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Editorial: Sustainable agricultural and livestock waste management through composting

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Editorial on the Research Topic
Sustainable agricultural and livestock waste management through composting

Effective waste management practices are crucial in achieving sustainable agriculture and food security goals. By prioritizing soil health, water quality, and resource efficiency, sustainable waste management can contribute to developing resilient agricultural systems that can meet the food needs of present and future generations, especially in a changing climate. Agricultural and livestock waste includes organic materials from farming, ranching, and animal husbandry, such as crop residues, food scraps, manure, and bedding materials, which need to be treated properly for sustainable agriculture practices. Agricultural and livestock waste management through composting could be a sustainable practice that helps recycle organic materials generated from farming activities and convert them into valuable soil amendments.

Composting is a natural process of recycling organic matter into a nutrient-rich soil amendment called compost. Like any process, it has its own set of advantages, of which it improves soil structure, texture, and fertility by reducing the need for chemical fertilizers, thus, promoting the growth of beneficial microorganisms that break down organic matter, suppressing harmful pathogens, and enhancing nutrient availability in the soil (Zainudin et al., 2022). It also helps to sequester carbon in the soil, mitigating climate change by reducing greenhouse gas emissions (Jeong et al., 2019; Nazir et al., 2024). More importantly, composting creates closed-loop systems within agricultural production systems by recycling organic materials into compost, which is then used to fertilize crops, improve soil health, and regenerate ecosystems (Ragany et al., 2023). This circular model minimizes inputs, maximizes resource efficiency, and reduces dependence on external inputs, such as synthetic fertilizers and chemicals (Selvan et al., 2023).

While composting offers numerous benefits, it also has some disadvantages and challenges to consider which are time and space, inconsistency of quality due to nutrient imbalance and contamination, limited acceptance of certain materials, initial investment, equipment costs, regulatory and permitting requirements, as well as odor, moisture, aeration, and temperature control. Despite these disadvantages, many of the challenges associated with composting can be addressed through proper management, which will be explained in each of the papers on this Research Topic. One of the disadvantages of the composting process is it may contain some contaminants such as heavy metals, pesticides, and pathogens if the input materials are not properly screened or if the composting process is not adequately managed. This can pose risks to human health and the environment. The first paper on this Research Topic by Gao et al. embarks on the study of nutrient content variation and potentially harmful elements in four types of organic wastes: household waste (HW), sewage sludge (SS), chicken manure (CM), and cow/sheep manure (SM). This study reveals significant differences in the dynamic changes of nutrient and potentially hazardous elements among different composting materials. The findings of this study draw attention to the critical need for a comprehensive and robust strategy that regulates the presence of hazardous elements during the production of organic waste and other relevant industrial processes. To ensure that the waste is suitable for subsequent use, it is imperative to employ effective and efficient treatment methods that eliminate any risks associated with the presence of harmful substances. This approach will help to support sustainable waste management practices and promote a cleaner and healthier environment.

The utilization of black soldier fly larvae (BSFL) as a feed nutrient is gaining popularity in several industries, including aquaculture, poultry, and livestock due to its high nutrient content, including protein, fat, and essential amino acids. They are also efficient in converting organic waste materials into biomass, reduce dependency on fish meal, and are environmentally sustainable. Insect rearing on organic waste can create a circular economy by producing protein-rich biomass for food or feed chains and by-products for other industries. One of the by-products of rearing BSFL is its excrement, referred to as frass, and larval shedding. Frass can be a potential alternative to synthetic fertilizers since it contains both macro and micronutrients. However, it has been described as having immature compost-like characteristics, which may not be ideal for plants. This is because it contains a high level of undegraded chitin in frass and shedding which might be detrimental to the plant's health and vitality. Thus, frass and shedding should be treated further through the composting process. The second article described by Jasso et al. showed that BSFL frass and shredding could serve as an effective compost ingredient. However, further research is required to determine the optimal inclusion levels that would maximize the quality of the finished compost. Based on the compost quality tests, it was found that the moisture/solids, organic matter, phosphorus, and stability levels (measured as mg CO_2-C/g organic matter/day) were not within the specified range for each pile, while pH, nitrogen (N), carbon (C), C/N ratio, and potassium levels were found to be within optimal ranges according to the United States Composting Council Seal of Testing Assurance. Additionally, the stability level (measured as mg CO_2-C/g solids/day) and maturity level (measured as seed emergence and seedling vigor) also fell within optimal ranges. This study is essential in demonstrating how the inclusion of frass and shedding affects the composting process and the quality of the final product. Additionally, this research provides a valuable resource for the insect-rearing industry as it helps to identify potential markets for these by-products in horticultural and agricultural applications.

To improve the utilization of agrifood waste as feedstock for the composting process, the third article by Nurin et al. conducted the optimization of co-composting of livestock, and food waste which are watermelon waste (WW), chicken manure (CM), and horse manure (HM). In this study, the impact of WW as a bulking agent on the composting process and its end-product quality were evaluated. The statistical approach of the response surface methodology (RSM) was used to optimize the process. The findings of the study suggest that the WW showed a significant effect in the co-composting of CM and HM by enhancing the organic matter and nutrient levels of the final compost product. However, it should be noted that the co-composting of HM and CM along with WW as a bulking agent showed no significant effect on the C/N ratio and phosphorus (P) contents. This mixture did not contribute to achieving a balanced C/N ratio, which could affect the mineralization rate and potentially lead to the loss of nitrogen as ammonia into the environment. Bulking agents play a crucial role in the composting process as they significantly impact parameters such as temperature, oxygen, moisture gradients, heat and energy balances, and biodegradability. The utilization of watermelon waste offers a novel perspective on the utilization of agricultural residues, as most research typically employs straws, plant prunings, sawdust, and woodchips as bulking agents. This study not only reduces waste but also emphasizes the potential of leveraging waste resources from agricultural products.

Besides composting, another way to promote a sustainable waste management system is to directly utilize or reuse the waste material as shown by Ahmed et al.. In this study, the rice straw (RS) and waste tea leaves (WTL) were used as substrates for growing mushrooms. This study indicated that WTL contributed to enriching zinc in mushrooms. Additionally, the iron level increased specifically in RS + WTL-based formulations. All essential and non-essential amino acids were detected, with the highest concentration of histidine, isoleucine, and methionine found in the WTL + SD formulation. The research findings reveal that utilizing crop waste is an efficient approach to significantly increasing the nutritional value of mushrooms. This innovative technique offers a practical solution to enhance the growth and quality of mushrooms, which benefits the mushroom industry. The study highlights the potential of crop waste as a valuable resource in the production of nutrient-rich mushrooms, thereby contributing to sustainable and eco-friendly practices.

This Research Topic delves into the vast potential of utilizing agricultural and livestock waste to promote sustainability and circularity in agroecosystems. The topic covers a diverse range of subjects, including the direct application of waste materials or treatment through composting processes. By exploring the various ways in which waste can be repurposed and reused, this research aims to contribute to the development of innovative and sustainable solutions for managing waste in agricultural and livestock industries.

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Conflict of interest

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