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SOME METHODS FOR COMPOSTING ORGANIC WASTE AND PRESERVING ENVIRONMENT AND SOIL BIODIVERSITY-A REVIEW

Larisa CREMENEAC, Mariana CARAMAN

Scientific and Practical Institute of Biotechnologies in Zootechny and Veterinary Medicine, 6525, v. Maximovca, district Anenii Noi, Republic of Moldova, Phone: +37322359350, Fax: +37322359350, E-mails: kremeneak@yandex.ru, m_ caraman@mail.ru

Corresponding author: kremeneak@yandex.ru

Abstract

The article reflects the problem of organic waste management and the composting methods used to improve the ecological situation of the environment. Some methods of composting organic waste of various origins are synthesized. Composting represents the process of decomposition and transformation of solid organic substances by microorganisms (mainly bacteria and fungi) into a stable material, which can be used (depending on the characteristics), in agriculture, instead of chemical fertilizers or in land improvement works (soil improvement). Only some methods of composting are characterized: the traditional method, worm cultivation and the method of effective microorganisms. All composting methods are welcome for agriculture because they solve complicated environmental problems: complete processing of organic waste, obtaining organic fertilizers and ecological agricultural production and improving the ecological situation.

Key words**:** *composting, efficient microorganisms, organic waste, traditional composting, worm cultivation*

INTRODUCTION

At the current stage, nature can no longer be saved and protected only by mischievous actions. The protection of the environment involves all global, regional, national and local actions aimed at preserving, rationally using and reproducing the nature of the Planet. Through cooperation, humanity adopts political decisions, legal acts, develops new technologies, performs collective and individual actions in the field of environmental protection. All these actions were concentrated in a concept of sustainable development, which is ecological in nature and has beneficial consequences on the improvement of the environmental situation.

Biodegradable rural waste differs from urban waste in composition and quantity. The lack of public sanitation services in the rural area and the primary record of waste generation makes it impossible to compile correct and timely statistics of rural biodegradable waste

The livestock sector generates animal waste and from birds, constituting a significant amount of biodegradable waste. Animal husbandry enterprises and large farms breeding animals and birds, in the public and private ownership of economic agents, as well as the small ones within the peasant households produce large amounts of waste and manure that require specific systems for their management, both at the local and regional level.

Manure was, is and will always remain a debatable topic. On the one hand, it is a waste that animal breeders want to get rid of, on the other hand, if it is not stored and used domestically, according to the requirements, it is a very dangerous factor of water pollution, both surface and to those in the groundwater. However, manure is an important resource for farmers, constituting a material that makes a particularly important contribution to restoring the humus layer, which chemical fertilizers cannot do.

Animal husbandry in rural areas has generated intensive pollution of the soil, underground water, phreatic wells and surface water. The collection and separate storage of waste from the livestock sector remains one of the biggest problems, considering that not all farmers are aware of the need to separate it, especially those who have not yet decided to safely store all the residues produced by animals. Taking into account the fact that in the zootechnical

sector the share of livestock has moved from the public to the private sector (85-97%) with unfavorable consequences of environmental pollution, it is recommended to all specialists to pay major attention to the management of animal manure. The amount of accumulated animal manure varies depending on the species of animals, their age, their number and the duration of the maintenance period in the stable [10].

The correct management of manure is done by setting up storage systems that can be individual (household), communal or a combination of the two. Right from the design stage of farms and the construction of manure storage capacities, it is necessary to pay special attention to the prevention of pollution, especially of water and environmental protection

Where the organic waste management plan is established in accordance with specific local conditions (soil type, distance to water sources, land slope, volume of precipitation, farm system and duration of storage periods) manure is managed correctly, without the risk of to cause environmental pollution. Manure must be kept in platforms, packed, covered with a layer of soil 15-20 cm thickness. In order to decompose, the garbage must have a humidity of 70-75%, otherwise it will dry out and mold. Before being covered with earth, the garbage is watered with garbage must, urine or even water to ensure the necessary moisture, improve the composition and reduce nitrogen losses [11].

MATERIALS AND METHODS

Material for the research served both literary sources in which the ecological problems in the livestock sector and phytotechnology sector are exposed, as well as our own research regarding the management of organic waste and the methods of solving these problems [2], [4], [5], [6]. As a result of the analysis of the studied materials, observations and own research, some methods of composting organic waste from the zootechnical sector were highlighted, in order to make it possible to use it as organic fertilizer in the phytotechnology sector.

RESULTS AND DISCUSSIONS

Composting: definition and importance

Composting can be defined as a controlled biological process of conversion and valorization of residual organic materials (biomass by-products, organic waste of biological origin) in a stabilized, hygienic, soil-like product, rich in humic compounds. Composting (the act of fermenting various organic residues in the presence of oxygen in the air) is a millennial empirical practice in agriculture and horticulture that has returned to the fore with technologies for processing and restoring what we now call biomass.

In the literary sources, data are presented regarding the importance of organic material, which is contained in biodegradable organic waste.

Michel Musten mentions that in the search for an autonomous and diversified agriculture, the use of organic waste is welcome. The progress of ecological ideas foresees a revival of agriculture that requires the search, renewal or discovery of methods of management and improvement of organic products. Traditionally used, various organic wastes (agricultural, agrifood, industrial, household, forestry, etc.) are no longer processed or processed unsatisfactorily. The level of humus in soils decreases, by increasing erosion and drought. For the management of organic waste in order to effectively combat pollution, new technologies have been developed, the so-called ecological technologies. Michel Musten's research in the field of biodegradable organic waste processing is very useful for all farmers, gardeners, horticulturists, government engineers and technicians, organic agrifood producers, amateur horticulturists, teachers and students [13].

In the works of G. Gigliotti et al., [11] it is mentioned that composting means recycling the organic matter and regulating the natural cycles that were interrupted by the abandonment of traditional agricultural practices.

At the same time, it is mentioned about composting that: it is a technique of stabilization and aerobic treatment of

biodegradable organic waste; addresses all organic waste, but especially solid and semi-solid waste; is a way to destroy the seeds of unwanted plants (weeds), and by means of heat and different internal factors, pathogenic germs and different parasites, carriers of various diseases, can be destroyed; it is a biological technique for recycling organic matter which, along its evolution, leads to the production of humus, a stability and fertility factor for soils; it is the result of a very complex microbiological activity, occurring under specific conditions.

G. Gigliotti et al., mention that the composting process helps to manage very large amounts of organic waste in a sustainable manner. Composting is one of the technologies that make up integrated waste management strategies, used to recycle organic matter into a useful product [11].

Composting is a well-known system for the rapid stabilization of organic matter. The application of compost, obtained from a wide variety of human activities, to arable soils is in the attention of scientists worldwide with the goal of increasing the content of organic matter. Although the transformation of organic matter during the composting process has been widely studied, most reports have focused on the humic fraction. The dissolved organic matter compost is a mixture of specific low molecular weight compounds (amino acids and sugars) and chemically heterogeneous high molecular weight polyelectrolytes (enzymes, amino-sugar complexes, polyphenols and humic-like substances). Because most of the biogeochemical transformations that are part of the evolution of organic matter during composting occur in solution, this being dissolved represents the most active fraction of compost, both biologically and chemically. Therefore, dissolved organic matter is the organic fraction most subjected to changes and, as such, should directly reflect the process of organic matter transformation. In fact, the chemical transformations that occur in the dissolved organic matter fraction of the compost could provide important indications regarding the evolution and stabilization of the transformation process during composting, as well as at the maturity of the final compost.

The involvement of dissolved organic matter in chemical and biochemical processes of soil after fertilizer incorporation has a direct influence on soil organic matter composition and plant physiological development. Even though the amount of dissolved organic matter in compost is small compared to that in solid organic matter, it still plays a significant role in microbial activity in the soil and in the transport of nutrients, metals and hydrophobic pollutants. Taking into account the important role that dissolved organic matter plays both in the composting process and in the application stages, this research aims to ascertain the assessment of compost stability and its maturity with respect to biochemical and microbiological transformations, which occur in the soluble fraction from the material initially to the final compost [13].

Compost is a product obtained through an aerobic, thermophilic process of decomposition and microbial synthesis of organic substances from residual products, which contains more than 25% relatively stable humus formed predominantly of microbial biomass and which is further subjected to poor decomposition, being sufficient stable so as not to reheat or cause odor or insect breeding problems. The compost resulting from organic waste is richer in nutrients for plants than any artificial fertilizer, being the best natural fertilizer and is produced very easily. The vast majority of organic waste can be submitted to the composting process: vegetable remains (grass, foliage, stems and roots), manure, etc.

Composting means all the microbial, biochemical, chemical and physical transformations that organic, vegetable and animal wastes undergo, from their initial state until they reach different stages of humification, the final product being known as compost.

Compost is the best mulch and natural soil amendment and it can be used instead of mineral fertilizers. But the most important thing is that it is a cheap product. The use of compost leads to the improvement of soil structure, improvement of excessive textures,

improvement of aeration and increase of water storage capacity, increases soil fertility and stimulates the development of a healthy root system of plants. The organic matter applied through compost provides food for microorganisms, which keep the soil in healthy conditions.

Methods used for composting organic waste

Various technologies (methods) are known for composting organic waste, including manure.

Traditional composting

The method has been known since ancient times by farmers who used manure to improve soil fertility [15].

Various technologies can be used in the traditional composting process:

- composting of manure with stratum in which special plots are used for fermentation on which piles of animal droppings are placed, which are covered with soil. The amount of soil should not exceed 15-20% of the weight of the manure;
- composting manure without stratum with alluvial soil. This technology initially provides for the study of the alluvial soil, then the land is chosen (located in a valley) with dimensions of 10 m×100 m, where the composting will take place;
- composting the solid fraction of manure without stratum with plant and soil residues. This compost can be obtained wherever plant residues are found (old straw, fibrous fodder residues). Initially, the land is prepared with an area of 25-30 m^2, which is leveled, plowed to a depth of 23-30 cm and then processed with discs. Plant remains are placed on this territory (2% of the weight of the solid fraction of the manure intended for composting) which is compacted. The weight of the soil used to cover the manure pile should not exceed 15% of the weight of the manure prepared for composting:
- composting the solid fraction of manure without stratum with old manure, depends on the shape and size of the pile prepared for composting. Composting begins with throwing the old manure over the solid fraction of the manure without litter, and then the whole mass of manure prepared for composting. In winter, the composting of these two components is carried out without adding soil;
- the production of compost for protected spaces (greenhouses) is carried out near the farms on lands cultivated with perennial grasses in their third year of cultivation, in spring and summer using the mixture of liquid manure, its solid fraction (30%) and alluvial soil (70 %);
- the composting of bird droppings with stratum is carried out similarly to the composting of cattle manure, being covered with a layer of soil.

Liquid poultry manure can be stored in concrete tanks, or incorporated into the soil with autumn plowing or during autumn cultivation [15].

Thus, traditional composting can be used in any type of household to transform animal droppings into organic fertilizer.

Worm cultivation for the bioconversion of organic waste

Another method used for the bioconversion of organic waste and obtaining compost is worm cultivation [1], [4], [5], [12]. This method provides for the use as a bio-transformer of organic waste and various species of earthworms (Photos 1 and 2).

Photo 1. The local earthworms of garbage
Source: Own from the internet.

All types of manure, which have been previously subjected to fermentation for various periods of time, can be processed using the technology of bioconversion of organic waste through worm cultivation [8]. Worm cultivation opens new perspectives and possibilities for the management of organic waste from the zootechnical sector in order to obtain valuable organic fertilizer, protein not

only for fodder, but also for food, which can become the basis for the production of ecological products [9].

Photo 2. Earthworm Red Hybrid of California
Source: Own photo.

The complex of eco-biotechnologies that are used to maintain the ecological situation of the environment differ according to their degree of effectiveness. They can also include "living technologies", which are used for the purpose of bioconversion of organic waste obtained in various branches of the national economy.

The development of the technology of bioconversion of organic waste through worm cultivation begins directly with the organization of households for worm cultivation. When organizing these households, some conditions related to the objectives and tasks that are placed before the household must be taken into consideration. It is necessary to determine which will be the dominant directions:

1. Increase in the earthworm population.
2. Producing worm compost for marketing.
3. Producing worm compost for personal needs.
4. The production of biological mass to be used in the food ration of animals, fish, birds and in other fields.

For the organization of households for worm cultivation, it is necessary to determine the place from where the organic waste will be collected, which will be the transport routes and the water sources used.

Worm cultivation technology can be practiced indoors and outdoors. No special capital investments are required for the development of indoor worm cultivation technology, but the remaining buildings on the territory of farms and zootechnical complexes can be used. In rooms, worm cultivation is carried out on concrete surfaces where sections are set up and on racks, using wooden or metal crates. It is necessary to mention that the practice of worm cultivation technology indoors is more effective than outdoors, because twice as much worm compost can be obtained here. In the absence of rooms, the organization of the household for worm cultivation can be carried out according to the scheme, which provides for its location in open-air territories, where the worm culture is placed in the substrate from ditches or piles and the technological process takes place from April to October (in the climatic conditions of Republic of Moldova). This scheme is accessible and its use allows the technique to be widely used. On designing the household for worm cultivation, it is necessary to take into account its profile (obtaining of worm compost or worm culture) [14]. Based on this, calculations are made regarding the number of sections and the area occupied by the household for worm cultivation.

In the first year of work, regarding the organization of the household for worm cultivation, it is foreseen to accumulate the necessary amount of earthworms. For this purpose, from 4,000 to 20,000 earthworms are placed in a section (2 m^2), resulting in only 200-300 kg of worm compost [4], [5].

The work on the complete cycle in the technology of worm cultivation starts from the second year, if in the previous year the required amount of earthworms was obtained. During this period, the livestock farm switches to the complete worm composting regime, when 30,000 to 10,0000 earthworms must be placed in each section. As a result of the processing of organic waste from a section, 1,000-1,200 kg of worm compost are obtained. The territory intended for the household for worm cultivation is divided into four production sectors. The first sector (for fermentation) is used for organic waste storage, fermentation and compost preparation. The sector is located on a previously prepared surface, where the basic technological process takes place in piles,

after the compost is transported to the second production sector (for worm composting). Here, under the influence of worm culture, the compost is processed and transformed into raw worm compost. The raw worm compost is transported to the third production sector, where the preparation of the worm compost takes place (dislodging and drying). From here, the worm compost is transported to the fourth production sector (finished production sector), where the quality of the fertilizer is determined. In this sector the worm compost is screened, sorted into different fractions, packaged, stored and prepared for sale or incorporation into the soil. The nutrient substrate has a double importance for worm culture, serving as a means of food and livelihood, thanks to which the optimal level of life of earthworms is ensured and maintained. Of particular importance for earthworms is the structure of the nutrient substrate and its chemical composition. The substrate must be homogeneous, loose and moist.

Worm cultivation presents a set of activities (stages), the correctness of which ensures the success of the entire technological process.

The main stages of the bioconversion technology of organic waste through worm cultivation are: the selection and preparation of the land in order to organize the sectors and sections for worm cultivation; preparation of the nutrient substrate; placing the worm culture in the nutrient substrate; selection (separation) of earthworms from the nutrient substrate and their preservation.

In households for worm cultivation, sectors with a width of one meter and a length of 50 m are recommended, practicing sector-pairs. The distance between 2 sectors can be 1 m, and between pairs - 4.0 m - 4.5 m. Each sector is divided into sections with dimensions of 1.0 m × 2.0 m. If trenches are used for worm cultivation, then their depth must be 0.5 m - 0.6 m, and if the sectors are practiced in the form of piles, their thickness must not exceed 0.4 m - 0.6 m. In practice, changes can be made in the structure of sectors for worm cultivation (Photo 3).

Photo 3. Modified sectors for worm culture
Source: Own photo.

In peasant households, where the amount of manure is not sufficient for the formation of sectors, for the purpose of efficient use of worm culture, earthworms can be placed in pits with dimensions of 1.0 m × 2.0 m, with a depth of 0.5-0.6 m or piles formed from organic waste of various origins. The bottom of the pit or the land for worm cultivation must be well tamped. The walls of the pit must be covered with planks or other material, to prevent earthworms from leaving the substrate. Heaps of organic wastes are placed on compacted lands. The technology of bioconversion of organic waste through worm cultivation solves the following problems in the sustainable development of agriculture: complete processing of organic waste; revitalization and improvement of soils; obtaining the ecological organic fertilizer with long action; increasing the yield and production of agricultural crops; protection of plants from diseases; environmental protection. The technology of bioconversion of organic waste through worm cultivation is proposed to each agricultural unit, land owners, animal owners, amateur farmers, etc., as an effective method in ensuring the sustainable development of agriculture.

The use of effective microorganisms for composting organic waste

Another method used in composting organic waste of various origins is the method of using effective microorganisms. This is a contemporary, relatively young technology, but it is a globally recognized branch of science. For the first time, at the international level, the term "Effective Microorganisms" began to be used in 1986. Later this term is permanently used for the specific technology -

the Technology of Effective Microorganisms) [2], [6].

Photo 4a. Effective Microorganisms
Source: Own from the internet.

Photo 4b. Colonies of Effective Microorganisms
Source: Own photo.

Effective Microorganisms are an ecological alternative with sustainable benefits for humans, animals and the environment. These are the little helpers in the work in the garden, household, agriculture, ponds and comfort, with the most diverse areas of use (Photo 4a and 4b). The use of Effective Microorganisms (EM) in agriculture opens up new perspectives. EM presents a wide spectrum of use both for businesses dedicated to organic agriculture and for those dealing with conventional agriculture. Efficient Microorganisms favour the vital capacities of nature, acting especially at the aerobic and anaerobic level of soil and plants.

These Efficient Microorganisms (EM) technology is a creative science always in development, which constantly discovers new possibilities of the specific use. Thus, it was found that EM efficiently decompose heavy metal salts.

In SPIBZVM the purpose of the investigations carried out was to evaluate the role of microorganisms of the preparations with EM „Baikal ЭМ-1", „EM-1" and PoultryStar®meEU on the bioconversion process of two types of cattle and poultry manure, with the subsequent study of the quality of the compost obtained and its influence on the physiological development, quality and yield of corn grown on the lots where this compost was incorporated.

The analysis of the obtained results demonstrated that the activity of Effective Microorganisms from preparations „Baikal ЭМ -1" and „EM-1", are manifested more intensively in the first period of underway in the process of bioconversion of the biodegradable organic wastes and influenced beneficially on quality indicators of obtained compost [6]. Preparations with EM are multifunctional, having a wide spectrum of action, due to the groups of microorganisms they contain. The largest groups of EM are: photosynthesis (photosynthetic), lactic (lactic acid bacteria), fungi (yeasts), actinomycetes, fermentation fungi. These groups possess antioxidant, purifying properties and do not contain genetically modified microorganisms, but consist of multiple microorganisms, which are present in the natural environment around the world [2]. The area of use of Effective Microorganisms is vast, it includes both organic and conventional agriculture.

The advantages of using EM Technology are:

- acceleration of the process of humus formation (formation of the clay-humus complex) and relaxation of the soil;
- improving soil quality, which will result in reduced erosion;
- supporting the activity of life in the soil, including the growth of the earthworm population;
- improving soil fertility, saving fertilizers, increasing the soil's heat capacity, which leads to early seed germination, flowering and faster fruit formation;
- obtaining more resistant and vigorous plants;
- obtaining a rich harvest with high quality products;
- reducing costs for fertilizers due to a better availability of nutrients in the soil;
- protecting groundwater from pollution [3], [7].

Compost is the best mulch and natural soil amendment and it can be used instead of mineral fertilizers. But the most important thing is that it is a cheap product. The use of compost leads to the improvement of soil structure, improvement of excessive textures, improvement of aeration and increase of water

storage capacity, increases soil fertility and stimulates the development of a healthy root system of plants. The organic matter applied through compost provides food for microorganisms, which keep the soil in healthy conditions. The use of organic waste composting methods in households with diverse ownership solves a number of problems, including: processing organic waste, improving the ecological situation and developing organic agriculture.

CONCLUSIONS

As a result of the research, it was found that: organic waste composting methods can be used as an effective solution in ensuring ecological agriculture with organic fertilizers and environmental protection;
all composting methods are welcome for agriculture, because they solve complicated environmental problems: complete processing of organic waste, obtaining organic fertilizers and ecological agricultural production, and improving the ecological state of the environment; organic waste management through the use of various composting methods can be proposed to each agricultural unit with various types of property, landowners, animal owners, amateur farmers, etc.

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