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Composting – A Solution to Reintegrate Biodegradable Waste into the Natural Cycle

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Abstract: The paper presents a few inexpensive and simple collecting and composting methods of biodegradable household waste. Biodegradable waste may be submitted centrally to collection in appropriate containers placed in crowded areas, which may further be lifted up and transported to specialized regional composting stations or it can be collected in domestic appliances that are easy to maintain, in the end the resulting compost being locally used.
By composting it is pursued a higher recovery rate of the biodegradable waste fraction. The separate collection would highly increase the efficiency of the sorting lines for other recyclable fractions. In general, recycling significantly reduces the amount of waste disposed in landfills.
Keywords: waste, municipal waste, waste collection, composting

1. THE COMPOSTING PROCESS AND COMPOST

Composting can be defined as a treating method of biodegradable organic waste, (organic components of municipal waste, sludge from wastewater treatment, organic waste from parks and gardens maintenance and others) with the purpose of recovery. During the process of composting the organic waste components are mineralized and humified by microorganism activity (mainly by bacteria and fungi). The resulting product – the compost is biologically stable and can be utilized as fertilizer. The word "compost" comes from Latin and it means "compound". The composting plants assume the model from nature and they transpose it into a controlled medium thus ensuring the optimal operation conditions for process (temperature, humidity, pH, aeration, raw material homogeneity, C/N ratio and others), [2], [2], [8].

Humidity is a basic factor which influences the composting process. Mineralizing microorganisms can only live in a humid medium. Optimum moisture content for composting material is between 50% and 60%. Minimum value is 20% and maximum 70% [2].

Oxygen content and aeration. During composting the oxygen consumption is 2 g O_2 / g decomposed waste, i.e. 2.50 l air / g dry waste. The air intake should be provided (by natural or forced ventilation) in order to avoid an anaerobic medium [2].

Temperature. In a properly functioning process the temperature adjusts itself. The optimum temperature is between 60 and 70 °C and varies during the process. A high temperature is necessary for the proper sanitation of compost [2].

Another important factor is the carbon-nitrogen ratio, the optimum C / N ranging from 25/1 to 35/1 [2, 7].

Table 1. C/N Ratio for different types of waste

Waste Type	C/N Ratio	Waste Type	C/N Ratio
Kitchen waste	12:1 to 20:1	Leaves	30:1 to 60:1
Lawn grass	12:1 to 25:1	Oatmeal straw	60:1
Vegetable scraps	13:1	Wheat straw	100:1
Poultry manure	13:1 to 18:1	Garden wood waste	100:1 to 150:1
Cattle manure	20:1	Fresh sawdust	100:1 to 200:1
Manure with a high straw content	25:1 to 30:1	Dry sawdust	500:1
General garden waste	20:1 to 60:1	Paper	1000:1

It can be noted that the green waste is optimum for composting. The C/N ratio can be improved by mixing different qualities of waste.

The pH value. The microorganisms require a pH between 5 and 9. If this condition is not fulfilled a filler material correction will be required. During the composting process the pH has a decreasing tendency [2].

2. THE SOURCE OF BIODEGRADABLE WASTE AND COMPOSTING OPPORTUNITIES

A very large part of the household waste is biodegradable. The sanitation companies aim to collect it separately or at least to separate it from other recyclable waste. Thus, in Timisoara is operating a two waste bins collection system - a dry bin for recyclable fractions and a wet bin which can include biodegradable waste. The quantity and quality of domestic biodegradable waste varies depending on the consumer living standard, their way of life, the nature of the locality (rural / urban), the predominant economic activity of the locality/area (agriculture, tourism, industry) and other factors.

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In the interest of a good waste management the aim is to collect the waste separately, thus the recyclable fractions are recovered and the disposed waste amount is minimized. A large part of the waste is recovered and used in industry as raw material (glass, metal, plastic, cardboard, paper, etc.). A special category is the readily biodegradable waste which is not stable and therefore it decomposes very quickly compared to other wastes. Their humidity varies greatly and their quantity is high, but fluctuating throughout the year. They also provide shelter for rodents and insects and they generate odor and others. One way of treating this waste is composting them, either in home or centralized facilities. The resulting product is an easy-to-use fertilizer with a wide applicability, [5].

Household waste suitable for composting, [7]

Principally kitchen and garden waste. This category includes vegetal residues from fruits and vegetables, lawn grass, leaves, weeds and other vegetal waste from garden work, coffee grounds, tea filters, eggshells and more.

Other organic wastes from domestic activities such as paper and cardboard, wool, feathers and even clean ash derived from wood stoves.

A special category is the waste from livestock or pets. The quantities of such waste like manure, straw, hay or bone meal are not significant in urban areas.

Compostable waste less recommended, [7]

Some biodegradable waste decomposes harder creating some local anaerobic conditions that are not suited for the composting process. This category includes waste such as meat food scraps. They may be subject to composting, but in small quantities. Composting garden waste from diseased plants should be avoided. Despite the fact that the composting process is exothermic, it does not always lead to the destruction of pathogenic agents. It is recommended to incinerate this sort of waste so that the resulting ash can be added to the compost.

Wastes that in no case shall be subject to composting, [7]

Inert waste such as packaging or other items of glass, plastic or metal, PVC bags, synthetic fabrics and others will not be submitted to composting. Even though it is obvious there must be taken care to the composites. Some are more difficult to identify and are included in the category of biodegradable waste. An example is the cardboard packaging that contains synthetic or metallic foil. It will also be avoided toxic waste such as pesticides, insecticides, petrochemical products and others. The authors do not recommend any expiring drug to be submitted to composting, these will rather be included in the category of hazardous waste [4].

3. WHEN IS COMPOSTING BIODEGRADABLE WASTE JUSTIFIED?

When there is a complex variety of biodegradable household waste or possibilities of adding other wastes in order to achieve quality compost (e.g. sludge from municipal wastewater, industrial waste and green waste from parks maintenance).

When weather conditions are favorable to the natural decomposition processes and the process does not become energy intensive. It can also be discussed the long distance transport of raw materials, obviously in good time.

When the compost can be used locally or there is a market demand.

When the local or regional operator is interested in producing and using the compost. This is where principally the legislative aspects intervene, i. e. the extent to which this economic activity is encouraged and supported. Small quantities of raw materials, non-selective collection or their difficult sorting, as well as the difficulties in the economic exploitation of the compost product will obviously lead to discouraging this alternative. On the other hand, restrictions on landfill will motivate composting and finding ways to use it.

A very effective solution widely discussed today, is combining the biodegradable waste with sludge from wastewater treatment plants. The quantities of sludge are being impressively great and their combination with other wastes for composting is an interesting solution currently applied in Europe. Obviously restrictions appear regarding the quality of treated sludge, such as heavy metals or pathogens.

In households good quality compost can only be produce from garden waste and by mixing it with other biodegradable household waste. Beneficiaries must be interested in this and have the needed time and space.

Compost can be regarded as a "bio" fertilizer, composting being actually a natural process of mineralization.

Nevertheless drawbacks to composting occur, either at the home or at the centralized stations:

- Release of odor;
- Attracting insects and rodents;
- Large occupied area;
- Long-term process;
- Danger of contaminating the raw material by non-complying to the collecting conditions;
- Vandalized public collection points;
- Varying quantity and quality of biodegradable waste;
- Changes in the quantity and quality of waste per season;
- Plants of small capacity (domestic) are not stable in operation;
- Poor quality raw materials;
- Lack of permanent opportunities to locally use the compost produced in household;

- Lack of permanent opportunities to use the compost produced in centralized plants because of very large quantities;
- There is currently a (justified) restraint to the compost originating from sludge or industrial wastes;
- Not always those who generate waste (meaning the consumers) are interested in the technical and economic aspects related to their removal.

4. ALTERNATIVES TO BIODEGRADABLE WASTE COMPOSTING

Considering the fact that it is intended not to dispose biodegradable waste by landfill, the only viable alternative for treating these wastes is incineration. The process is complex and energy intensive and economically justified only for large amounts of waste (e.g. collected from the range of several counties). Low-capacity incinerators are commonly used for special waste incineration.

5. CASE STUDY

In 2008 a waste sorting campaign was conducted in the City of Timisoara, the purpose being to determine the composition of the waste collected by the RETIM sanitation operator in the municipality. The campaign was conducted in two stages, the first stage in June and the second in September. The participants in this action were RETIM Ecologic Service S.A. Timisoara, The Technical University of Stuttgart and The Polytechnics University of Timisoara.

In 2008 the two bins collection system was already serving 50% of the beneficiaries in Timisoara, i.e. a "wet" bin for common waste and a "dry" bin for recyclable fractions (cardboard, paper, plastic packaging, cans). The campaign aimed to determine the waste composition of the common bin (for the areas where the two bins collection system was not implemented) and the waste composition of the wet bin (for the areas where the system was already implemented). The analysis of the recyclable waste collecting bins was performed only randomly in order to verify their correct use.

The action included the following events, [1], [3], [6]:

- Setting the research theme;
- Determining the specific municipality areas where samples were to be collected;
- Sampling according to a set schedule;
- Waste sorting and weighing the different fractions for each feature area of the city;
- Preparing the final report.

Because Timisoara does not have a homogeneous structure in terms of waste, the city was divided into eight specific areas, four for each collection system (with two, respectively one bin). Thus were chosen two central areas (in the historic center), two areas with blocks of flats (also central), two residential districts and two old suburban neighborhoods.

The sampling was done in accordance with the RETIM waste collection schedule.

The collected waste was discharged on a platform where it was further manually sorted in fractions, the fine part being sifted. The fractions were then weighed and the data recorded. The following waste categories were separated and weighed: organic waste, plastics, paper and cardboard (by quality), construction waste, glass, textiles and shoes, diapers, metals, composite materials, hazardous waste (chemicals), electric waste and fine fractions (<40mm). Weighing was performed immediately after sorting with the waste having their natural moisture.

The results of both campaign stages are presented below:

Table 2. The waste collecting system with two bins (the data is expressed in % of the total mass)

Waste Group (fraction)	**%**
Organics (incl. <40mm)	50
Plastics	12
Paper, Cardboard	9
Non-organic fine waste (<40 mm)	6
Construction Waste	6
Textiles and Shoes	5
Glass	5
Others	7
Total Composting Material 59%	

Table 3. The waste collecting system with one bin (the data is expressed in % of the total mass)

Waste Group (fraction)	**%**
Organics (incl. <40mm)	48
Plastics	12
Paper, cardboard	10
Non-organic fine waste (<40 mm)	6
Glass	6
Construction waste	6
Diapers	3
Others	9
Total Composting Material 58%	

CONCLUSIONS

Composting biodegradable waste is always justified, even if there are some drawbacks. The results of the sorting campaign showed that over 50% of the household waste is compostable.

Firstly it should significantly reduce the amount of waste to be sorted, collection being selectively performed and the waste going on the sorting line mainly consisting of recyclables. Selective waste collection is in still a necessity. The result of composting is a natural fertilizer with a very good price/quality ratio. The collecting process of compostable waste in a locality does not require specific infrastructure. Collection can be carried out either from households or from public points set for submitting this type of waste. In Timisoara such collecting points already exist for plastic packaging and glass.

Where possible, biodegradable household waste is mixed with sewage sludge and other industrial wastes and is composted in a high or very high capacity centralized station. Larger stations have the advantage of mechanical work and the composting process is controlled.

Composting at home requires a minimum investment and a suitable place to locate the container (or containers). During the sorting campaign the use of garden waste was found only in the old suburban neighborhoods. These neighborhoods are characterized by large estates therefore the residents use their own garden for growing vegetables and fruits. In the new residential districts the interest in composting is very low, even non-existent. This is primarily due to small areas, the residents being limited to fitting a lawn and to cultivating flowers or ornamental shrubs. Another justification would be the age and occupation of the residents of these neighborhoods, mostly being younger people with a working schedule during the day. Some of them told us that they prefer the landscaping to be performed by a service provider. In this case the resulting waste would still be collected and removed properly.

Small domestic composting equipments are recommended primarily for house residents where the resulting compost can be used on their own land. In crowded centers it is preferable to collect selectively the biodegradable organic waste and to gather it periodically by a local or regional operator. These wastes will be mix composted with others in a large capacity composting station.

The authors hope that the facilities for domestic waste composting will become a common sight in households, in addition to rainfall water catchments, solar energy installations and heat pumps.

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