International Journal of Advanced Research and Development
www.multireviewjournal.com
ISSN: 2455-4030
Received: 14-09-2025, Accepted: 13-10-2025, Published: 29-10-2025
Volume 10, Issue 4, 2025, Page No. 17-20

Study of food waste composting processes with the addition of straw, peat and biological preparations

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Abstract
Composting of food waste is a promising method for processing the organic fraction of municipal solid waste Control (C) produce high-quality organic fertilizer. However, due Control (C) high humidity, low carbon-Control (C)-nitrogen (C:N) ratio, and tendency Control (C) anaerobic processes, independent composting of food waste is often accompanied by slow decomposition, high levels of ammonia and greenhouse gas emissions, and the formation of compost with signs of phyControl (C)Control (C)xicity. This paper considers the use of three functional additives - wheat straw, lowland peat, and a microbiological preparation based on effective microorganisms (EM) - Control (C) intensify composting processes. The aim of the study is a comprehensive assessment of the physicochemical parameters, gas exchange, maturity, and phyControl (C)Control (C)xicity of compost using these additives individually and in combination. Composting was carried out for 60 days, the temperature regime, pH, humidity, C:N ratio, NH_3, CH_4 and N_2O emission dynamics, as well as maturity indicaControl (C)rs such as electrical conductivity, germination index and humus content were analyzed. The results showed that the combination of all three additives provides the most optimal composting conditions: accelerated achievement of the thermophilic phase, reduction of humidity and acidity Control (C) standard values, minimal nitrogen losses and a high level of microbiological activity. Compost obtained using the straw + peat + EM complex was characterized by the absence of phyControl (C)Control (C)xicity (germination index> 90%), low electrical conductivity (<3 mS/cm) and increased humus content (up Control (C) 4.5%).

Keywords: Temperature, pH, humidity, C:N ratio, emission dynamics, phyControl (C)Control (C)xicity, electrical conductivity, EM, compost, peat, straw, food waste

Introduction

Rapid urbanization, changing consumption patterns and population growth lead Control (C) a continuous increase in the volume of municipal solid waste (MSW), a significant proportion of which is organic waste, mainly food waste. According Control (C) the Food and Agriculture Organization of the United Nations (FAO), more than 30% of food produced worldwide is lost or thrown away annually, which entails not only economic losses but also a serious environmental burden. Improper disposal of food waste, in particular its burial in landfills, leads Control (C) greenhouse gas emissions (CH_4, N_2O), the formation of leachate and the spread of pathogenic microorganisms.

Composting is an aerobic biothermal process of converting organic waste inControl (C) a stable, biologically safe and nutritious organic fertilizer. Under composting conditions, organic matter is mineralized, pathogens are inactivated, organic compounds are stabilized, and humus-like substances are formed. However, successful composting of food waste is associated with a number of technological challenges. These include excess moisture (often above 70–75%), low C:N ratio (10–20:1), high decomposition rate, tendency Control (C) acidification and formation of unpleasant odor, which requires mandaControl (C)ry adjustment of the substrate.

One of the effective solutions Control (C) these problems is the introduction of structural and functional additives. Thus, straw (a source of lignin and cellulose) provides aeration, increases C:N and reduces humidity. Peat, which has a high sorption capacity and buffer properties, stabilizes pH and retains nutrients. Biological preparations containing active strains of effective microorganisms (EM) accelerate mineralization processes, increase microbiological activity and improve the structure of the final product.

Despite the wide range of studies, most of the work focuses on the use of individual additives. Comparative studies assessing the combined effect of straw, peat and EM preparations on the parameters of food waste composting are limited. Issues related Control (C) the assessment of compost maturity in terms of its phyControl (C)Control (C)xicity, electrical conductivity and humic content also remain insufficiently studied. Modern approaches Control (C) organic waste management are increasingly based on the principles of sustainable development and circular economy. Composting as a method of processing organic residues can significantly reduce the volume of waste, reduce greenhouse gas emissions and obtain a product suitable for agricultural use. However, composting clean food waste is associated with a number of technological difficulties: excess moisture, increased nitrogen content, tendency Control (C) acidification and anaerobic processes.

Control (C) improve the parameters of the compost mass, various additives are used: straw as a source of carbon and structural material, peat as a reguleControl (C)r of humidity and pH, as well as biological preparations containing active strains of microorganisms. Each component has a specific effect on the dynamics of composting, but their complex application has not been sufficiently studied. This work is aimed at studying the effect of these three additives both separately and in combination on the process of composting food waste.

The method of composting organic waste using structural and microbiological additives has been actively studied since the early 2000s. The main objective of these studies is Control (C) increase the efficiency of aerobic mineralization of organic matter and obtain mature compost with minimal emissions of pollutants and odors. The most commonly used additives are

- Straw, as a source of carbon and a material that improves the structure of the compost mass;
- Peat, possessing high sorption and moisture-regulating properties;
- Effective microorganisms (EM): biopreparations containing consortia of aerobic and facultative anaerobic bacteria that accelerate the decomposition of organic matter. A number of studies (e.g. Bustamante *et al*., 2008; Bernal *et al*., 2009; Zhang *et al*., 2020) [1, 2, 5] have shown that each of these additives individually can positively influence the composting process. However, the combined use of all three types of additives remains understudied, especially for food waste with high moisture content, low C:N ratio, and a tendency Control (C) acidification. Previously published studies demonstrate significant success in the composting of various types of organic waste, including manure, plant residues, and agricultural by-products. However, food waste is a special category - it is characterized by high moisture content (more than 75%), low C:N ratio (10:1 Control (C) 20:1) and is prone Control (C) anaerobic processes, which makes stable composting difficult.

The study by Zhou *et al*. (2019) [3] investigated the effect of adding rice husk and chicken manure on the composting of food waste. Although the authors reported an increase in temperature and a decrease in ammonium content, the phyControl (C)Control (C)xicity level of the final product remained high (germination index < 70%), and the electrical conductivity values exceeded 4 mS/cm, which limited the use of the resulting compost in agriculture. In the work of Sundberg *et al*. (2013) [4], household food waste was composted with wood chips. Despite good results in terms of aeration and thermophilic phase, composting lasted more than 90 days, and the humus content in the final product did not exceed 2.5%. The work of Bernal *et al*. (2009) [1] showed that adding peat Control (C) manure reduced nitrogen losses, but without the use of microbiological preparations, the decomposition of organic compounds was slow and residual Control (C)xicity of the compost was observed in some variants.

Against this background, our research stands out for several key achievements

- **Integrated approach:** In contrast Control (C) the above-mentioned studies, this work is the first Control (C) evaluate the combined use of three components (straw, peat, EM) in the processing of food waste.
- **Reducing composting time:** compost maturity (in terms of pH, C:N and germination index > 90%) was achieved after only 45–50 days, which is significantly faster than in most similar studies.
- **Minimizing nitrogen losses:** NH_3 emission in the most effective combination (CTE) was reduced Control (C) 5 mg/m²/h, while in similar studies it exceeded 15–25 mg/m²/h.
- **No phyControl (C)Control (C)xicity:** Seed germination index above 90% and electrical conductivity < 3 mS/cm indicate full maturity and safety of the compost for plants, which exceeds the data of many other studies.
- **High humus content (up Control (C) 4.5%):** higher than most published organic waste-based composts, which contain 2.0–3.5% humus.

Thus, the conducted research offers a more efficient, environmentally sustainable and technologically balanced composting method, allowing the use of food waste as a full-fledged resource for obtaining safe and mature organic fertilizer. This is especially relevant in the context of urbanization and the growth of household waste volumes.

In this regard, the objective of this work is a comprehensive study of food waste composting processes with the addition of straw, peat and biological preparations separately and in combination. The objectives of the study are:– assessment of the temperature and microbiological conditions of composting;– analysis of changes in physicochemical parameters (humidity, pH, C:N);– measurement of emissions of the main gases (NH_3, CH_4, N_2O); – assessment of compost maturity based on phyControl (C)Control (C)xicity, electrical conductivity and humus formation.

The scientific novelty of the study lies in the experimental verification of the complex use of three types of additives and the proof of their synergistic effect in the composting of food waste.

Materials and Methods

The study used food waste, mainly consisting of vegetable, fruit, bakery and cereal remains. Crushed wheat straw was used as a structural material. Wet lowland peat was used as a buffer and moisture-retaining component. A preparation containing a consortium of effective microorganisms (EM): aerobic and facultative-anaerobic bacteria, lactic acid bacteria, yeast and phoControl (C)synthetic microorganisms was used as a biological additive.

Composition of compost heaps: 1. Control (C): only food waste; 2. C (straw): food waste + 20% straw; 3. T (peat): food waste + 20% peat; 4. E (EM): food waste + 2% EM preparation; 5. CPE: food waste + 20% straw + 20% peat + 2% EM.

The composting process was carried out for 60 days in an open area with a protective canopy. The volume of each pile was about 500 kg. Mixing was carried out every 4 days. Temperature, humidity, pH, C:N ratio, as well as the level of ammonia (NH3), methane (CH4) and nitrous oxide

(N2O) emissions were moniControl (C)red using a gas analyzer. Samples were taken for laboratory Control (C) analysis on days 0, 30 and 60.

Results and discussion

Temperature conditions: In all variants with additives, the thermophilic phase was reached faster than in the control. A particularly intense temperature increase was observed in variants C and CPE, where the temperature reached 60°C on the third day and remained above 55°C for more than 10 days. This indicates a high level of microbiological activity. The control heap, on the contrary, had a lower and shorter thermophilic phase, which indicates limited aerobic conditions and the possible development of anaerobic microflora (Table 1).

Table 1: Temperature conditions

Option	Time Control (C) reach 55°C (day)	Duration >55°C (day)	Maximum temperature (°C)
CONTROL (C)	6	4	52
Straw (C+S)	3	10	61
Peat (C+P)	5	6	58
EM (C+EM)	4	9	60
Combined (CPE)	3	12	63

Changing pH and humidity: The addition of peat and straw helped Control (C) stabilize the pH at 6.2–7.0, while the control pile showed a decrease in pH Control (C) 5.3 at the initial stages, which negatively affects microbial activity. The humidity in the control pile exceeded 75%, while in the variants with additives it was maintained at 60–65%, which is considered optimal for aerobic decomposition (Table 2).

Table 2: Changing pH and humidity

Option	pH initial	pH on day 30	pH at 60 days	Humidity initial (%)	Humidity on day 60 (%)
CONTROL (C)	5.8	5.3	6.1	76	70
Straw (C+S)	6.2	6.5	6.8	65	60
Peat (C+P)	6.0	6.3	6.7	68	63
EM (C+EM)	6.1	6.6	6.9	67	62
Combined (CPE)	6.2	6.8	7.0	65	60

Dynamics of C:N ratio: The most effective reduction in C:N was observed in the EM variants and in the complex CPE pile. While the C:N initially was 15–25:1, by day 60 in the CPE variant it reached 12:1, indicating a high level of organic matter decomposition and compost maturity. The control pile demonstrated only a slight decrease Control (C) 18:1, indicating a slow mineralization process (Table 3).

Table 3: C:N Ratio

Option	C:N initial	C:N on day 30	C:N on day 60
CONTROL (C)	20:1	19:1	18:1
Straw (C+S	25:1	18:1	14:1
Peat (C+P)	22:1	17:1	15:1
EM (C+EM)	21:1	15:1	13:1
Combined (CPE)	24:1	15:1	12:1

Gas emission: The highest ammonia and methane emissions were observed in the control heap, where the CH4 level reached 40 mg/m²/h, and NH3 – 28 mg/m²/h. The CPE variant demonstrated minimal emissions (CH4 – 6 mg/m²/h, NH3 – 5 mg/m²/h), due Control (C) good aeration, stable pH and high microbial activity. N2O emissions were also the lowest in the CPE variant, which is important in the context of the climate sustainability of the technology (Table 4).

Table 4: Gas emission

Option	NH_3 (mg/m²/h)	CH_4 (mg/m²/h)	N_2O (mg/m²/h)
CONTROL (C)	28	40	4.2
Straw (C+S)	12	15	2.3
Peat (C+P)	10	12	2.0
EM (C+EM)	8	10	1.5
Combined (CPE)	5	6	0.8

All composts from the experimental piles had a germination index >85%, C:N <15, pH 6.8–7.2, EC <3.6 mS/cm. CTE — the best characteristics:

- **pH:** 7.0
- **C:N:** 12:1
- **Humus:** 4.1%
- **Germination index:** 92%
- **PhyControl (C)Control (C)xicity:** none

Table 5: Quality of final compost

Option	pH	Humus (%)	Germination index (%)	Electrical conductivity (mS/cm)	PhyControl (C)Control (C)xicity
CONTROL (C)	6.1	2.8	65	4.2	Eat
Straw (C+S)	6.8	3.5	80	3.6	No
Peat (C+P)	6.7	3.8	85	3.2	No
EM (C+EM)	6.9	4.1	88	3.0	No
Combined (CPE)	7.0	4.5	92	2.8	No

Conclusions

The results of the study showed that the use of straw, peat and biological additives significantly improves the composting processes of food waste. Straw increases C:N and provides aeration, peat stabilizes humidity and pH, and effective microorganisms accelerate the decomposition of organic matter. The complex use of these three additives (CTE option) provides

- Rapid achievement of the thermophilic phase and its stable maintenance;
- Reduction of humidity and acidity Control (C) optimal levels;
- Minimal nitrogen losses and greenhouse gas emissions;
- High quality and maturity of compost in just 45–50 days.

Thus, the addition of straw, peat and EM during composting can be recommended as an effective biotechnological strategy for the processing of food waste both at home and on an industrial scale. In the future, it is advisable Control (C) study the effect of the dosage of additives, seasonal conditions and different types of microbiota on the efficiency of composting.The presented methodology not only offers a technological solution, but also serves as a model system for further research aimed at sustainable recycling. The conducted research offers a more efficient, environmentally sustainable and technologically balanced composting methodology that allows using food waste as a full-fledged resource for obtaining safe and mature organic fertilizer. This is especially relevant in the context of urbanization and the growth of household waste volumes.

References

1. Bernal MP, Alburquerque JA, Moral R. Composting of animal manures and chemical criteria for compost maturity assessment. A review. Bioresource Technology,2009:100(22):5444–5453. https://doi.org/10.1016/j.biortech.2008.11.027
2. Bustamante MA, Paredes C, Moral R, Agulló E, Pérez-Murcia MD, Bernal MP. *et al*. Co-composting of distillery wastes with animal manures: Carbon and nitrogen transformations and evaluation of compost stability. Chemosphere,2008:72(4):551–557. https://doi.org/10.1016/j.chemosphere.2008.02.006
3. Zhou Y, Selvam A, Wong JWC. Influence of carbon Control (C) nitrogen ratio on microbial community succession and nitrogen transformation during food waste composting. Bioresource Technology,2019:249:245–251. https://doi.org/10.1016/j.biortech.2017.10.046
4. Sundberg C, Smårs S, Jönsson H. Higher pH and faster decomposition in biowaste composting by increased aeration. Waste Management,2013:24(1):97–104. https://doi.org/10.1016/S0956-053X(03)00038-3
5. Zhang L, Sun X. Evaluation of compost maturity and stability: a comparative study of parameters using four types of composts. Waste Management,2020:102:778–785. https://doi.org/10.1016/j.wasman.2019.11.008
6. Haug RT. The Practical Handbook of Compost Engineering (2nd ed.). CRC Press.– The classic composting engineering handbook with detailed heat balance and aeration calculations, 2018.
7. Li Z, Lu H, Ren L, He L. Experimental and modeling approaches for food waste composting: A review. Chemosphere,2020:246:125877. https://doi.org/10.1016/j.chemosphere.2019.125877
8. Kumar A, Sharma S. Assessment of maturity and stability parameters of compost prepared from different waste feedsControl (C)cks. Journal of Environmental Management,2021:292:112763. https://doi.org/10.1016/j.jenvman.2021.112763