VALORISATION OF BIODEGRADABLE WASTES USING WORMS' CROPPING

VALORIFICAREA DEŞEURILOR BIODEGRADABILE PRIN INTERMEDIUL VIERMICULTURII

ŞUTEU Daniela[1], BĂDEANU Marinela[2], ZAHARIA Carmen[1]
[1] "Gh. Asachi" Technical University of Iasi, Romania
[2]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

Abstract. *Worms' cropping or worms' composting are included into the category of biological treatment applied on biodegradable wastes, being an aerobic composting process of organic wastes, relatively cold, using worms. The procedure is based on their capacity to use as food different types of organic wastes coming from agriculture, wood industry and food industry, from slaughter houses or zootechny, together with domestic or housekeeping wastes. Finally, the wastes are transformed into stabilized products that can be used as organic manure named bio humus or bio compost.*

Key words: biodegradable waste, worms, worm composting

Rezumat. *Viermicultura sau viermicompostarea face parte din categoria metodelor biologice de tratare a deseurilor biodegradabile, fiind un proces aerob de compostare relativ rece a deşeurilor organice cu ajutorul viermilor. Procedeul se bazeaza pe capacitatea acestora de a folosi în calitate de hrană diverse tipuri de deşeuri organice provenite din agricultură, industria lemnului şi cea alimentară, de la abatoare sau din zootehnie, precum şi deşeuri menajere. In final, deseurile sunt transformate în îngrăşământ organice numit biohumus sau biocompost.*

Cuvinte cheie: deseuri biodegradabile, rame, viermicompostare

INTRODUCTION

The management of the solid waste has always been a problem especially in the rural areas, where there are no special places for the controlled waste storage or disposal techniques; most of the times the waste is left in the outskirts of the localities, on the shore of a river. There are 3 categories of environments affected by the wrong storage of the waste: *exogenous* (on the ground surface), *endogenous* (inside the ground) and *hypogenous* (from the deep layer, under the soil horizon). The faster affected are the endogenous environments, which include the biotopes of the soil and its annexes: the humus layer, the litter, the moss layer, and the micro-caves.

The organic (biodegradable) wastes represent an important part of the city waste, approximately 40-70%. There are then important quantities of waste from the agriculture and zootechnics, from agro-industrial processes, as well as the mud from the water treatment stations.

Seeing their capacity of fermentation, and in order to implement some efficient techniques for the treatment of these types of waste, several biotechnologies were developed and improved, which are used in parallel in some cases or which

replace the techniques of incineration and controlled storage. They have the big advantage that the waste volume is reduced, producing instead two very useful products: **compost** and **biogas** (Istrati L. and all, 2006).

Among the biotechnologies applied for the waste exploitation and treatment, the digestion technology are highly considered lately (aerobic – compost and anaerobic – anaerobic fermentation). Due to the main products generated by them, they meet the new tendencies of the European Union regarding the obtainment of energy out of new resources and the replacement of the chemical products for the soil conditioning with ecological products, with a reduced negative impact on flora and fauna.

MATERIAL AND METHOD

Materiales: biodegradable home wastes (food wastes) and four-six worms from *Lumbricus rubellus* and *Eisenia foetida* species (fig. 1).

Fig. 1. *Lumbricus rubellus*

Working method: An amount of chopped paper waste is put into a drilled plastic box as a support and part of the grinding food waste was added. The worms are added over this and then a new amount of waste. Everything was covered with paper waste, that serves as cellulose material for worms and as covering material, with the role of maintaining the moisture and providing the escape of the worms. The entire box is kept at 20-25^{o}C, making sure that the moisture is maintained around 50-70% by means of swilling. After two weeks, the composting degree of the waste is checked, by sampling an amount of the formed biohumus and chemical testing it. The sample is replaced with an approximately equal amount of new food waste.

Fig. 2. Selected food wastes

Fig. 3. The worms added in the plastic box prepared for composting process

RESULTS AND DISCUSSIONS

1. Before introducing the solid wastes into the process of worm composting, these must be firstly physically and chemically characterized in order to determine the inhibitors or other toxic compounds having negative actions into *Lumbricidae* growth (e.g. heavy metals or pesticides). The analysis methods are adapted after the actual standards for soil quality:

- determination of organo-chlorate pesticides using extractions liquid-liquid and gas chromatography;
- spectrophotometric determination of Fe ions content;
- determination of other heavy metals using the demineralization with concentrated nitric acid and AAS analysis.

2. *Worms' composting* is a relatively cold composting process of the organic waste with the help of the worms, based on their capacity of using various types of organic waste as food. The worms crumble mechanically the compostable organic material, and they partially decompose them after swallowing. Then biochemical decomposition is realized through bacteria and different chemical substances present in the worm's digestive tract (Duca Gh. and all, 2006). Eventually, the waste is transformed into organic fertilizer called **biohumus** or **biocompost**. This method of treatment of the organic waste is practiced at a small scale, mostly in individual farms or in pilot projects (Germany, Japan, Sweden, Republic of Moldavia). This technique stands at the base of educational projects, being practiced in schools (in 40% of the German schools) where simultaneously with the ecological education; it can be an attractive material for the Chemistry and Biology classes (Duca Gh. and all, 2006). He main advantages of this method lie in the fact that it does not require high-costs, it can be practiced in any type of farm, and under favourable weather conditions the vermicomposting can be practiced even in the open air. Moreover, the use of the biological material represented by the earthworm species is cheap and easy to get for everybody, as our country has a considerable fauna of *Lumbricidae*.

3. There are over 35 animal species which live from the vegetal and animal waste, directly or indirectly participating to the recycling. From all these, nine species belong to *Annelida*, Class of *Oligochaeta*, and they are the humifying species, and 26 species are part of the *Arthropoda*, Class *Insecta*, belonging to 4 families: *Histerinae, Sacarbaeidae, Silphidae* and *Staphylinidae*, coprophagus, necrophagus, detritivorous species or with mixed food (Pop V., 1949). Earthworms intervene in the transformation of the organic waste into biohumus (*Annelida*, Class *Oligochaeta*), in whose nutrition process several types of organic waste, which passed the fermentation process, are used. They may or may not have purple pigment. The species with purple pigment (porphyrin) get into the soil only accidentally; they live on the surface, under the rocks, under the fallen timbers, under the foliage on the soil, under the moss or under the manure. The most

frequent are *Eisenia foetida*, *Lumbricus rubellus*, *Lumbricus castaneus*, *Dendrobaena octaedra*, *Dendrobaena rubida.*

In this experiment we used the worms from *Eisenia foetida* species. The pigmented lumbricids on the surface eat plant pieces, leaves, which they transform in the digestive tract into humic matter, eventually eliminated as excrements. The non-pigmented lumbricids or those with other pigment than prophyrin get into the soil and eat the humus produced by the first ones and the edaphon's components (Pop V., 1949). Instead, these lumbricids compensate the negative activity on the soil quality with a very efficient mechanical action, by deeply aerating the soil. The most globally used species (in Moldova Republic for example) is *Eisenia foetida*, also known as "California's Red Hybrid".

4. The wastes with a biodegradable fraction are used in vermiculture:

- the domestic waste, selectively collected from the population or from bars, restaurants, canteens, which is not contaminated with dangerous substances or pathogenic agents;
- vegetal waste: mown lawn; leaves and springs from the vine (if it was not recently treated with pesticides); the leaves of the orchard trees fallen in the autumn; all the leaves and stems of the vegetables, etc. Among the trees for leaves, in the first weeks after death the cherry and pear leaves are preferred; the red shamrock from the fodder species; and onion leaves from the vegetables. Only the beech leaves are consumed undegraded, immediately after their falling.
- animal debris;
- domestic waste: skins from vegetables and fruit, cereal products. The egg shells, crashed or finely ground, are very useful as they have an important quantity of calcium.

In view to obtained a qualitative biohumus, the raw material used to produce the wormcompost must comply with the following requirements (Duca Gh. and all, 2006; 6): the humidity of the organic waste must be of 73-80%; the absence of uncompostable materials (rocks, metal, timber, glass etc.); the avoidance of the contamination with chemical polluting agents (traces of heavy metals or pesticides), the assuring of a pH appropriate for the development of the frames and the wormcasting process (6.8 – 7.5). An essential condition is an optimum C:N ration, which may ensure the energy necessary for the development of the microorganisms involved in the degradation of waste, preparing them for the wormcasting process.

5. As a consequence of the studied wormcomposting process, we obtained an intense black biohumus with high content of moisture (70%) which was subject to the physical-chemical characterization: humidity determination, active acidity, total carbon and nitrogen, Ca, Mg, K and P, microbiological contamination.

Table 1

Quality indexes of the vermicompost (biohumus)

Nr.	Indicators	Adsmisible values	
		minime	maxime
1.	Humidity, %	30	40
2.	Organic substances,%	20	30
3.	Active acidity (pH)	6,5	7,5
4.	Total Nitrogen, %	0,9	1,0
5.	Fosphour (P_2O_5), %	0,8	1,5
6.	Photasium (K_2O), %	0,8	1,0
7.	Calcium, %	-	4,0
8.	Magnezium, %	-	1,0
9.	Lead, %	-	-
10.	Non-patogen bacterium flora, colonies	-	$2x10^{12}$

Following the bioconversion process of the organic waste, the result is the compost called *biohumus*, used as fertilizer for the soil, in agriculture or floriculture. It can be used one year after fermentation. The biohumus obtained like this with certain quality indexes, standardized (table 1) is dried, screened and packed in polyethylene bags or send directly to the fields (7).

CONCLUSIONS

1. The vermiculture is constituted into an ecological and future alternative for the present ways of treating biodegradable waste. A number of 33 species are involved in the organic waste degradation process, 9 of which are earthworms (*Oligochaeta-Lumbricidae*) and 24 are insects (*Coleoptera*). Among the most efficient lumbricids for the biohumus production we mention *Eisenia foetida*, *Lumbricus terestris*, *Lumbricus castaneus* şi *Dendrobaena rubida*, which are species with porphyric pigmentation, excellent humifiers.

2. The ecological agriculture will be put into practice thanks to these products. The main advantages of this method are the facts that the technology is not expensive, it can be applied in any type of farm, and in good weather conditions the worm culture may be practiced even in the open air. Moreover, the use of the biologic material represented by earthworm's species is cheap and easy to be found by anyone, as our country has a significant lumbricid fauna.

3. If we take into consideration the economic aspect of the process (low achievement costs), the favourable climate from Romania, as well as the fact that the use of the biological material made of worms species is cheap and handy, as the lumbricide fauna of our country is considerable, we may conclude that the treatment of biodegradable waste by wormcomposting can become a promising technique.

4. Due to these aspects, wormcomposting is a technique easy to apply in any type of household (urban or rural), with perspectives of extending it to a macro scale.

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