

## Recycling of domestic organic waste with the use of composting and vermicomposting

The increase of the world population associated to the concentration of this population in urbanized environments has caused the growth of the production of residues of organic solids, that in most of the times are discarded in inadequate places that can pollute the environment. Another factor that is also related to population growth is the demand for more food, mainly agricultural products, which need different inputs, such as fertilizers to increase productivity. Given this context, it is essential to use technologies that allow the recycling of nutrients from organic waste, which have the potential to condition soils and fertilize agricultural crops. This work has the objective of evaluating two already consolidated technologies for recycling solid organic waste, such as composting and vermicomposting, implanted in compact systems. Among these feasible systems were evaluated the humic compounds and the slurries generated, the parameters being evaluated the assimilable phosphorus (P), the active acidity, organic matter and the organic carbon. The results obtained indicate that the vermicompost presents a higher production of humic compound and less of slurry in relation to the composting process, and that the humic compound produced in the composting process and the slurry produced by the vermicompost process have higher P indices, organic and organic carbon, in relation to their corresponding, and the acidity index was practically the same for the slurries and humic compounds produced in both organic matter recycling processes.

**Keywords:** Organic Solid Waste; Composting; Vermicomposting; Recycling.

## Reciclagem de resíduos orgânicos domésticos com uso de compostagem e vermicompostagem

O aumento da população mundial associado à concentração dessa população em ambientes urbanizados tem causado o crescimento da produção de resíduos de sólidos orgânicos, que na maioria das vezes são descartados em locais inadequados que podem poluir o meio ambiente. Outro fator também relacionado ao crescimento populacional é a demanda por mais alimentos, principalmente produtos agrícolas, que necessitam de insumos diferentes, como fertilizantes, para aumentar a produtividade. Nesse contexto, é essencial o uso de tecnologias que permitam a reciclagem de nutrientes a partir de resíduos orgânicos, com potencial para condicionar solos e fertilizar culturas agrícolas. Este trabalho tem como objetivo avaliar duas tecnologias já consolidadas para reciclagem de resíduos orgânicos sólidos, como compostagem e vermicompostagem, implantadas em sistemas compactos. Entre esses sistemas viáveis foram avaliados os compostos húmicos e as pastas geradas, sendo avaliados os parâmetros fósforo assimilável (P), acidez ativa, matéria orgânica e carbono orgânico. Os resultados obtidos indicam que o vermicomposto apresenta maior produção de composto húmico e menor quantidade de chorume em relação ao processo de compostagem, e que o composto húmico produzido no processo de compostagem e o chorume produzido pelo processo de vermicomposto apresentam maiores índices de P, orgânicos e carbono orgânico, em relação ao correspondente, e o índice de acidez foi praticamente o mesmo para as pastas e compostos húmicos produzidos nos dois processos de reciclagem de matéria orgânica.

**Palavras-chave:** Resíduos Sólidos Orgânicos; Compostagem; Vermicompostagem; Reciclando.

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## INTRODUCTION

The increase in solid waste generation over the years is closely related to population growth. And, with this, been occurring the increasing energetic cycle imbalance of these discarded materials has , since some of the energy is deposited or put up in inappropriate places, such as in dumps that can cause contamination of soil, air and surface waters and groundwater, and consequently impair the quality of life of people and the environment that may be exposed to these places (0). According to the National Solid Waste Plan, in 2008 Brazil produced 183,481.5 tons of household waste, 51.2% of which was composed of organic materials 0.

Specifically, household solid waste, on average, consists of 67% of food waste, 19.8% of paper, 6.5% of plastic, 3% of glass and 3.7% of metals 0. Currently, most urban solid waste is disposed of inappropriately in the environment, which evidences the need to seek sustainable alternatives to correctly target wastes and avoid social and environmental problems, as well as to optimize available resources.

As consolidated alternatives for the treatment of solid organic waste we have composting and vermicomposting, to which the first refers to the natural process of aerobic decomposition of organic waste by microorganisms 0. Vermicomposting is carried out by a symbiosis between worms and microorganisms 0. Both result in a compound rich in macro and micronutrients useful to soil and plants.

Currently, a large part of the world's population lives in urban areas, and in this context there are increasingly initiatives to promote urban agriculture that seek to promote the sovereignty and food security of its inhabitants. Composting and vermicomposting are organic matter recycling tools that provide compounds that supply the need for soil fertilization to produce food, providing an environment with the most balanced energy cycle. This minimizes the use of synthetic fertilizers, which are derived from non-renewable resources, which contribute to the ecological imbalance of the production system 0.

The theory of trophobiasis reports that soil mineral imbalance, the use of soluble mineral fertilizers and agrochemicals interfere in the process of proteosynthesis and carbohydrate metabolism, causing the plant to accumulate amino acids and reducing sugars in the tissues, making them more attractive to pests and diseases 0.

For the viability of agroecological production, the input of low economic and energy cost, and that contributes to the environmental sustainability, especially in urban areas where the space for the production of organic fertilizers is scarce for the success of the production. This work aims to evaluate the composting and vermicomposting systems in compact containers that can be used in any urban dwelling for the generation of fertilizers through domestic solid waste. The humic compounds and the generated slurries are evaluated by the assimilable phosphorus (P), active acidity, organic matter and organic carbon parameters.

## MATERIALS AND METHODS

The experiment was conducted in Paraíso do Sul – Brazil, from september 11 to november 26, 2017, totaling 62 days. The experiment was conducted in a place protected from solar radiation and rainfall, with a mean temperature of 19.0°C ( $\pm$  2.0°C). The design was completely randomized, with two variations and four replications. The variations consisted of different processes of transformation of domestic waste, through composting and vermicomposting.

The vessels were made with three plastic bottles with a capacity of 2 L, fitted so that the container had a slurry collector, a space for the compound that was in the process of formation and another space for the insertion of fresh residue. The total capacity was 4 L, the bottles were colored black so that there was no light interference in the process, shown in Figure 1.



**Fig.1:** Production of vessels composting and vermicomposting.



**Fig.2:** *Eusemia andreii* earthworms.

Domestic solid waste used falls within Class II A non-hazardous and non-inert 0, such as fruit peels, yerba mate, and leftover vegetables. The residues were cut in 3-5 cm so that the granulometry did not interfere in the result and were added weekly in the plots. In the first week 500g of domestic organic waste with 100g of grass straw was placed. In the other weeks only 500 g of various household waste were introduced. The vermicompost was composed of 5 *Eusemia andreii* earthworms in each plot 0, with a mean of 3 cm ( $\pm$  0.5 cm) in length. After three weeks, an evaluation was made and the number of dead earthworms was restored so that all the plots were left with 5 earthworms, shown in Figure 2.

### Determination of assimilable phosphorus

For assimilable P analysis, the samples were diluted in 4 concentrations (0, 1, 2, 3, 4 mL P/L) onto aqueous HCl solution a 0.05 mol/L., for reading the optical density was used the equipment Digital Spectrophotometer model UV-2000A, wavelength of 660 mμ 0, shown in Figure 3.

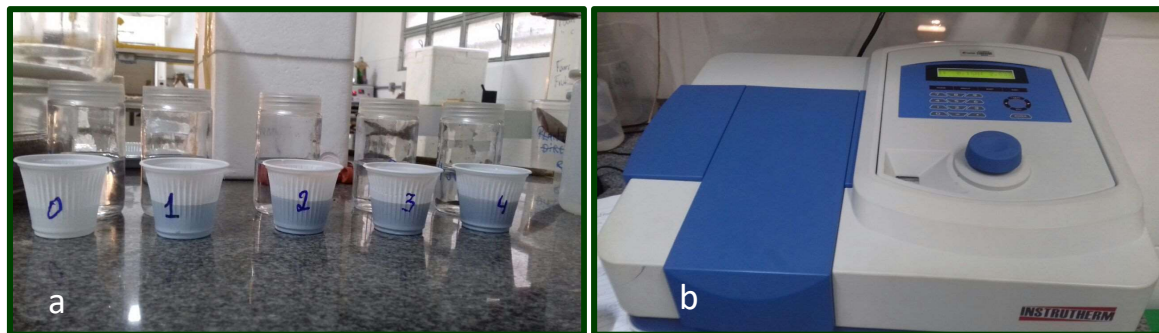


Fig.3: (a) Dilutions of samples e (b) Spectrophotometer model UV-2000A.

### Determination of organic matter

For determination of organic matter each sample 1.5 mL of was mixed with 15 mL sulfocromic solution (15%  $\text{Na}_2\text{Cr}_2\text{O}_7$  in 5 mol/L  $\text{H}_2\text{SO}_4$ ) and heated for 30 minutes in a water bath at 80 °C, after the solution was stirred 5 minutes, and added 15 mL of distilled watter, remaining at rest for 18 h. After was removed 3 mL of the produced supernatant, and distilled water was added. Samples was analised with use of with the aid of the equipment Spectrophotometer model UV-2000A, wavelength of 645  $\mu\text{m}$  0, shown in Figure 4.

### Determination of active acidity

For determination of ph the samples were diluted in distilled water in the ratio of 1:10 (v/v), respectively. After being rested for 30 min and analyzed by the Meter Digital pH equipment.

### Result Treatment

The results were submitted to analysis of variance and the averages were analyzed by the Tukey test at 5% probability of error, using the statistical program Assistat.

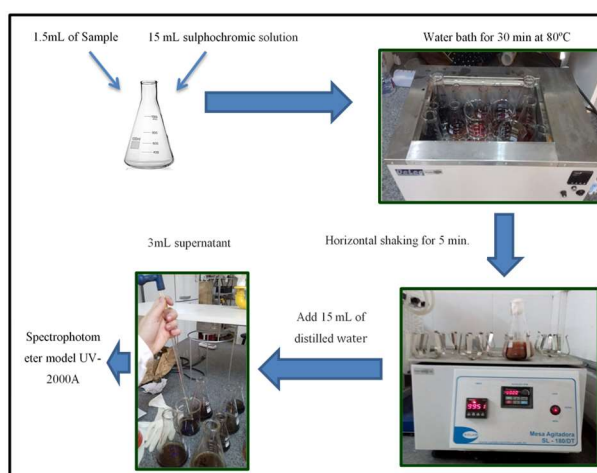


Fig.4: Procedures for determination of organic matter.

## RESULTS AND DISCUSSION

After 62 days of experiment, the compounds formed were dark color, but only a few were loose and odor of earth, which indicate that it was mature. Some natural enemies of earthworms were observed in the plots that may have caused the death from some earthworms, which were the ants and some unidentified

larvae. Ants search their food containers, damaging the earthworms indirectly by reducing the supply of food or directly when they attack, injuring and killing them.

The 5.5kg of household waste submitted to 11 weeks of experiment produced 0.754kg of vermicompost compound and 0.4945kg of compound (Table 1). Therefore, the conversion was more efficient in the vermicomposting process, with the percentage of 13.7% compared to the 9.0% produced by the composting process. Nevertheless, the production of slurry was higher in the composting system. Thus, the choice of the chosen system should be based on the production objective and soil in which the compound and/or slurry can be disposed, considering the physicochemical compositions of each of these products. The active acidity did not present statistical difference for the compounds or slurries produced (Table 1). Although not statistically significant, it can be observed that the pH of the vermicompost compound was higher than the pH of the compound generated in the composting.

**Table 1:** Production and active acidity (AA) of the compounds and slurries. With the standard deviations (S) of the treatments vermicomposting (V) and composting (C).

	Production Compound (Kg)	S	Production Slurry (L)	S	AA Compound	S	AA Slurry	S
V	0,75a*	±0,18	1,03b	±0,74	8,75a	±0,39	8,62a	±0,02
C	0,49b	± 0,05	1,28a	±0,59	8,66a	±0,09	8,63a	±0,01
Average	0,62		1,15		8,71		8,62	
CV (%)	21,73		2,22		3,23		0,20	

\* Averages followed by the same letter in the column do not differ from each other by the Tukey test.

The treatments presented significant differences for the P, organic matter and C-organic content of the compounds and slurries produced. The composite of composting had a higher P content of 109.5 mg P/kg, being the slurries, of both composting and vermicomposting, presented lowest levels (Table 2). Regarding the organic matter content, the vermicompost compound presented the value of 13.42%, while the composting compound process 11.41%.

**Table 2:** P content, organic matter and C-organic and their respective standard deviations (S) of the compounds and slurries of the vermicomposting (V) and composting (C) treatments.

		P		Organic Matter				C-Organic	
		mg/Kg	S	%	S	g/Kg	S	g/Kg	S
V	Compound	83,61ab	±28,49	12,87a	±1,82	128,65a	±18,23	73,94a	±10,48
	Slurries	23,16b	±15,08	0,55b	±0,10	5,52b	±1,00	3,17b	±0,58
C	Compound	109,5a	±42,52	8,14ab	±5,92	81,35ab	±59,22	46,75ab	±34,03
	Slurrie	31,67b	±5,48	3,27b	±5,78	32,71b	±57,82	18,80b	±33,23
	Average	61,99		6,2		62,06		36	
	CV (%)	49,7		68		68,29		68	

\* Averages followed by the same letter in the column do not differ from each other by the Tukey test.

## CONCLUSIONS

The results obtained showed that the vermicompost presents higher production of compost and less of slurry, in relation to the composting process. And, that the compounds and slurries produced have characteristics that allow their use as biofertilizers for crops and soil conditioners, provided that in concentrations suitable for each soil and crop to be developed 0.

The resulting products have considerable nutrient levels beneficial to plants that vary according to the purpose and nutritional status of the soil to be fertilized. Soils poor in phosphorus can be fertilized with

the compound formed by composting. On the other hand, if the objective is to increase the nitrogen content, one can use the compound formed by the vermicompost. The slurry can be used for the manufacture of biofertilizers and/or biogas for the production of vehicle fuels or electric energy. The use of the products generated by the composting and vermicomposting processes can reduce costs with the acquisition of inputs for agricultural production, besides contributing to the environmental sustainability and self-sufficiency of the producers.

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