. The physical parameters being analyzed were water, volatile, and ash content. While the chemical parameters being analyzed were C-organic and NTK. Particularly for samples T0 and T30, heavy metals, phosphate, and toxicity are also analyzed.

3. Results And Analysis

3.1. Daily monitoring

Temperature is the most important indicator of the efficiency of the composting process (Imbeah, 1998). According to the US Environmental Protection Agency (USEPA, 1995), all microorganisms have an optimum temperature range. For composting this range is between 32°C and 60°C. Gotaas (1956) stated that the optimum temperature for composting is between 50-70°C. To satisfy the regulatory requirement for composting by US Environmental Protection Agency (USEPA, 1995), composting temperature must be maintained above 55°C for at least three consecutive days to destroy pathogens and weed seeds. However, composting temperature must not be too high as this could kill almost all microorganisms and cause the process to cease (Golueke and Diaz, 1996).

The experiment showed that the initial average temperature in the rotary composter was 25°C which was the same as the air temperature. The temperature kept increasing during the first 14 days of the process, and then it decreased slowly during the rest of the process. The compost temperature in the rotary composter was always higher than the air temperature. While in the stockpile, the initial average temperature is equal to the air temperature. This went on for five days and then the temperature increased significantly until it reaches its maximum point. The highest temperature recorded in the rotary composter was 38°C at T14. In stockpile, the maximum temperature reached was 42 ° C which occurs at T5. These temperatures lie in the optimum temperature range determined by the USEPA (1995). After that, the temperature stays above 30°C. This is not in accordance with the optimum temperature required to kill bacterial pathogens by Gotaas (1956). Based on the criteria of USEPA (1995), the compost from the rotary composter and the stockpile is not acceptable for sanitation purposes. This is probably because the composting material contained cellulose or lignin derived from the straw so that the process of decomposition of organic material is slower. Changes to the rotary composter and stockpile temperatures can be seen in Fig. 1.

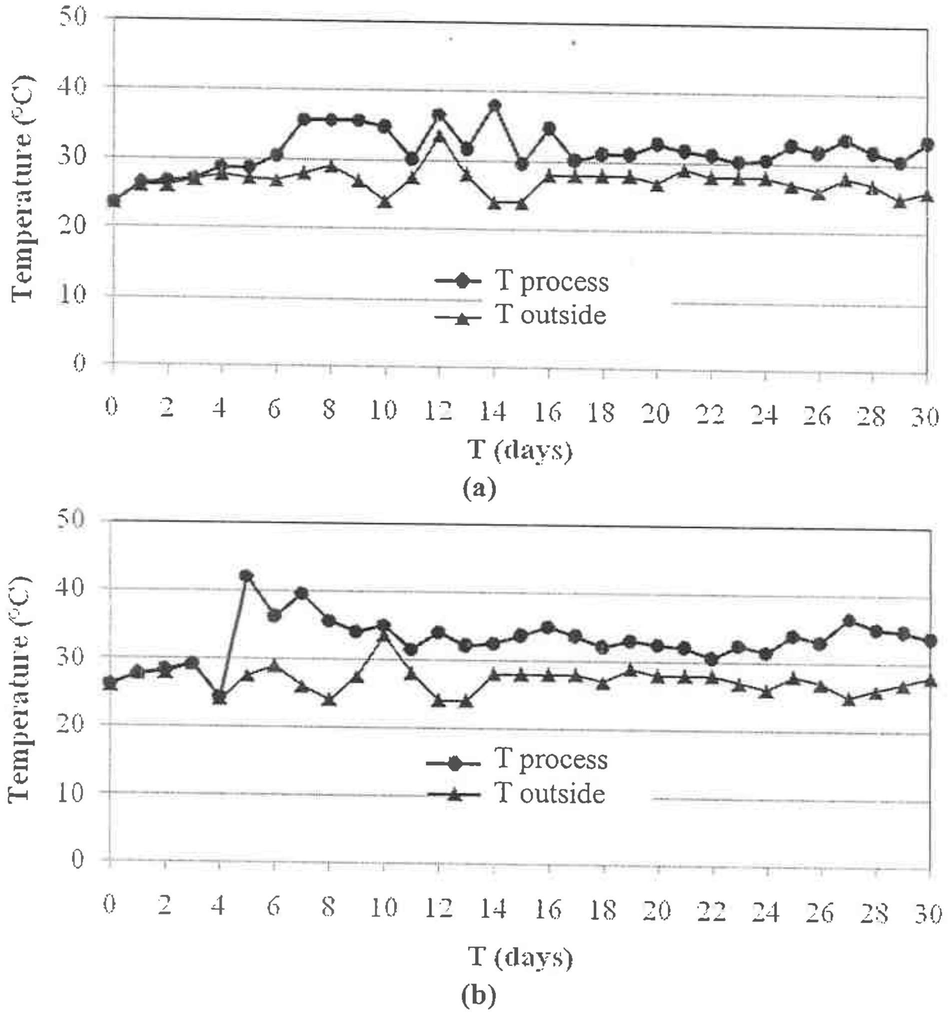

Figure 1 Temperature Profile in (a) Rotary Composter and (b) Stockpile

Water is an essential part of all forms of life and the microorganisms in a compost pile are no exception (USEPA, 1995). Proper moisture content is necessary to support microbial activity. Although the range of 50-60% is generally recommended for composting, Liang et al. (2003) reported that a range of 60–70% provided maximum microbial activities, while Gotaas (1956) found that composting at moisture content of 30-100% was feasible as long as the composting material has sufficient porosity to allow good air supply.

In the rotary composter, the moisture content ranged between 40% and 100%. These numbers met the criteria stated by Gotaas (1956). After 15 days, the moisture content decreased until it reached 0% at the end of the process. In stockpile, moisture content was 100% for the first four days and then slowly decreased. However, the moisture content increased in certain days due to the adding of water. The decrease of moisture content in both processes was caused by water evaporation from the heat produced during the composting process. Fig. 2 shows the profile of the moisture content profile during the composting process.

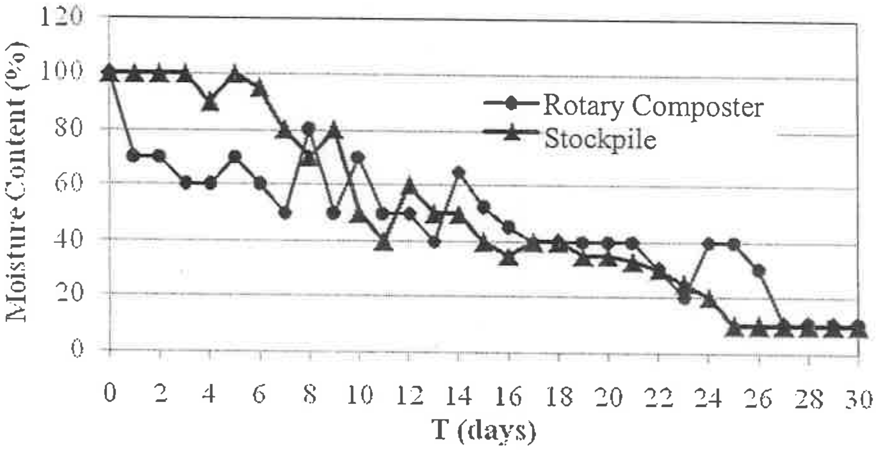

Figure 2 Moisture Content Profile in Rotary Composter and Stockpile

pH control is one of the most important parameter to evaluate the living environment of microorganisms and waste stability. During composting process the pH will vary between 6 to 8 (USEPA, 1995). If there is a lack of aeration, then anaerob condition will occur and the pH will decrease to 4.5. This will slow down the composting process. According to the USEPA (1995), wide swings in pH are unusual. Because organic materials are naturally well-buffered with respect to pH changes, down swings in pH during composting usually do not occur.

From the experiment, pH number in the rotary composter never went below 6.9 and the highest number was 7.1. While in the stockpile, the pH number was between 7 and 7.2. This means that the process occur aerobically with suficient oxygen level. The pH range also met the criteria stated by the USEPA (1995). The changes in the pH numbers can be seen in Fig. 3 below.

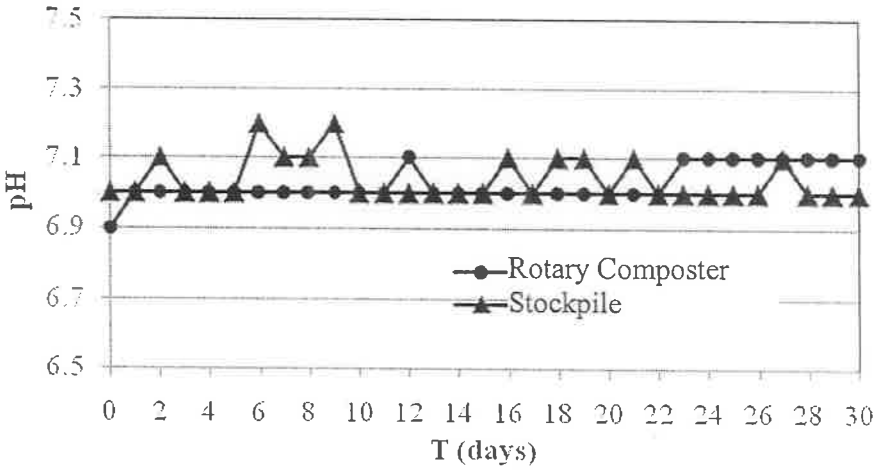

Figure 3 pH Profile in Rotary Composter and Stockpile

To ensure that the composting process is done aerobically, oxygen availibility is one of the parameters that must be present. Turning and mixing the compost pile will provide oxygen availibility. Mechanically supplied oxygen can also be done. By turning and mixing the pile several factors will be achieved, such as aerob condition, optimum humidity, and more equal contact of waste with microorganisms.

The compost pile should have enough void space to allow free air movement so that oxygen from the atmosphere can enter the pile and the carbon dioxide and other gas emitted can be exhausted to the atmosphere (USEPA, 1995). This is why the adding of rice straw as a bulking agent was necessary beause the dairy processing sludge characteristic is water-absorbent, so when the sludge is stacked in the composting process; there will be very little air holes. This condition will disturb the composting process.

The oxygen level was measured in eight air holes spread around the rotary composter. There were some measurements that showed vacuum condition in some of the air holes. This was because the air hose was blocked by the content of the rotary composter.

From the experiment, it can be seen that the average oxygen level during the process was between 20,3-20,9%. This means that the process was done aerobically, because the oxygen level is the same as the oxygen level in the atmosphere. The low number of oxygen level was probably caused by the blocking of the air hose by the compost. During the last days of the composting process, the oxygen level was constant at 20,9%. This was because the volume of the compost had decreased so that all of the oxygen holes are exposed to the outside air. The oxygen level profile can be seen in Fig. 4 below.

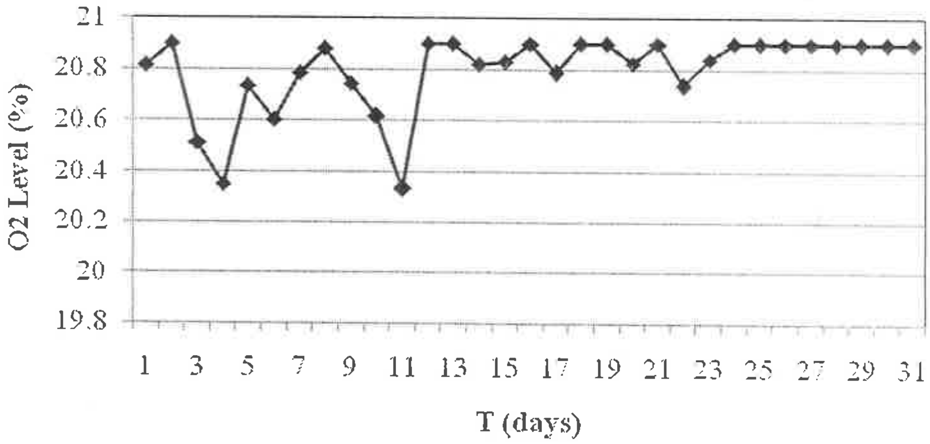

Figure 4 Oxygen Level Profile in Rotary Composter

During composting process, organic matter is oxidized and converted to carbon dioxide, water, ammonia and new microbial biomass. The rate of organic matter loss is an indicator of the overall composting rate (Petric at al., 2009). During the experiment, the mass and volume of composting material within the rotary composter were decreasing significantly. This decrease was mainly the result of degradation of organic matter during composting process. Other than that, during the composting process heat will be produced and water content will evaporate. This can be seen from Fig. 4 that the water content kept decreasing during the process which caused the weight reduction of the compost.

The initial weight of the compost was 23,8 kg and it kept decreasing during the process untill it reaches 5,7 kg. The weight reduction ratio was 24%. This result was similar to that obtained by Yue et al. (2008). Fig. 5 shows the decreasing of compost's weight.

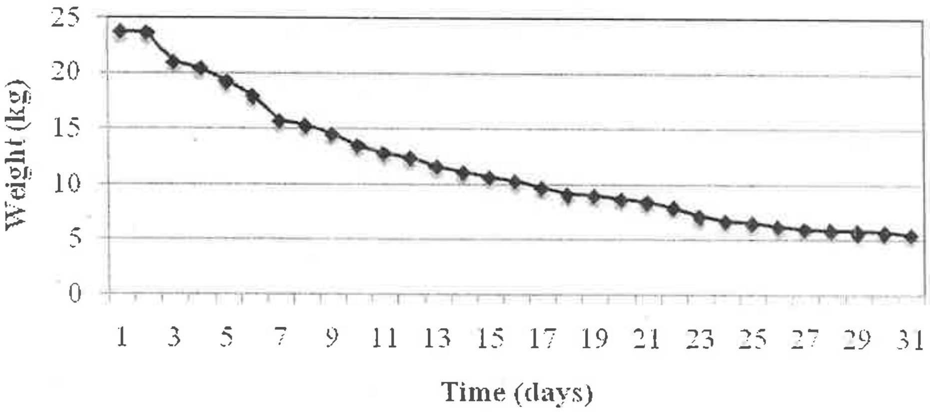

Figure 5 Weight Reduction in Rotary Composter

3.2. Laboratorium Analysis

Water content plays an important role in the quality of compost. If the compost is too dry, it will not affect the activity of microorganisms in the pile, on the other hand if it is too wet it will affect the process of degradation to become anaerobic (Thenaya, 2007).

Initial characterization showed that the sludge has a water content of a very high 86.19%. Therefore, straw which has water content of 6.99% was added to absorb excess water in the sludge.

Water content basically indicates the amount of water mass component in the compost that contributes to its total mass, expressed in percent by weight. Water content in the rotary composter was decreased by 32.24%, while in the stockpile was 22.13%. The decrease of water content in the stockpile was smaller due to the addition of water to the pile. On T15, the water content in both processes increased. This was because on that day, water was added because the compost was very dry. Fig. 6 shows the water content in both processes.

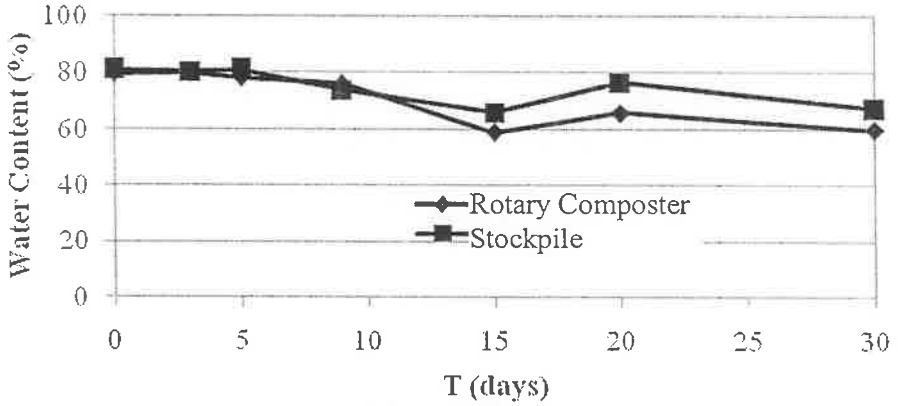

Figure 6 Water Content Profile in Rotary Composter and Stockpile

One of the main purposes of analyzing solids sludge is to determine the amount of organic material in the sludge. This analysis is performed by combustion procedure in which the organic matters are converted into carbon dioxide and water. The lost weight after going through the combustion process is interpreted as organic matter (Sawyer, 2003).

Volatile contents being analyzed are the approximate amount of organic material in the compost. Volatile content can be organic compounds that can be evaporated including gas (eg: NO_2, H_2S, and O_2). Volatile solids as organic contents in sludge are useful to demonstrate the efficiency of biological processes. Fig. 7 shows the changes in volatile contents during the composting process. At T0 to T15, volatile contents gradually decreased. This was because during the composting process degradation of organic matter occurred. However, in T20 volatile content was increased. This may be due to the ongoing biochemical reactions that produce organic compounds.

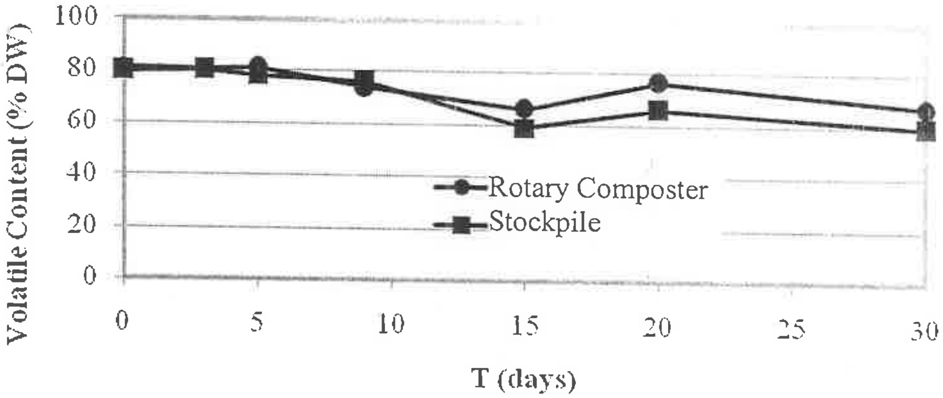

Figure 7 Volatile Content Profile in Rotary Composter and Stockpile

Ash content is the approximate amount of inorganic material in the sludge (Sawyer, 2003). Ash content in the compost samples can be derived from the decomposition of organic compounds, where the chain bond is degraded into simpler compounds, also the release of inorganic compounds such as ammonia and nitrates from protein degradation (Maharja, 2007). Fig. 8 shows the changes in ash contents during the composting process.

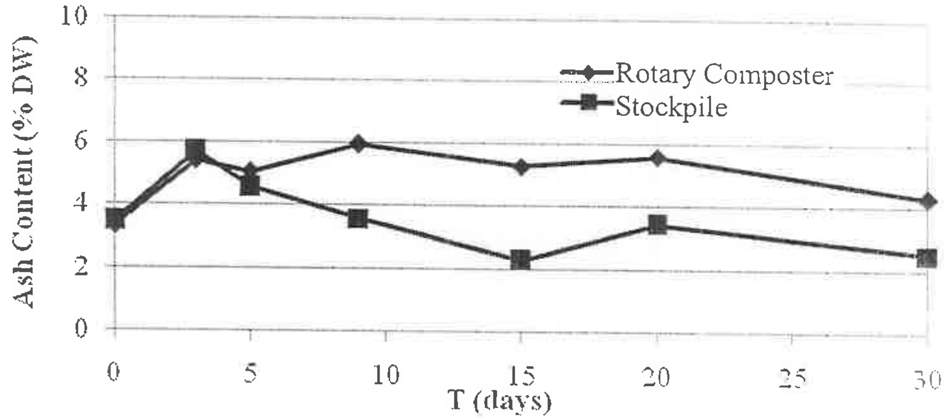

Figure 8 Ash Content Profile in Rotary Composter and Stockpile

Based on the analysis of compost samples during the process can be determined C and N concentrations of each composting process. Analysis of levels of C and N was also performed on the sludge and straw. The C/N ratio sludge was 11.03 and 31.18 of straw is. C/N ratio measurements of the sludge is not much different from the results of initial characterization of 10. But the C/N ratio straw far different measurement results from the initial assumption of 70. This is probably because the analysis levels C and N in the straw only used samples taken from one point. Therefore, the analyzed samples do not represent the entire composition of C and N that is in the straw.

Generally, the C/N ratio at the beginning of the process of composting is 30:1. If the C/N ratio is high, then the nitrogen will be exhausted and diminished biological activity so that microorganisms will die. Nitrogen stored by dead organisms will be used by other organisms to form new cells, which causes the process to be more concentrated in the combustion of carbon (Prabandari, 2005) so that the process of decomposition will be slow (USEPA, 1995). Conversely, if the value of C/N is low (<25:1), excess nitrogen will be toxic so that microorganisms will die and cause biological processes in the pile to stop (Prabandari, 2005). When temperature in the compost pile increases and the C/N ratio less than 25:1, nitrogen will be lost to the atmosphere in the form of ammonia that cause odor (USEPA, 1995). The most effective action to raise the value of C/N is to add organic material in the form of cellulose such as straw or rice husk (Prabandari, 2005).

In the rotary composter, C and N concentrations measured were very low at 9.04. This ratio is very low when compared with the optimal ratio at the beginning of the composting process of 30. The low C/N ratio was probably because of the compost samples are not homogeneous. Mixing between the sludge and straw was not done perfectly because the two materials have very different textures. The size of the chopped straw was too big so that there is not a perfect mixing with the sludge. Therefore, the composition of the sludge and straw in the sample is not proportional, so the analysis of C and N concentration obtained is very small.

At T3, biochemical reactions started to occur that cause the value of C increased significantly. Increased concentration of N also occurs because the composition of sludge is basically high in protein. At T5, the level of N was sufficient so that only changes slightly (from 3.29% to 3.10%). Microorganisms using C as an energy source so that the levels are reduced significantly (from 81.53% to 23.37%).

At T30, C concentration increased significantly again to 64.42%. Sludge may have much degraded, whereas straw is difficult to degrade because it contains cellulose and lignin. Therefore, the sample is taken, the composition of the straw far more than the composition of the sludge so that the measured levels of C derived from straw that has not been unravelled. Ratio C/N at the end of the process is 15.16%. This value meets quality standards for compost by SNI 19-7030-2004 which states that the C/N ratio compost is between 10 to 20. Concentrations of C and N in the rotary composter can be seen in Table 2.

Table 2 C and N Concentrations in Rotary Composter

Days (T)	%C	%N
0	17.67	1.96
3	81.53	3.29
5	23.37	3.10
9	26.01	2.84
15	26.88	3.24
20	30.65	3.58
30	64.42	4.25

The same thing happened to stockpile composting process. At the beginning of the process, the value of C / N obtained is very low at 8.11%. This is also caused by the compost sample was not homogeneous. At the end of the process, the ratio C / N was obtained by 23%. This value does not meet the standards of quality compost by SNI 19-7030-2004. Concentrations of C and N in the stockpile can be seen in Table 3.

Table 3 C and N Concentrations in Stockpile

Days (T)	%C	%N
0	27.26	3.26
3	29.43	3.61
5	23.32	3
9	29.89	2.72
19	40.69	3.51
20	61.22	4.03
30	63.98	2.78

According to Gotaas (1956), the concentration of C at the ripe compost is 8-50%. While the concentration of N is 0.4-3.5%. In the composter, the concentration of C and N in the end does not meet this standard. While the stockpile, the concentration of C does not meet the standards but the concentration of N already meet the standards.

Long-term accumulation of heavy metals in the soil must be considered as heavy metals can cause adverse effects to the food chain, are toxic to plants and soil microbiological processes. Heavy metals are persistent in the soil. Therefore, an important heavy metal analysis conducted in this study must be conducted so that the compost does not harm the environment.

After extracting the samples, then the heavy metal contents can be checked at the AAS (Atomic Absorption Spectrophotometer). The initial characterization of the sludge shows that of the 14 kinds of heavy metals analyzed, only zinc (Zn) and copper (Cu) which showed high rates of 541.34 and 62.96 mg/kg DW (dry weight). Some heavy metals such as arsenic, cadmium, mercury, molybdenum, tin, and selenium was not detected in the sludge. Therefore, the heavy metal analysis of the final compost samples (T30) is only done on the elements that the highest estimated abortion, which are copper, lead, nickel, and zinc.

From the results of heavy metal analysis of the final compost samples (T30) showed that lead and nickel are not detected in samples from the rotary composter and stockpile. Zinc and copper concentrations also decreased to 144.65 mg/kg and 51.29 mg/kg of DW in the composter and 152.47 mg/kg and 58.43 mg/kg of DW in the stockpile. This indicates that during the composting process, heavy metal concentration was decreased. Because the sludge contains heavy metals that are not needed, the bulking material which is straw dilute the concentrations of heavy metals and reduce their availability to the plant (Corbitt, 1989). Heavy metal analysis of the final compost samples (T30) can be seen in Table 4.

According SNI 19-7030-2004, the maximum content of Cu and Zn elements that can be owned by compost is 100 mg/kg and 500 mg/kg. Based on the analysis results obtained, it can be seen that the concentration of Cu and Zn at the end of the compost samples (T30) is below the standard maximum limit of SNI.

Table 4 Heavy Metals Analysis

Sample	Parameter	Unit	Analysis
Rotary composter	Copper (Cu)	mg/kg DW*	51,29
	Lead (Pb)	mg/kg DW	Nd**
	Nickel (Ni)	mg/kg DW	Nd
	Zinc (Zn)	mg/kg DW	144,65
Stockpile	Copper (Cu)	mg/kg DW	58,43
	Lead (Pb)	mg/kg DW	Nd
	Nickel (Ni)	mg/kg DW	Nd
	Zinc (Zn)	mg/kg DW	152,47

* DW = Dry Weight
** Nd = Not detected

Toxicity of a compound can generally be interpreted to the potential of a chemical to cause adverse effects when these compounds enter human body. The main concern is the quantity or toxicity of the compound dose.

Toxicity test was conducted on samples T0 and T30. The purpose was to compare the toxic properties of the compost at the beginning and the end of composting process. Samples were extracted first and then diluted with variations of 25%, 60%, 75%, and 100%. In this test Lactuca sativa is grown in a petri dish and incubated for five days at a temperature of 20°C. In this test was done duplo. After that, the length of roots was measured and statistical test on the data was performed. The results can be seen in Table 5.

In the table above, it can be seen that the influence of sample T0 sample concentration at 100% of the lettuce root growth was 42.89%. Meanwhile, in the T30 sample, the effect was reduced to 13.63%. This indicates that the final compost samples (T30) has a toxicity level that is lower than the initial compost sample (T0). Therefore, it can be concluded that the composting process can reduce the toxicity of the sludge.

Table 5 Effects of Sample Concentration on Roots Growth

Sample Concentration Variation (%)	Effect on Roots Growth (%)
T0	
25	25,67
60	17,71
75	29,05
100	42,89
T30	
25	11,04
60	27,16
75	12,84
100	13,63

4. Conclusion

The results obtained from the experiment confirmed that the dairy processing sludge and rice straw are compatible to be used in composting process. The only parameter that did not meet the requirement is the temperature. The highest temperature recorded was 38°C. This temperature was not able to kill pathogens and weed seeds. The compost is not acceptable in sanitation terms. This was probably due to miscalculation of the mixing ratio between the dairy processing sludge and rice straw. The other parameters being monitored already met the optimum requirements for composting process. Water content in both experiments decreased. This indicates that during the composting process heat occurs that causes water evaporation. C-organic content in both experiments increased at the end of the process. This is caused by straw was not degraded because it contains cellulose and lignin. Nitrogen levels in both experiments decreased at the end of the process. This indicates that degradation occurs in the sludge. The ratio of C/N at the end of the process in a rotary composter has been compliant with mature compost by SNI, but in stockpile the C/N ratio did not meet the standard. Heavy metals content were decreased at the end of composting process. Toxicity tests showed that the compost produced has toxic levels lower than the initial sample. This means that composting can reduce the toxicity of the sludge. Compost did not meet some standard of mature compost from SNI 19-7030-2004 after 30-day process. Sludge can be composted, but several changes should be made to the process, such as the mixing ratio of sludge with straw, straw size, and time of composting. Future composting experiments must be carried out to figure out the correct composting time and the mixing ratio between the dairy processing sludge and rice straw.

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