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Bioconversion of organic substances of champignon substrates into vermicompost using Extrakon product

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The purpose. To study the complex effect of transformation of organic matter and formation of plant-microbial systems when using domestic product Extrakon on the used champignon substrates. **Methods.** Microbiological (method of entering preparations for the destruction of agricultural residues, obtaining a pure culture, studying the cultural properties of colonies), obtaining water extracts from substrates, the «rolls» method, biochemical (determining the fluorescence induction of chlorophyll leaves), statistical (leaf surface area, notching method). The object of the study was the used champignon substrate and the multifunctional biological preparation Extrakon. **Results.** When using extracts from the used champignon substrate, the stem length of the model object of the wheat of the soft winter variety «Smuglianka» is 24.2% longer, the root length is 4% longer compared to the control. When using extracts from the waste champignon substrate fermented with Extrakon biological product, the length of the plant stem, roots, and dry weight of wheat seedlings were 10.6%, 34.8, and 20.6% higher, respectively, compared to the control. With the use of the used champignon substrate fermented with Extrakon biological product in wheat plants, the area of the root system is increased, which activates the beneficial microflora, which in its turn effectively transforms all its components. **Conclusions.** The use of Extrakon biological product for fermentation and transformation in biological fertilizer of the used mushroom substrates is proposed. The use of traditional organic fertilizers with the addition of new ones will contribute to the return of organic matter to the biological cycle and increase the morphometric parameters of crop plants.

Key words: *non-waste technologies, transformation, mushroom growing, biohumus*
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Mushrooms are a fairly valuable food product. For the cultivation of mushrooms use special substrates based on plant and animal components. Globally, a rather urgent problem for mushroom farms today is the utilization of spent substrate after mushroom cultivation. Due to the lack of scientific justification for the use of waste substrates in the form of organic fertilizers, mushroom farms dispose of the blocks with waste substrate near the production or on the farm, which can lead to negative environmental risks in the form of further disease through further pathogenic effects infections in landfills.

One of the main ways of bioconversion of the spent mushroom substrate is its use as an organic fertilizer for the cultivation of different crops. As raw material for biofuel production, also as a medium for growing vermiculture, in wetlands for the recovery of contaminated waters, in stabilization of severely disturbed soils, in bioremediation of contaminated soils, and as ingredients for the cultivation of other fungi [1-5].

The purpose of the study is to investigate the effect of an extracon biological product based on a consortium of soil microorganisms on spent mushroom substrates as a basis for returning substrates in an ecologically safe form to biological circulation in the form of fertilizers.

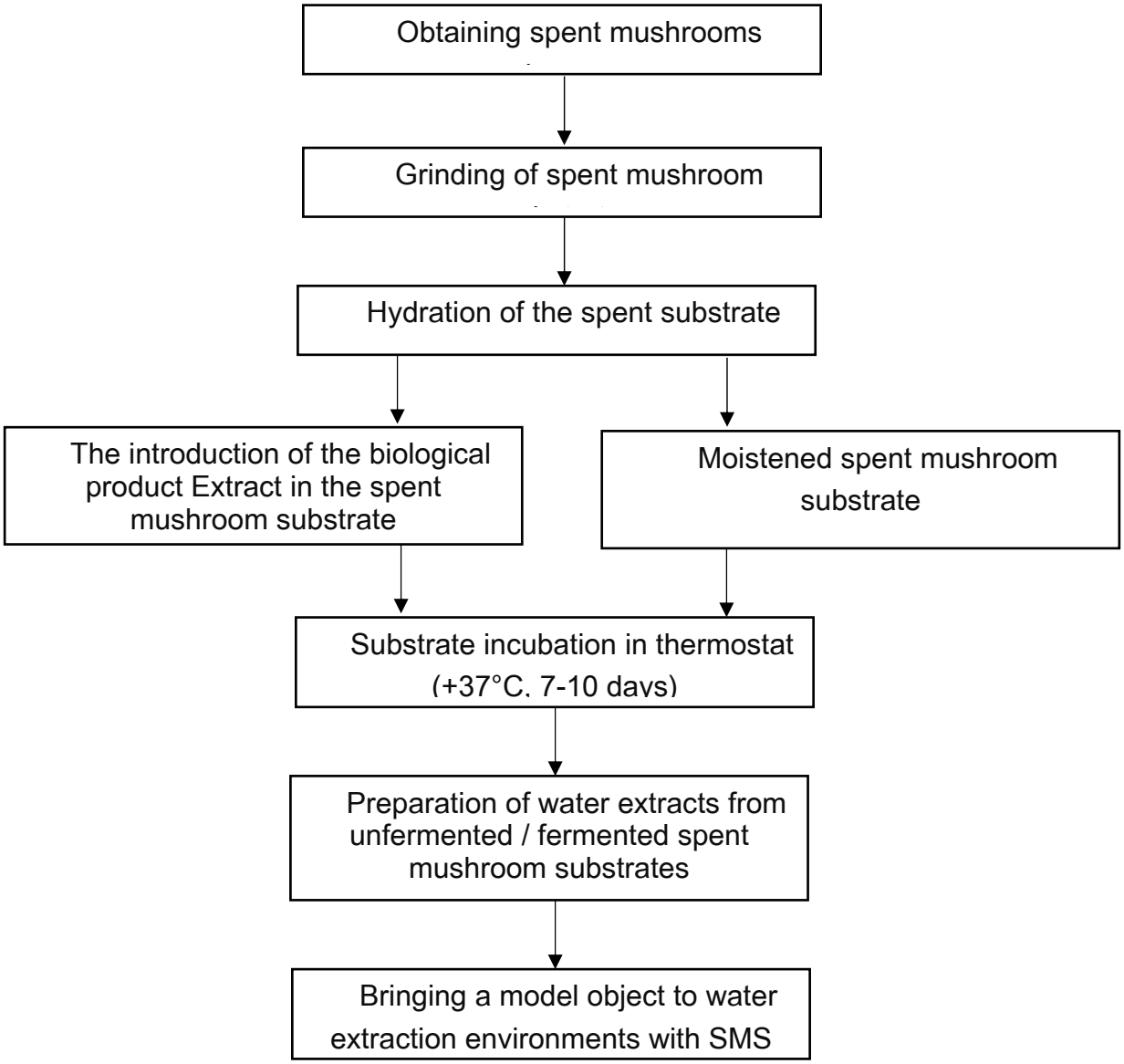
Materials and methods of research. The studies were conducted at the Department of Ecobiotechnology and Biodiversity of the National University of Life and Environmental Sciences of Ukraine. The object of study is a spent mushroom substrate. For transformation of the substrate used multifunctional biological preparation Extract of domestic production, agents of which is a natural consortium of soil cellulosic bacteria and micromycetes (*Sporocytophaga mixococcoides, Sorangium cellulosum, Cellvibrio mixtus, Trichoderma viridae* spp.) and heterotrophic representatives of *Pseudomonas spp.* and *Bacillus spp*. The biological product in the form of a homogeneous dry form was introduced into a pre-moistened spent mushroom substrate (humidity up to 60-70%) in a ratio of 10:1, stirred well and left in the thermostat for 7-10 days. At this time, due to the activation of the bioagents of the drug, the transformation of plant residues without putrefactive processes takes place [6-7]. As a model object in the research we used soft winter wheat of the "Smuglyanka" variety, entered in the State Register of Plant Varieties, suitable for distribution in Ukraine in 2019.

Water extracts from the spent mushroom substrate were prepared by the classical method as is done from the soil. To obtain them, the substrate was poured into water, the suspension was stirred well for 10 minutes, left to stand. The obtained extract from the spent mushroom substrate was filtered [8].

Winter wheat seeds were sterilized with KMnO4 solution. The sterilized wheat seeds were placed on filter paper using a modified roll method (5-6 rolls in several repetitions). Previously obtained extracts from the substrates were made in Petri dishes with seeds of 10 ml each. Seeds with plain water were selected as controls. 16 days after the application of winter wheat seeds to the media of water extracts from the spent mushroom substrate, we conducted an account of biometric parameters [9].

To determine the physiological indicators of plant growth and development (induction of chlorophyll fluorescence), the domestic device "Floratest" was used [10-11].

In order to investigate the effect of the biological product Extracton on spent mushroom substrates, we applied the determination of phytotoxicity to winter wheat in three variants: 1 variant – control (tap water); 2 variant – extract from spent unfermented mushroom substrate; 3 variant – extract from the spent mushroom substrate inoculated with Extracon (inoculation exposure during the week). The studies were performed in three replicates. At the beginning of our work we developed a scheme of experiment (Fig.). 16 days after the introduction of winter wheat seeds into the media of water extracts from the spent mushroom substrate, we conducted an account of growth parameters for comparison.



Scheme of experiment on the use of the biological product Extractor for transformation of spent mushroom substrate

The method of introduction of drugs for the destruction of agricultural residues. After a complete cycle of growth and collection of fruiting bodies of mushrooms remains HCV. For the transformation of plant residues into biohumus contained in the substrate, as well as the activation of the function of beneficial microflora use drugs-destructors or multifunctional biological products.

The biological product in the form of a homogeneous dry form is introduced into a pre-moistened spent mushroom substrate (humidity up to 60-70%) in a ratio of 10: 1, mixed well and left in the thermostat for 7-10 days. At this time, due to the activation of the soil microflora, the plant residues are transformed without putrefactive processes. Biochemical methods. Rapid and informative methods are used to determine the impact of various factors on a plant's condition, which allow it to assess the condition of plants in laboratory and field conditions with minimal disruption to the integrity of the objects under study. One such method is the method of inducing fluorescence of chlorophyll. The chlorophyll fluorescence index allows to investigate the course of photochemical reactions related to the work of photosystem 2, which is most sensitive to the influence of environmental factors, in living objects. The change in the fluorescence of chlorophyll reflects the processes of light and dark phase.

Studies of fluorescence of chlorophyll in a leaf apparatus are carried out with the help of special instruments – fluorometers. Studies of IFN change are performed in 3-repetition with a measurement cycle duration of 3 min. To conduct the study, the leaf of the object under study is placed in the optical unit of the device, by clicking on special levers, a gap is formed between the upper illumination and the

lower recording part, where the leaf is placed against the light source. Carefully release the levers to avoid damaging the object under study. The leaf is protected by soft pads, which also prevent the outside light from penetrating as the sheet adapts to the dark. Adaptation of the leaf surface should take 10-15 minutes, after which the measurement is made. The obtained measurement results are transferred to a personal computer, with the help of Microsoft Office Excel the curves of the IFH control and samples are compared and compared.

Research results. Indicators of high morphological potentials, on which the productivity of crops depends, are the size of photosynthesis organs, the state of the root system. The use of the biological product Extracton in mushroom substrates showed a positive effect on the biometric parameters of wheat plants. The measurement results are shown in the diagrams.

It is established that when using the extract from the spent mushroom substrate, the root length is 4% longer than the control, the largest value of root length is observed in the first version of the average data and is 175.77 mm. When using extracts from fermented Extraconan spent mushroom substrate, the root length compared to the control is greater by 34.8%, the highest value of the root length is observed in the first variant and is 219.67 mm. By increasing the root system increases the area of plant nutrition. This is due to the fact that the biological product "Extracon" is designed for introduction into the soil and the use of it activates the useful soil microflora, which transforms the components of the spent mushroom substrate. They are absorbed by plants and have a positive effect on the nutrition of the root system of plants.

When using the extract from the spent mushroom substrate, the length of the stem of the model object is greater by 24.2% compared to the control, with the highest value of the length of the stem is observed in version 4 and is 121.25 mm. When using an extract from fermented Extraconan spent mushroom substrate, the length of the stem of the model object is greater than the control by 10.6%, the highest value of the length of the stem is observed in 3 repetitions of 100.5 mm. It should be noted that the beginning of vegetation of plants is more related to the quality of the seed, but due to the formation of plant microbial systems allows to qualitatively form the ontogeny of plants and its physiological processes due to agronomically valuable microorganisms, which is confirmed by the development of the root system when applying biopreparation.

The highest weight of wheat seedlings, 20.6% greater than the control, was determined using the extract from the fermented "Extract" of the mushroom substrate. This indicates that the use of extract from the spent mushroom substrate fermented with the biological product Extract, promotes better development of seedlings as a whole.

The method of chlorophyll fluorescence induction is quite convenient to use due to its expressiveness and can be used in various conditions, including field, which allows to diagnose the functional state of the plant in real time. The basis for this use is the close inverse relationship between the fluorescence intensity of chlorophyll and photosynthetic reactions. Thus, according to the physiological growth indices of wheat plants obtained after measuring the induction of chlorophyll fluorescence, a Kautsky chlorophyll fluorescence induction curve was constructed, which shows the dependence of the fluorescence intensity and other physiological processes of plants in variants.

The shape of this time-dependence curve of chlorophyll fluorescence intensity is quite sensitive to changes occurring in the photosynthetic apparatus of plants upon adaptation to different environmental conditions (substrate), which has been the basis for the extensive use of the Kautsky effect in photosynthesis studies. It is shown that the maximum content (and can write how many times was higher than one then other variants and then they were located as follows) of chlorophyll and the intensity of photosynthesis is observed in variant 3 - winter wheat, which was grown on the medium of extract from fermented Substrate mushroom . The preparation includes microscopic bacteria and fungi, which have a complex of properties useful in the agronomic aspect. Micromycetes *Trishoderma* are active cellulosorbent bioagents that have the ability to decompose plant residues. They secrete a complex of cellulosolytic enzymes that begin to decompose straw immediately after application and throughout the life of the mushrooms in the soil. A significant advantage of micromycetes of the genus Trichoderma is

their fungicidal activity, which ensures the disinfection of plant residues. The bacterial component of the drug is represented by the bacteria *Pseudomonas*. These microorganisms are activators of the beneficial microflora of the substrate due to the synthesis of a large number of biologically active compounds, such as enzymes, phytohormones, vitamins and substances of antibiotic nature, which inhibit the development of phytopathogens.

The complex work of bacteria and micromycetes, which are part of the preparation, allows to accelerate the processes of decomposition of organic residues, leaving carbon and nitrogen of plant origin in the substrate. In addition, the drug improves the phytosanitary state of the substrate as a whole by effectively competing with the phytopathogenic microflora and improving transformation. Due to its multifunctionality, "Extracton" promotes the growth and development of cultivated plants, which is very important in the initial stages.

Conclusions

The results of the studies showed that when using the extract from the spent mushroom substrate, the length of the stem of the model object is greater by 24.2% and the root length is 4% longer than the control. When using extracts from fermented Extraconan waste mushroom substrate, the length of the plant stems is greater by 10.6%, the length of the roots is greater by 34.8%, and the dry weight of wheat seedlings is greater by 20.6% compared to the control. When using the biological product Extract with spent mushroom substrate in wheat plants increases the root system due to this and increases the area of nutrition. This is due to the fact that the drug Extracton is designed for introduction into the soil and its use activates the useful soil microflora, which transforms the components of the spent mushroom substrate, which are then absorbed by the plants and have a positive effect on the nutrition of the root system. The use of the biological product Extractor for fermentation of waste mushroom substrates gives the opportunity to obtain organic fertilizers to stimulate the growth and development of agricultural plants by forming effective systems with microorganisms, with organic substances returning to the biological cycle and is able to significantly improve growth and development. The advantage of using the drug on the used substrates is to improve the phytosanitary state of the environment, stimulate the natural decomposition of organic residues, enrich them with natural carbon and nitrogen and increase the activity of beneficial microflora with increasing productivity of subsequent crops by 10-30%.

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