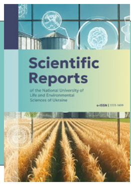
Received 04.11.2025 Revised 05.02.2026 Accepted 26.02.2026 Published: 04.03.2026

Vol. 22, No. 1
2026



Scientific Reports of the National University of Life and Environmental Sciences of Ukraine

Journal homepage: https://scireports.com.ua/en e-ISSN 2223-1609

UDC 595.38:631.86:633.11 DOI: 10.31548/dopovidi/1.2026.22

Vermiculture cultivation on a substrate containing composted wheat straw using an accelerated method

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Suggested Citation:
Mitioglo, L., Merzlov, S., Merzlova, H., Kovtun, P., & Osipenko I. (2026). Vermiculture cultivation on a substrate containing composted wheat straw using an accelerated method. *Scientific Reports of the National University of Life and Environmental Sciences of Ukraine*, 22(1), 22-35. doi: 10.31548/dopovidi/1.2026.22.

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Abstract. The relevance of the study is conditioned by the need to improve the technology of manufacturing substrates for vermiculture growing, which is important for obtaining high-quality organic fertiliser and improving the efficiency of biotechnological processes for organic waste disposal. The goal was to determine the optimal dose of fermented wheat straw as part of the substrate to increase the growth, development and reproductive capacity of vermiculture. The experiment was conducted in the vivarium of the Bila Tserkva National Agrarian University on seven groups of microbeds formed based on bovine cattle manure with varying contents of composted wheat straw. The Control Group contained cattle manure and only fresh crushed straw, and the substrate from the experimental microbeds included 2.0-6.0% fermented wheat straw. One hundred sexually mature worms were placed in each microbed. For 125 days, the number and weight of sexually mature and non-sexually mature individuals, the number and weight of their cocoons were monitored. The results were processed using variational statistics methods. The best indicators were found with the introduction of 3.0-4.0% of composted straw in the substrate. In these groups, a significant increase in the number and biomass of worms, and an increase in the number of cocoons were recorded. It was recorded that the optimal level of composted straw contributed to improving the adaptation of the population, increasing the number and weight of sexually mature worms in the experimental microbeds. Exceeding the content of composted wheat straw to 5.0-6.0% did not provide an increase in the number of worms in microbeds. This indicates the presence of an upper limit of the population's tolerance to an increase in the carbon-to-nitrogen ratio in the substrate. It was determined that the optimal dose is 3.0% composted wheat straw, which provides a statistically significant increase in the number and weight of worms compared to the Control. The use of this dose helped to maintain a biologically balanced ratio of nutrients and created conditions for effective reproduction and development of vermiculture. The results obtained can be used to develop effective methods for growing vermiculture based on composted wheat straw, which will help to improve soil fertility and increase the efficiency of organic farming

Keywords: hybrid Red California worms; worm cocoons; microbed; sexually mature individuals; fermentation

Introduction

Growing vermiculture on a substrate with composted wheat straw by the accelerated method is a promising area in the field of organic farming, which contributes to the sustainable use of natural resources and reduces the negative impact on the environment. Composting wheat straw together with other organic materials allows creating a high-quality substrate, which is an ideal environment for the growth and reproduction of worms. The use of vermiculture products not only improves the structure of the soil and increases its fertility, but also contributes to the preservation of moisture, which is especially important in the context of climate change and insufficient water resources. In addition, vermicompost is an environmentally friendly, organic fertiliser that provides plants with the necessary macro- and microelements and other essential nutrition factors that contribute to the realisation of their genetic potential.

The transition from growing vermiculture on a substrate with composted wheat straw to using it in animal feed rations opens up new opportunities for sustainable management of agricultural resources. Analysing the effect of wheat straw chopping length, the study by C.D. Havekes *et al.* (2020a) showed how the physical properties of straw can affect feed consumption and animal health, which, in turn, increases the efficiency of using organic materials in agriculture. This study adds to the understanding of how innovative straw processing techniques can be applied to improve feed quality and optimise animal nutrition. L.V. Mitiohlo *et al.* (2023) investigated the physical and chemical parameters of wheat straw fermented using a Ukrainian-made biodestructor. The results showed that fermentation of straw significantly improves its organic composition and increases its suitability for use as a feed or substrate for growing vermiculture. This confirms the effectiveness of using biotechnological approaches in the treatment of agricultural waste to improve its quality and environmental safety.

F.A.M. Tuyttens (2005), C.D. Havekes *et al.* (2020b) considered that livestock production technologies involve the use of various types of straw, in particular wheat straw, which is used as coarse feed and as bedding. In the conditions of Ukraine in recent years, there has been a decrease in the number of ruminants, which contributes to the accumulation of significant volumes of straw, which is often stored for a long time. This leads to its spoilage, microbiological contamination, and loss of nutritional value. According to Q. Sun *et al.* (2025), accumulated straw poses an environmental burden, since it releases greenhouse gases during rotting and can be a source of pathogens.

In modern environmental approaches, the development of efficient and safe technologies for its disposal is relevant. One of these solutions was the use of accelerated microbiological composting. I.S. Osipenko & S.V. Merzlov (2023) developed a method for biodegradation of spoiled wheat straw using the BTU-CENTR biological product. Under the action of microorganisms, intensive hydrolysis of the hemicellulose complex and partial destruction of lignin occurred, which significantly accelerated composting. It was found that a dose of biodestructor of 28 cm^3/t reduced the loss of nitrogen and phosphorus by 26.7% and 37.2%, respectively, which is important for reducing the negative impact on the environment. I.S. Osipenko & S.V. Merzlov paid special attention to the interaction between microbial consortia and vermiculture in combined straw processing technologies. The researcher noted that fermentation not only enriches the substrate with available nutrient compounds, but also plays the role of a "detoxification" stage: at excessive concentrations of ammonia, worms die or are suppressed, while enzymatic processes allow stabilising nitrogen compounds in a form that is safe for their development. Thus, the interaction of bacteria and vermiculture has a synergistic character: microorganisms create optimal conditions for worms, and worms, in turn, structure the substrate and form the final product with high agrochemical value.

Global studies confirm the effectiveness of pre-microbial treatment of straw. A. Sahu *et al.* (2025), who found that thermophilic lignocellulosolytic microorganisms significantly increase the composting efficiency of rice and wheat straw, providing a significant increase in the nutrient content of compost compared to conventional methods and offering an environmentally safe alternative to processing plant residues. One of the promising areas for further use of the resulting composted biomass is its use as a substrate for vermiculture. Vermicomposting with the participation of *Eisenia fetida* is widely recommended as an effective method of disposing of plant waste and improving its structural and nutritional properties (Alwaneen, 2016). P. Vyas *et al.* (2022) found that the combination of microbial degradation and vermicomposting increases the rate of substrate stabilisation by 30-50% and promotes an increase in the content of macronutrients (N, P, K). Similar results are presented in the paper by Y. Wang *et al.* (2024), where a study on composting corn straw and pig manure with microbial inoculants showed that thermophilic and low-temperature microbial systems significantly enhance lignocellulose degradation and humic substance development, which increases process efficiency and is essential for sustainable organic waste management in agriculture.

In general, the analysis of the literature confirms that integrated approaches to processing spoiled wheat straw are the most technologically sound and environmentally appropriate. The tendency to combine microbial destruction and vermiculture corresponds to modern principles, reduces the burden on the environment, and promotes the production of organic fertilisers that increase soil fertility. Thus, the results of numerous studies indicate a high prospects for the use of integrated biotechnologies in solving the problem of organic waste disposal in the agricultural sector. In agriculture, straw-based vermicompost has shown significant agronomic potential. Based on the results of the considered studies, it can be concluded that the use of composted wheat straw as a substrate for growing Red California worms is a promising area for environmentally oriented management of agricultural waste. Therefore, conducting research to establish the effectiveness of growing worms on a substrate of fermented bovine cattle manure with different doses of spoiled wheat straw composted by the accelerated method is of important scientific and practical importance.

The purpose of the study was to determine the optimal dose of composted (prepared by the accelerated method) wheat straw as part of the vermiculture substrate.

Materials and Methods

The study of the effect of different doses of fermented wheat straw in the substrate on the growth and development of vermiculture was conducted in the vivarium of the Institute of Animal Husbandry and Food Technologies of the Bila Tserkva National Agrarian University. A substrate for growing vermiculite for 7 groups of microbeds was prepared from bovine cattle manure composted for 8.0 months using conventional methods (without the addition of biodestructors and aeration) and shredded uncomposted wheat straw. The study was conducted according to the Convention on Biological Diversity (1992).

In the Control Group, bovine cattle manure containing 3.0% by weight of fresh wheat straw was used as a substrate for a hybrid of Red California worms. In the Experimental Group 1, the microbed substrate, in addition to the main components, contained 2.0% wheat straw composted using the BTU-CENTR biodestructor. Microbeds from the Experimental Group 2 were formed from a substrate containing 3.0% fermented wheat straw. In the Experimental Group 3, bovine manure containing 4.0% composted wheat straw was used to form microbeds. The substrate from Experimental Groups 4 and 5 contained 5.0 and 6.0% fermented wheat straw. The weight of the substrate in each microbed was 17.5 kg.

The average weight of worms older than 90 days, which were placed in the microbed at the beginning of the experiment, was 0.75 ± 0.03 g. The experiment lasted 125 days. 100 sexually mature worms were added to each microbed. At the end of the study, worms were divided into sexually mature and non-sexually mature, counted, and the weight of worms and their cocoons was determined. The air temperature in the vivarium with microbeds was maintained at the level of 23-25°C. Aeration of the substrate with vermiculture was performed every 2 days (Table 1).

Table 1. *Experiment design using worms*

Microbed group	Number of individuals in one microbed	Factor under study
Control	60.0	Substrate (main) for growing worms (97.0% fermented cattle manure + 3.0 crushed wheat straw)
Experimental 1	60.0	Main substrate containing 2.0% compostable wheat straw
Experimental 2	60.0	Main substrate containing 3.0% compostable wheat straw
Experimental 3	60.0	Main substrate containing 4.0% compostable wheat straw
Experimental 4	60.0	Main substrate containing 5.0% compostable wheat straw
Experimental 5	60.0	Main substrate containing 6.0% compostable wheat straw

Source: compiled by the authors

The weight of sexually mature and non-sexually mature worms and their cocoons was recorded using techno-chemical and analytical scales. The experimental results were statistically processed to determine the significance using Statistica software suite.

Results and Discussion

Control of the number of worms and their weight was carried out on day 125 of the experiment. In the Control Group, the number of sexually mature worms in one microbed was 405 units. When 2.0% of fermented wheat straw was included in the substrate, the number of sexually mature worms increased by 1.2%, but the difference in relation to the Control Group was not statistically significant. Cultivation of vermiculture on a substrate containing 3.0% fermented wheat straw revealed an increase in the number of sexually mature worms by 18.5% relative to the Control Group ($p < 0.001$). This confirms the rapid adaptation of vermiculture to the substrate and the increased transformation of nutrients from it into the body of worms. In the Experimental Group 3, an increase in the number of sexually mature worms by 19.2% compared to the Control Group was shown. The difference was statistically significant (Table 2).

Table 2. *Number of worms on day 125 of the study, M ± m, n = 6*

Microbed group	Sexually mature individuals per bed		Sexually mature individuals per bed	
	quantity, units	weight, g	quantity, units	weight, g
Control	405 ± 5.4	303.7 ± 7.88	4,750 ± 84.6	522.5 ± 14.6
Experimental 1	410 ± 6.8	315.7 ± 10.5	4,790 ± 89.6	526.9 ± 17.5
Experimental 2	480 ± 5.5***	369.6 ± 8.6***	5,100 ± 86.5*	663.0 ± 11.4***
Experimental 3	482 ± 6.3***	376.0 ± 9.3***	5,050 ± 83.7*	606.3 ± 12.9**
Experimental 4	415 ± 4.3	307.1 ± 7.7	4,764 ± 88.5	514.4 ± 19.5
Experimental 5	395 ± 7.5	284.4 ± 11.6	4,630 ± 97.7	457.1 ± 18.2*

Note: ** – $p < 0.01$; *** – $p < 0.001$ – relative to the Control Group

Source: compiled by the authors

With an increase in the additional content of composted wheat straw in the substrate (Experimental Group 4), the increase in the number of worms in microbeds was not statistically significant. At the highest dose of composted straw, the number of sexually mature worms in microbeds decreases by 2.4% compared to the Control Group. The difference was not statistically significant. The influence of the content of composted straw in the substrate on the body weight of sexually mature worms was proved. The average weight of one individual in the Control Group was 0.74 g. In microbeds with a substrate content of 2.0% composted wheat straw, the average weight of one worm (sexually mature) was 4.0% higher than in the Control Group. Growing vermiculture on a substrate with a compostable wheat straw content of 3.0%, it was possible to obtain 21.6% more biomass of sexually mature worms. The difference was statistically significant. A statistically significant increase in the biomass of the Red California worm hybrid was also found in the Experimental Group 3, where the substrate contained 4.0% composted wheat straw. The weight of sexually mature worms grown on a substrate with contents increased by a statistically insignificant amount. The difference with the Control Group was 1.1%. When growing vermiculture in a substrate containing 6.0% composted wheat straw, the weight of sexually mature worms decreased by 6.3%. The difference was of a trend nature.

Describing the number of individuals who did not reach sexual maturity, it was proved that in microbeds from the Control Group, the indicator was 4,750 units. When growing vermiculture on a substrate containing 2.0% composted wheat straw, the number of worms was 0.8% higher than in the Control Group. The difference was within the margin of error. The largest number of young worms was in a substrate containing 3.0% composted wheat straw. The difference with the Control Group was 7.3% and was statistically significant. An increase in the population size relative to the Control Group in microbeds where worms were grown using a substrate containing 4.0% composted wheat straw was also proved. The increase in population size was statistically significant. In terms of the number of non-sexually mature worms, the Experimental Group 4 practically did not differ from the Control Group. The increase in the number of worms relative to the Control Group was only 0.2%. At the highest dose of composted straw in the substrate, the number of non-sexually mature worms was 2.5% lower compared to the Control Group. The difference was within the margin of error.

Investigating the weight of worms that did not reach sexual maturity, it was found that the more individuals in microbeds, the greater their weight. The average weight of individuals who did not reach sexual maturity in the Control Group was at the level of 0.11 g. When growing worms on a compostable substrate (Experimental Group 1), the average weight of one individual increased by 0.8%. It was found that the weight of vermiculture from the Experimental Group 2 increased by a statistically significant amount. The difference with the Control Group was 26.8%. The use of a substrate containing 4.0% composted straw contributed to an increase in the weight of worms in the Experimental Group 3 by 16.0% ($p < 0.01$). A lower average weight of one worm (not sexually mature) was found in the Experimental Group 3. The difference with the Experimental Group 2 was at the level of 8.5%. Despite the fact that the number of non-sexually mature individuals in the Experimental Group 4 was higher than in the Control Group, however, their weight was lower than in the Control Group by 1.6%. It was found that the weight of worms grown on a substrate with the highest content of composted wheat straw decreased by a statistically significant amount. The difference with the Control Group was 12.5%.

The optimal content of composted wheat straw in the substrate composition has been experimentally established. Growing vermiculture on a substrate of bovine cattle manure with a content of 3.0% composted straw allows increasing the number of worms and their weight due to the optimal content and availability of nutrients. The number of young worms depends on the number of cocoons. At the end of the experiment, the number of cocoons in the Control Group was at the level of 640 units. When using a substrate containing 2.0% composted straw, the number of cocoons in microbeds increased by 2.0% relative to the Control Group. In the Experimental Group 2, the number of cocoons was 10.1% higher than in the Control Group. The difference was statistically significant (Figure 1).

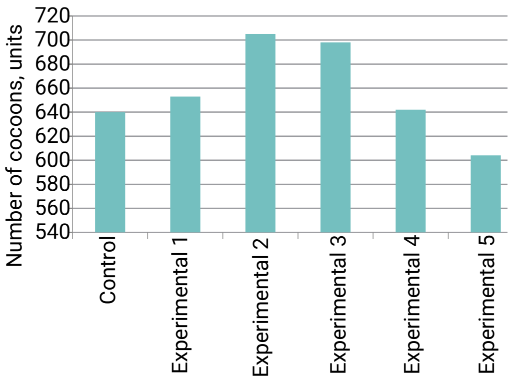

Figure 1. *Average number of cocoons in microbeds*

Source: compiled by the authors

When growing worms on a substrate containing 4.0% composted wheat straw, the number of cocoons was higher relative to the Control Group by a statistically significant amount. The difference with the Control Group was at the level of 9.0%. The indicator of the number of cocoons in the Experimental Group 4 almost did not differ from the data obtained in the Control Group. The lowest cocoon content was found in microbeds where the substrate contained 6.0%. The difference with the Control Group was of a trend nature.

Not all groups increased the number of cocoons in proportion to the number of worms that reached sexual maturity. A study was also conducted to establish the weight of cocoons before the young worms left them. In the Control Group, this indicator was 640 units. The weight of cocoons depends mainly on the number of worms that develop inside. In the Control Group, this indicator was at the level of 15.2 mg. When growing worms on a substrate containing 2.0% composted straw, the weight of cocoons deposited by them was 3.2% higher compared to the Control Group. The difference was of a trend nature (Fig. 2).

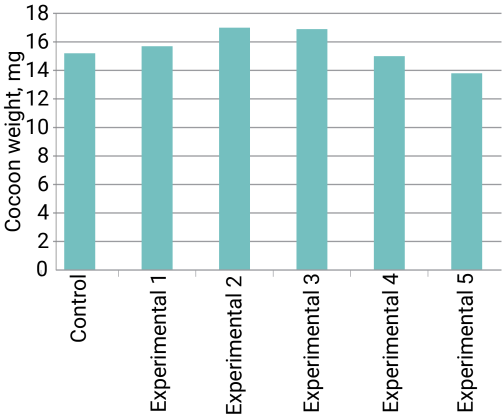

***Figure 2.** Average weight of cocoons in microbeds*

Source: compiled by the authors

In the Experimental Group 2 of microbeds, the average weight of cocoons was higher by 11.8% compared to the Control Group. The difference was statistically significant. It was found that cocoons from the group where the substrate contained an additional 4.0% of composted wheat straw had a higher weight compared to cocoons from the Control Group by 11.2 %. The increase in the indicator was at the level of statistical significance. An increase in the content of composted straw in the substrate to 5.0% does not lead to an increase in the weight of worm cocoons in microbeds from the Experimental Group 4. An increase in the available carbon content due to the content of 6.0% composted wheat straw in the substrate affected the decrease in the average weight of cocoons. The difference with the Control Group was 9.2% and was statistically significant.

The concentration of fermented wheat straw in the substrate affects the reproduction and growth of worms, and the number of cocoons they form. Growing vermiculture in a substrate containing 3.0% composted wheat straw leads to an increase in the number of sexually mature worms in one microbed compared to the option where the substrate contained only fresh crushed straw (Control Group). According to their biological characteristics, worms reach sexual maturity by day 90 of their life, and young worms develop in a cocoon for up to 15 days under optimal growing conditions (Herasymenko, 2006). Based on this, an increase in the number of sexually mature individuals in microbeds in the presence of 3.0% composted straw contributes to accelerated adaptation of worms and the creation of optimal conditions for mating. The rationale for this phenomenon is that with the optimal content of composted wheat straw in the substrate, worms do not experience habitat discomfort. In addition, this indicates the absence of harmful compounds in composted straw. According to Y. Cao *et al.* (2021) straw mainly improves the productivity of earthworms during vermicomposting.

The results obtained in the current study show that the introduction of an optimal dose of composted wheat straw into the substrate for growing Red California worms provides a significant increase in both the number of sexually mature individuals and the total weight of worm biomass. This pattern is consistent with the logic of biochemical processes that occur during microbial destruction of straw, and is confirmed by a number of scientific sources. Composting using a biodestructor containing a complex of cellulolytic, amylolytic, and nitrogen-fixing microorganisms significantly increases the bioavailability of organic nitrogen and carbon, which is a key factor in earthworm nutrition. As noted by V.H. Herasymenko (2006), the optimal ratio of carbon to nitrogen in vermiculture substrates should be approximately 20:1. The results of the current study show that adding exactly 3.0% by weight of composted straw allows bringing the value of this indicator closer to the biologically optimal one. In addition, the increased availability of easily accessible forms of carbon after composting allows worms to adapt more quickly to the substrate and consume organic matter more actively.

When comparing the data of the current study with the results of international scientific papers, it was found that the identified patterns were consistent with the conclusions of R. Panjgotra *et al.* (2019). In particular, these researchers have shown that the use of wheat straw, even non-composted, contributes to an increase in biomass growth of Eisenia fetida by increasing the structural looseness of the substrate and increasing its air permeability. However, R. Panjgotra *et al*. did not use preliminary microbial destruction, which is a limitation of their study, since it did not consider the potential for increasing the bioavailability of nutrients. But the data of the current study shows that it is biodegradation that accelerates the decomposition of cellulose and hemicellulose, which creates more favourable conditions for the assimilation of the substrate by worms.

The properties of the compostable straw substrate observed in the current study are also consistent with the results of A. Nigussie *et al.* (2021), who found that microbial inoculants generally have a positive effect on the composting process, increasing the total nitrogen and phosphorus content, humification levels, compost maturity, and accelerating the degradation of cellulose, hemicellulose, and lignin, although their effect on bioavailable forms of nutrients is negligible. In the case of a similar effect – the preservation of nitrogen and phosphorus – was found by I.S. Osipenko & S.V. Merzlov (2023), which is fully consistent with international data. In addition, the results of current studies are consistent with the findings of A. Vyas *et al.* (2022), who obtained an increase in vermicomposting productivity using a combined microbial-vermicomposting approach. The researchers proved that pre-destruction of plant material stimulates the reproduction of worms, increases their biomass, and accelerates the development of humic substances. Data from the current study also indicate an increase in live weight gain of *Eisenia fetida* with an optimal content of composted straw, which is a confirmation of similar trends. In addition, P. Vyas *et al.* (2022) found that the combination of microbial fermentation and vermicomposting leads to improved degradation and conversion of organic matter, which is consistent with an increased conversion rate of organic mass to vermicompost and stimulation of worm growth with optimal substrate treatment. This is consistent with the results of the current study, because the optimal dose of composted straw contributed to faster assimilation of the substrate by worms and improved their reproduction and biomass accumulation. A slightly different aspect of the problem was considered by I. Ahmad *et al.* (2022), who investigated the effects of vermicompost derived from straw. They found that composted straw is a high-quality substrate for creating nutritious vermicompost, which confirms the positive impact of such biomass on ecosystem processes. This is consistent with the findings of the current study on the positive effects of such compost on vermiculture. Therefore, the results obtained in the current study logically fit into global trends involving the integration of microbial composting and vermiculture.

Summarising, it is worth noting that the results of the current study do not contradict the data of other researchers, but on the contrary – they complement them, highlighting the scientific originality: the use of the optimal dose of composted wheat straw (3.0%), which provides the most favourable conditions for growth and development of *Eisenia fetida*. Thus, the established pattern regarding the effectiveness of this dose is a logical continuation of existing scientific developments and contributes to improving the efficiency of biotechnologies for processing agricultural waste. In scientific publications, the problem of accumulation of spoiled wheat straw was considered as an important environmental and production challenge for the agricultural sector. J.K. Leet & D.C. Volz (2013) and X. Shen *et al.* (2015) noted that unutilised straw can cause a complex of negative consequences: contamination of soil and water with decomposition products, accumulation of phytopathogenic microorganisms and harmful metabolites, and a potential increase in greenhouse gas emissions due to uncontrolled rotting. It was emphasised that straw, even in its damaged state, remains a renewable resource and contains organic compounds (carbohydrates, fibre, proteins, etc.) that are suitable for use as a substrate in biotechnological processes. This position is consistent with the approach used in the current study, where straw was considered not as inefficient waste, but as a substrate component for bio-processing.

In a number of studies, the expediency of technological schemes in which preliminary microbial treatment of organic mass was combined with subsequent vermicultivation was justified. In particular, H. Zhang *et al.* (2016) showed that controlled biotechnological composting conditions contributed to more active decomposition of organic matter and substrate stabilisation. A. Nasiru *et al.* (2013) considered vermicomposting as a tool for sustainable organic waste management and emphasised that the efficiency of the process increases with pre-preparation of the substrate, which reduces toxicity and improves nutrient availability. A similar statement was supported by I. Zekker *et al.* (2019; 2021), who noted that the use of microbial conglomerates allows controlled initiation of hydrolysis of organic components, breakdown of complex polysaccharides, reduction of substrate toxicity, and optimisation of ammonia concentrations. The results obtained in the current study were consistent with the above provisions. The effect of including composted straw in the substrate was manifested as an improvement in the conditions for the growth and reproduction of vermiculture, which was logically explained by the mechanisms described by A. Nasiru *et al.* (2013). In particular, during fermentation, as noted in these studies, microorganisms synthesised a range of hydrolytic enzymes that hydrolysed insoluble polymers (cellulose, hemicellulose, and partially lignin) into more accessible forms. The resulting intermediates (simple sugars, amino acids, mineral compounds) formed a more nutritious substrate suitable for the next stage – vermicomposting. It was this transformation of the substrate that could determine the improvement in vermiculture performance found in the study after the addition of composted straw.

Importantly, the results of the current study are also consistent with the biological prerequisites for effective vermiculture described by K.D Brown (2019). The researcher emphasised that the most effective in world practice are various species of manure worms, in particular, a hybrid of Red California worms *Eisenia fetida*, which is characterised by a high intensity of consumption of the nutrient medium in which it lives, rapid growth of biomass, and the ability to efficiently process organic substrates. It was also noted that under the condition of preliminary fermentation of the substrate, such worms show maximum growth rates and quickly transform the mass treated with microorganisms into high-quality vermicompost. Therefore, the use of a fermented (composted) component in the substrate in this study corresponded to the approaches that were considered most effective for realising the biological potential of *E. fetida*.

The results of the study show that the optimal content of composted wheat straw in the substrate for growing worms is 3.0%. This concentration provides a significant increase in both the number and biomass of worms, contributing to their efficient development. Higher doses of composted straw do not provide additional benefits and do not contribute to further population growth. Thus, the use of 3.0% composted straw is the most effective for optimising the processes of growing vermiculture. Adding composted straw to the substrate improves the conditions for the growth and development of worms, increasing their adaptation and reproductive ability. Exceeding the optimal dose of straw does not lead to improved results and may negatively affect the efficiency of the process.

Conclusions

With the introduction of an additional 3.0% composted wheat straw in the substrate (bovine cattle manure containing 3.0% by weight of fresh non-composted wheat straw), a significant increase in the total biomass of vermiculture in one microbed was established. The data obtained confirm that composted straw is an effective structural and nutritional supplement that can stimulate both the development of the substrate microbiota and the subsequent growth of vermiculture. It was also found that the use of 3.0% composted wheat straw as part of the substrate contributes to an increase in the average weight of sexually mature worms. In particular, their weight increased by 21.6% compared to the option where composted straw was not added. This indicates that composted straw has a positive effect not only on the total number and biomass of the worm population, but also on their physiological state, providing a more stable and balanced nutrient environment for their development and reproduction.

A statistically significant increase in the number and weight of worms that have not reached sexual maturity in microbeds with a substrate containing 3.0% composted wheat straw indicates an improvement in the bioavailability of hydrolysed organic compounds. The presence of available carbon and its optimal ratio to nitrogen formed favourable conditions for the growth of non-sexually mature worms, which are the first to respond to changes in the qualitative characteristics of the substrate, demonstrating an increased growth rate. The results of the study confirm that composted wheat straw obtained using Ukrainian-made biodestructors can be considered as a promising environmentally safe component for enriching substrates for vermiculture. The use of 3.0% composted straw is the optimal dose to stimulate the growth and reproduction of Red California worms.

Thus, the research is not only theoretical, but also of significant practical importance for the development of ecological technologies for bio-processing of organic raw materials and improving the efficiency of vermicompost production. A promising area of further research is the investigation of the chemical composition of vermiculture biomass grown on a substrate with different contents of composted wheat straw.

Acknowledgements

None.

Funding

None.

Conflict of Interest

None.

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Вирощування вермикультури на субстраті із вмістом компостованої соломи пшениці прискореним методом

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Анотація. Актуальність дослідження зумовлена необхідністю вдосконалення технології виготовлення субстратів для вирощування вермикультури, що має важливе значення для отримання високоякісного органічного добрива та підвищення ефективності біотехнологічних процесів утилізації органічних відходів. Мета полягала у визначенні оптимальної дози ферментованої соломи пшениці у складі субстрату для підвищення росту, розвитку та відтворювальної здатності вермикультури. Експеримент проводився у віварії Білоцерківського національного аграрного університету на семи групах мікролож, сформованих на основі гною великої рогатої худоби (ВРХ) із різним вмістом компостованої соломи пшениці. Контрольна група містила гній ВРХ і лише свіжу подрібнену солому, до субстрату із дослідних мікролож включали 2,0-6,0 % ферментованої соломи пшениці. У кожне мікроложе вносили по 100 статевозрілих черв'яків. Протягом 125 діб контролювали чисельність та масу статевозрілих і нестатевозрілих особин, кількість і масу їх коконів. Обробку результатів здійснювали методами варіаційної статистики. Найкращі показники встановлено за включення 3,0-4,0 % компостованої соломи у субстрат. У цих групах зафіксовано істотне зростання чисельності та біомаси черв'яків, а також підвищення кількості коконів. Зафіксовано, що оптимальний рівень компостованої соломи сприяв покращенню адаптації популяції, підвищенню кількості та маси статевозрілих черв'яків у дослідних мікроложах. Перевищення вмісту компостованої соломи пшениці до 5,0-6,0 % не забезпечило збільшення кількості черв'яків у мікроложах. Це свідчить про наявність верхньої межі толерантності популяції до збільшення співвідношення Карбону до Нітрогену у субстраті. Визначено, що оптимальною є доза 3,0 % компостованої соломи пшениці, що забезпечує статистично достовірне збільшення кількості та маси черв'яків у порівнянні з контролем. Застосування цієї дози дозволило підтримувати біологічно збалансоване співвідношення елементів живлення та створює умови для ефективного розмноження й розвитку вермикультури. Отримані Результати можуть бути використані для розробки ефективних методів вирощування вермикультури на основі компостованої соломи пшениці, що сприятиме поліпшенню родючості ґрунтів та підвищенню ефективності органічного землеробства

Ключові слова: гібрид червоних каліфорнійських черв'яків; кокони черв'яків; мікроложе; статевозрілі особини; ферментація