Research Article
Open Access
CrossMark

Use of composting to produce organic fertilizer from horse stall residues

Abstract

The development of agriculture in Brazil has changed the role of horses from working animals to animals for sport competition and recreation. Horse breeding is a relevant activity in Brazilian agribusiness and approximately 6 million animals are currently involved in such activity. Recreation and sport horses are usually confined in stalls, where the animals spend the days. A variety of materials are used for bedding horse stalls, such as wood shavings, rice husks and dry grasses. These materials are removed daily or weekly. Horse manure is not well regarded as good plant fertilizer. The present work aims to develop a methodology for the reuse of waste from equine stalls (wood shavings, feces, urine, and animal food remains) through composting, characterizing, and evaluating the potential of the final product as a biofertilizer. For this, beds of 2 horses were used, composed of wood shavings, feces, urine, and food leftovers dropped by the animals on the bedding. Two types of wood shavings were tested – sawdust and chips. After 15 days of confinement, the litter was removed and went through a composting process with daily control of temperature, humidity, aeration, and smell until stabilization of the compost, which occurred after approximately 60 days. After this period, part of the material was collected for analysis of carbon (C) and nitrogen (N) concentration, and C/N ratio. The results obtained indicate that the final compost is suitable for use as organic fertilizer.

Keywords: horse manure, aerobic decomposition, biofertilizer

Volume 8 Issue 5 - 2023

Gabriel Dias Costa,[1] Breno Mourão de Souza[2]

[1]Coordinator in the areas of agricultural sciences, health sciences and human sciences at UNA Contagem, Brazil
[2]Veterinary Medicine, UNIBH University Center, Brazil

Correspondence: Gabriel Dias Costa, Coordinator in the areas of agricultural sciences, health sciences and human sciences at UNA Contagem, Professor at the UNIBH University Center, Brazil, Tel (31) 992807354, Email gabriel.d.cost@una.br

Received: September 28, 2023 | **Published:** October 12, 2023

Introduction

Organic and sustainable agricultural production has experienced great growth in Brazil in recent years. Accordingly, the demand for organic fertilizer has also increased sharply. However, the costs of this type of fertilizer are often prohibitive.[1]

Brazil's significance on global agribusiness is indisputable. Among the main agribusiness activities, equine production has stood out with a herd of approximately 6 million animals in 2020, according to the Municipal Livestock Survey (PPM).[2]

The valorization of animals and/or increased production means that they are kept in large groups and often in individual stalls, where they spend most of the day. The bedding of equine stalls contains large amounts of manure, as a horse produces approximately 15 kg of feces per day. Typically, residues in the stalls consist of feces and urine mixed with the material used as lining.[3]

The bedding materials vary across regions and farming practices. Usually, they are comprised of rice husk, wood shavings and dry grasses.[4]

The incorrect disposal of waste generated in equine stalls can impact both the environment, causing soil and water contamination, and the horses themselves. One potential consequence for the horses is the transmission of diseases, such pneumonia and habronemiasis. Pneumonia is caused by the bacteria *Rhodococcus equi*, that multiplies easily in soils with manure.[5] Habronemiasis is caused by *Habronema muscae*, an intestinal parasite.[6]

Horse manure can also pollute the soil and water if not treated or disposed of correctly. The potential for pollution varies according to animal husbandry practices, such as the type of feed, amount and type of litter used, stall cleaning schedule, time and type of storage used for residues, and the spread of waste on the ground.[7]

A viable alternative for the treatment of waste from equine stalls would be composting. The composting process occurs through the controlled decomposition of organic matter. In this process, microorganisms, such as bacteria and fungi, break down organic matter, recycling it into fertilizer that can enrich the soil and promote plant growth.[8–10]

Santos[8] states that horse manure takes between 90 and 120 days to become a stable compost. The first two weeks are characterized by high microbial activity and, therefore, high temperatures are achieved. During this period, it is necessary to stir and irrigate the compost. After this phase, the compost should be homogeneous, dark in color and with a pleasant smell.

Organic fertilizers receive this classification because they are obtained through matter of plant or animal origin, such as manure or decomposed plants.[11] The objective of this work was to develop a sustainable methodology for the reuse of waste from equine stalls in the composting process, characterizing and evaluating the potential of the final product as an organic biofertilizer.

Materials and methods

Beds of two 6-year-old America Quarter horses were used from a stud farm in the rural area of Contagem (Minas Gerais, Brazil). The animals were randomly selected and housed in 16m² stalls. The bed of one of them had sawdust wooden shaving. The bed of the other one had chip wooden shaving.

After the stalls were completely cleaned, wooden shaving was added according to the farm's current practice (Table 1). The animals were housed in these stalls for 15 days and were removed daily for training. After training they returned to the same stall.

The animals were fed from the same source of feed, mineral salt, and hay for 10 days prior to the beginning of the experiments. Samples of animal feces and wood shaving were collected on the day that the animals were introduced into the stalls. Fifteen days after the beginning of the experiment, the residues of the animals' bedding had enough feces for the removal of the material. This decision was based on the amount of animal dirt, humidity of the stall and color of the wood shavings.

Table 1 Amount of horse manure and wood shavings in each composting pile

Chip wooden shaving	Amount (Kg)	Sawdust	Amount (Kg)
Wooden shaving	240,25	Wooden shaving	310,8
Manure	262,95	Manure	293,82
Total weight	503,2	Total weight	604,62

All the material collected was placed in piles in a separate environment where the composting process took place. The material was turned daily to ensure aeration throughout the compost. The temperature was measured by thermography with a FLIR 2 thermograph, 1.5 meters away from the middle of the pile (Figure 1). Moisture was measured by visual evaluation of an iron rod introduced in the middle of the pile. If the iron rod got wet during the check, then the entire pile was humid enough to produce slurry. Samples were collected from piles after 42 and 60 days of composting. The following analyses were performed: analysis of humidity at 65ºC, organic carbon (C) and nitrogen (N) concentration, and C/N ratio.

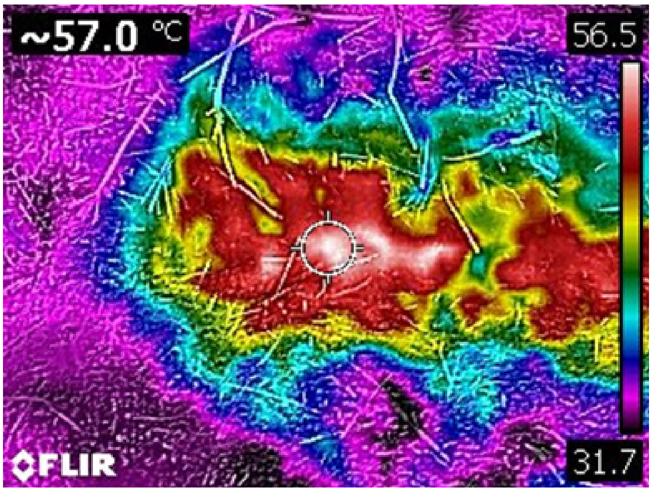

Figure 1 Thermal image from the compost pile with sawdust wooden shaving.

The temperature was continuously monitored during the composting process, which was terminated when the temperature was close to room temperature.

Results and discussion

Composting is complete when the temperature of the final compost is stable and close to room temperature. It can be divided into three phases according to the temperature and microbial activity.[9] During the first phase (mesophilic), temperatures and microbial activity are low. The second phase (thermophilic) is longer than the first one and higher temperatures and greater microbial activity are observed. The third phase (maturation) lasts between one and two months. During this last phase, temperature and microbial activity gradually decrease (Figure 2).

The tested compost completed the first phase of composting in two days, the second phase in approximately 30 days and the third phase in approximately 28 days (Figure 3). This pattern differs from what has been reported by Castaldi et al.[9] and by Santos[8]. According to these authors, the entire process takes between 90 and 120 days to be completed.

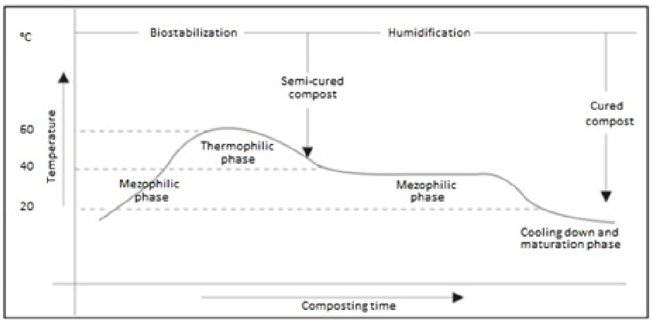

Figure 2 Temperature changes during composting (Gonçalves, 2014).

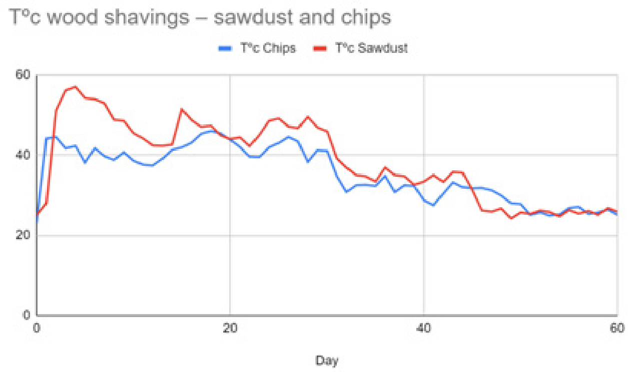

Figure 3 Temperature curve over time.

In the present study, the highest temperature observed during composting was 57ºC for the sawdust-based bedding, and 46ºC for the chip-based bedding. When the compost reaches temperatures between 50 and 57ºC, a reduction in the number of infectious agents is observed, which is ideal for the microbiological safety of the compost (Czapela et al, 2020).

In a high-quality compost, that can be successfully used as organic fertilizer, the concentration of organic C and N and the C/N ratio must stay within a certain range. The measurement of nitrogen concentration and C/N ratio are fundamental factors for determining the nitrogen release potential of substances and consequently the quality of the compost. The time required to complete the composting process is directly dependent on the C/N ratio and is correlated with the concentration of nitrogen released in the form of ammonia. Low C/N ratios cause nitrogen losses in the form of ammonia, generating an unpleasant odor, while high nitrogen values increase the duration of the composting process and reduce microbial activity (Cotta et al., 2015).

According to Cotta et al (2015), successful composting requires a C/N ratio of the raw material between 20 to 30 parts of carbon per part of nitrogen, which is favorable to the metabolism of microorganisms. In the present study, the C/N ratio was on the lower side of this range (Table 2). Therefore, the amount of wood shavings necessary for a horse during 15 days in a 16m² stall was used as a reference.

Despite starting the process with a C/N ratio lower than recommended, the final compost did not present an unpleasant odor and was similar to the reported by Kiehl[12] and Barreira[13]. Composting significantly reduced carbon and nitrogen concentrations of the material (Table 3), suggesting their assimilation by microorganisms, conversion from mineral to organic forms, and partial elimination in the form of carbon dioxide (CO_2).[14]

Citation: Costa GD, Souza BM. Use of composting to produce organic fertilizer from horse stall residues. *MOJ Eco Environ Sci.* 2023;8(5):177‒179.
DOI: 10.15406/mojes.2023.08.00289

Table 2 Carbon and nitrogen concentration, C/N ratio, and humidity at 65ºC of horse bed material before composting

Wooden shaving	Carbon (%)	Nitrogen (%)	C/N	Humidity at 65ºC
Sawdust	16,8	0,84	20	52,18
Chip	17,33	1,37	12,65	49,82

Table 3 Changes in carbon and nitrogen concentration and C/N ration during composting

Sawdust				
Sawdust/Chip	**Carbon**	**Nitrogen**	**C/N**	**Humidity at 65ºC**
0	16,8	0,84	20	52,18
30	14,67	1	14,67	55,16
42	10,98	1,03	10,66	68,08
Chip				
Days of composting	**Carbon**	**Nitrogen**	**C/N**	**Humidity at 65ºC**
0	17,33	1,37	12,65	49,82
30	12,27	1,51	8,13	63,92
42	10,61	1,45	7,32	69,03

Conclusion

The data presented indicates that horse litter composed of sawdust or chip wood shaving, feces and urine can be used efficiently in composting.

Despite the good C/N ratio after the stabilization of the compost, the horse bed with sawdust presented better performance than the bed with wood chip due to its higher temperature peak. The higher temperature causes the death of a greater number of microorganisms, increasing the biosafety of the compost.

The present work serves as a reference for future research aiming at the characterization of other aspects of compost produced from horse stall residues.

Acknowledgments

The authors are very grateful to the Southern University of Santa Catarina (UNISUL) and the Ânima Institute.

Funding

None.

Conflicts of interest

Authors declare that they have no conflicts of interest.

References

1. Donato A, Santos M, Donato IML. Organic customization cost optimization model. *Revista Eletrônica Perspectivas da Ciência e Tecnologia*. 2021;13:84–102.
2. Instituto Brasileiro de Geografia e Estatística. IBGE 2021: Produção Pecuária Municipal 2020 ed. Rio de Janeiro: Departamento de Editoração e Gráfica – DEDIT/CDDI. 2020;48:1–12.
3. Adam FG, Schaeffer L, Souza J. Economic feasibility for the implementation of biodigesters on small rural properties in the coastal area of the municipality of Taquara – RS. Porto Alegre, 2014. 4. RenoMat – *Conferência Internacional de Materiais e Processos para Energias Renováveis*. 2014.
4. Gonçalves F. Treatment of equine bedding by composting and vermicomposting. Monografia (Graduação em Engenharia Ambiental) – Londrina: Universidade Tecnológica Federal do Paraná; 2014.
5. Meijer WG, Prescott JF. Rhodococcus equi. *Vet Res*. 2004;35(4):383–396.
6. Duro LSLS. Gastrointestinal parasitism in animals of the fifth pedagogical two olives. Special reference to hoofed mammals. Lisboa: Universidade de Lisboa; 2010.
7. Hadin A, Eriksson O, Hillman K. A review of potential critical factors in horse keeping for anaerobic digestion of horse manure. *Renewable and Sustainable Energy Reviews*. 2016;65:432–442.
8. Santos MRG. Production of substrates and organic fertilizers from composting horse litter. Dissertação (Mestrado Profissional em Agricultura Orgânica) – Instituto de Agronomia, Seropédica: Universidade Federal Rural do Rio de Janeiro; 2016.
9. Castaldi P, Albeti G, Merella R, et al. Study of the organic matter evolution furing municipal solid waste composting aimed at identifying suitable parameters for the evaluation of compost maturity. *Waste Manag*. 2005;25(2):209–213.
10. Reyes–Torres M, Oviedo–Ocaña ER, Dominguez I, et al. A systematic review on the composting of green waste: Feedstock quality and optimization strategies. *Waste Manag*. 2018;77:486–499.
11. Dutra KOG, Cavalcante SN, Vieira IG, et al. Organic cultivation in the cultivation of melancieira cv. Crimson sweet. *Revista Brasileira de Agropecuária Sustentável*. 2016;6(1).
12. Kiehl EJ. Manual composting: compost maturation and quality. 4th edn. Piracicaba. 2004. 173 p.
13. Barreira LP. Availability of composting plants in the state of São Paulo in the function of quality of composts and production processes. 2005. 204f. Tese (Doutorado em Saúde Ambiental) – São Paulo: Universidade de São Paulo; 2005.
14. Zittel R, Silva CP, Domingues CE, et al. Treatment of smuggled cigarette tobacco by composting process in facultative reactors. *Waste Manag*. 2018;71:115–121.