The effect of complex composts on the growth and dynamics of the number of vermiculture *Esenia Fetida*

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**Abstract.** The article considers the complex composts role from the wastewater residues and beer pellets on the *Esenia fetida* vermiculture growth dynamics in closed ground conditions as the Yugra territory sustainable development regional aspect. The substrates used: the soil with a total humus content of 1.83 ± 0.51%, the wastewater residues, the brewer pellet, the plants, the food waste, the paper, the bird droppings, the Tamir microbiological preparation, as well as 50 immature worms, the hybrid Prospector. The experiment lasted 30 days. In each compost variant, there were 7 replicates with the MP and worms, as well as 2 controls without worms: with MP and without it. The complex composts showed a positive trend in the increase in the earthworms number and their total mass. The decrease in the substrate mass after vermicomposting using the Tamir microbiological preparation was observed in all variants. A statistically regular decrease in the substrate mass over time due to the growth of the worms was found. The optimum temperature for the worm's development is +21 degrees, and the pH values at which a high worms number were observed are in the range from 7.8 to 8.2. Thus, it is possible to use all the complex composts variants. The decomposition process and the growth of the worms positive dynamics were observed everywhere at different rates. The beer pellets use in the raw state is possible when adding 10-25% of the compostable substrate total mass with the organic components that have sorption capacity.

1. **Introduction**

The processing of the organic waste problem is one of the pressing topics in city ecology. The most beneficial and safe for human health and the environment is the recycling waste method. But this method requires a high environmental culture, modern technology, material costs, the separate waste collection organization [1-3].

The main beer industry waste is beer grains, which volume is quite large, and the development of the methods for its disposal remains relevant. The preliminary experiments on the beer pellets disposal using the earthworm culture showed that the beer pellets amount in the substrate should be less than 25% [4, 5].

The accumulated urban wastewater residues (WWS) in different Russian cities differ in their physicochemical properties, as well as in the microelement composition, which is due to the industrial enterprises' type, the ratio in the household and industrial wastes total volume, as well as technological schemes used at the cleaning and dehydration treatment plants TSCD. At the same time, the inorganic and organic reagents use for the wastewater solid and liquid phases separation leads to a decrease in both nitrogen macrocells content in WWS, phosphorus and potassium, and microelements, including heavy metals. The effective wastewater disposal technologies lack hinders its widespread use as
fertilizer. For the WWS environmentally sound use as fertilizers, it is advisable to organize their chemical, bacteriological, ecotoxicological composition comprehensive study, as well as to study the WWS effect on soil and agro phytocoenosis [6, 7].

The earthworms use for organic fertilizers production is now gaining widespread popularity. At the same time, practical problems are solved: the need for storage of WWS and beer grains is eliminated; soil fertility and crop productivity are increasing. Of the many earthworm species, the most productive and suitable for organic waste processing technologies was the compost worm *Eisenia fetida* [3, 8-12].

2. Materials and methods

During the experiment, the substrates were used: soil (250 g) with a total humus content of 1.83 ± 0.51%, WWS (100), beer pellet (100), plants (50), food waste (peel: bananas, potatoes, oranges; tea bags, coffee) (200), paper (100), bird droppings (100), the microbiological preparation Tamir (MP), as well as 50 immature worms *Eisenia fetida* Hybrid Prospector (involved 2100 individuals). The experiment lasted 30 days. In each compost variant, there were 7 replicates with MP and worms, as well as 2 controls without worms: with MP and without it.

The containers with the substrate were installed in a dark room with an air temperature of +18 - +25°C. The substrate moisture content was brought to 75-80%.

The statistical processing was carried out in the program Statistica 10.0. The relationship between the decrease in substrate mass and the increase in worm mass was determined using the Spearman correlation coefficient (r). The worms mass dependence on the substrate mass was described using the regression equation.

3. Results

In the vermicomposting organic waste process, the complex composts showed a positive trend in the increase in the earthworms number terms (2-4 times) and their total mass (4-5 times). The decrease in substrate mass after vermicomposting using MP was observed in all cases. A significant decrease, up to 3 times, was detected in option No. 6, while in the control without worms and MP, the weight reduction was 1/3.

Weak (variants 2 r = -0.14 and 3 r = -0.07) and medium (variants 1 r = -0.5, 5 r = -0.57, 6 r = -0.43) worm mass growth negative associations of in substrates were established. A regular decrease in the substrate mass over time due to the worms growth.

Figure 1 shows that in the 4th, poorest substrate, there is the smallest increase in the worm's mass and a decrease in the substrate mass. The reverse tendency was found in the 6th, the most multicomponent substrate.

The most optimal temperature for the growth and development of the worms is +21 degrees (figure 2). At a given ambient temperature, the most uniform increase in their quantity was observed at high abundance indices. The highest abundance indicators, with the highest growth variability, were detected at 20 and 23 degrees. The least favourable conditions for the worms life are in the temperature range of less than 18 and more than 25 degrees.

The substrate most favourable acidity for worms was established at pH=7.9 (figure 3). The alkaline environment formation contributed to the beer grains introduction. The optimal pH values at which a high worms number were observed are in the range from 7.8 to 8.2.

4. Conclusion

In the vermicomposting organic waste process, the complex composts showed a positive trend in the increase in the earthworms number and their total mass (4-5 times). The decrease in substrate mass after vermicomposting using the MP was observed in all cases. A statistically regular decrease in the substrate mass over time due to the growth of the worms was found. The most optimal temperature for the growth and development of the worms is +21 degrees. The optimal pH values at which a high worms number were observed are in the range from 7.8 to 8.2, which was formed by the beer pellet.
Figure 1. The worms increase in mass dependence on the substrate (compost options 1 - 6) mass.

Thus, it is possible to use all complex composts variants, since the decomposition process and the growth of the worms were observed everywhere at different speeds. The beer pellets use in the raw state is possible when adding 10-25% of the compostable substrate total mass with the organic components that have sorption capacity. The use of WWS also positively affects the growth of compost worms.
Figure 2. The substrate temperature effect on the increase in the number of worms.

Figure 3. The substrate acidity effect on the worm population growth.

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