GREENHOUSE GAS EMISSIONS IN TWO SCENARIOS OF GARDEN WASTE DISPOSAL AT THE UFMG/BRAZIL (CASE OF PAMPULHA CAMPUS)

DOI: http://dx.doi.org/10.55449/conresol.5.22.I-021

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RESUMO

O Plano Nacional de Mudanças Climáticas incentiva boas práticas ambientais como reciclagem e investimento em tecnologias limpas e de baixo carbono. Além disso, estabeleceu como meta atingir 43% de reduções de gases de efeito estufa até 2030. O estado de Minas Gerais deu início, em 2022, ao Plano Estadual de Energia e Mudanças Climáticas, para alcançar a meta de zerar as emissões líquidas de Gases de Efeito Estufa até 2050. Neste sentido, faz-se importante destacar as iniciativas já existentes e que pode servir de modelo na implantação do Plano Estadual. Desde 2005, a Universidade Federal de Minas Gerais realiza a compostagem dos resíduos verdes gerados no Campus da Pampulha, localizado em Belo Horizonte, estado de Minas Gerais, Brasil. O método de compostagem adotado é o “windrows”, utilizando apenas os resíduos oriundos de podas de árvores e dos gramados, dispostos diretamente sobre o solo, em formato de pilhas, durante aproximadamente 230 dias. A quantidade total de resíduos de podas de árvores e gramados (galhos e folhas) compostados foi de 1,68 toneladas. Para estimar as emissões de GEE, foi utilizada a planilha "on line" Waste Reduction Model (WARM) proposta pela Agência de Proteção Ambiental dos Estados Unidos, simulando dois cenários: a destinação final para o aterro sanitário ou a destinação para o processo de compostagem. No processo de compostagem, a emissão foi de 0,24 $MtCO_2$eq., o que representa uma redução nas emissões de GEE de 68%, quando comparado ao seu descarte no aterro sanitário municipal.
PALAVRAS-CHAVE: resíduos orgânicos, gestão, universidade, mitigação

ABSTRACT

The Brazilian Climate Change Plan encourages good environmental practices such as recycling and investment in clean, low-carbon technologies. In addition, it has set target to achieve 43% reductions of greenhouse gas by 2030. Minas Gerais State started, in 2022, the Energy and Climate Change Plan, to reach the goal of zero net greenhouse gas emissions by 2050. In this sense, it is important to highlight the existing initiatives that can serve as a model in the implementation of the State Plan. Since 2005, the Federal University of Minas Gerais has been composting the green waste generated at the Pampulha *Campus*, located in Belo Horizonte, state of Minas Gerais, Brazil. The composting method adopted is the "windrows", using only the residues from the pruning of trees and gardens, placed directly above the soil, in the form of piles, for approximately 230 days. The total amount of waste from pruning trees and gardens (branches and leaves) composted was 1.68 tons. To estimate GHG emissions, the online Waste Reduction Model (WARM) spreadsheet proposed by the US Environmental Protection Agency was used, simulating two scenarios: the final destination for the sanitary landfill or the destination for the composting process. The composting process, emission was 0.24 $MtCO_2$eq., which represents a reduction in GHG emissions of 68%, when compared to its disposal in the municipal sanitary landfill.
KEY WORDS: Organic waste, Management, University, Mitigation.

INTRODUCTION

The generation of waste in 2020 in Brazil was 82.5 million tons, revealing an increase by about 4% over the previous year. A total of 76.1 million tons were collected, recording a collection coverage rate of 92.2% for the country, which shows that 6.4 million tons of waste were not collected and, consequently, had an inadequate destination. Of these, 60.2% of the collected were disposed of in sanitary landfills. The remainder, corresponding to 39.9% of the collected waste, was placed in inappropriate locations (ABRELPE, 2020; ABRELPE, 2021).

Of the total urban waste generated in Brazil, organic waste represents about 50%. These wastes have the particularity of being able to be recycled through processes such as composting, at any scale, from domestic to industrial (MMA, 2017).

The national solid waste law (12305/2010) includes composting as an environmentally correct final destination for the organic portion of the waste generated (BRAZIL, 2010). Composting is a low-cost technology, mainly when it is performed as close to its source as possible. During its process, the organic residues are decomposed by microorganisms under aerobic conditions, resulting in a fertilizer rich in nutrients and soil conditioner, that can be used in gardens and urban gardens or agriculture in general.

Composting consists of a set of techniques applied to control the decomposition of organic matter, in order to obtain, in the shortest possible time, a stable material, rich in humus and mineral nutrients, with physical, chemical and biological attributes superior to that of the material (MELLO-PEIXOTO *et al.*, 2014). According to Costa *et al*. (2005), the composting process aims to accelerate the decomposition of organic material, provided that there are conditions for microbial development, namely: temperature, humidity, C/N ratio and nutrients.

However, when organic waste is sent to landfills, it is decomposed under anaerobic conditions, generating toxic leachates, in addition to emitting large amounts of methane (CH_4) into the atmosphere, a highly polluting gas that contributes 28 times more to the worsening of global warming than carbon dioxide (CO_2) (RODRIGUES *et al*., 2019).

The waste treatment sector has the potential to be one of the biggest reducers of GHG emissions since, when waste is recovered and reinserted into the production chain, emissions from the extraction and transport processes of natural resources for the production of raw materials are avoided, positively affecting the entire production flow (FIRMO *et al*., 2019).

The Brazilian Climate Change Plan encourages good environmental practices such as recycling and investment in clean, low-carbon technologies (BRAZIL, 2007). In addition, it has set targets to achieve 43% reductions by 2030 (SEEG, 2019). The state of Minas Gerais started the State Climate Action Plan (FEAM, 2015), to achieve the goal of reducing net greenhouse gas (GHG) emissions by 2050. In this sense, it is important to highlight the existing initiatives that can serve as a model in the implementation of the State Plan.

The Federal University of Minas Gerais (UFMG) has 340 hectares primarily covered by vegetation of various plants species and grass. Due to this, the Pampulha *campus* (in Belo Horizonte, capital city of Minas Gerais state) generates a large volume of waste obtained in the services of pruning, weeding, rooting, (grass, leaves, twigs and firewood). Since 2005, they are intended for composting within the *campus*, proposed in the Green Solid Waste Management Plan of the UFMG (BARROS *et al*., s.d).

OBJECTIVE

The objective of this work was to quantify and compare the greenhouse emissions impacts generated by the organic residues generated in the Pampulha campus - UFMG, considering two different scenarios of final destination, i.e., landfill or "in situ" recycling, through composting.

METHODOLOGY

The study was carried out in one of the composting yards located at the Pampulha *campus* of the Federal University of Minas Gerais (UFMG) (Figure 1).

Figure 1. Location of the composting yard, at the Federal University of Minas Gerais, Pampulha *campus*, Belo Horizonte, Minas Gerais, Brazil.

The residues, from the maintenance of the gardens, were quantified for the implantation of three piles of compost. The method of composting adopted was the "Windrows", directly above the soil (Figure 2).

Figure 1: Pile of compost with "Windrow "method, at Pampulha *campus* of UFMG

The piles were irrigated every day of the week, except weekends and holidays, in the morning for about 1 (one) hour, using a sprinkler on each pile. The turning was carried out according to the availability of machinery and labor, unfortunately occurring in a smaller number of times than the technically recommended, which would be every fifteen days, according to Kiehl (2002). The composting duration from the start to the final product for use was approximately 230 days.

In the composting process water and energy consumption was very low; therefore, disregarded in the analysis. To estimate GHG emissions, the online calculation worksheet of the Waste Reduction Model (WARM), proposed by the United States Environmental Protection Agency (EPA, 2018).

RESULTS

Using the online model of the Waste Reduction Model, knowing that the total amount of pruning residues of trees and lawns (branches and leaves) composted in this monitoring was 1.68 tons, it was possible to calculate the emission of gases of greenhouse effect for the two scenarios: final destination for the sanitary landfill and destination for the composting process.

Emissions referring to the destination of this waste to sanitary landfill would be 0.75 $MtCO_2eq$, in GHG emissions. For the scenario adopted, the composting process, emission was 0.24 $MtCO_2eq$., which represents a reduction in GHG emissions of 68%. Composting presents itself as an effective way to treat organic waste with low environmental impact, because, during the process of decomposition of organic matter under aerobic conditions, the main product of the process is carbon dioxide, without the presence of methane (SOUZA *et al*., 2019).

Composting also generates CO_2 due to the consumption of fossil fuels by vehicles transporting waste and operating equipment (SANCHES *et al*., 2015). The adoption of decentralized composting, as is the case at UFMG, reduces gas emissions from fuel and energy consumption, since the process is carried out in a location close to the source of waste (LIMA JUNIOR *et al*., 2017). In this way, UFMG, by opting for the use of the composting process instead of disposing of these residues to the soil, avoided emissions equivalent to the burning of 215 liters of gasoline, calculated by WARM.

According to the Observatory of Climate (2018), the urban waste sector in Brazil is a significant contributor to greenhouse gas emissions. Between 1990 and 2016, this sector increased emissions by 186% in the country. Nowadays, in Belo Horizonte, there is no electric energy use of residues in the sanitary landfill for municipal waste, and composting is insignificant (as less than 1% of organic waste).

The UFMG green waste composting initiative is an example of good practices in municipal waste management and is aligned with the goal of organic waste retention at the generating source provided for in the Municipal Integrated Plan for the Solid Waste Management of Belo Horizonte and mitigation of the emissions, in the Minas Gerais Energy and Climate Change Plan.

In addition, composting offers many benefits in addition to lower GHG emissions, which are the use of the organic compost generated as a fertilizer and soil conditioner (AWASTHI *et al*., 2019). Composting also proves to be more technically and economically advantageous, as it is more efficient in the treatment of the organic fraction of Municipal Solid Waste, presenting, therefore, less polluting potential. It does not present a restriction on the useful life of the enterprise and has lower implementation and operating costs (BARROS, 2012).

CONCLUSIONS

Composting at universities is efficient to meet federal regulations for reducing waste and greenhouse gas emissions in the municipality. In addition, the organic compost generated can be used to maintain the institution's gardens, improving soil quality and saving public resources.

However, the lack of financial resources can compromise waste management within educational institutions, when there is no awareness on the subject on the part of the administrative direction.

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