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INFLUENCE OF CHOSEN INSECTICIDES ON THE CHARACTERISTICS OF VERMICOMPOST PRODUCED FROM KITCHEN WASTE

WPŁYW WYBRANYCH INSEKTYCYDÓW NA CECHY WERMIKOMPOSTÓW WYPRODUKOWANYCH Z ODPADÓW KUCHENNYCH

Abstract: The research concerned the possibility of vermicomposting organic wastes separated from kitchen residues. Vermicomposting was conducted with the presence of the earthworm *Eisenia fetida* (Sav.) in ecological boxes. The occurrence of a dipteran *(Sciaridae)* was reduced by the application of anti-dipteran preparations into the substrate (in environmentally safe doses recommended by the producers). The insecticides Nomolt 150S.C, Dimilin 25WP and Dar 2.5GR were used. The aim of the research was to determine the influence of these preparations on the rate of vermicomposting and on the characteristics of the vermicomposts produced by *E. fetida.* Over a period of 6 months, it was shown that a Dar 2.5GR preparation had the largest impact on the daily rate of vermicomposting. The vermicomposts produced with the addition of insecticides did not differ in content of nutritional elements for plants (nitrogen N-NO_3, calcium, assimilable phosphorus, potassium and magnesium) in comparison with the control vermicomposts. The qualities of the produced vermicomposts were as follows: pH in H_2O 5.9-6.2; salt concentration: min 4.7 - max 5.4 g NaCl · dm^{-3}, nitrogen N-NO_3 min 808 - max 902; phosphorus P min 344 - max 372; potassium K min 1185 - max 1424; magnesium Mg min 279 - max 335 mg · dm^{-3}; calcium Ca min 1940 - max 2381 mg · dm^{-3}.

Keywords: ecological boxes, *Eisenia fetida*, *Sciaridae,* insecticide, vermicompost

At present, many factors have an influence on the quality of the natural environment, with excessive contamination of xenobiotics as decisive factor in disturbing homeostasis and leading to deteriorating quality of crops [1]. Poorly utilized wastes, including organics, can also pose a threat. As a consequence, finding pro-environmental solutions to this problem is a matter of urgency [2]. One of the solutions might be to vermicompost the organic wastes (*eg* household wastes) in ecological boxes at the site, where they are produced. Such actions can ensure the utilization of segregated organic wastes and can also facilitate the production of vermicompost - a coprolithic fertilizer, rich in nutritional elements for plants [3-6].

Vermicomposting on a small scale in ecological boxes has some disadvantages such as the troublesome presence of dipterous insects, which compete with earthworms for food (the wastes). In order to eliminate this inconvenience, insecticides can be added to the wastes.

In this research, the ecological boxes contained anti-dipteran insecticides - phosphorganic Dar 2.5GR and two inhibitors of chitin biosynthesis, Dimilin 25WP and Nomolt150SC, in environmentally safe doses recommended by the producers. The influence of these insecticides on the daily rate of vermicomposting and on the characteristics of vermicomposts produced was examined in laboratory conditions.

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Materials and methods

The research was conducted in a climate chamber (in containers of size $21 \cdot 15 \cdot 10$ cm^3), in which constant humidity was maintained (approx. 70%), according to the norm [7], and the ambient temperature was 20ºC. The stratification layer was substrates with the volume of 2 dm^3 and with characteristics shown in Table 1.

The following waste materials were vermicomposted: in each case 150 cm^3 of cooked pasta, bread, apple and potato peelings (600 cm^3 of waste in total), mixed with 300 cm^3 of shredded cellulose, added to improve the conditions of vermicomposting (shredded egg boxes) [3]. In order to check the possibility of utilization of insecticides which limit the occurrence of dipterous insects (*Sciaridae)* in the ecological box, the following preparations were added to the vermicomposted mass: Dimilin 25WP (dose of 4 g · m^{-2}, active substance diflubenzuron), Nomolt 150SC (dose of 5 cm^3 · m^{-2}, active substance teflubenzuron), and Dar 2.5GR (dose 400 g · m^{-2}, active substance chlorfenvinfos).

Table 1

Plan of kitchen wastes vermicomposting

Containers	Insecticide*	Stratification layer	Vermicomposted waste	Earthworms
1-5	Control	In each case 2 dm^3 of universal medium for ornamental plants**	In each case 600 cm^3 of kitchen organic waste*** and 300 cm^3 of cellulose into each container	In each case 50 sexually mature specimens of *E. fetida* with a balanced total biomass (20.3 ± 0.6 g) into each container
6-10	Dimilin 25WP			
11-15	Nomolt 150SC			
16-20	Dar 2.5GR			

*in doses advised by the producer; **universal medium for ornamental plants Floro-hum: highmoor peat, lowmoor peat, pearlite, sand, microelements, mineral fertilizer NPK (pH in H_2O - 6.2; salinity - 0.5 mg · dm^{-3}; N-NO_3 - 18 mg · dm^{-3}; P - 63 mg · dm^{-3}; K - 186 mg · dm^{-3}; Mg - 141 mg · dm^{-3}; Ca - 1027 mg · dm^{-3}; ***in each case 150 cm^3 of cooked pasta and bread leftovers, apple and potato peelings mixed with cellulose in the ratio of 2:1

The average rate of vermicomposting the above-mentioned organic wastes was calculated thanks to their isolation from the stratification layer and then from the produced vermicompost, by placing them inside a large-holed nylon mesh (which simultaneously facilitated free access of the earthworms). The rate of waste processing into vermicompost was determined regularly (during inspection of the earthworm population in the control and treatment containers), by multiple comparison of the volume of the unprocessed wastes. The results obtained were compared with the volume of the leftovers processed into vermicompost according to the following formula:

$$a_t = 900 - b_t$$

where: a_t - the volume of processed leftovers in subsequent examinations b_t - the volume of subsequently determined leftovers (not processed by earthworms).

The characteristics of produced vermicomposts were determined in a dynamic system (three times). The content (N-NO_3, P, K and Mg and Ca) was determined in the extract of 0.03 moles of acetic acid CH_3COOH by means of the following methods: the content of nitrogen N-NO_3 potentiometrically with an ionometer and ion-selective electrode, phosphorus with the vanadium-molybdenum method, the content of potassium and calcium was determined by using a flame photometer and magnesium was checked with a spectrometer by means of atomic absorption (in mg · dm^{-3}). pH in water was determined potentiometrically and the concentration of salt conductometrically (in g NaCl dm^{-3}).

The results (presented as mean ± standard deviation, $n = 6$), were analysed by means of the spread sheet Excel. The calculated averages were compared by means of the variance method using the Tukey's t-test (the program Statistica PL was used).

Results and discussion

The research demonstrates the efficiency of vermicomposting of chosen kitchen leftovers on site where the waste is produced - in earthworm ecological boxes [6]. In the present research, special attention is paid to the influence of xenobiotics on the process of the monthly rate of vermicomposting. It transpired that only in the case of the acyl urea preparation - Dimilin 25WP - the efficient removal (from the substrate) of larvae of *Sciaridae* competing with earthworms for food (organic waste) affected the increase in the rate of processing waste into vermicompost (Table 2).

In contact with xenobiotics Dar 2.5GR and Nomolt 150SC, the rate of vermicomposting reduced. The lower rate of vermicomposting, in comparison with the control, was determined in the presence of Dar 2.5GR (significantly to control and Dimilin 25WP) and Nomolt 150SC (non-significantly).

Table 2

The influence of the tested preparations on the rate of vermicomposting of selected organic wastes [cm^3/day/ 1 dm^3 of vermiculture]

Tested preparation	**Control**	**Dimilin 25WP**	**Nomolt 150SC**	**Dar 2.5GR**
The volume of processed wastes	6.8±2	7.0±2	6.0±2	4.5±2
The volume in relation to the control [%]		102	88	66
p level				
Control		.999688	.863869	**.000336**
Dimilin 25WP	.999688		.859634	**.003370**
Nomolt 150 SC	.863869	.859634		.153583
Dar 2.5GR	**.000336**	**.003370**	.153583	

The daily rate of vermicomposting in control containers achieved in the experiment is in accordance with the data given by Sinha and others [8]. The vermicompost had a granular structure - with no remaining unprocessed wastes. Conducted under laboratory conditions, the vermicomposting proceeded smoothly, without emitting unpleasant smells (odourless). The range of pH values in the produced vermicomposts was 5.9÷6.2; they were not different as far as salt concentration was concerned, although this characteristic exceeded the tolerance threshold for garden plants - (up to 3 g NaCl · dm^{-3}). The produced vermicomposts were also not different with respect to the content of plant nutritional elements (nitrogen N-NO_3, assimilable phosphorus, potassium, magnesium and calcium) (Table 3).

The content of all the nutritional elements exceeded the optimal level for plants, which, in combination with the high salinity of the vermicomposts, indicates the absolute necessity for their dilution before use (Table 4).

Table 3

Characteristics of vermicomposts (in fresh mass, at humidity of 70%)

Characteristic \ Tested preparation	Control	Dimilin 25WP	Nomolt 150SC	Dar 2.5GR
pH in H_2O	5.9÷6.2	5.9÷6.0	5.9÷6.0	5.9÷6.2
The concentration of salt [g NaCl · dm^{-3}]	5.4±1.0	4.8±0.6	4.7±1.2	5.3±0.7
N-NO_3 [mg · dm^{-3}]	880±89	815±149	808±149	902±27
P [mg · dm^{-3}]	345±66	372±51	351±99	344±106
K [mg · dm^{-3}]	1415±198	1418±390	1285±253	1424±245
Ca [mg · dm^{-3}]	2124±356	1999±248	2241±249	2281±219
Mg [mg · dm^{-3}]	279±67	309±33	305±59	335±25

Table 4

Characteristics of vermicomposts obtained during research compared with optimal levels for plants

Characteristic	pH in H_2O	Salinity NaCl [g · dm^{-3}]	Element [mg · dm^{-3} of fresh mass]				
			N-NO_3	P	K	Ca	Mg
Produced vermicomposts	5.9÷6.2	4.7÷5.4	808÷902	344÷372	1285÷1424	1999÷2281	279÷335
The optimal level for garden plants*	6.0÷7.5	about 1.0	50÷120	40÷80	125÷250	1000÷2000	60÷120

*the optimal level for garden plants according to [9]

The production of vermicompost on site has invaluable ecological and economic importance, because it allows utilization of segregated organic wastes in a sensible way. An essential aspect in managing an ecological box is the permanent monitoring and control of the abiotic and biotic conditions of this process [3]. Vermicomposting should be performed according to specified steps, otherwise it will not proceed smoothly and odourlessly. For example, if proper humidity conditions are not provided (*eg* overflow in the substrate), anaerobic conditions can occur or an unpleasant smell can be emitted as a result of putrefaction beginning. The rate of processing wastes can, consequently, be reduced. The produced vermicomposts were rich in nutritional elements for plants and had pH in water close to neutral (min 5.9; max 6.2), although lower than that established by Kostecka in the vermicomposts from kitchen wastes [3], which, on average, was in the range of 6.5÷7.5. The characteristic feature of vermicomposts produced here was the high average concentration of salt (min - 4.7; max - 5.4 g NaCl · dm^{-3}). This fact confirms the earlier results of the research performed by Kiepas-Kokot and Szczech [10] and Kostecka [3], which determined a similar regularity and even higher values of this characteristic of vermicompost.

A high salinity of the substrate is an unfavourable factor for the proper growth of plants and that is why (in addition to the high content of nutritional elements for plants in the researched vermicomposts) before using this product for fertilization, all these values should be determined and dilution should be applied (appropriately for the species of the plant) [10-14]. As a result of the necessity of the limitation of the threat of higher concentration of salt in agricultural soils, it is also possible to mix the vermicomposted household wastes with cellulose, soil, peat or sand. It is a problem of utmost importance, because Kostecka [3] established that over the period of one year of farming, the salinity of fertilizers produced from household organic wastes rose from 3.9 to 12.6 g NaCl · dm^{-3}.

The conclusion that can be drawn from the present work is that the highest salinity of the substrate was the characteristic of vermicomposts in control (5.9÷6.2) and boxes with the preparations Dar 2.5GR (5.9÷6.2), and the lowest concentration of salt was found in the ecological boxes with the preparations Nomolt 150SC and Dimilin 25WP, although no statistically significant differences were determined. The average concentration of salt in the vermicomposts was at the level of 4.7 g NaCl · dm^{-3}.

During vermicomposting, earthworms permanently loosen the organic waste (thus producing a granular structure), which facilitates the development of the root system of plants after placing the vermicompost in soils. Earthworm excrements contain mucus, which facilitates the development of soil bacteria and also contain silica, available for plants and strengthening their cell walls. According to some authors, vermicompost, to a bigger extent than compost, stimulates the population growth of microorganisms [15, 16]. These animals also influence the accumulation of vitamin B_{12} in soil. After death, the tissues of the earthworm bodies, in which protein constitutes almost 70% of dry matter, rapidly decompose and become an additional source of nitrogen, which could easily become mineralized.

Conclusions

1. Organic kitchen waste can be neutralised on site - in earthworm ecological boxes. The troublesome presence of dipteran insects while managing the boxes can be minimised by means of the examined insecticides: Dimilin 25WP, Nomolt 150SC and Dar 2.5GR.
2. Among the tested anti-dipteran preparations, it is Dar 2.5GR that significantly reduced the daily rate of waste vermicomposting.
3. Vermicomposts produced from organic kitchen waste were rich in nutritional elements for plants (nitrogen N-NO_3, assimilable phosphorus, potassium and magnesium and calcium).
4. Because the salinity of vermicomposts from kitchen waste exceeded the tolerance threshold for plants, the produced fertilizers should be diluted before applying them in agricultural soils.

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WPŁYW WYBRANYCH INSEKTYCYDÓW NA CECHY WERMIKOMPOSTÓW WYPRODUKOWANYCH Z ODPADÓW KUCHENNYCH

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Abstrakt: Badania dotyczyły wermikompostowania segregowanych kuchennych odpadów organicznych w skrzynkach ekologicznych z zastosowaniem dżdżownic *E. fetida* (Sav.). Występowanie muchówek *Sciaridae* zredukowano w nich przez aplikację do podłoży preparatów antymuchówkowych (w dawce zalecanej przez producentów). Użyto insektycydów Nomolt 150SC, Dimilin 25WP i Dar 2.5GR. Celem badań było określenie wpływu tych preparatów na tempo wermikompostowania i na cechy wyprodukowanych przez *E. fetida* wermikompostów. Przez okres 6 miesięcy prowadzenia badań wykazano, że jedynie preparat Dar 2.5GR istotnie obniżył dzienne tempo wermikompostowania. Wyprodukowane wermikomposty z dodatkiem insektycydów nie różniły się zawartością składników pokarmowych roślin (azotu $N-NO_3$, przyswajalnego fosforu, potasu i magnezu oraz wapnia) w porównaniu do wermikompostów z pojemników kontrolnych. Cechy wyprodukowanych wermikompostów kształtowały się następująco: pH w H_2O 5,9÷6,2; stężenie soli min. 4,7, max 5,4 g NaCl · dm^{-3}, azot $N-NO_3$ min. 808, max 902; fosfor P min. 344, max 372; potas K min. 1185, max 1424; magnez Mg min. 279, max 335 mg · dm^{-3}; wapń Ca min. 1940, max 2381 mg · dm^{-3}.

Słowa kluczowe: skrzynki ekologiczne, *Eisenia fetida*, *Sciaridae,* insektycydy, wermikomposty