Preparing of compost by using different types of substrates

Dimitar YAKIMOV [1], Mariana IVANOVA [1], Svetla DIMITROVA [1], Elena NIKOLOVA [1], Teodora ILIEVA [1], Lyubomir LALEV [2]
[1] *University of Agribusiness and Rural Development-Plovdiv, Bulgaria*
[2] *"Goton" Ltd., Bulgaria*
email: dimit.yakimov@gmail.com

ABSTRACT

The using of organic fertilizers is essential, which do not pollute the environment and also contribute for a more delicious and healthier food and sustainable yields in a distant period of time. On the planet billions of tons of organic waste are created every year which contain all the necessary elements and compounds: proteins, vitamins, salts, active biological substances etc. By applying new techniques in the composting we have achieved to obtain a quality product in its entire volume, and to preserve as well the activity of the red Californian worm /RCW/ for a maximum long period of time. By applying a specific proportion in the mixture of sediments from wastewater treatment plants and straw, and by adding technologically activated mineral rocks, we have achieved to obtain a compost having the specific organoleptic characteristics and to reduce in full the unpleasant smells.

Key words: *environmental protection, sustainable agriculture, compost, wastewater treatment plants*

INTRODUCTION

Agroecological technologies to be well applicable into practice, requires technological innovation, changes in agricultural policy, socio-economic changes, but mostly a deeper understanding of its complex interactions between permanent resources, people and their environment. Environmental protection is another major result, which reflects not only on the quality of the final production of agricultural crops, but also on the stability of agroecosystems and soil fertility. The use of organic fertilizers is essential, which do not pollute the environment and also contribute for a more delicious and healthier food and sustainable yields in a distant period of time [1]. Most studies show, that in the first year of conversion to organic farming, the yields of conventionally grown vegetables are higher than those grown organically [2], but in subsequent years the reported yields, for example of tomatoes, there are no statistical differences between the two farming systems [3]. In recent years, fertilizes have established themselves as a promising component of an integrated system for a procurement of food in agriculture [4].

On the planet billions of tons of organic waste are created every year which contain all the necessary elements and compounds: proteins, vitamins, salts, active biological substances etc. They contain as well a considerable amount of energy [5.6]. In the course of the last two or three decades of the 20th century in several countries of the world there has been conducted a commercial exploitation which deals with the red Californian worm (*Lubrocum rubellis*) and the tiger worm (*Perionus escavatus*) [7].

The aim of the present study is optimizing the technological actions into preparing compost from red Californian worm /RCW/ and composting the sludge from wastewater treatment plants of municipal waste.

1. Optimizing the technological actions into preparing compost from RCW

The private farm for compost from the RCW at Berievo village, municipality of Sevlievo /firms "Biohum" Ltd. and "Goton" Ltd./, partner in different venues of UARD (University of Agribusiness and Rural Development), has been successfully expanded. From the previous 200 square meters occupied in 2011, the farm is presently increased to 10 da and it is the biggest farm of its kind on the territory of Bulgaria. The RCW which are in use, are imported from Italy due to their selection for fast reproduction. The increasing of the surface of the industrial installations has been carried out in accordance with the Measure 112 for stimulation of young farmers (up to age 40). Meanwhile, a number of application documents have been sent to other programs projects in similar venues, which comes along with the help provided by the Italian scientific and developmental base, consisting in counseling and financing. Evenmore, the plan for the further development of the farm includes packaging workshop and scientific laboratory.

The process of producing the compost has been optimized in order to obtain a homoform production in the volume of the entire substrate, equally rich on humus compost, and, as well, to maintain the best possible physiological conditions for the development of the worms. For the present moment there has been essentially used a manure of unchangeable bedding which contains semidegradable straw in proportion 6:1 in favor of the manure.

After no more than 3 months time, the beddings are divided in two. During that period the worms had engendared a new litter and their population had been doubled. In respect of the largely used by now practice which consists in covering the new bed, where the worms are to be moved, with a 5 cm thick bedding of manure, in the farm of the village of Berievo a new method has been put in place. It significantly improves the complete and homogenic assimilation of the manure by the worms in the bottom part of the substrate.

During the initially adopted practice of the standard method of covering the beds with 5 cm lightly putrid manure it had been seen that in the most of the cases that layer hadn't been well assimilated and the resulting compost was of inferior quality. The reason for this was that the worms tryed to move upwords where there is a better aeration. We have experimented the version of placing the top layer of worms of the old bed directly in the bottom of the new one as a bedding. We have come to a conclusion that the substrate is assimilated in its entire volume which results into preparing a standard compost.

According to the described methods for winterizing of the worms, over the compost is placed a 20 to 40 cm tick layer of manure for food, on top of which is placed a layer of fresh manure of the same type. This procedure is repeted every 10 to 15 days. After placing the fresh manure follows a layer of 10 to 20 cm of straw or 10 cm of dry leaves [8]. However, as a result of the thick layer of the new manure and the fact that the straw is getting packed under the snow, the access of oxygen decreases as the carbon dyoxide, ammonium and other nocive gases are accumulated, which may lead to their encrease and the reach of their toxic levels which may end in destroying the worms. We have adoperated an alternative method consisting in covering the already devided 20 cm thick ground with a layer of 30 cm lightly putrifyed manure. In this way a good aeration takes place, and in the same time, as a result of the ongoing process of fermentation, the lightly putrid manure keeps the temperature slightly higher.

There are data [9] which demonstrate that while longer, the composting periods augment the possibility of creating a considerable quantities of humic acids as well as fulvoacids. On one hand the latter are newly synthesized but on the other hand they are also a product of the previously created humic acids, consequently transformed. According to these data, we let the substrate remain in the beds with RCW for approximately 2 years. Very likely this is the main reason why the compost obtained by us is high in organic matter, under the form of humic acids. Table 1 shows the results of the chemical analysis done by us for the purposes of its application in customers domain. The analysis is performed in the accredited Laboratory Complex for testing at the Agrarian University at Plovdiv. The numbers are given without the standart deviations on the basis of repeting the tests as we fully trust the Laboratory results on the ground of its proven reliability and precision in applying the quality norms.

Table 1. Quantity of analysed substances and mineral elements in the obtain compost by red Californian worms

Index	Unity of measure	Standards/validated methods	Result	Norm
pH	-	БДС EN 13037:12	7,23	-
Dry matter	%	БДС EN 13040 :07	88,55	-
Organic compounds	%	БДС EN 13039:12	52,53	-
Total nitrogen	mg/g	БДС EN 13654/1:04	42,8	-
Phosphorus	mg/kg	БДС EN 13650:03	1349	-
Potassium	mg/kg	БДС EN 13650:03	9797	-
Natrium	mg/kg	БДС EN 13650:03	1822	-
Calcium	mg/kg	БДС EN 13650:03	11554	-
Magnesium	mg/kg	БДС EN 13650:03	6350	-
Copper	mg/kg	БДС EN 13650:03	51,31	70
Zinc	mg/kg	БДС EN 13650:03	193,14	200
Manganese	mg/kg	БДС EN 13650:03	512,3	-
Iron	mg/kg	БДС EN 13650:03	20,69	45
Cadmium	mg/kg	БДС EN 13650:03	< 0,5	0,7
Chromium	mg/kg	БДС EN 13650:03	12,33	70

2. Composting the sludge from wastewater treatment plants of municipal waste.

Apart the treatment of the barn manure, we have investigated the possibility of finding new substrates for obtaining compost from RCW. The European legislation stimulates the no-waste biotechnologies aiming the useful treatment of the organic waste and in particular the use of the sediments created by the modern wastewater treatment plants of municipal waste: “The sediments of wastewater treatment plants is to be treated as useful no-waste, according TC COM 2007/59 of the Commission of European Matters, p.3.3 and the Appendix 1, applicable in regard of the nutritive components/feed mixtures for a specific biological species, in particular, the RCW (*Lumbricus rubellus*) and the possibility of being used on grounds registred according the Law of animal raising, specifically the Law for the veterinarian and medical activities” [10].

We have developed the existing methodologies in such a way that the only common part is the usage of RCW for composting the substrate. Our proposition is a new technology that may

become an integrated part of the wastewater plants structure. It is understood that the wastewater plants should be furnished with modern biotechnological methods for treatment of the waste in such a way that combined with our technology may shorten the technological time of some of the previous standart stages of the wastewater station. The investigation process has been conducted within the wastewater plant for municipal waste of the town of Sevlievo, while the substratus was collocated in the beds with RCW in the village of Berievo. One mandatory condition is that the substratus is free of heavy metals. We have demanded that a protocol of chemical analysis should be issued stating that there weren't any heavy metals above the acceptable levels. The protocol of the contents analysis testifies that in the obtained sludge there isn't any above normal quantity of heavy metals.

Our experiment was not only conducted by using RCW but also by adding zeolite to the subtrate as well as the German bioproduct "Bioaktiv". Both products are of natural origine. "Bioaktiv" will be largely mentionned in the further chapters as it has been used in different investigations pointing to its diverse ways of application, in one case as its variety as modified creda ($CaCO_3$), and in the other as modified epsomit /$MgSO_4$ x 7 H_2O/. These two natural minerals are modified with a patented technology, so that when the minerals are immersed in water or in feed mixtures, they contribute to release of active oxygen [11]. The zeolite in use is activated by drying without thermal treatment. The zeolite [12,13,14] as well as the "Bioaktiv" [15] have the distinguished capacity for adsorbing noxious gases such ammonium, carbon dyoxide, hydrogen sulfide, methane, which are released throughout the fermentation process. The so mentionned gases (with the exception of carbonate dyoxide) not only suppress the growing and the development of the plants but are also greenhouse gases. By the input of the Bioaktiv the active oxygen helps the further decompose of the organic matter stimulating as well the development of some types of microorganisms, for instance such as species *Bacillus* [15]. The development of microorganisms, low order and undefined fungi, and actinomycetes, adds in great measure to the acceleration of the composting through the engendered by them hydrolytic exoenzymes, decomposing different types of organic polymers [16,17,18,19].

The experiment has been conducted in two variants. One consists of a mixture of sediments, activated zeolite and Bioaktiv, the other is the same mixture with the supplement of straw in proportion 6:1 in favor of the mixture with the sediments, which is analogical to the rest of the unchangeable bedding, collected in the barn during the previous composting. We have come to the conclusion that: in the first applied mixure the worms grow considerably, but their vital and multiplying activities decrease with time. In the second variant the worms develop and multiply in the same pace as those raised in the barn manure. The quality characteristics of the obtained compost are defined organoleptically, as well through the change in pH of the ground to light alkaline reaction. It was found that it needed less time for the compost to change into the characterial for the compost color, i.e. dark gray-brown, and for the clearing of the smell of the initially emited gases. It is a question of future research to establish the chemical ingredients of the obtained compost, from the sludge of the wastewater plants and from the biological tests.

CONCLUSION

The use of organic fertilizers is essential, which do not pollute the environment and also contribute for a more delicious and healthier food and sustainable yields in a distant period of time. By applying new techniques in the composting we have achieved to obtain a quality product in its entire volume, and to preserve as well the activity of the RCW for a maximum long period of time. By applying a specific proportion in the mixture of sediments from wastewater treatment plants and

straw, and by adding technologically activated mineral rocks, we have achieved to obtain a compost having the specific organoleptic characteristics and to reduce in full the unpleasant smells.

REFERENCES

1. Иванова, М., Т. Илиева, Д. Якимов (2013). *Биологично земеделие*, Изд. "Център за евроинтеграция и култура към ВУАРР – Пловдив", 167 стр.
2. Gregori M., Prestamburgo M. (1996). *Produzioni biologiche e adattamenti d'impresa*. F. Angeli,Milano, 234 p.
3. Steffen K.L., Dann M.S., Harper J.K., Fleischer S.J., Mkhize S.S., Grenoble D.W., MacNab A.A., Fager K., Russo J.M. (1995). Evaluation of the initial season for implementation of four tomato production systems. *J. Amer. Soc. Hort. Sci.* 120 (2): 148-156.
4. Shehata M.M., S. A. El-Khawas (2003). Effect of two biofertilizers on growth parameters, yield characters, nitrogenous components, nucleic acids content, minerals, oil content, protein profiles and DNA Banding Pattern of Sunflower *(Helianthus annus L. cv. Vedock*) Yield, *Pakistan Journal of Biological Sciences* 6 (14): 1257-1268
5. Flaig W. (1978). Contributions of soil organic matter in the system soil-plant. *Environ. Biogeochem. and Geomicrobiol./ Proc. 3rd Int. Symp., Wolfenbuttel*. Vol. 2.- Ann. Arbor. Mich. (1978).- pp. 419-435
6. Cook, B.D., Halbach,T.R., Rosen, C.J., Moncrief, J.R. (1994). Effect of a waste stream component on the agronomic properties of municipal solid waste compost. *Compost Sci Util.* 2(2), pp. 75
7. Нанкова, М., А. Иванова, Е. Пенчев (2004). Хактеристика на течен К-хумат ломрикомпост и възможности за използването му през вегетацията на *T. aestivum L. Изследвания върху полски култури*, Т. I–2, с. 292-293
8. http://red-californian-worms.blogspot.com/2012/10/blog-post_9027.html
9. Попов, А. (2004). *Хуминовые вещества – строение, свойства, образование*. Санкт-Петербург, изд. СПбГУ, с. 147-159
10. *Тълкувателно съобщение относно отпадъците и страничните продукти* (Брюксел, 21.2.2007 COM (2007) 59 окончателен) на КОМИСИЯ НА ЕВРОПЕЙСКИТЕ ОБЩНОСТИ
11. Люпке, В. Г. и кол. (2010). Прилагане на препарата Bioaktiv – алтернатива за опазване на околната среда и ефикасно средство за борба срещу климатичните промени. *Сб. доклади „Условие за устойчиво развитие на селските райони" от научно-практическа конференция на ВУЗК (12-14 ноември 2009).* В. Търново. с. 148-155
12. Wen, D., Yuh-Shan Ho, X. Tang (2006). Comparative sorption kinetic studies of ammonium onto zeolite. *Journal of Hazardous Materials* B133, pp. 252–256
13. Gh. Rafiee, Che Roos Saad (2006). The Effect of Natural Zeolite (Clinoptiolite) on Aquaponic Production of Red Tilapia (*Oreochromis* sp.) and Lettuce (*Lactuca sativa* var. *longifolia),* and Improvement of Water Quality. *J. Agric. Sci. Technol*. Vol. 8, pp. 313-322
14. Moussavi et al. (2011). The investigation of mechanism, kinetic and isotherm of ammonia and humic acid co-adsorbtion onto natural zeolite. *Chemical Engineering Journal* 171, 1159-1169
15. Люпке и кол., Фуражната добавка "Биоактив Пулвер" - гаранция за оптимално органично земеделие. *Ново знание*, год.2, бр.1, 194-196
16. GÜRAY, M. (2009). Partial purification and characterization of polyphenol oxidase from thermophilic *Bacillus* sp. *Publ. by İzmir Institute of Technology*, Izmir, pp. 4-11

17. GENÇKAL, H. (2004). Studies on Alkaline Protease Production from *Bacillus* sp. *Publ. by İzmir Institute of Technology*, Izmir, pp. 4-14
18. Gupta, R., Q.K. Beg · P. Lorenz (2002). Bacterial alkaline proteases: molecular approaches and industrial applications. Appl. Microbiol Biotechnol №59, pp. 15 – 32
19. Goshev, A. Gousterova, E. Vasileva-Tonkova, P. Nedkov (2005). Characterization of the enzyme complexes produced by two newly isolated thermophylic actinomycete strains during growth on collagen-rich materials. *Process Biochemistry*, Vol. 40, Issue 5, pp. 1627-1631
20. Yin, Li-Jung, Hsin-Hung Lin and Zheng-Rong Xiao (2010). Purification and characterization of a cellulase from *Bacillus subtilis* YJ1. *Journal of Marine Science and Technology*, Vol. 18, No. 3, pp. 466-471
21. Антонов, А. (2007). Обзор на възможностите и класификацията на съществуващите технологии за компостиране на биоразградими отпадъци. *Сб. „Годищник на Техничеки университет – Варна, 2007 г.”,* стр. 352-360