Vermicomposting of sewage sludge

Marta BOŻYM* – Faculty of Mechanical Engineering, Opole University of Technology, Opole, Poland

Please cite as: CHEMIK 2016, **70**, 10, 616–619

Introduction

The term "vermicomposting" or "vermiculture" refers to the use of earthworms for composting organic matter from sewage sludge and the latest biotechnology which helps in giving biofertilizers in the term of "vermicompost". In the first half of the twentieth century the vermicomposting process of agricultural waste were started the Americans. In Poland, vermicompost manure produced since 1980. Since the 90s of the twentieth century vermicomposting apply to the treatment of sewage sludge. A pioneer in this field was a sewage treatment plant in Pyrzyce, which began producing vermicompost for agricultural purposes [1]. Vermicomposting process is conducted in special stations using *Eisenia fetida* earthworms species. Vermicomposting of sewage sludge is carried out in several stages. Sewage sludge is applied in thin layers alternating with green waste (straw, hay). So it is not necessary to discharge composting mass to aeration. The most important during vermiculture is suitably selected fodder composition, constant moisture and regular feeding earthworms. Vermicomposting usually carried out from April to October. Vermicompost from sewage sludge quality depends on the substrate composition, contamination content and treatments [2–3]. Earthworms build corridors and thus it is possible aerating composting mass, otherwise it is crushed and mixed organic matter, which increases the rate of sewage sludge mineralization. The effect of vermicomposting of sewage sludge is to improve their structure, reducing odors, dehydration, weight reduction, increases the content of available forms of macronutrients [2–5]. Whereas a side effect is to reduce the content of organic carbon and nitrogen and to increase the content of heavy metals [1, 6–7]. Vermicomposting sludge can be used as fertilizer and for the remediation of degraded soils [1, 6–8].

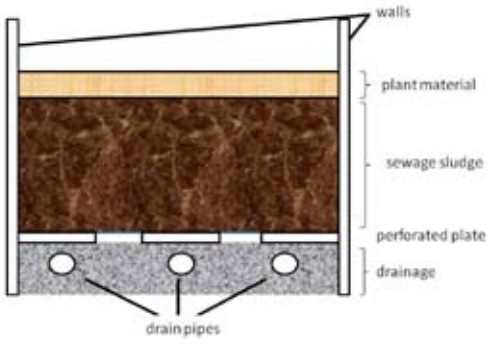
Conditions of vermicomposting process

Production of vermicompost requires optimal conditions for the survival and development of earthworms. The optimum conditions for earthworms are parameters such as pH, C/N ratio, temperature and humidity, and the substrate. For the development of earthworms substrate should be mixed with a structural material, which is straw, leaves, waste and sawdust. The main factor of the vermiculture is a high proportion of organic matter. The pH of the substrate should be in the range 6–8. The pH can be adjusted by adding alkaline products such as chalk, limestone or acidic such as peat or leaves of conifers. Similarly one can affect the C/N ratio by increasing the carbon content by the addition of cellulose-containing material: cardboard or straw. The earthworms optimal C/N ratio is 25/1, and most preferred grinding medium is 25 mm. An important factor for the activity of earthworms is also humidity. It is recommended that the share of water in the substrate was 70–80%. This is due to a specific diet of earthworms, which draw nourishment in the form of semi-liquid. The water content should be regular monitored. Sludge should be free from ammonia. Very high concentration of NH_3, greater than 0.5 mg/g of substrate, is toxic to earthworms, causing losses in their population. The optimum temperature for earthworms ranges from 12 to 28°C. When the temperature is lower than 10°C or above 25°C, this reduces the reproduction of earthworms. Resistance earthworms to low temperatures depends on the season. In the summer, when temperatures could be below 0°C earthworms died, but in the winter they can survive in the frozen soil. Therefore, before winter, vermiculture must be covered with an additional layer: manure, straw and leaves, which contributes to protection against low temperatures [8].

*Corresponding author:
Marta BOŻYM – Ph.D., (Eng.), e-mail: m.bozym@po.opole.pl

Technical aspects of vermicomposting process of sewage sludge

Vermiculture are carried out in a properly prepared stations, fenced with boards or concrete elements. The side walls of stations must strictly attached, as well as the bottom. Therefore the vermiculture is separated from the environment, including natural predators such as mole. The station of vermiculture should consist of a layer of drainage, pipes which collecting leachate and openwork concrete slabs, allowing leachate (Pic. 1).



Picture 1. The scheme of the vermicomposting of sewage sludge station

Vermicompost production takes place in several stages. The precipitate is distributed in thin layers alternating with green waste (straw or hay). Consequently, there is no need to flip through the compost mass, which is a routine during normal composting process in piles. The most important treatment is water spray of vermiculture and regular feeding earthworms. The water content in the sludge must be controlled. A large hydration during rains, can cause decay and death of the earthworms population. Therefore, it is important to well-functioning drainage below the vermiculture. In the dry or most hydrated substrates the reproduction is decrease. The rains determine the hydration of the substrate in nature. While excessive rainfall is recommended to install roof. While the natural evaporation can be reduced and easier to control when vermiculture are located in shaded place and sheltered from the wind, or by constructing a protective shield. Near to vermiculture station should be a source of water. Another factor influencing the life of earthworms is the temperature of the substrate. For this reason, the vermiculture should not be built in open areas with strong sunlight. During the vegetation season the correct temperature of the vermiculture can be adjusted only by shading and proper irrigation. After the process, earthworms can be easily separated from the vermicompost using physical or chemical methods. Then earthworms are moved to the

new vermicultures station. It is possible to use for this purpose one part of individuals. The remaining amount of earthworms can be used for other purposes, such as animal feed [8].

Advantages and disadvantages of the process

The advantages of the sewage sludge vermicompost production should be: reduction of volume, homogenization and stabilization of the composition, reduce odors, improve the structure, the development of compost microorganisms or the increase the available forms of macronutrients. Disadvantages of the process are: a large area is needed, work consumption and regular process control, reduced content of organic matter and nitrogen, incomplete hygienisation effect and accumulation of heavy metals in vermicompost by reducing the volume of the substrate.

The use of vermicompost from sewage sludge

The quality of vermicompost depends on the composition of substrate, pollutant content or performed treatments. Vermicomposting process of sewage sludge causes organic matter mineralization, which reduces its content and nitrogen concentration [8]. Vermicomposted sewage sludge can be used as fertilizers. However, vermicompost characterized a lower content of certain trace elements, for example potassium, as compared to the other organic fertilizers. Therefore, it is recommended that a common soil fertilization: vermicompost and mineral fertilizers, in order to supplement nutrient deficiencies. Earthworms affect not only the chemical composition and physical properties of the treated sludge. Earthworms change the microbial composition of vermicomposts and produce specific enzymes. For this reason vermicomposted sludge could be used for the reclamation of degraded soils. However, in the literature there are reported that negative impact of vermicomposts on germination and seedling growth of some plants [8]. It is thus clear that, prior to applying vermicompost or other organic fertilizers, must first investigate their effect on plants, in order to avoid yield losses.

Conclusions

Vermicomposting of sewage sludge is mainly suitable for wastewater treatment plants in rural or non-industrialised small town. The process is time- and work-consuming and requires regular monitoring of environmental conditions. The result of the process is to improve the structure and fertilizer valueof sewage sludge. Reported in the literature that vermicompost not always could be used for the cultivation of vegetables, because of the possibility of reduced yields. It is recommended to use vermicomposts common with mineral fertilizers for the supplementation of missing ingredients. In the case of the correct process of vermicomposting, by the use of restrictive earthworms requirements, the end result is the production of valuable fertilizer.

Literature

1. Bożym M.: *Kumulacja metali ciężkich przez dżdżownice w wermikompostowanych osadach ściekowych*, Chemik, 68(10), 2014, 868–873.
2. Kostecka J.: *Kompostowanie z udziałem dżdżownic – nowe możliwości*, Materiały I Konferencji Naukowo Technicznej „Kompostowanie i użytkowanie kompostu, Puławy-Warszawa, 16–18.06.1999, 125–131.
3. Kostecka J.: *Uzdatnianie osadów ściekowych w wermikulturze*, Materiały II Konferencji Naukowo Technicznej „Przyrodnicze użytkowanie osadów ściekowych", Puławy-Lublin-Jeziórko 26–28.05.1997, 171–176.
4. Patorczyk-Pytlik B., Spiak Z., Rabikowska B.: *Ocena wartości nawozowej obornika i osadu ściekowego przetworzonego przez dżdżownice w drugim roku po zastosowaniu*, Zeszyty Naukowe Postępów Nauk Rolniczych, 409, 1993, 143–150.
5. Zabłocki Z., Kiepas-Kokot A.: *Zmiany niektórych właściwości chemicznych komunalnych osadów ściekowych w procesach: kompostowania i wermikompostowania*, Zeszyty Naukowe AR w Krakowie, 58, 1998, 101–108.
6. Bożym M.: *Zmiany parametrów fizykochemicznych osadu ściekowego w czasie wermikompostowania*, Zeszyty Problemowe Postępów Nauk Rolniczych, 498, 2004, 33–39.
7. Bożym M.: *Wpływ metali ciężkich na życie dżdżownic*, Biuletyn Naukowy, 25(1), 2005, 201–210.
8. Bożym M.: *Biologiczne przetwarzanie biodegradowalnej frakcji odpadów komunalnych i osadów ściekowych w wermikulturze,* Prace Instytutu Ceramiki i Materiałów Budowlanych, 10, 2012, 335–369.

Marta BOŻYM – Ph.D., (Eng.), completed a Masters degree in chemistry, is a graduate of the Faculty of Mathematics, Physics and Chemistry, University of Opole (1998). Additionally, in 2005, graduated from engineering, majoring in environmental engineering, is a graduate of the Faculty of Mechanical Engineering Opole University of Technology Ph.D. obtained at the Wrocław University of Environmental and Life Sciences (2006). Currently, works at the Faculty of Mechanical Engineering at Opole University of Technology. Research interests: migration of heavy metals in the environment, development of municipal and industrial waste, the use of sewage sludge. The author of over 50 scientific articles and authored or co-authored over 50 papers and posters at national and international conferences.

e-mail: m.bozym@po.opole.pl, phone: +48 77 449 8381

Aktualności z firm

News from the Companies

Dokończenie ze strony 617

Konkurs „30 laboratoriów na 30-lecie Adamedu" rozstrzygnięty

Nauka wcale nie jest nudna, a naukowe zagadnienia można przedstawić w kreatywny i nieszablonowy sposób. Udowodnił to zorganizowany przez Grupę Adamed konkurs „30 laboratoriów na 30-lecie Adamedu", w którym uczniowie z całej Polski rywalizowali o nowoczesne wyposażenie szkolnych pracowni laboratoryjnych. Ogromne zaangażowanie młodych ludzi oraz bardzo duża liczba zgłoszeń pokazują, że polska młodzież chce i potrafi uczyć się nowocześnie. Do wygrania było wyposażenie 30 szkolnych pracowni badawczych – każde warte około 10 tys. PLN. Aby zwyciężyć, uczniowie musieli opracować scenariusz lekcji i na jego podstawie nagrać maksymalnie 3-minutowe wideo na jeden z zadanych tematów: „Chemia w kuchni i jedzeniu", „Co by były gdyby?" (o roli mikroorganizmów w świecie), „Z czego składa się Wszechświat?", „Jak komórka przetwarza energię z pożywienia". Listę nagrodzonych szkół można sprawdzić w internecie pod adresem http://adamed.com.pl/pl/30lecie/konkurs. Tam również znajdują się linki do nadesłanych w konkursie filmów. *(kk)*

(*http://adamed.com.pl/, 30.09.2016*)

Hanplast liderem DIAMENTÓW FORBESa w województwie kujawsko-pomorskim

Po raz kolejny zostały przyznane Diamenty Forbesa, dla firm które w ostatnich trzech latach najdynamiczniej zwiększały swoją wartość. Firma Hanplast zajęła I miejsce na liście regionalnej firm z przychodami powyżej 250 mln PLN, w rankingu w województwie kujawsko-pomorskim. Na liście ogólnopolskiej plasuje się na pozycji 53, a więc jest w setce najbardziej dynamicznie rozwijających się firm w Polsce. *(kk)*

(http://www.hanplast.com/, 2.09.2016)

Dokończenie na stronie 622