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Intensive biotechnologies for the degradation of organic wastes and obtaining of fertilizers for soil ecoremediation

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Abstract

Knowing nature and respecting the rules regarding the exploitation of natural resources regards, among others, the controlled biodegradation of organic wastes.

It is known the fact that to compensate the ever – growing of the quantity of wastes, a various number of processeses was experimented upon. Among these is the intensive aerobic degradation technologies of wastes (which use vegetal and microbial biopreparations) used to obtain fertilizing elements for soil ecoremediation and for global reduction of wastes.

Keywords: intensive biodegradation, organic wastes, fertilizers.

Introduction

The making of soil ecoremediation biotechnologies implies: obtaining of natural, fertilizing substrates with an improved capacity to retain water and with improved ion exchange capacity, a permeability level which is adequate for different soil and culture types, with a high potential for the stimulation of the activity of microorganism in soils and with a high content of protection and energizing compounds. [1, 5]

This paper proposes the optimization of the traditional ways by technological reevaluation and improvement and by assessing the optimum conversion levels of the biopolymeric structures. Also, it's taken into account the automatization of the process: maintaining the optimum oxygen, temperature and humidity parameters and the colonization with selected microorganisms. [4]

All these improvements will contribute to the shortening of the humification time, without the drawback of the neosynthesis processes, the nitrogen losses and the quality of the compost.

The wastes that can be used can be structured cellulosic materials combined with the organic and mineral materials obtained from the epuration of organic waste waters, having the ratio C / N = 20 / 1.

In some cases that are based on the quality of the wastes, biodynamic products can be used to stimulate the action of the microorganisms and the humification.[4,7] Among these products are the following: *Achillea millefolium, Chamomilla chamomilla, Urtica dioica, Taraxacum officinale, Quercus robur, Valeriana officinalis*.

The diversity of the cellulosic materials function of their physical structure and chemical architecture leads to their grouping and to the establishment of a general model of the technological processes. [1, 6]

The intensive aerobic method of biodegradation of organic wastes (vegetal and animal) is based on producing a compost starter, which is ready after 10 days and represents the inoculum. The inoculum is formed from organic and cellulosic wastes, from cellular microbial mass resulted from biofilms (from the treatment of some waste waters), from biopreparates (thermophilic aerobic microbial cultures) and biodynamical products (known for their effect in harmonization and vitalization processes).

Under the conditions of heated aerobic fermentation (T = 55- 65^0 C, 65% humidity), the material having a C:N ratio of 11-20:1, 10% constitutes the inoculum for initiating a new batch. From each batch of mature compost, 10% is the starting inoculum for the next reshuffling, 90% being used as an organic fertilizer. [3, 7]

The inoculum contains selected microorganisms (thermophilic), enhances the composting process and the quality of the product by neosynthesis methods.

This procedure aims for the obtaining of natural fertilizers and to promote sustainable cultures by the natural transformation of aromatic compounds from organic wastes (which are part of the complex biodegradation systems from which intermediates are formed, capable to sustain electron transfer in the redox processes which take place at cellular level) and also aims the humus formation in the soil. [2, 5]

Materials and Methods

Using a compost starter and maintaining constant the working parameters lead to an automated process, to the precise calculation of the process time and the standardization of the final product, the compost

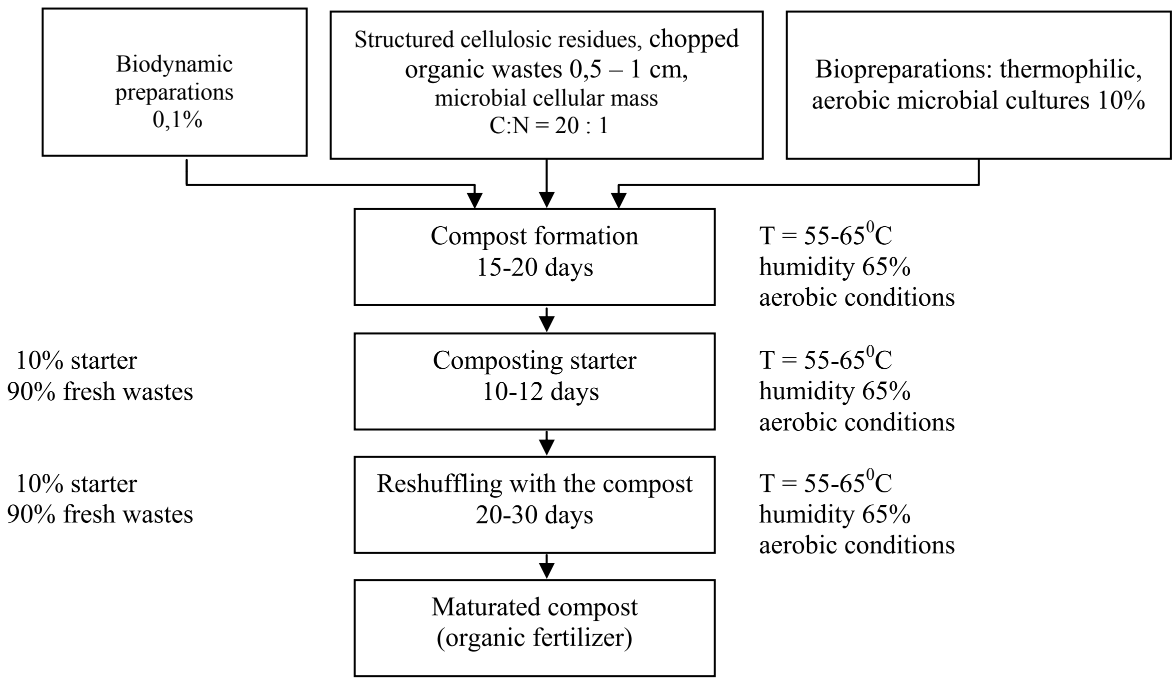

Figure 1. Aerobic heated intensive biodegradation

The technology uses a compost starter and maintains the work parameters (temperature, humidity and aeration) according to an automatized program.

Creating aerobic and thermophilic processing conditions has some advantages: shortening of the processing time, the destruction of pathogens, no unpleasant odours, destruction of weed seeds.

Results and Discussions

The obtained organic compost was analyzed to find out the main elements which are important in soil remediation.

The values of the chemical analyses are given in Table 1.

Table 1. Chemical composition of the compost

Sample	Type of analysis	U.M.	Value	Analysis method
Organic compost	Total nitrogen	%(w/w)	0,17	Volumetric method: Directive 2003/2003-method 2.2.1
	Kjeldhal nitrogen	%(w/w)	0,1081	Volumetric method: Directive 2003/2003-method 2.3.3
	Mineral nitrogen	%(w/w)	0,062	Volumetric method: Directive 2003/2003-method 2.2.1
	P_2O_5	%(w/w)	0,1329	Gravimetric method: Directive 2003/2003-method 3.2
	Total organic carbon	%(w/w)	13,66	Walkley-Black method
	C/N ratio		80,35/1	-
	Organic residues	%(w/w)	81,72	Combustion (600^0C)
	Ash	%(w/w)	18,27	Combustion (600^0C)
	Humidity	%(w/w)	19,88	Humidity determination according to STAS – 8379/3-69

Spectral determinations were also made with the help of a SPECORD 210-222 K 268 – Analytikal Jena – 2008 apparatus (fig. 2, 3 and 4) regarding the scission level of the organic biomass following the composting process.

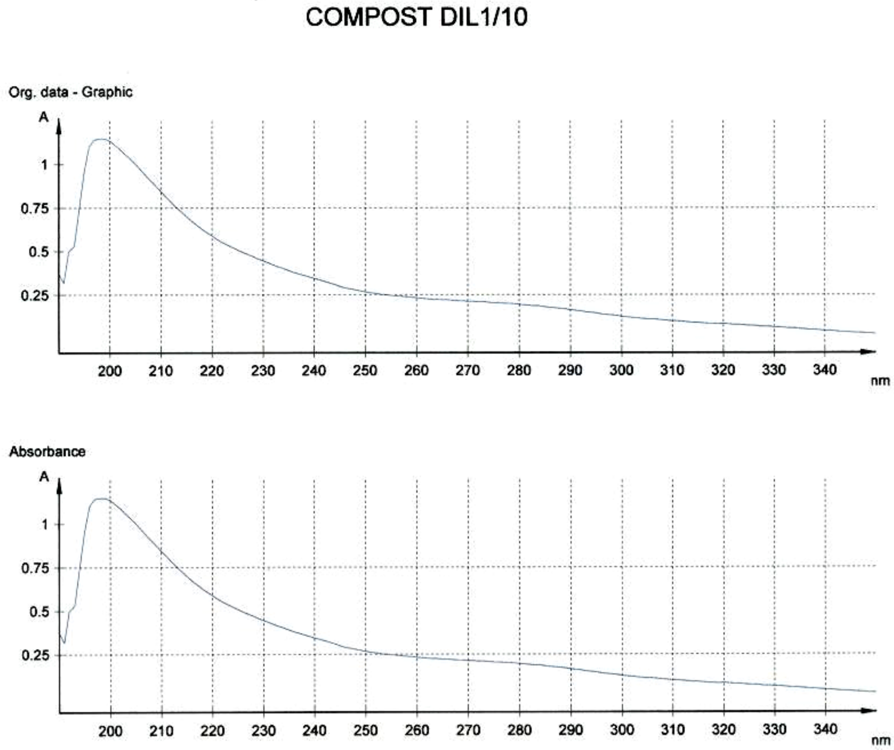

Figure 2. Spectral evaluation of the compost, 1/10 dilution

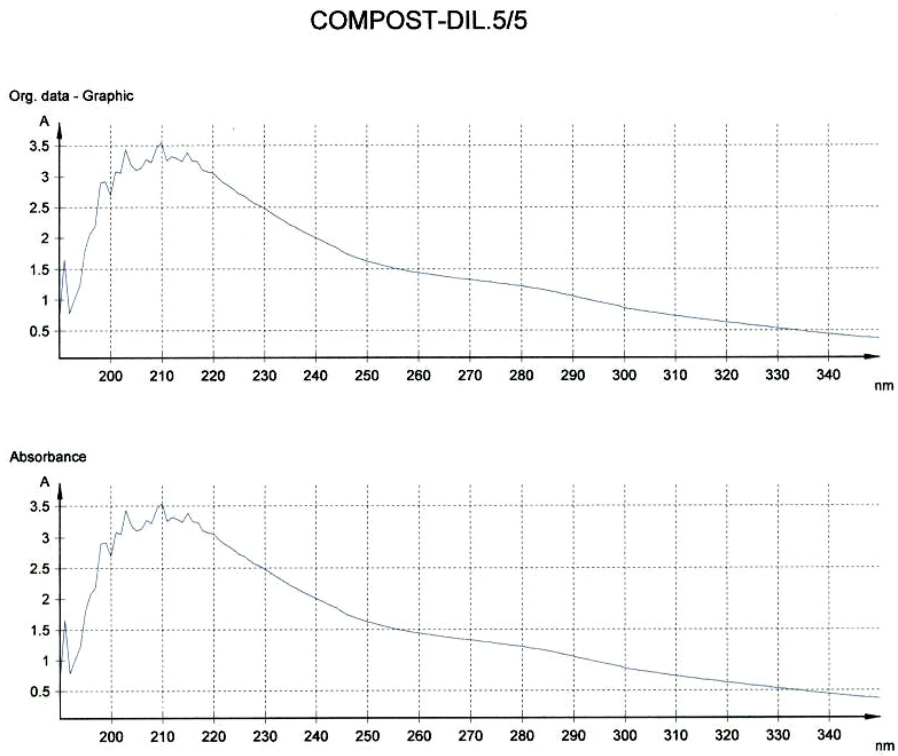

Figure 3. Spectral evaluation of the compost, 5/5 dilution

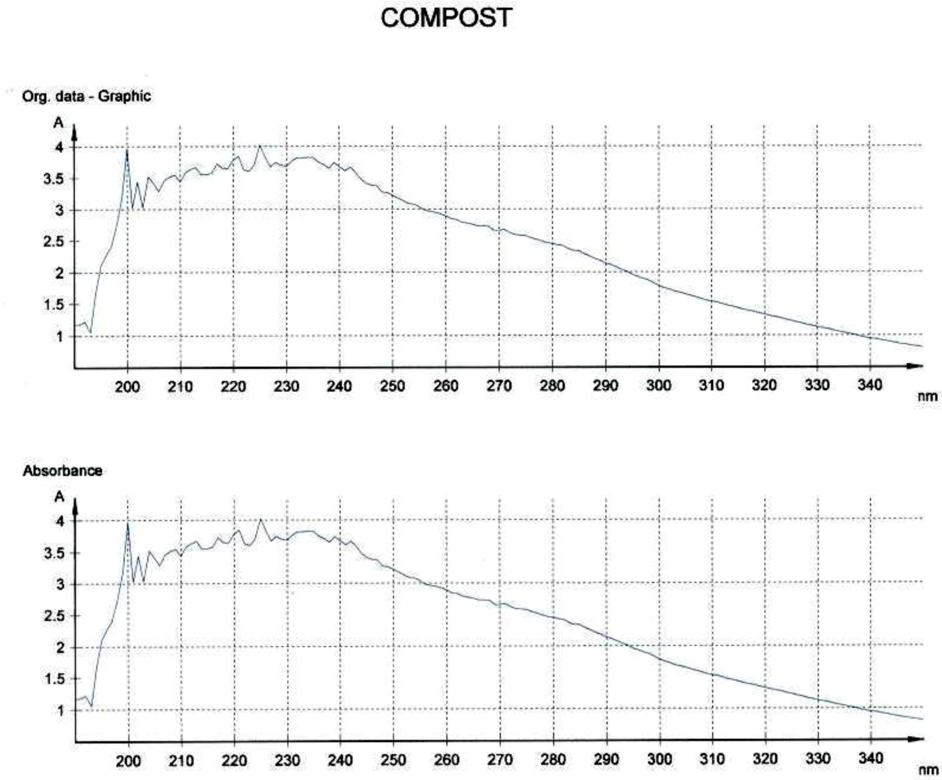

Figure 4. Spectral evaluation of the compost, no dilution

The fractionation in a 50% ethanolic medium of the substrate was done to underline the level of the solubilized compounds following the scission of the organic biomass by microorganisms.

The level of the detected compounds was determined UV spectra at different dilutions. The profile of the elution spectra presented resemblances regarding the wavelengths at which the absorption accentuated:

- at a 1/10 dilution of the initial extract, the maximum absorption appeared at 199 nm, respectively at a 1.15 uA level. A gradual drop follows, another absorption peak being at 200 nm (1.13 uA), and another two peaks at 201 nm and 204 nm. The total depletion of the absorption was recorded at 243 nm;

- at a 5/5 dilution, seven peaks are outlined, corresponding to the concentration of the solubilized compounds, in the interval 193 – 243 nm. At 203 nm, an absorption of 344 uA is recorded, at 209 nm, a value of 3.55 UA, at 212 nm, a value of 3.64 uA, at 225 nm the highest value of the absorption being recorded at 4.03 uA;

- the initial extract recorded also a number of absorption peaks in a wider plateau, but with very small differences at 202 nm, with a value of 344 uA, at 205 nm, with a value of 3.41, the highest peak being recorded at 225 nm, with an absorption value of 4.03 ua.

The UV absorptions recorded at 200 – 202 nm indicate the fragmentation of the compounds with high energetic level and with relative structural instability. The absorption peaks that are slightly differentiated can represent the meaning of some scissions of the vegetal matrix in fragments with close sizes and similar energetic levels. The substrate processing finalized with the obtaining of compounds with suitable solubility, which can ease a good utilization by the radicular system of the plants in the case of the use of the composted substrates, at the mentioned parameters. The ratio between the solid organic biomass and the compounds that are fragmented by the fractionalized solubilization is at least 3:1.

As it is presented in the literature, the spectral evaluations of the fractions that are easy extractable from the compost biomass, appreciated at different composting time intervals for similar substrates, can make a useful database as indicators for a chemometric programmed software.

Conclusions

The technological reevaluation of the classical processes and their improvement implies: the appreciation of the optimum conversion intervals of the biopolymeric structures, performing analytical methods and solutions, the obtaining of natural fertilizing substrates with an increased water retaining capacity and ion exchange properties, with a high permeability level which is adequate to different soils and cultures, a high potential regarding protecting and energizing compounds and performing microorganisms.

These biotechnologies correspond with the research directions regarding the evaluation and the exploitation of the natural resources to increase the safety and the security of food and agricultural production and to diminish the quantity of wastes resulted from the natural biostructures.

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