Fermentation vs. composting of organic waste

# Harnessing Our Trash

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**Organic waste accounts for a significant percentage of what gets dumped into landfills, but that should not be the case. Like plastics or metals, biowaste represents a valuable secondary raw material**

Discussion has been underway for years about the need to minimize the amount of waste that gets dumped into landfills by recycling as large a share of them as possible. Nevertheless, as much as 96% of communal waste in Poland still goes unsorted. Garbage trucks drive out of our cities and towns hauling a mixture of plastic bags, bottles, newspapers, and vegetable peels that is difficult and costly to subsequently re-separate. Organic material, in particular, should not end up dumped into landfills because it gets quickly broken down by biochemical processes and becomes suitable for use as fertilizer.

The growing challenge of recovering and neutralizing this organic fraction of waste, especially from solid communal waste, is sparking ever-greater interest in various processing technologies. An EU directive from 1999 and corresponding national laws are now forcing EU member countries to gradually lower the organic fraction of waste that gets landfilled. This especially entails strategic efforts to separate out and harness the organic fraction of communal waste.

## Problematic mixture

For waste that gets separated at the source, a very broad range of recovery and utilization methods are available: from simple composting technologies to complex thermal processes. Organic waste from households, "green waste" (such as grass clippings from parks), and waste from agricultural food production are suitable for direct processing and do not have to be land-

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The organic matter in mixed waste is contaminated and is usually only suitable for biogas recovery filled. All it takes is for local governments to invest in local composting facilities or in methane fermentation technologies. Mixed communal waste, on the other hand, poses a much more complex problem. Composting such waste is discouraged due to its contamination with heavy metals and other environmentally harmful substances, so such mixtures first need to be separated.

One quite widely used method that partially solves the problem of organic waste disposal is landfill degassing. In Poland, one-quarter of all active landfill facilities now have installations for utilizing landfill gas (biogas). However, it is more feasible to recover organic waste before it gets landfilled, an approach that requires organized, selective collection and biological processing efforts.

The fundamental objective of such recycling of organic waste, including that separated out of communal waste, is to reduce the quantity of trash that gets dumped into landfills. Yet the economic aspect is also vital, because every initiative of this sort will sooner or later need to be evaluated in terms of its economic feasibility.

## With or without oxygen

There are two basic ways to process segregated biowaste: composting and fermentation. The composting process, which mostly involves aerobic degradation, is now the most frequently used method, especially in open-air heaps. Fermentation, on the other hand, is an anaerobic process for which the influx of atmospheric air must be restricted. Both of these processes are considered good insofar as they are done right and yield tangible results. Indeed, sometimes a combination of both methods is used.

Still, composting and fermentation each have a range of limitations. Waste that is easily biodegradable but contains a high degree of moisture may pose a problem for composting because water can create anaerobic areas within a compost heap. On the other hand, not all waste suitable for composting can be fermented - research indicates that 50-66% of the overall mass of biodegradable waste is more suitable for fermentation than for composting.

Choosing to process organic waste segregated out of communal waste by traditional composting techniques entails the costs of establishing open-air heaps or building special bioreactor systems. Similarly, choosing instead to use anaerobic fermentation of ground-up and hydrated waste entails the costs of building closed fermentation chambers (also called bioreactors).


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**A bioreactor for composting mixed organic waste using the MUT Dano technology**

The composting method with bioreactors has been in large-scale use for more than 30 years now and is considered a very effective biowaste processing technology. Fermentation, on the other hand, was until 1995 considered an insufficiently well-studied and too costly technology for handling the organic fraction of communal waste. That is why most communities have chosen to build composting facilities, opting for smaller risk and lower investment costs. Advancements in research on the fermentation process and lessons learned from operational fermentation facilities in the world have nevertheless shown that anaerobic waste processing can indeed compete with composting in terms of both effects and costs.

The choice of which processing method is right in a given case must take account of specific criteria like the quantity and kind of waste to be processed, where the facility is to be located, the degree of public acceptance, and the potential for harnessing the output product (compost or biogas). The choice of technology and the facility's processing capacity need to be tailored to fit the guaranteed quantity of waste, while also providing for possible future expan-

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**Open-air composting is the most widespread method for neutralizing organic waste, but not always the most optimal**

sion. A generally adopted rule of thumb is that one composting facility should serve a region with a maximum radius of 30 km. Using anaerobic technologies is economically justified only in the case of large facilities capable of handling upwards of 40,000 tons a year.

For aerobic processes, regardless of the composting technology chosen, the quality of the output product (compost) primarily depends on the composition of the input material. The choice of technology should be determined by such factors as the quantity of waste, the intended use of the compost, and the specific site and climate conditions. If there is a potential to use the compost as fertilizer, it is better to compost selectively collected waste using for example the MUT Kyberferm, MUT Herhof or SDE technologies. But if the compost is slated for recultivation or disposed of in landfills, the approach of composting mixed waste might be considered, using for example the MUT Dano technology.

## Energy and fertilizer

Technologies for fermenting the organic fraction separated out of communal waste have been growing more and more popular in recent years. The use of such technologies yields biogas with high methane content plus what is called the process remainder, which can be made suitable for use as compost through additional maturation under aerobic conditions. Two fermentation methods are currently in use: wet or dry. Either method may be used to process both selectively collected biowaste or the organic fraction of mixed waste.

The suitability of this solution in specific cases is nevertheless determined by the final output, i.e. the quantity of biogas generated (which translates into the surplus of electrical and thermal energy that can be harnessed) or the quality of compost. The problem is that certain fermentation technologies have been developed with a focus on waste neutralization, treating the electrical and thermal energy so obtained as a side effect. On the other hand there are also technologies that focus on organic waste mainly as a source of biogas as an alternative fuel, treating waste neutralization as a secondary issue. That is why the choice of a specific technology should be based on a thorough analysis of the real needs and possibilities.

Anaerobic fermentation has numerous advantages over composting. Above all, the process takes half the time. A fermentation facility also requires 30 percent less space than composting or simple maturation in heaps. Another great advantage is the lack of unpleasant smells – odors are drawn out of bioreactors and purified in biofilters (a similar solution is only employed in composting facilities with bioreactors). The post-fermentation mass has very good fertilizing properties, and when it is too contaminated to serve in that capacity it can be compacted to more than 1.3 tons/m$^3$, enabling the volume of landfills to be optimally utilized. Fermentation also breaks down a greater percentage of the organic material than the composting process, entailing a smaller post-process remainder. Moreover, methane fermentation is characterized by a positive energy balance.

## The quality issue

The quality of the compost generated by organic recycling (such as the utilization of communal waste via the composting method) is the basic criterion for evaluating its feasibility. To avoid the risk of polluting soils, waters, or crops, compost has to meet strictly defined norms, precisely regulating its content of basic nourishing components, its permissible heavy metal content, and the presence of pathogenic microorganisms.

To determine the suitability of composts for use as fertilizer, the Institute of Environmental Engineering in Zabrze has performed a long-term study of the composts obtained using the MUT Dano technology from communal waste from the Katowice region. Although that technology was developed for composting mixed communal waste, while the study was underway Katowice implemented a segregation program and so the processed material was in fact partially separated. The study was performed over 10 years and yielded very interesting findings.

One important criterion for evaluating the suitability of composts for further use in nature is their overall heavy metal content. However, some heavy metals form insoluble compounds that will remain inaccessible to plants in the future. Only after the chemical bonding of these metals is identified can their soil and water impact be predicted.

Our study indicated that the heavy metal content in composts varied greatly. Although the norms for lead and zinc were exceeded during several seasons, thus ruling out the possibility of these composts being put to natural use, their heavy metal content did significantly drop after partial selective collection of biowaste was introduced. Yet interestingly, the onset of waste segregation also brought an unfavorable change in the makeup of heavy metal compounds: although their levels were quantitatively lower, a larger percentage of them were in fact weakly bonded, thus increasing the risk that they would enter the food chain. It also seems that copper, nickel, and chromium especially have a tendency to accumulate in organic matter. That signals a need to closely monitor these elements in output composts.

Regardless of whether composting or fermentation is chosen, the processing of organic matter enables the amount of communal waste dumped into landfills to be reduced by as much as 25–40%. That guarantees the partial fulfillment of EU requirements for reducing the stream of organic waste dumped into landfills. ■

**Further reading:**

Rosik-Dulewska Cz. (2007). *Podstawy gospodarki odpadami* [*Fundamentals of Waste Management*]. Wydawnictwo Naukowe PWN.

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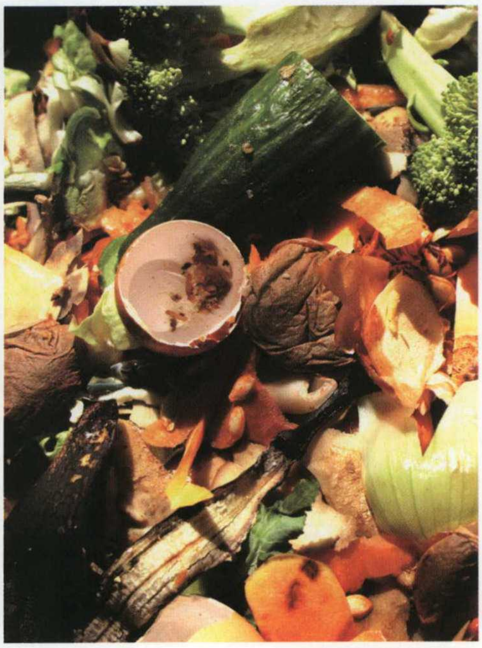

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**In rural areas, organic waste usually ends up in household compost heaps. In cities, on the other hand, recovering and processing it takes logistical and educational effort**