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SLAUGHTER HOUSE SOLID WASTE MANAGEMENT IN INDONESIA

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ABSTRACT

The solid slaughter house waste (SSW) in Indonesia is generally disposed of into open dumped landfill. This type of solid waste can cause odor and atmospheric pollution if discharged directly into the environment. Additionally, it may spread disease due to the nesting vectors, and the resulting leachate can lead to groundwater contamination. This paper reviews the characterization of slaughter house (SH) types and SSW generation potential and to review the development of treatment technology of SSW and its application. The SH in Indonesia is divided into 3 classes, namely: 1) SH for large and small ruminants; 2) SH for poultry; 3) SH for pigs. Application technologies in Indonesia include compost and biogas technologies, and the use of rumen content for animal feed. Problem in biogas technology is generally caused by the high nitrogen content in the SSW. The most suitable raw material for biogas production is herbivore waste. The main advantages of using SSW for compost production are: the appropriate characteristics for composting process, free of hazardous contaminant, and appropriate composting technologies are available to reduce environmental problems caused by SSW. In addition, rumen content is considered to be a potential alternative for animal feed because have high content of amino acids (approximately 73.4% of the total protein) and rich in vitamin B complex. Among the disadvantages, the composting process of SSW requires long time period and generate air pollutants, such as ammonia and hydrogen sulphide.

Key words: *biogas , composting, Indonesia, management, rumen content as animal feed, slaughter house solid waste*

INTRODUCTION

Indonesia is an agricultural country which gradually moves towards industrialization. This country needs manure for agriculture activities and energy resources. Slaughter house (SH) is a building or a complex of buildings, which is designed for livestock slaughter for the provision of public consumption (Minister of Agriculture Decree No. 13, 2010). According to Wahyono and Sahwan, 2011, SH is a place designed as a means of public service in the provision of healthy and safe meat for consumption. Slaughter house solid waste (SSW) generally consists of livestock manure, rumen content, meat, fat, leather, bone, and grass residuals. In Indonesia, the SSW is generally disposed of to open dumped landfill (Department of Animal Husbandry, 2010). The SSW can cause odor and atmospheric pollution if discharged directly into the environment (Pagans et al., 2007). Additionally, it may spread disease due to the nesting vectors, and the resulting leachate can lead to groundwater contamination (Imbeah, 1998).

Currently, the development of SSW processing technology has evolved. Cakung SH in East Jakarta has produced compost from the SSW manure, rumen, and grass (Wahyono and Sahwan, 2011). Meanwhile, in Semarang City a research on anaerobic digestion for biogas production from the cattle manures and liquid rumens has been carried out (Budiyono, et al. 2011). While in Medan city, rumen content used as animal feed for ducks (Nova, 2000) and tilapia (Fauzana 2001). The aims of this paper are to identify characterization SH types and SSW generation potential, and to review the development of treatment technology of SSW and its application in Indonesia.

SH Types and SSW Generation Potential

Based on the types of cattle being slaughtered the SH in Indonesia is divided into 3 classes, namely: 1) SH for large and small ruminants, which comprise cows, buffaloes, and small ruminants such as of goats and sheeps. This SH class is regulated in the Minister of Agriculture Decree No. 13 (Minister of Agriculture Decree No. 13, 2010); 2) SH for poultry, namely chickens, ducks, pigeons, turkeys, geese, quail, and grouse. This SH is regulated in the Minister of Agriculture Decree No. 557 (Minister of Agriculture Decree No. 557, 1987); 3) SH for pigs, which is regulated in the Minister of Agriculture Decree No. 555 (Minister of Agriculture Decree No. 555, 1986). Table 1. shows the number and type of registered SH in several cities in Indonesia. Unfortunately, most recent data on the number of SH in Indonesia is not available. Data in Table 1. mention the number of SHs in several cities in Indonesia, which ranges from 1 to 5 per city.

Table 1. The number and type of registered SH in several cities in Indonesia

City, Province	Total number of SH
Surabaya, East Java[2]	2
Bandung, West Java[3]	2
Medan, North Sumatera[4]	1
Semarang, Central Java[5]	4

[1] Dinas Peternakan Provinsi Jawa Timur, 2013
[2] Dinas Peternakan Provinsi Jawa Barat, 2013
[3] Dinas Peternakan Provinsi Sumatera Utara, 2013
[4] Dinas Peternakan Provinsi Jawa Tengah, 2013

The SSW in Indonesia is mainly composed of manure and grass feed residue. The generation rate of these kinds of SSW at Cakung SH is 11.8 tons/day. The total SSW generation rate from the caged 785 ruminants in this SH is 15.2 tons/day. Depending on its composition, the SSW may have C/N ratios of different values. Grass residual material has a high carbon value of 52.72 (Wahyono et al., 2003). Therefore, the C/N ratio is higher than 30 (Padmono, 2005). In contrast, manure and rumen content have a low C/N ratio, due to the high nitrogen content (Table 2).

Table 2. Characteristic of SSW

Parameter	SSW Types						
	Animal by-product, AP (poultry and rabbit)	Cow Rumen	Cow Manure	Grass	SHW (poultry)	Pig faeces	**Swine manure**
Moisture content, % (wb)	45.9 (Barrena *et al.*, 2009); 55.0 (Pagans *et al.*, 2007)	13 (Wahyono *et al.*, 2003)	88 (Neves *et al.*, 2009)	-	-	71.2 (Meat Technology Update, 2002)	**66.11 (Zhu, 2006)**
Organic matter content, % (db)	67.58 Barrena *et al.*, 2009; 69.1 (Pagans *et al.*, 2007)	50.15 (Wahyono *et al.*, 2003)	49.31 (Wahyono *et al.*, 2003)	52.72 (Wahyono *et al.*, 2003)	39.6 (Jiang *et al.*, 2011)	36.2 (Meat Technology Update, 2002)	**371.5 (Zhu, 2006)**
pH	8.0 (Pagans *et al.*, 2007); 8.2 (Barrena *et al.*, 2009)	8.6 (Wahyono *et al.*, 2003)	7.8 (Wahyono *et al.*, 2003)	6.75 (Wahyono *et al.*, 2003)	-	-	-
N-Kjeldahl, % (db)	4.3 (Pagans *et al.*, 2007); 5.52 (Barrena *et al.*, 2009)	0.88 (Wahyono *et al.*, 2003)	0.63; 1.0 (Wahyono *et al.*, 2003)	1.11 (Wahyono *et al.*, 2003)	6.2 (Cuetos *et al.*, 2008)	27.4 (Meat Technology Update, 2002)	**22.73 (Zhu, 2006)**
C/N ratio	**7.08 (Barrena *et al.*, 2009); 8.8 (Pagans *et al.*, 2007)**	**17-21 (Padmono, 2005)**	**14.8**	**± 30**	**3.7; 2-24**	**13.2 (Meat Technology Update, 2002)**	**16.34 (Zhu, 2006)**

Development of Treatment Technology of SSW

1. Composting

Composting is biological conversion of organic substrate to stable humus-like products, which is affected by carbon to nitrogen ratio, moisture content, oxygen levels, temperature, and activities of successive groups of microorganisms (Bueno et al., 2008 and Boulter-Bitzer et al., 2006). Among its advantages, composting is a low-cost natural method of organic waste recycling (Bueno et al., 2008), of which product can be used for soil conditioner. On the other hand, composting process has some limitations. It is a time-consuming process, which needs protecttion from rain and herbicides, and requires leachate treatment. In addition, it needs odor management, maintenance of moisture condition and oxygen level (Zaleski and Paquin, 2005).

SSW can be processed by composting process for the following reasons: 1) it has appropriate characteristics for composting process, with combined high and low C/N ratio values; 2) it is free of hazardous contaminant; 3) supply of raw material is assured the continuity of compost production, which will impact the networking markets (Wahyono et al., 2003); 4) appropriate composting technologies are available to reduce environmental problems caused by SSW; 5) the compost product can generate income for the SSH; 6) the product is an alternative to the use of chemical fertilizers, which can continuously make the soil to become acidic.

Former research on SSW windrow composting process in Cakung SH, which used manure, rumen, and grass, could produce compost within 65 days (Wahyono and Sahwan, 2011; Wahyono et al., 2003). In the early stage the temperature increased up to 65-70 ºC. Slowly, the tem-perature decreased to 40 ºC within 4-8 weeks. The com-post material was turned with a machine twice a week. In order to keep the moisture of compost materials, watering was done routinely.

The compost product of Cakung SH has comparable physical and chemical qualities to SSW compost products from various countries, and meet the quality standards (Table 3). Physically, the compost product has a relatively loose and smooth texture. The content of nutrient was higher than other compost. In addition, biologically SH Cakung compost contains high diversity of microorganisms that may improve soil fertility. SH Cakung compost product is also free of pathogenic bacteria, parasites, and weed seeds.

2. Biogas

In Indonesia biogas production technology was introduced in 1980's. The advantages of this technology are:

1) reducing the effect of greenhouse gas; 2) producing environmentally friendly fuel; 3) digested sludge can be used as fertilizer; 4) can kill pathogenic bacteria; 5) Anticipates odor problems. Constraints in biogas production are: 1) lack of technical expertise; 2) biogas reactor operation is difficult due to problems with closed systems and frequent leaks; 3) reactor design is not user friendly; 4) Requires manual handling (feed/remove sludge from the reactor); 5) expensive construction costs.

Utilization of SSW as biogas has been done by Budiyono *et al.*, 2011. Raw materials for biogas production from the cattle manures and liquid rumens were taken randomly from SH located on Semarang city, Indonesia. The biogas production can run optimally with substrate C/N ratio range of 20/1 to 30/1. The results showed that SSW was very suitable for anaerobic digestion for biogas production. The SH wastewater has potential biogas production of 2.472 m^3/m^3 wastewater, whereas cattle manure potential biogas production was 618.90 L/kg of dry based raw materials. The biogas product was composed of CH_4, CO_2, and NH_3 of 48.89 %; 47.87 %; and 2.43 % volume respectively. The methane gas was produced with 305.06 L/kg dry based.

The problem in biogas technology is the generally high content of nitrogen in the SSW, particularly that of the poultry SH. The most suitable raw material for biogas production is herbivore waste.

Table 3. Characteristics of mature compost from various SSW

Parameters	SSW Source						Compost Quality Standards
	Cakung, Indonesia (Wahyono and Sahwan, 2011; Wahyono *et al.*, 2003)	Jorba, Spain (Barrena *et al.*, 2009)	Shujiatuo Town, China (Jiang *et al.*, 2011)	Iowa, USA (Tiquia *et al.*, 2002)	Leon, Spain (Gomez-Brandon *et al.*, 2003)	Jabalpur, India (Gautam *et al.*, 2003)	
Raw material	Cow rumen and manure	Poultry and rabbit	Pig faeces	Pig manure	Cattle manure	Municipal solid waste	-
pH	8.2	8.63	8.1	-	2.8	7.82	**5.5-8.5** (Hong Kong Organic Resource Centre, 2005)
Moisture, (% db)	45	49.40	71.6	-	-	41	**< 50** (Gautam *et al.*, 2003)
Organic matter, (% db)	-	58.56	-	-	-	47	**> 20** (Hong Kong Organic Resource Centre, 2005)
TKN, (% db)	0.025	4.18	0.029	0.017	2.9	0.03	**> 0.6** (Gautam *et al.*, 2003)
Carbon, (% db)	-	-	-	0.3	32.15	37	**30-40** (Gautam *et al.*, 2003)
C/N ratio (total db)	11	7.42	10.7	17.8	11.4	32:0,03	**≤ 25** (Hong Kong Organic Resource Centre, 2005)
Phosphorus, %	0.014	-	-	1.12	-	0.005	**No Specs** (Gautam *et al.*, 2003)
Potassium, %	0.039	-	-	2.07	-	0.34	**No Specs** (Gautam *et al.*, 2003)
Chromium, mg/kg	34.8	-	-	-	-	-	**≤ 100** (Hong Kong Organic Resource Centre, 2005)
Zinc, mg/kg	249	-	-	-	-	-	**≤ 600** (Hong Kong Organic Resource Centre, 2005)
Mercury, mg/kg	**< 0.1**	-	-	-	-	-	**≤ 1** (Hong Kong Organic Resource Centre, 2005)

(db, dry basis)

3. *Rumen Content As Animal Feed*

Rumen content is potential biological resource that can be used as for poultry and swine feed. According to Hernawati (1996), approximate weight of rumen contents of a cow or buffalo is about 5.30 kg, and that of a goat or sheep is about 8.28 kg. Bogohl (1981) stated that rumen content of fasted buffalo or cow was 8-10 %. This author further stated that the rumen content, which is rich in nutrients, could be used as food mixture of poultry, pigs, and sheep.

Nova (2000) fermented dried rumen contents of S-SW with *Trichoderma harzianum* in laboratory scale. Product of this fermentation was fed to ducks. Results of this study showed significant weight gain of the ducks, the increase of consumption and conversion rate.

Both rumen fluid and dried rumen have high content of amino acids (approximately 73.4% of the total protein) and rich in vitamin B complex. For this reason, rumen content is considered to be a potential alternative for animal feed. In addition, the rumen content also contains crude fiber and lignin (Enari, 1983). However, high contents of crude fiber and lignin can disturb growth and consumption rates.

Fauzana (2001) reported the SSW rumen contained rumen protein of 10.09%, fat of13.91%, crude fiber of 18.-73%, dry weight of 89.71%, and ash content of 16.3%. When applied as tilapia feed, it gave significant increase in weight, length, and relative growth of the fish.

Based on the discussion can be conclude that Slaughterhouses in Indonesia are divided into 3 classes SH, namely: 1) SH for large and small ruminants; 2) SH for poultry; 3) SH for pigs. Application technologies in Indonesia inclu-de compost and biogas technologies, and the use of ru-men content for animal feed. Problem in biogas tech-nology is generally caused by the high nitrogen content in the SSW. The most suitable raw material for biogas pro-duction is herbivore waste. The main advantages of using SSW for compost production are: the appropriate charac-terristics for composting process, free of hazardous conta-minant, and appropriate composting technologies are av-ailable to reduce environmental problems caused by SSW. In addition, rumen content is considered to be a potential alternative for animal feed because have high content of amino acids (approximately 73.4% of the total protein) and rich in vitamin B complex. Among the disadvantages, the composting process of SSW requires long time period and generate air pollutants, such as ammonia and hyd-rogen sulphide.

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