Accredited by Kemendikbudristek Dirjendiktiristek No 225/E/KPT/2022. E-ISSN 2541-5875

The Quality of Cattle Manure Compost with Addition of Various Peatland Vegetation

Ria Anjalani*, Paulini, and Ayu Kusuma Ningsih

Animal Science Study Program, Department of Agriculture, Faculty of Agriculture, University of Palangka Raya
*** Corresponding author email: riaanjalani@pet.upr.ac.id**

Abstract. This study aimed to determine the quality of cattle manure compost with the addition of various peatland vegetation plants. The study used a Completely Randomized Design consisting of five treatments with four replications, namely P1 (*Stenochlaena palustris*), P2 (*Dryopteris* sp.), P3 (*Hymenachne amplexicaulis*), P4 (*Eleocharis dulcis*), and P5 (*Imperata cylindrica*). The observed parameters included the physical and chemical properties of compost. Data on physical properties were descriptively analyzed, while chemical properties were analyzed using analysis of variance followed by Duncan's Multiple Range Test when significant differences were found among treatments. The results showed that composts P1 and P2 exhibited changes in color, smell, and texture. Compost P3 showed only a color change. Composts P4 and P5 showed changes in color and smell. Final compost temperature ranged from 28.50 to 28.88°C. The addition of peatland vegetation significantly affected pH, organic C, total N, and C/N ratio (P<0.01).

Keywords: compost quality, physical properties, chemical properties, cattle manure, peatland vegetation

Abstrak. Penelitian ini bertujuan untuk mengetahui kualitas kompos kotoran sapi yang ditambah dengan berbagai macam tanaman vegetasi lahan gambut. Penelitian menggunakan Rancangan Acak Lengkap menggunakan 5 perlakuan dengan masing-masing terdiri dari 4 ulangan, yaitu P1 (*Stenochlaena palutris*), P2 (*Dryopteris sp.*), P3 (*Hymenachne amplexicaulis*), P4 (*Eleocharis dulcis*), and P5 (*Imperata cylindrica*). Parameter yang diamati adalah sifat fisik dan sifat kimia kompos. Data sifat fisik dideskripsikan. Data sifat kimia dianalisis dengan analisis variansi yang akan dilanjutkan dengan *Duncan's Multiple Range Test* jika terdapat perbedaan di antara perlakuan. Hasil penelitian menunjukkan bahwa sifat fisik kompos P1 dan P2 mengalami perubahan pada warna, bau, dan tekstur. Kompos P3 hanya menunjukkan perubahan pada warna. Kompos P4 dan P5 menunjukkan perubahan pada warna dan bau. Temperatur akhir kompos dari kelima perlakuan berkisar antara 28,50–28,88°C. Penambahan berbagai macam tanaman vegetasi lahan gambut menunjukkan perbedaan yang sangat nyata pada pH, C organik, N total, dan rasio C/N (P<0,01).

Kata kunci: kualitas kompos, sifat fisik, sifat kimia, kotoran sapi, vegetasi lahan gambut

Introduction

Vegetation on peatlands consists of trees, poles, shrubs, ferns, and grasses. Several plant species grow naturally in peat swamps, such as *Eleocharis dulcis*. Some plants are used by local communities for food, traditional medicine, animal feed, handicrafts, and other purposes; however, others are considered weeds and are often burned during land clearing. Peatland vegetation biomass is abundant and grows year-round.

For smallholder farmers in Central Kalimantan, burning remains the cheapest method of land clearing and preparation. Burning can increase short-term soil fertility, as ash provides a low-cost fertilizer source for crop cultivation (Jaya et al., 2020). However, burning also increases the risk of peatland fires. Various efforts have been implemented to reduce fire risks by utilizing peatland vegetation as valuable and environmentally friendly products, one of which is composting.

Livestock waste, especially cattle manure, also poses environmental challenges. Without proper management, manure can contribute to air, water, and soil pollution, methane emissions, and sanitation issues. Therefore, converting livestock waste into organic fertilizer is an important strategy (Zuhro et al., 2019).

Composting is the biological decomposition of organic materials from plants and animals into humus under controlled conditions (Abu-Zahra et al., 2014). This process is driven by microorganisms that require specific environmental conditions including nutrients, moisture, pH, temperature, and oxygen availability (Marlina et al., 2020). Cattle manure contains essential nutrients such as nitrogen, phosphorus, potassium, sulfur, magnesium, and trace minerals, making it a suitable compost material (Font-Palma, 2019).

Bulking agents are required to adjust manure properties during composting (Nada, 2015). Incorporating peatland vegetation may optimize the composting process while reducing fire risk, increasing the value of peatland plants, and controlling weeds without burning. This study aimed to determine the effect of different peatland plant species on compost quality.

Materials and Methods

The study was conducted from February to May 2020 at the Laboratory of Animal Science and the Analytical Laboratory, University of Palangka Raya. The materials used were cattle manure, EM4, palm sugar, water, Kalakai (*Stenochlaena palustris*) fern, Pakis (*Dryopteris* sp.) fern, Kumpai Minyak (*Hymenachne amplexicaulis*), Purun tikus (*Eleocharis dulcis*), and Alang-alang (*Imperata cylindrica*). Cattle manure and peatland vegetation were obtained from the cattle sheds of the Ngudi Makmur cattle group and from plants growing on vacant land and roadsides, respectively. Both locations are situated in Kalampangan Sub-district, Sebangau District, Palangka Raya.

Fresh cattle manure was air-dried under shade for one week. Fresh plant materials were chopped into approximately 1 cm pieces using a chopper and then left for one day to reduce moisture content. EM4 was activated by mixing it with water supplemented with palm sugar and allowing the mixture to stand overnight.

The study was conducted at laboratory scale. Composting materials were prepared at a ratio of 1:1 (1 kg cattle manure : 1 kg of each peatland plant) with the addition of 5 mL EM4 for each treatment. All materials were thoroughly mixed until homogeneous, then placed into black plastic bags and tightly tied. Composting was carried out for 20 days. The compost was turned every three days, while temperature was recorded daily. Physical changes in the compost were observed during each turning process. On day 21, the compost was opened and final physical observations were conducted. Samples were then collected for analysis of pH, organic C, total N, and C/N ratio.

The experiment employed a Completely Randomized Design (CRD) consisting of five treatments with four replications. The treatments were P1 (Kalakai, *Stenochlaena palustris*), P2 (Pakis, *Dryopteris* sp.), P3 (Kumpai Minyak, *Hymenachne amplexicaulis*), P4 (Purun tikus, *Eleocharis dulcis*), and P5 (Alang-alang, *Imperata cylindrica*).

The observed parameters included the physical and chemical properties of the compost. Physical properties comprised color, texture, odor, and temperature. Chemical properties included pH, total nitrogen (N), organic carbon (C), and the C/N ratio. Organic C content was determined using the titration method, while total N content was analyzed using the Kjeldahl method. The C/N ratio was calculated as the ratio of organic C content to total N content (Wulandari et al., 2014).

Data on physical properties were described descriptively. Chemical property data were analyzed using analysis of variance (ANOVA) and, when significant differences among treatments were detected, followed by Duncan's Multiple Range Test.

Results and Discussion

Physical properties of compost

The physical properties of cattle manure composts with the addition of various peatland vegetation plants showed changes in color, odor, and texture after 20 days of composting (Table 1). The physical appearance of composts in treatments P1 and P2 exhibited characteristics of mature compost. The physical properties of these composts were consistent with the standards specified in SNI. In contrast, composts from treatments P3, P4, and P5 indicated that the compost had not yet reached maturity.

The color of the composts in this study changed from greenish to blackish brown and black. The blackish-brown and black coloration of the resulting compost indicates the decomposition of organic matter in the initial materials. This color change occurs due to microbial decomposition processes that convert complex carbon chains into simpler carbon compounds (Kumalasari and Zulaika, 2016). In addition, the decomposition of leaf materials causes the loss of chlorophyll, contributing to the dark coloration of compost (Sriharti and Salim, 2010).

The composts in treatments P1, P2, P4, and P5 exhibited a soil-like odor, whereas the compost in treatment P3 showed no change in odor. Changes in compost odor indicate that the microbial decomposition of organic materials has progressed toward completion. Mature compost typically has an earthy smell because the organic materials have been decomposed into stable compounds similar to those found in soil (Budiman et al., 2018; Wahyono and Sahwan, 2010). According to Wahyono and Sahwan (2010), compost that retains an initial or rotten odor suggests incomplete decomposition and requires additional time to reach maturity.

Organic matter decomposition may occur under aerobic or anaerobic conditions. Aerobic decomposition requires oxygen and produces heat and carbon dioxide, which are odorless. In contrast, anaerobic decomposition occurs in the absence of oxygen and involves anaerobic microorganisms, producing compounds such as hydrogen sulfide (H_2S), which has an unpleasant odor (Asngad and Suparti, 2005). The disappearance of odor in mature compost is also associated with the utilization of sulfur by bacteria, which is subsequently oxidized to sulfuric acid within bacterial metabolic processes (Sholihah and Wahyuningrum, 2016).

Table 1. Physical properties of cattle manure composts with addition of various peatland vegetation and the comparison with SNI No. 19-7030-2004

Physical properties	Treatments					SNI No. 19-7030-2004
	P1	P2	P3	P4	P5	
Color						
Initial	Greenish	Greenish	Greenish	Greenish	Greenish	Blakckish brown to black
Final	Black	Black	Blackish brown	Blackish brown	Blackish brown	
Odor						
Initial	Forage odor	Forage odor	Forage odor	Forage odor	Forage odor	Soil odor
Final	Soil odor	Soil odor	Forage odor	Soil odor	Soil odor	
Texture						
Initial	Rough texture	Rough texture	Rough texture	Rough texture	Rough texture	Soil texture
Final	Soil texture	Soil texture	Rough texture	Rough texture	Rough texture	
Average final temperature (°C)	28.73	28.63	28.50	28.88	28.80	accordance with the groundwater temperature

The texture of composts in treatments P1 and P2 resembled soil and crumbled easily when pressed. This soil-like texture results from the decomposition of organic materials through the activity of microorganisms (Sahwan, 2016). In contrast, composts from treatments P3, P4, and P5 showed little change in texture and remained coarse, indicating that the decomposition process was incomplete. Factors contributing to the coarse texture include a relatively short composting duration and the presence of organic materials with high cellulose and lignin content. Decomposition proceeds more rapidly in plant materials with lower lignin and cellulose contents (Asngad and Suparti, 2005).

The average final compost temperature across the five treatments ranged from 28.50 to 28.88 °C. These temperatures indicate that the composts had entered the cooling and maturation phase. At this stage, the population of thermophilic microorganisms declines due to reduced availability of nutrients, while mesophilic microorganisms become active again. These mesophilic organisms further decompose remaining cellulose and hemicellulose into simpler sugars. As the amount of degradable material decreases, the heat generated during composting is reduced (Widiyaningrum and Lisdiana, 2015). Temperature is a critical indicator of composting progress, reflecting microbial activity throughout the process. Compost is considered mature when its temperature approaches ambient or groundwater temperature, typically ≤30 °C (Dewilda and Darfyolanda, 2017).

Chemical properties of compost

The chemical properties of cattle manure composts with the addition of various peatland vegetation plants observed after 20 days of composting included pH, total nitrogen (N), organic carbon (C), and the C/N ratio (Table 2). The results showed that the addition of different peatland vegetation plants resulted in very significant differences in pH, organic C, total N, and C/N ratio among treatments ($P < 0.01$).

The final pH of the composts ranged from 7.46 to 8.53. Composts from treatments P1, P2, P3, and P5 had pH values above the standard for mature compost according to SNI, while only P4 met the SNI pH standard. The pH values observed in this study were higher than those reported by Alfadili et al. (2018), who found that cow dung compost prepared with various decomposers had a pH range of 7.00–7.02. This difference may be attributed to the relatively short composting duration of 20 days in the present study, during which organic matter decomposition was still ongoing. Compost pH generally increases during the composting process due to the degradation and mineralization of organic compounds (Benito et al., 2003). According to Hasibuan et al. (2012), increases in compost pH are also associated with ammonia production from nitrogen-containing compounds.

Table 2. The chemical properties of cattle manure compost with addition of various peatland vegetation and the comparison with SNI No. 19-7030-2004

Chemical properties	Treatments					SNI No. 19-7030-2004
	P1	P2	P3	P4	P5	
pH	8.43^{b}	8.56^{b}	8.34^{b}	7.46^{a}	8.31^{b}	6.80 – 7.49
Organic C (%)	50.22^{ab}	46.04^{a}	48.98^{ab}	56.18^{bc}	52.5^{bc}	9.80 - 32
Total N (%)	1.09^{a}	1.50^{b}	1.45^{b}	0.83^{a}	0.92^{a}	≥0.40
C/N ratio	46.80^{b}	31.83^{a}	35.50^{ab}	68.3^{c}	$57.0b^{c}$	10 - 20

a, b, c Different superscripts on the same line showed very significant differences ($P < 0.01$)

The organic C content of the composts ranged from 46.04% to 56.18%, with the highest and lowest values observed in treatments P2 and P4, respectively. The organic C content in all treatments remained above the SNI standard, indicating that the decomposition process was still in progress. Ongoing decomposition results in relatively high organic C levels at early composting stages. Organic C content serves as an important indicator of the composting process and compost maturity (Mirwan, 2015). During decomposition, carbon is utilized as an energy source for microbial metabolism and cell synthesis, with carbon released in the form of CO_2 and other volatile compounds.

The total N content of composts in treatments P1, P2, P3, P4, and P5 was 1.09%, 1.50%, 1.45%, 0.83%, and 0.92%, respectively. Total N levels in all treatments exceeded the minimum standard specified by SNI. The increase in total N content during composting is attributed to the decomposition of organic materials by microorganisms, which transform nitrogenous compounds through processes such as ammonification and nitrification (Bachtiar and Ahmad, 2019). Nitrogen is essential for microbial growth, maintenance, and cell formation. Higher nitrogen availability accelerates the decomposition of organic materials, as microorganisms involved in composting require sufficient nitrogen for their development (Sriharti and Salim, 2010).

The C/N ratio for P1, P2, P3, P4, and P5 were 46.80%, 31.83%, 35.50%, 68.3% and 57.0% respectively. The C/N ratios observed in this study were higher than the SNI standard for mature compost. The high C/N ratios in all compost treatments were primarily due to the high organic C content resulting from incomplete decomposition by microorganisms. Although the total N content in all treatments met the minimum requirement of the SNI standard, it was not sufficient to substantially reduce the C/N ratio. The C/N ratio of organic materials is a critical factor in composting, as carbon serves as an energy source and nitrogen as a nutrient source for the formation of microbial biomass during the composting process (Trivana and Pradhana, 2017).

The composts produced in this study showed different results compared with those reported by Kajiya et al. (2014), who found that compost mixtures of cattle manure and sawdust composted for 20 days were suitable for use as organic fertilizer. Based on both physical and chemical properties, composts from treatments P3, P4, and P5 exhibited similar characteristics, indicating that they had not yet reached maturity. In contrast, treatments P1 and P2 showed different results. Physically, composts from P1 and P2 exhibited characteristics of mature compost; however, chemically, they did not meet the maturity standards for compost based on SNI criteria, with the exception of total N content.

The time required for compost to reach a specific maturity level varies depending on the characteristics of the input materials and the management of the composting process (Van der Wurff et al., 2016). Several factors may have influenced compost maturity in this study, including composting duration, chemical composition of the plant materials, microbial activity, and the overall composition of the composting materials. Composting in all treatments required a processing time longer than 20 days. Differences in plant chemical composition, particularly lignin and cellulose contents, played an important role in the composting process. Therefore, the activity of cellulolytic and ligninolytic microorganisms was necessary to degrade cellulose and lignin components in the composted plant materials.

In addition, the material composition ratio of 1:1 between cattle manure and plant materials may not have provided optimal conditions for composting and may have contributed to the high C/N ratios observed. According to Triatmojo et al. (2016), optimal composting requires favorable conditions such as appropriate moisture content, aeration, pH, C/N ratio, temperature, humidity, material composition, particle size, microbial population, and nitrogen availability.

Conclusions

The results indicated that the composts produced exhibited different physical and chemical characteristics. Physically, composts from treatments P1 and P2 demonstrated characteristics of mature compost; however, these characteristics were not supported by chemical parameters. In contrast, composts from treatments P3, P4, and P5 did not reach maturity, either physically or chemically. Factors influencing compost maturity in this study included composting duration, chemical composition of the plant materials, microbial activity, and the composition of the composting materials.

References

Alfadili, NS., S Noor, BY Hertanto, and M Cahyadi. 2018. The Effect of Various Decomposers on Quality of Cattle Dung Compost. Buletin Peternakan. 42(3): 250-255.

Abu-Zahra TR, RA Ta'any and AR Arabiyyat. 2014. Changes in compost physical and chemical properties during aerobic decomposition. International Journal of Current Microbiology and Applied Science. 3 (10):479–486

Asngad A dan Suparti. 2005. Model Pengembangan pembuatan pupuk organik dengan inokulan (studi kasus sampah di TPA Mojosongo Surakarta). Jurnal Penelitian Sains dan Teknologi. 6(2):101–113

Bachtiar B dan AH Ahmad. 2019. Analisis kandungan hara kompos Johar *Cassia siamea* dengan penambahan aktivator Promi. BIOMA : Jurnal Biologi Makassar. 4(1):68–76.

Benito M, A Masaguer, A Moliner, N Arrigo and RM Palma. 2003. Chemical and microbiological parameters for the characterisation of the stability and maturity of pruning waste compost Biolology and Fertility of Soils. 37:184–189

Budiman B, S Suyono dan N Fazriaty. 2018. Pengaruh tiga jenis bioaktivator ragi terhadap karakteristik fisik kompos sampah organik di Rumah Sakit Cahaya Kawaluyaan. In Prosiding Pertemuan Ilmiah Nasional Penelitian dan Pengabdian Masyarakat (PINLITAMAS 1). Cimahi, Oktober 2018. Pp : 298–304.)(in Indonesian with abstract with English).

Dewilda Y and FL Darfyolanda. 2017. Pengaruh komposisi bahan baku kompos (sampah organik pasar, ampas tahu, dan rumen sapi) terhadap kualitas dan kuantitas kompos. Jurnal Dampak. 14(1):52–61.

Faatih M. 2012. Dinamika komunitas Aktinobakteria selama proses pengomposan. Jurnal Kesehatan. 15(3):611–618

Font-Palma C. 2019. Methods for the treatment of cattle manure—A review. C—Journal of Carbon Research. 5(2):27. https://doi.org/10.3390/c5020027

Hasibuan Z H, T Sabrina dan MB Sembiring. 2012. Potensi bakteri *Azotobacter* dan hijauan *mucuna bracteata* dalam meningkatkan hara nitrogen kompos tandan kosong kelapa sawit Jurnal Agroekoteknologi. 1(1):237–253.

Jaya A, BS Lautt, EU Antang, S Sibot, S Dohong, P Surawijaya and S Dohong. 2020. Effects of zero burning waste on the quality of liquid fertilizer and vermicompost. International Journal of Agricultural and Biolological Engineering. 13(4):159–165.

Kajiya, Y., Y Ishii, K Fukuyuma and S Idota. 2014. Precise optimization of cattle manure composting using an experimental small-scale instrument. Journal of Biological Sciences. 14(4)317-321. https://dx.doi.org/10.3923/jbs.2014.317.321.

Kumalasari R dan E Zulaika. 2016. Pengomposan daun menggunakan konsorsium *azotobacter*. Jurnal Sains dan Seni ITS. 5(2):64-66.

Marlina E T, DZ Badruzzaman, E Harlia, H Hidayati and I Susilawati. 2020. Microbial population dynamics and fiber reduction in the initial decomposition of beef cattle waste composting. ZIRAA'AH. 45(1):94–102.

Mirwan M. 2015. Optimasi pengomposan sampah kebun dengan variasi aerasi dan penambahan kotoran sapi sebagai bioaktivator. Jurnal Ilmiah Teknik Lingkungan. 4(1):61–66.

Nada W M. 2015. Stability and maturity of maize stalks compost as affected by aeration rate, C/N ratio and moisture content. Journal of Soil Science and Plant Nutrition. 15(3):751–764. http://dx.doi.org/10.4067/S0718-95162015005000051.

Sahwan F L. 2016. Kualitas produk kompos dan karakteristik proses pengomposan sampah kota tanpa pemilahan awal. Jurnal Teknologi Lingkungan. 11(1):79–85. https://doi.org/10.29122/jtl.v11i1.1225.

Sholihah S M dan MA Wahyuningrum. 2016. Penggunaan bioaktivator kelinci pada pengomposan limbah padat tahu. Jurnal Ilmiah Respati. 2(9):650–658.

Sriharti dan T Salim T. 2010. Pemanfaatan sampah taman (rumput-rumputan) untuk pembuatan kompos. In Prosiding Seminar Nasional Teknik Kimia "Kejuangan". Yogyakarta, 26 Januari 2010. Pp:1–8. (in Indonesian with abstract with English).

Triatmojo S, Y Erwanto dan NA Fitriyanto. 2016. Penanganan Limbah Industri Peternakan, Universitas Gadjah Mada Press, Yogyakarta. 206 pages.

Trivana L dan AY Pradhana. 2017. Optimalisasi waktu pengomposan dan kualitas pupuk kandang dari kotoran kambing dan debu sabut kelapa dengan bioaktivator Promi dan Orgadec. Jurnal Sain Veteriner. 35(1):136–144.

Van der Wurff, A.W.G., JG Fuchs, M Raviv and A Termorshuizen. 2016. Handbook for composting and compost use in organic horticulture. BioGreenhouse. http://dx.doi.org/10.18174/375218.

Wahyono, S dan FL Sahwan. 2010. Standarisasi kompos berbahan baku sampah kota. Jurnal Rekayasa Lingkungan. 6(3):223–233.https://doi.org/10.29122/jrl.v6i3.1936.

Widiyaningrum P dan L Lisdiana. 2015. Efektivitas proses pengomposan sampah daun dengan tiga sumber aktivator berbeda rekayasa. Rekayasa.13(2):107–113.

Wulandari D A, R Linda dan M Turnip. 2016. Kualitas kompos dari kombinasi eceng gondok (*Eichornia crassipes Mart. Solm*) dan pupuk kandang sapi dengan inokulan *Trichoderma harzianum L.* Protobiont. 5(2):34–44.

Zuhro F, HU Hasanah, S Winarso, M Hoesain dan D Arifandi. 2019. Karakteristik pupuk organik berbahan dasar kotoran hewan. Agritrop. 17(1):103–112.