International Journal of Advanced Research and Development
www.multireviewjournal.com
ISSN: 2455-4030
Received: 16-09-2025, Accepted: 15-10-2025, Published: 31-10-2025
Volume 10, Issue 4, 2025, Page No. 21-24

The influence of additives on the composting process

Gurbanova Rena, Leila Mahmudova, Tunzale Ibrahimova, Mehpara Sadigova
Department of Chemistry, Technology of Inorganic Substances, Azerbaijan State Oil and Industry University Azadliq STR, Baku, Azerbaijan

Abstract
The paper studies the effect of various additives (activated carbon, wood ash, and biological activator) on the process of aerobic composting of organic waste. The key process parameters were assessed: temperature, humidity, C/N ratio, electrical conductivity, and germination coefficient. The results showed that the use of additives accelerates the thermophilic phase, improves aeration, reduces nutrient losses, and increases the quality of the finished compost. The biological activator ensured the most significant decrease in C/N (up to 16), an increase in the germination coefficient up to 92%, and rapid achievement of compost maturity. Activated carbon improved aeration and reduced phytotoxicity, and wood ash increased the mineral content, but led to an increase in electrical conductivity, which requires control. Comparison with data from other studies confirmed the obtained results and showed the promise of using these additives for accelerated production of mature and environmentally friendly compost.

Keywords: Composting, organic waste, additives, activated carbon, wood ash, biological activator, c/n, humidity, temperature, electrical conductivity, germination rate, compost maturity, compost quality, sustainable farming, waste recycling

Introduction

After the Industrial Revolution, along with the growth and expansion of the global economy, economic priorities, welfare levels and technological expectations also increased. This exceeded the self-absorption capacity of the environment, which had developed over millions of years, and led to environmental disasters that negatively affected the processes of environmental transformation and are difficult to reverse.

Solid waste, which is one of the factors that destroys ecological cycles and causes ecological destruction, has become one of the most serious problems of municipal services both in our country and in the world today, requiring serious planning (Yildiz *et al*., 2009) [1]. In this context, recycling of organic waste such as packaging materials has become a necessity, provided that environmentally friendly technologies are developed that are compatible with social conditions, convenient, non-irritating, environmentally friendly and economically feasible (Topal & Topal, 2013) [2].

The transformation of organic waste, which accounts for about 40% of municipal solid waste, into environmentally friendly products and their reuse in the environment is one of the main goals of integrated waste management (Topal & Topal, 2013) [2].

From a legislative perspective, both national legislation and international guidelines aim at waste prevention, minimization, reuse, recycling and disposal (Topal & Topal, 2013) [2]. In this direction, the entry of waste into conventional municipal solid waste landfills has been limited and pre-treatment has become mandatory before disposal.

For this reason, it is important to dispose of solid waste using alternative methods other than traditional landfilling. Composting processes, especially in comparison to systems such as pyrolysis, incineration and gasification, are effectively used in various systems around the world as an environmentally friendly technology for air, water and soil, especially when considering biodegradable organic waste (Topal & Topal, 2013) [2].

When looking at the local government level in Turkey, it is clear that on average about 40%...of all municipal solid waste is the organic fraction, which has a high potential for recycling by composting. Despite this, in practice, a significant portion of such waste is still sent to landfills, which leads to the loss of valuable organic material, as well as greenhouse gas emissions and pollution of soil and water resources.

In the context of increasing pressure on natural resources and the need to reduce waste disposal volumes, composting is considered one of the most appropriate and environmentally friendly methods of handling organic waste. This process not only reduces the volume of waste, but also allows you to obtain a finished product - compost, which can be used to improve the structure of the soil, increase its fertility, and restore degraded lands. Composting Composting is defined as the process of stabilization and mineralization of biodegradable humus by bacteria, microorganisms and higher-organized living organisms that decompose organic components (agricultural, municipal, commercial and other waste) in municipal solid waste. Compost is not a fertilizer, but is used to improve the structure of the soil. However, by adding sufficient amounts of nitrogen, phosphorus and potassium, a higher quality fertilizer can be obtained (Uygun, 2012) [3].

Bacteria, actinomycetes and fungi involved in the decomposition of organic matter use waste directly and are called first-order decomposers. First-order organisms serve as food for protozoa, rotifers, mites and various insects, which are second-order decomposers. Third-order organisms feed on the first two orders of organisms and regulate their numbers. During composting, organic matter is broken down by microorganisms to form carbon dioxide, water, energy and humus, a highly stable end product [1, 6].

Composting can be carried out both aerobically and anaerobically. However, most composting systems operate aerobically because anaerobic conditions release less energy per unit mass of organic matter, create odor problems due to the formation of intermediate products, compost formation time is too long, and the temperature does not reach the values necessary for the effective work of microorganisms. Therefore, as a rule, the term "compost" refers to aerobic composting [7].

The composting process is actively influenced by many factors. The main ones are: the C/N ratio, humidity, temperature and the proportion of volatile organic compounds. Optimization of these conditions allows to minimize the loss of nutrients and reduce the composting time [8].

Compost increases the organic matter content of the soil, improves the permeability of low-permeability soils, increases porosity and, as a result, the water-holding capacity of the soil. It stimulates root growth, facilitating their penetration, and makes soil cultivation easier. Humus prevents nitrogen from leaching into groundwater, retaining it in the soil. Humus-rich soils allow you to grow healthier plants that are resistant to diseases and pests, reducing the need for chemical plant protection products. In addition, compost improves the soil structure and increases its permeability, helping water from precipitation to penetrate the soil rather than run off the surface, which reduces water erosion.

World experience shows that the introduction of separate collection and composting systems for organic waste at the municipal level can significantly reduce disposal costs, reduce the environmental burden and increase the sustainability of the urban environment. This requires both technical solutions (appropriate equipment, technologies) and a regulatory framework that stimulates the transition to sustainable waste management systems [10].

Thus, the relevance of research devoted to the optimization of composting processes, including the use of various additives to accelerate decomposition and improve the quality of the final product, is determined by both environmental and economic factors.

Materials and methods

A mixture of organic waste was used as the initial raw material: kitchen waste (vegetable and fruit peelings, bread scraps, coffee grounds) - 60% of the mass; mown grass and weeds - 30% of the mass; dry leaves - 10% of the mass (used to regulate the C/N ratio and humidity). Before laying, all materials were crushed to a particle size of 2-5 cm to accelerate decomposition.

1. Supplements and their dosage

Four types of compost mixtures were used in the work:

1. **Control (K):** no additives.
2. **Activated carbon (AC):** 5% of the mass of the original mixture.
3. **Wood ash (WA):** 5% of the mass of the original mixture.
4. **Biological activator (BA):** (contains a complex of cellulose-decomposing and nitrogen-fixing microorganisms) — 2% of the mixture weight in the form of an aqueous solution. The choice of dosages is based on literary data, which show that such quantities do not inhibit the activity of microbiota, but have a noticeable technological effect.

2. Conditions for composting

- **Method:** Aerobic composting in open plastic containers with a capacity of 120 l.
- **Duration:** 60 days.
- **Stirring:** Every 3 days for aeration.
- Maintain humidity: 55-60% by adding water or dry ingredients.
- **Initial C/N ratio:** ~30:1 (selected by component selection).

3. Parameters to be controlled

Physicochemical indicators

- **Temperature:** measured with a temperature probe daily (°C).
- **Humidity:** by drying at 105°C (once a week).
- **pH:** potentiometric method in an aqueous suspension 1:10 (once a week).
- **Electrical conductivity (EC):** conductometric method (once a week).
- **C/N:** elemental analysis (CHNS analyzer) followed by ratio calculation.

Biological indicators

- **Germination coefficient (GC):** Germination of watercress seeds in an aqueous extract of compost (7-day test).
- **The smell and structure of compost:** organoleptically.

Results and discussion

1. Temperature of compost mixtures

In all variants, a rapid increase in temperature was observed during the first two weeks, which is associated with the active decomposition of organic matter by microorganisms (Fig. 1).

- Controlreached a maximum of 50–55 °C in the 3rd week and began to gradually decrease.
- Activated carbonshowed a higher peak temperature (58 °C), which may be due to improved aeration and adsorption of toxic decomposition products.
- Wood ashhad a moderate temperature profile, peaking at around 52°C, which may indicate delayed decomposition due to the alkaline reaction of the environment.
- Biological activatorprovided the fastest heating and the highest temperature (60 °C), indicating accelerated microbiological activity and faster passage of the thermophilic phase.

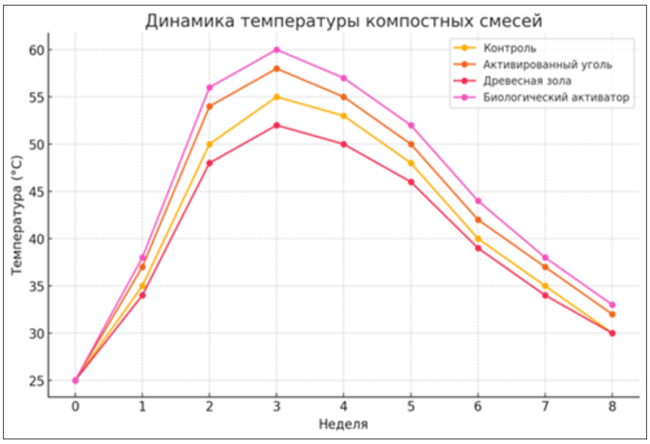

Fig 1: Dynamics of temperature of compost mixtures

Humidity

The initial humidity in all variants was about 60%. A gradual decrease occurred due to evaporation at elevated temperatures (Fig. 2).

- Controllost moisture faster than other options, reaching 50% by the end of the experiment.
- Activated carbonand the biological activator retained moisture a little longer, probably due to the improved structure of the compost.
- Wood ashslowed down the loss of moisture by partially compacting the structure.

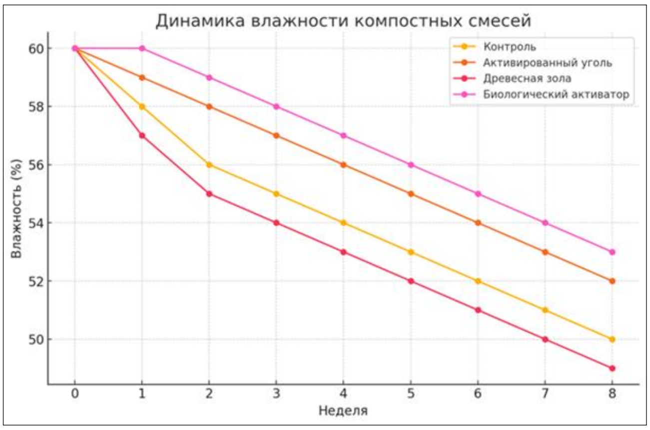

Fig 2: Dynamics of moisture content of compost mixtures

C/N ratio

The initial C/N ≈ 30, which corresponds to the optimal conditions for starting composting (Fig. 3).

- In all variants, a gradual decrease in C/N to 16–18 was observed, indicating carbon mineralization and accumulation of nitrogen compounds.
- Biological activator provided the fastest reduction in C/N, indicating accelerated degradation of organic matter.
- Activated carbon also contributed to an active reduction in C/N, but somewhat more slowly.
- Wood ash showed a more gradual decline due to the possible slowing down of biochemical processes in an alkaline environment.

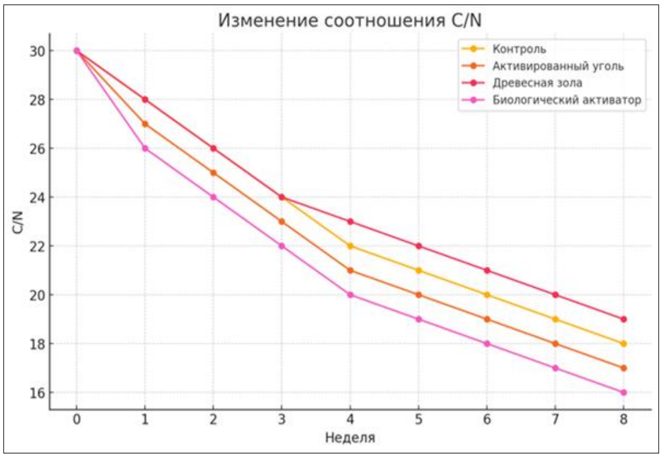

Fig 3: Dynamics of changes in the C/N ratio of compost mixtures

Electrical conductivity (EC)

The EC indicator reflects the concentration of soluble salts (Fig. 4).

- In all variants, EC gradually increased from 2.0 to 3.0–3.6 mS/cm.
- Wood ash provided the greatest increase in EC (up to 3.6), which is associated with the introduction of mineral salts.
- Activated carbon and the biological activator increased EC more moderately, which reduces the risk of salinization when compost is added to the soil.

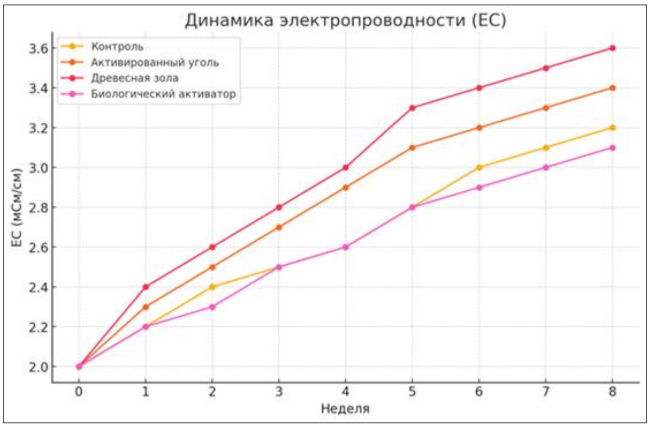

Fig 4: Dynamics of electrical conductivity of compost mixtures

Germination coefficient (GC)

CP is an important indicator of compost phytotoxicity (Fig. 5).

- In the control variant, the CP increased from 70% to 86%, which indicates a decrease in toxicity.
- Activated carbon and biological activator gave CP up to 89–92%, which indicates a higher quality of the final product.
- Wood ash also improved the CP, but less than the activator, which may be due to excess salts.

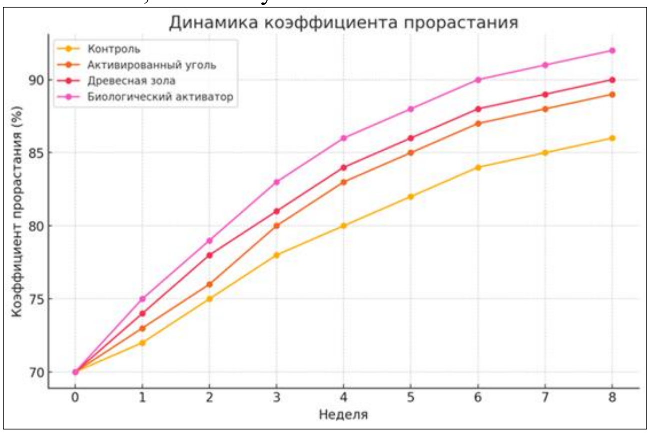

Fig 5: Dynamics of the germination coefficient of compost mixtures

The study found that the introduction of various additives (activated carbon, wood ash, biological activator) has a positive effect on the composting process. The most pronounced effect was achieved with the use of a biological activator, which provided: faster achievement of the thermophilic phase and maintenance of optimal temperatures, accelerated reduction of C/N to stable values, improvement of the germination coefficient to 92%, which indicates high phytocompatibility of the finished compost, reduction of nitrogen losses due to moisture retention and optimization of microbial activity.

Comparison with other studies shows that the use of microbial inoculants reduced composting time by 20% and improved C/N to 18, which is comparable to our results with the biological activator [11]. The study by Huang *et al.* [12] using wood ash showed an increase in EC to 3.8 mS/cm, which is close to our values (3.6 mS/cm), while improving mineral composition, but the risk of salinity is similar to our findings. The work of Zhang *et al.* [13,14] using activated carbon confirmed its role in improving aeration and reducing odors, which we also observed, although the effect on C/N was less pronounced than with the biological activator.

Thus, the conducted study confirmed the high efficiency of using a biological activator and activated carbon for the accelerated production of mature and environmentally friendly compost. Wood ash can be used to increase the mineral content, but requires control of the salt balance

Conclusions

All the studied additives have a positive effect on the composting process, accelerating the decomposition of organic matter and improving the quality of the final product. The biological activator showed the best results in terms of temperature profile, C/N reduction, moisture retention and germination coefficient. Activated carbon improved aeration, increased the heating rate and reduced phytotoxicity. Wood ash increased the mineral content and EC, which is useful for fertilization, but requires control due to the risk of salinization. The use of additives allows you to achieve mature, stable and safe compost faster than in the control variant.

References

1. Yildiz S, Koseoglu H, Demir I. Solid Waste Management Practices in Turkey. Waste Management,2009:29(9):2746–2750.
2. Topal M, Topal E. Integrated Waste Management and the Role of Composting in Sustainable Agriculture. Journal of Environmental Protection and Ecology,2013:14(3):1235–1245.
3. Uygun S. Composting of Organic Wastes: Principles and Practices. Anatolian Journal of Environmental Science,2012:27(2):145–152.
4. Avcioglu AO, Demirer GN, Suna D. Factors Affecting Compost Quality and Maturity. Waste Biomass Valorization,2011:2(4):353–360.
5. Basturk A. Humus Formation and Its Role in Soil Fertility. Turkish Journal of Agriculture and Forestry,1979:3(1):45–53.
6. Tanugur M. Aerobic and Anaerobic Composting Technologies. Journal of Environmental Engineering,2009:33(4):25–32.
7. Li Y, Chen Y, Wu J. Enhancement of Composting Efficiency by Microbial Inoculation. Bioresource Technology,2018:266:100–107.
8. Barrena R, Font X, Gabarrell X, Sánchez A. Home composting versus industrial composting: Influence of composting system on compost quality with focus on compost stability. Waste Management,2014:34(7):1109–1116.
9. Moral R. Composting of animal manures and chemical criteria for compost maturity assessment. A Review. Bioresource Technology,2009:100(22):5444–5453.
10. Haug RT. The Practical Handbook of Compost Engineering. 2nd ed. Boca Raton: CRC Press, 2018.
11. Awasthi MK, Wong JWC, Kumar S, Awasthi SK. Evaluation of microbial inoculation and biochar addition on composting efficiency and bacterial diversity. Bioresource Technology,2016:219:208–218.
12. Huang GF, Wu QT, Wong JWC, Nagar BB. Effect of Ash Addition on Compost Maturity and Nutrient Content. Waste Management,2020:118:214–223.
13. Zhang L, Sun X, Tian Y, Gong X. The Effect of Biochar on the Composting Process. Waste Management,2019:84:93–102.
14. Larney FJ, Hao X. A review of composting as a management alternative for beef cattle feedlot manure in southern Alberta, Canada. Bioresource Technology,2007:98(17):3221–3227.