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A IMPORTÂNCIA DA COMPOSTAGEM NOS NÚCLEOS DE ENSINO AMBIENTAL: FOMENTANDO EDUCAÇÃO, SUSTENTABILIDADE E EMPREENDEDORISMO

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RESUMO: Devido ao acentuado crescimento demográfico o descarte inadequado de Resíduos Sólidos Urbanos (RSU) apresenta sérios impactos ambientais e sociais. Este estudo explora a eficácia de oficinas de compostagem como estratégia educativa e prática para a gestão sustentável, conforme a Política Nacional de Resíduos Sólidos. A metodologia foi baseada em uma abordagem quali-quantitativa, com dados coletados por meio de questionários aplicados aos alunos de Engenharia Ambiental e Sanitária e Ensino Médio do Instituto Federal de Educação, Ciência e Tecnologia do Ceará (IFCE) Campus Juazeiro do Norte, após a realização de atividades práticas. Os resultados destacam o impacto positivo da oficina na formação de uma consciência ambiental crítica, ao mesmo tempo que incentivam o empreendedorismo e a inovação em sustentabilidade. Conclui-se que é fundamental abordar a gestão de RSU e incentivar a prática da compostagem nos núcleos de ensino ambiental, a fim de promover uma maior conscientização e práticas sustentáveis.

Palavras-chaves: gestão de resíduos; percepção ambiental; resíduos sólidos urbanos; geração de renda.

THE IMPORTANCE OF COMPOSTING IN ENVIRONMENTAL TEACHING CENTERS: FOSTERING EDUCATION, SUSTAINABILITY AND ENTREPRENEURSHIP

ABSTRACT: Due to sharp demographic growth, the inadequate disposal of urban solid waste (MSW) has serious environmental and social impacts. This study explores the effectiveness of composting workshops as an educational and practical strategy for sustainable management, according to the National Solid Waste Policy. The methodology was based on a qualitative–quantitative approach, with data collected through questionnaires applied to students of Environmental and Sanitary Engineering and High School at the Federal Institute of Education, Science and Technology of Ceará (IFCE) Juazeiro do Norte campus, after carrying out practical activities. The results highlight the positive impact of the workshop in forming critical environmental awareness while encouraging entrepreneurship and innovation in sustainability. In conclusion, addressing the management of MSW and encouraging the practice of composting in environmental education centers are essential to promote greater awareness and sustainable practices.

Keywords: waste management; environmental perception; urban solid waste; income generation.

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1 INTRODUCTION

Since the Industrial Revolution, technological advances and the intensification of industrial production have generated a significant increase in consumption and, consequently, in the generation of waste. In Brazil, much of the waste still faces challenges related to the urgent need for more efficient strategies for waste management, especially with respect to separation at the source and appropriate final destination (AZEVEDO, 2024). Similarly, the lack of infrastructure and effective public policies for the segregation and treatment of waste results in serious environmental impacts, such as soil and water contamination. Figure 1 illustrates the current situation of most of Brazil in this context, demonstrating the difficulties faced in implementing effective segregation and disposal systems.

Figure 1. Current situation in Brazil regarding waste segregation and disposal

Source: ABREMA (2024).

This situation has worsened in recent years. In 2022, Brazil improperly disposed of 33.3 million tons of solid waste (garbage), which represents 380 kg of solid waste per inhabitant. In total, the country generated 77.1 million tons of garbage, according to data from the Brazilian Association of Waste and Environment (ABREMA). According to Reis and Freitas (2024), more than 50% of organic waste, such as food scraps, fruit peels, and tree prunings, can be reused to enrich the soil. However, its incorrect disposal generates leachate, a highly contaminating liquid that, when it comes into contact with hazardous waste, worsens its environmental impact.

To better configure the opportunity for paradigm changes in society, Law No. 12,305/10 was instituted, which institutes the National Solid Waste Policy (PNRS), which requires organizations to be transparent with the management of their waste, encouraging reduction, reuse, treatment and proper disposal, with the regulation, inspection and ownership of basic sanitation services being the responsibility of municipalities, in accordance with Law No. 11,445/2007 and CF/88 (Brazil, 2010).

Lima, Dias and Lima (2016) concluded that the use of solid organic waste from school meals was used to produce organic fertilizer through a composting process that emerged as a sustainable alternative, transforming organic waste into useful resources for the soil, in addition to reducing the amount of waste in landfills and greenhouse gas emissions. According to the National Association of Municipal Sanitation Services (ASSEMAE, 2019), despite its many benefits, composting is still rarely adopted in Brazil, with only 1% of organic waste being reused. In this context, environmental perception studies become essential, as they allow us to analyze how different groups perceive environmental issues, contributing to effective public policies. Moimaz and Vestena (2017) define perception as the interpretation of sensory information, which is an important tool for understanding the relationship between humans and the environment. Figures 2 and 3 show the composting workshops held in environmental

education centers in Cariri, in which we used a perception technique to interpret sensory information, observing how participants interact with the process and understand its importance for local sustainability.

Figure 2. Composting workshops in environmental education centers in Cariri – Experience at the Military Police College Coronel Hervano Macedo Júnior in Juazeiro do Norte- CE

Source: Authors (2024)

Figure 3. Composting workshops in environmental education centers in Cariri – Experience at the Technical Vocational Center (CVTEC) in Barbalha – CE

Source: Authors (2024)

In Brazil, studies on environmental perception, especially related to composting, are limited. However, research with environmental engineering students is crucial for raising awareness of sustainable alternatives for waste management. The Federal Council of Engineering and Agronomy (CONFEA, 2000) highlights the importance of environmental engineers in the management of urban solid waste, with composting being an essential practice. This study aims to analyze the perceptions of students of the Federal Institute of Education, Science and Technology of Ceará (IFCE), Juazeiro do Norte campus, on composting by applying a questionnaire to assess their opinions on this technique and the possibility of implementing solid waste management solutions at the institution and in the community, promoting environmental education and sustainable business models.

2 MATERIALS AND METHODS

This study adopted a quantitative and qualitative approach to investigate the perceptions of students of Environmental and Sanitary Engineering, Technical High School in the Environment, about the practice of composting. The research was conducted at the Juazeiro do Norte-CE campus of the Federal Institute of Education, Science and Technology of Ceará (IFCE), located at Av. Plácido Aderaldo Castelo, 1646 - Planalto, Juazeiro do Norte - CE, 63047-040, Brazil. Under the coordination of the Laboratory of Ecological Studies (LEECO), data collection was carried out through a structured questionnaire and practical composting workshops. Figure 4 illustrates the participants who participated in the workshops and who collaborated with the research, assisting in data collection and allowing a more in-depth analysis of the environmental perception related to composting.

Figure 4. Composting workshops in environmental education centers in Cariri – Experience at the Federal Institute of Education, Science and Technology of Ceará - Juazeiro do Norte Campus – CE

Source: Authors (2024)

A quantitative and qualitative approach was chosen to provide a broad and detailed understanding of the data. The quantitative research, which is characterized by the objectivity and predictability of the data, followed a systematic plan to quantify information about the participants' profile and disposal practices (Proetti, 2017). The research was designed with an exploratory nature, as defined by Piovesan and Temporini (1995), to investigate students' understanding of the composting process and organic waste management.

For data collection, a questionnaire was used as the main technique, which was applied online via Google Forms, aiming at greater reach and feasibility in student participation. The questionnaire consisted of 21 questions divided into three main sections: participant profile, disposal habits and perception of composting. To allow for personalized responses, some questions progressed according to the students' responses, following a conditional logic.

Table 1. Questionnaire used to collect data on environmental perception and education

Name
Course
Institution
Level of Education
Before the workshop, did you have any knowledge about composting?
How do you assess the importance of organic waste management for the environment and society?
Do you consider composting an entrepreneurial opportunity?
What was the most valuable aspect of the workshop for you?
What topics would you like to see covered in future workshops?
After the workshop, did you start separating organic waste in your home?
Do you feel more prepared to apply composting in your home or other locations?
What challenges have you faced when trying to implement composting in your home or community?
Do you have any suggestions for improving the workshop?

Source: Authors (2024)

The composting workshops involved practical activities divided into three main stages:

2.1 Theoretical and Conceptual Introduction

Students received instruction on fundamental composting concepts, including the types of aerobic composting and the importance of monitoring factors that influence the process, such as temperature, humidity, aeration, and the carbon/nitrogen (C/N) ratio. As illustrated in Figure 5, the theoretical part was taught in a closed environment, allowing us to observe students' interest in the content and their willingness to follow the explanation before the practical stage. Among the different factors, the C/N ratio appears to be a crucial parameter for process efficiency (Qiao *et al.*, 2021).

Figure 5. Theoretical part of the workshop

Source: Authors (2024)

2.2 Practical composting activities

The field activities involved the construction of homemade composters and static windrows with passive aeration, as described by Veras *et al*. (2020). As illustrated in Figures 6 and 7, the practices were carried out in an open space, using recommended techniques to promote efficient waste decomposition and minimize greenhouse gas emissions (Stuchi; Rodrigues, 2014). In addition to its instructive nature, this stage allowed us to assess the students' perceptions of the management of their own waste, since the organic materials used in composting were discarded in the academic cafeteria, encouraging reflection on the appropriate disposal of this waste.

Figure 6. Practical part of the workshop

Source: Authors (2024)

Figure 7. Practical part of the workshop

Source: Authors (2024)

2.3 Assessment and encouragement of entrepreneurship

The last stage of the workshop included an assessment of practices and encouraged discussion on sustainable entrepreneurship. The participants were encouraged to consider the economic potential of composting and discuss the possibility of commercializing products such as biofertilizers and organic compounds on the basis of the literature that associates composting with the promotion of sustainable entrepreneurship (Marchi, 2018). As illustrated in Figure 8, the lettuce and pepper bed was used to test the organic compost as a substrate and the biofertilizer produced in the workshop for fertigation, demonstrating in a practical way how these products can be applied in cultivation. During this process, students were instructed on the economic value of these inputs, monitoring the reduction in input costs in their production and research.

Figure 8. Lettuce and pepper bed for testing organic compounds as substrates and for fertigation of the biofertilizer produced

Source: Authors (2024)

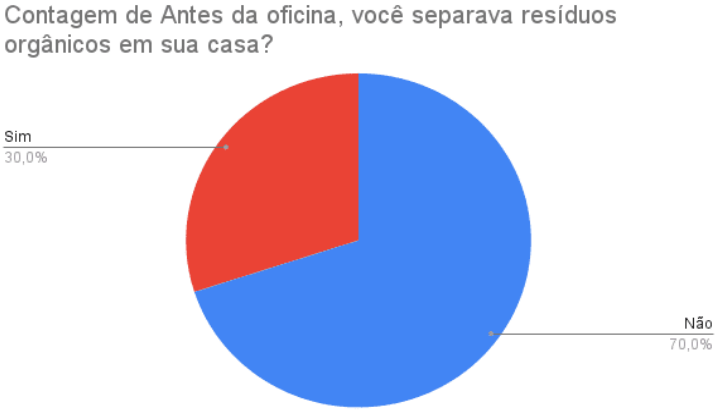
3 RESULTS AND DISCUSSION

The survey was conducted to verify the perceptions of thirty-five IFCE students who participated in the composting workshops, covering the period from July to October 2024. The questionnaire, which was administered via Google Forms, collected information on gender identity, level of education and daily habits, revealing that 55.8% of the interviewees were cis women, 40.3% were cis men, and 2.5% preferred not to respond. With respect to education, 54.3% attended higher education, whereas 45.7% did not have a technical level. The survey also investigated waste disposal habits, as illustrated in Graphs 1 and 2, which show that although 65% of the participants already had some knowledge about composting, 70% did not separate waste in their homes. Only eight participants indicated that they practiced separation, while the majority disposed of organic and recyclable waste in the conventional way.

Graphs 1. Knowledge about Composting

Source: Authors (2024)

Graphs 2. Knowledge of waste segregation practices



Source: Authors (2024)

According to Proença (2017), the inadequate disposal of organic waste has serious consequences for the environment and society, as the decomposition of organic matter results in leachate, which contaminates the soil and surface and groundwater and generates toxic gases that are released into the atmosphere.

A survey revealed that 65% of students like composting, but only 30% practice it, reflecting the national scenario of low reuse of organic waste presented by the National Association of Municipal Sanitation Services (ASSEMAE, 2019). The reasons cited for not practising it include a lack of space and time, although alternatives, such as static windrow composting with passive aeration, can minimize these obstacles (Veras *et al.*, 2020). Among those who practice composting (30%), as illustrated in Graph 3, the majority (90%) view composting and its byproducts as a new entrepreneurial opportunity.

Charts 3. Composting as Entrepreneurship

Source: Authors (2024)

The lack of incentives was identified as a challenge, but 30% of the participants were interested in transforming composting into a source of income, either through the commercialization of biofertilizers or by applying compost in scientific research. One of the main recommended uses was its incorporation in laboratory experiments on *wetlands*, which are natural systems designed for the treatment of effluents and the recovery of degraded areas (Vymazal, 2010). *Wetlands* use substrates, microorganisms and plants to remove contaminants from water, and the organic compost generated by composting can act as a conditioner for filter media, enhancing the retention of nutrients and the development of vegetation. Thus, the valorization of compost for scientific purposes strengthened the students' connection with campus initiatives, encouraging a more sustainable approach to waste management. Furthermore, as illustrated in Figure 9, fertilizer and compost began to be used in projects in other research laboratories, expanding their academic and environmental impact.

Figure 9. Students use compost to assemble substrates for wetlands, which are plants that are being used for research.

Source: Authors (2024)

4 CONCLUSIONS

The profile of most of the interviewees in the survey is composed of cis women. With respect to daily habits and customs, most participants demonstrated knowledge about waste management methods and their benefits. However, when asked about the practice of waste separation and disposal, the answers indicate a discrepancy between the knowledge acquired and its application in daily life. Despite being familiar with composting, most students do not practice it regularly. Notably, students in the final years of the Environmental Engineering course are those who adopt the most sustainable actions.

Furthermore, the research revealed that many students have a fragmented environmental perception, in which they regulate the negative impacts of solid waste on the environment but do not see themselves as active agents in the process of environmental manipulation. This distance compromises the sense of belonging and individual responsibility regarding pollution, making it essential to implement initiatives that promote awareness and connection among students with the impacts of their own actions.

Understanding environmental engineering students' perceptions of composting and their habits regarding solid waste disposal contributes to the formulation of educational strategies and the promotion of more efficient management of urban waste. Given the growing annual volume of urban solid waste (MSW), the country needs qualified professionals to work on the proper disposal of these materials.

Finally, the results of the research reinforce the importance of composting workshops at the IFCE as a tool to raise awareness among students about sustainability and entrepreneurship. By offering an accessible practice with the potential to generate income, the initiative encouraged participants to see organic compost as an important resource, with both commercial and academic applications. In addition, the integration of practical learning with support for research conducted on campuses strengthens the role of workshops in the training of environmentally conscious and proactive professionals.

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