

Ministry of Education and Science of Ukraine
**ODESSA NATIONAL ACADEMY OF
FOOD TECHNOLOGIES**

International Competition of
Student Scientific Works

**BLACK SEA
SCIENCE 2020**
PROCEEDINGS



ODESSA, ONAFT 2020

Ministry of Education and Science of Ukraine
Odessa National Academy of Food Technologies

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2020

Proceedings

Odessa, ONAFT 2020

Editorial board:

Prof. B. Iegorov, D.Sc., Rector of the Odessa National Academy of Food Technologies, Editor-in-chief

Prof. M. Mardar, D.Sc., Vice-Rector for Scientific and Pedagogical Work and International Relations, Editor-in-chief

Dr. I. Solonytska, Ph.D., Assoc. Professor, Director of the M.V. Lomonosov Technological Institute of Food Industry, Head of the jury of «Food Science and Technologies»

Dr. Yu. Melnyk, D.Sc., Assoc. Professor, Acting Director of the G.E. Weinstein Institute of Applied Economics and Management, Head of the jury of «Economics and Administration»

Dr. S. Kotlyk, Ph.D., Assoc. Prof., Director of the P.M. Platonov Educational-Scientific Institute of Computer Systems and Technologies “Industry 4.0”, Head of the jury of «Information Technologies, Automation and Robotics»

Prof. B. Kosoy, D.Sc., Director of the V.S. Martynovsky Institute of Refrigeration, Cryotechnology and Ecoenergetics, Head of the jury of «Power Engineering and Energy Efficiency»

Prof. G. Krusir, D.Sc., Head of the Department of Ecology and Environmental Protection Technologies, Head of the jury of «Ecology and Environmental Protection»

Dr. V. Kozhevnikova, Ph.D., Senior Lecturer of the Department of Hotel and Catering Business, ONAFT, Technical Editor

Black Sea Science 2020: Proceedings of the International Competition of Student Scientific Works / Odessa National Academy of Food Technologies; B. Yegorov, M. Mardar (editors-in-chief.) [*et al.*]. – Odessa: ONAFT, 2020. – 621 p.

Proceedings of International Competition of Student Scientific Works «Black Sea Science 2020» contain the works of winners of the competition.

The author of the work is responsible for the accuracy of the information.

Organizing committee:

Prof. Bogdan Iegorov, D.Sc., Rector of Odessa National Academy of Food Technologies, Head of the Committee

Prof. Maryna Mardar, D.Sc., Vice-Rector for Scientific and Pedagogical Work and International Relations of Odessa National Academy of Food Technologies, Deputy Head of the Committee

Prof. Stefan Dragoev, D.Sc., Vice-Rector for Scientific Work and Business Partnerships of University of Food Technologies (Bulgaria)

Prof. Baurzhan Nurakhmetov, D.Sc., First Vice-Rector of Almaty Technological University (Kazakhstan)

Prof. Mircea Bernic, Dr. habil., Vice-Rector for Scientific Work of Technical University of Moldova (Moldova)

Prof. Jacek Wrobel, Dr. habil., Rector of West Pomeranian University of Technology (Poland)

Prof. Michael Zinigrad, D.Sc., Rector of Ariel University (Israel)

Dr. Mei Lehe, Ph.D., Vice-President of Ningbo Institute of Technology, Zhejiang University (China)

Prof. Plamen Kangalov, Ph.D., Vice-Rector for Academic Affairs of “Angel Kanchev” University of Ruse (Bulgaria)

Dr. Alexander Sychev, Ph.D., Assoc. Professor of Sukhoi State Technical University of Gomel (Belarus)

Dr. Hanna Lilishentseva, Ph.D., Assoc. Professor, Head of the Department of Merchandise of Foodstuff of Belarus State Economic University (Belarus)

Prof. Heinz Leuenberger, Ph.D., Professor of the Institute of Ecopreneurship of University of Applied Sciences and Arts (Switzerland)

Prof. Edward Pospiech, Dr. habil., Professor of the Institute of Meat Technology of Poznan University of Life Sciences (Poland)

Prof. Lali Elanidze, Ph.D., Professor of the Faculty of Agrarian Sciences of Iakob Gogebashvili Telavi State University (Georgia)

Dr. V. Kozhevnikova, Ph.D., Senior Lecturer of the Department of Hotel and Catering Business of Odessa National Academy of Food Technologies, Secretary of the Committee

5. ECOLOGY AND ENVIRONMENTAL PROTECTION

**ORGANIC WASTE DISPOSAL WITH USING OF IMPROVEMENT
METHOD OF VERMICULTIVATION BY CALIFORNIAN WORMS
(EISENIA FETIDA)**

Author: Elina Zaitseva

Supervisors: Julien Castelin¹, Harkovych Oleksii²

¹ISA Lille - Graduate School of Agriculture and Bio-engineering

²Odessa National Academy of Food Technologies

Abstract. *As part of this research work, an efficient and environmentally friendly technology for the disposal of organic wastes based on vermiculture of the California worm (*Eisenia fetida*) has been substantiated and developed. The developed technology allows not only to fully utilize vegetable raw materials, but also to obtain a valuable fertilizer for increasing yields (biohumus) and a source of animal protein for food (worm biomass).*

*The studies have made it possible to determine the most rational parameters of the substrate for cultivation of the California red worm (*Eisenia fetida*), which will significantly increase the yield of free humic acids, and therefore - to improve the quality of biohumus (pH = 6.5 -7.0, temperature - 18 -25 ° C, humidity -70-80%).*

*It is experimentally found that the best variant of solid organic substrate on which the red worm (*Eisenia fetida*) is cultivated, as well as undergoing the most efficient disposal of waste is potato peel, cabbage, apple peel, tea in a ratio of 2:1:1:1:1.*

*It is found that the best variant of the substrate based on wastewater MPP and activated sludge is the option with a weight ratio. Studies have shown that the cultivation of the California worm (*Eisenia fetida*) on plant substrates processes of destruction of dietary fibers.*

*Technology for the disposal of organic food waste and WFP waste and activated sludge using the cultivation of the red California worm (*Eisenia fetida*) has been developed, and each step of the technological process has been described, indicating the optimal technological parameters obtained through experimental studies*

Keywords: *recycling, waste, biotechnology, biohumus, vermiculture, earthworm, vermicompost, recycling.*

I. Introduction

Actuality of theme: As a result of human activity, a large amount of various (solid, liquid and gaseous) wastes are present at all stages of production and in life, which contaminate the biosphere and pose a threat to public health. Nowadays, man-made waste has reached a geological scale. The occurrence of local environmental problems related to air and soil pollution, contamination and pollution of natural waters, transboundary pollutants, leads to the accumulation of harmful substances in the environment.

Awareness of the effects of environmental pollution and the depletion of natural resources has contributed to the development of approaches to the disposal and reuse of waste as secondary material resources. Recycling of waste generated by society is one of the indicators of its sustainability. Therefore, in most developed countries, recycling and disposal of waste have become a priority in the economic sectors. Waste

recycling reaches 80%, and their disposal is in compliance with all environmental requirements.

However, in Ukraine, the gap between the progressive accumulation of waste and the measures for its disposal and disposal at the present stage has not been overcome. There is a deepening ecological crisis.

Today, in most developed countries, there is a shift from landfilling and incineration to alternative solutions to waste management that minimize the negative impact of waste on the environment. The practical experience of waste management in different countries shows that there is no one-size-fits-all method that meets the current requirements of ecology, economy and resource conservation. The implementation of biotechnological disposal methods is the most consistent with these requirements and trends in world practice.

There are many technologies known to successfully solve the problem of the efficient disposal of vegetable waste. The combustion of vegetable raw materials in boilers generates emissions of pollutants into the atmosphere, which contributes to the deterioration of the environment. It is also worth noting that using traditional recycling technologies reduces the utilization rate of natural resources, since organic waste is a valuable raw material for further biofertilization. Therefore, the development of an efficient and environmentally friendly technology for the disposal of organic waste is urgent.

The purpose of this qualification is to substantiate and develop a technology for the disposal of organic waste by cultivating the red California worm (*Eisenia fetida*);.

To achieve this goal, the following tasks were defined: to analyze the current problem of waste disposal; to consider biotechnological methods of waste disposal and determine their benefits; to identify the main features of the substrates on which the red California worm (*Eisenia fetida*) is cultivated; to determine the basic parameters of the process of cultivation of red California worm (*Eisenia fetida*), which may affect its biological efficiency; to determine the rational ambient temperature for the cultivation of the red California worm (*Eisenia fetida*); to determine the rational moisture level of the substrate for cultivation of the red California worm (*Eisenia fetida*); to determine the rational pH of the substrate for cultivation of the red California worm (*Eisenia fetida*); to determine the best version of the solid organic substrate on which the red worm (*Eisenia fetida*) is cultivated.

Subject: Investigation of organic waste utilization by vermiculture of the California rain worm (*Eisenia fetida*).

Object of study: household and industrial organic waste.

Purpose: The justification and development of technology for the disposal of organic waste by vermiculture California rain worm (*Eisenia fetida*).

Practical importance of the topic: The technology of organic waste utilization, which has no negative impact on the environment, is substantiated and developed. This technology allows not only to dispose of waste, but also to obtain biofertilizers and additional feed for livestock.

Conclusion. Development of technology for recycling of organic waste. Based on the results of research, the technology of organic waste utilization has been developed and substantiated.

II. Analytical review of literature

At this time of active development, the technology of vermicomposting exists. Vermicomposting is based on the ability of the Red Hybrid Californian's (ECG) (*Eisenia fetida* Andrei) to absorb a large amount of organic matter, plant residues, and with them the bacteria, fungi, algae, protozoa [1]. Worms are known to contribute to the conversion of nutrients into readily available form and to activate microbiological activity [2]. Spanish scientists have described vermicomposting as "biological oxidation and stabilization of organic matter, that associated with the action of earthworms and [mesophilic] microorganisms" [3]. Thus, with the participation of microorganisms in the process of composting in the beds, the decomposition of easily digestible compounds - sugars, polysaccharides, proteins, hemicelluloses, and at last the lowest speed of decomposition have lignin, tannins, etc. at first. The decomposition is accompanied by the synthesis of a complex of humic compounds. As a result, the mass of organic matter decreases, the substrate is enriched with nitrogen, humus, its ash content increases [4].

It is interesting that vermiculture has a sterilizing effect on pathogenic microorganisms. Thus, the study of the sanitary status of composts showed that vermicompost does not contain representatives of dangerous groups of microorganisms [13]. The worm's gut is a kind of "filter" and simultaneously an enzymatic system for microorganisms. Part of the microorganisms that enter the gut of the worm is eliminated, others multiply and enrich the substrate [5]. The results of studies of American and Russian scientists show that the worm's coprolites are dominated by gram-negative aerobic bacteria of the genus *Pseudomonas*, in slightly smaller numbers - representatives of the genera *Flavobacterium*, *Streptomyces*, *Bacillus* [6], as well as *Cellulomonas*, *Acetobacterium*, [7]. In works [4-8], the dominant bacterial species in vermicompost (biohumus) are presented. Thus, the bacterium *Pseudomonas putida* has a high intestinal survival and reproduction in the biohumus, and species such as *Azospirillum brasilense* and *Pseudomonas stutzeri* do not develop under these conditions at all. The survival of bacteria from the genus *Pseudomonas* has been confirmed by other researchers. At the Institute of Agricultural Microbiology and Agroindustrial Production of NAAS, it is established that the grouping of vermicompost microorganisms is represented by bacteria of the genus *Pseudomonas*, *Bacillus*, *Enterobacter*, *Alcaligenes*, *Flavobacterium* and others. In the course of research, the active growth of the stimulating and phosphate-mobilizing strain of *Pseudomonas putida* 17 was isolated [6]. Despite the aforementioned advantages and the prospect of vermicomposting, technology has some disadvantages. These include the considerable duration of composting (4-6 months), the unmanageable microbiological processes, and the production of compost as a general-purpose organic fertilizer, which does not allow solving individual problems in growing crops.

One of the ways to solve the last drawback is to create biohumus based fertilizers and microbial preparations with specified properties (fungicidal, growth-stimulating, phosphate-mobilizing, etc.) by inoculation of the compost with agronomically valuable microorganisms. To a greater extent, today it is hypothetical. However, such attempts have been described in the literature. Thus, a method of producing biofertilizers, which is to obtain biohumus by composting a substrate from an organic waste of agriculture

and industry with the participation of "Obolensky hybrid", that obtained as a result of crossing the red hybrid Californian with the Russian population of rainworms (*Eisenia fetida*). Vermicomposting is carried out at + 16-24 ° C for 4-6 months. In the resulting biohumus, the microorganisms with fungicidal properties are introduced. Microorganisms are introduced after the removal of worms and maturing of biohumus. As a producer of fungicides used strain of bacteria *Bacillus subtilis* IPM-215 in the amount of from 10⁹ to 10¹² spores per 1 kg of biohumus, or culture *Trichoderma viride* 16 at concentrations from 10⁴ to 10⁸ colony forming units (CFU) per 1 kg of biohumus [8].

III. Object, subject and methods of research

Object of research: bioconversion of organic waste of composting.

Subject of study: change of indicators of bioconversion process of organic waste by vermicomposting method.

The studies were conducted within three months. Worms cultivation was in cultivators (plastic containers). The width of the container is 0.15 meters, the length is 0.25 meters, the height is 0.1 meters. The container was put a pre-fermented substrate (in our case - potato peel, cabbage, apple peel + tea / coffee), which was pre-prepared by grinding, moistening (crushed substrate with water in a ratio of 1: 1.5) and naturally was fermented with microorganisms, a layer of 2 cm, and introduced worms. Conditions of the environment were monitored during the bioconversion period. New portions of the substrate were added after 7-10 days with a layer of 1 cm. The number of worms was calculated 1/30 (once a day) [9]. After the bioconversion process, worms and biohumus are separated. Excess worms are used in feed production [10].

In laboratory studies, standard and adapted methods of analysis were used: determining the optimal temperature, humidity and pH of the medium for worms to calculate their population [11]; determination of the chemical composition of the substrate according to the calculations of the biological efficiency coefficient [12]; determination of the amount of humic acids by extraction method [12].

IV. Results of the work

To determine the speed and efficiency of organic waste processing by vermiculture we use the biological efficiency indicator. The essence of the calculation is to determine the relationship between the increase in biological mass and the time during which this gain.

$$\frac{\Delta}{\tau}, \text{h/d} \quad (1)$$

де Δ – biomass growth, τ – time, days (we are take like 10 days).

At a temperature of 30-32 ° C, especially at excess moisture of the substrate, in response to the temperature stimulus, the activity and body weight of the earthworms is reduced by increasing the secretion of the mucous secretion. At 37 ° C, the worms die. The effect of temperature on the number of individuals has been investigated. It is shown that the most favorable temperature at which *Eisenia fetida* increases with maximum speed and retains high activity is 18-28 ° C (Fig. 1). The studies were performed for 25 days.

The effect of temperature on the weight gain of worms has been investigated. It

is shown that the most favorable temperature at which *Eisenia fetida* gains mass with maximum speed and retains high activity is 18-25 ° C (table 1).

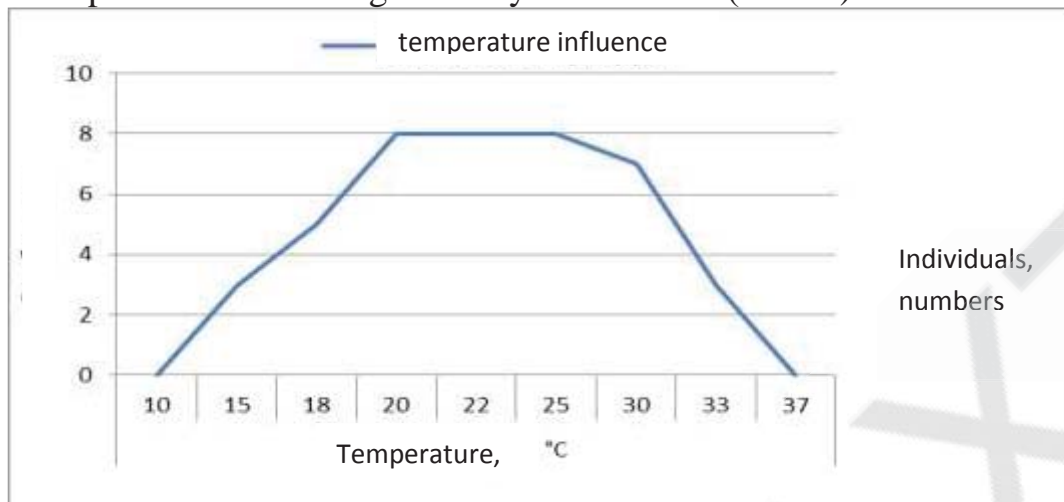


Fig.1 - Effect of temperature on the number of individuals *Eisenia fetida*.

Table 1 - Effect of pH of substrates on BA of red California earthworm *Eisenia fetida*.

Substrates variation	pH,unit.	BA, t/days
№1	5,0	0,63
№2	5,3	0,69
№3	6,5	0,72

Studies have shown a relationship between the BE of the red California worm (*Eisenia fetida*) and the pH of the substrate on which it is cultivated (Fig. 2).

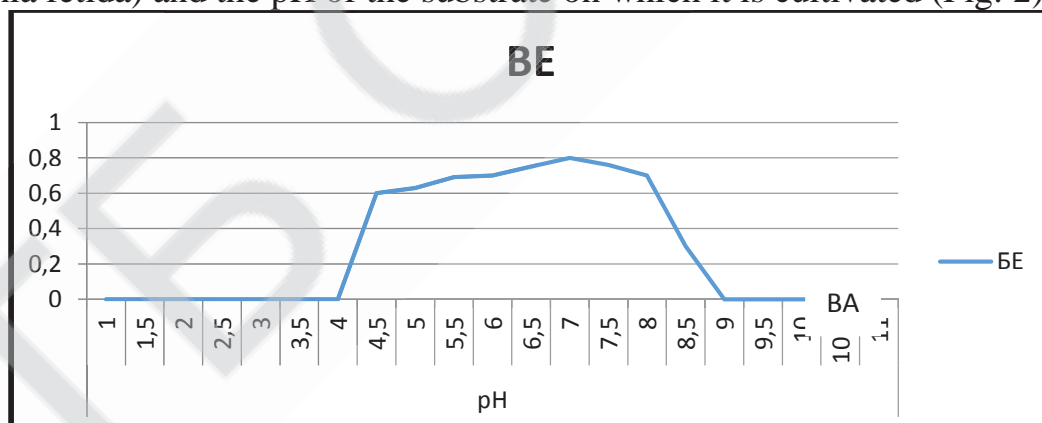


Fig. 2 - Substrate pH dependence on the BE of the California worm.

An increase in humidity of up to 90% impeded the access of oxygen to the substrate, which led to the development of anaerobic processes of substrate decomposition, which slowed the growth and development of worms. The studies were performed for 25 days.

The dynamics of growth of the number of individuals is shown in Fig. 3.

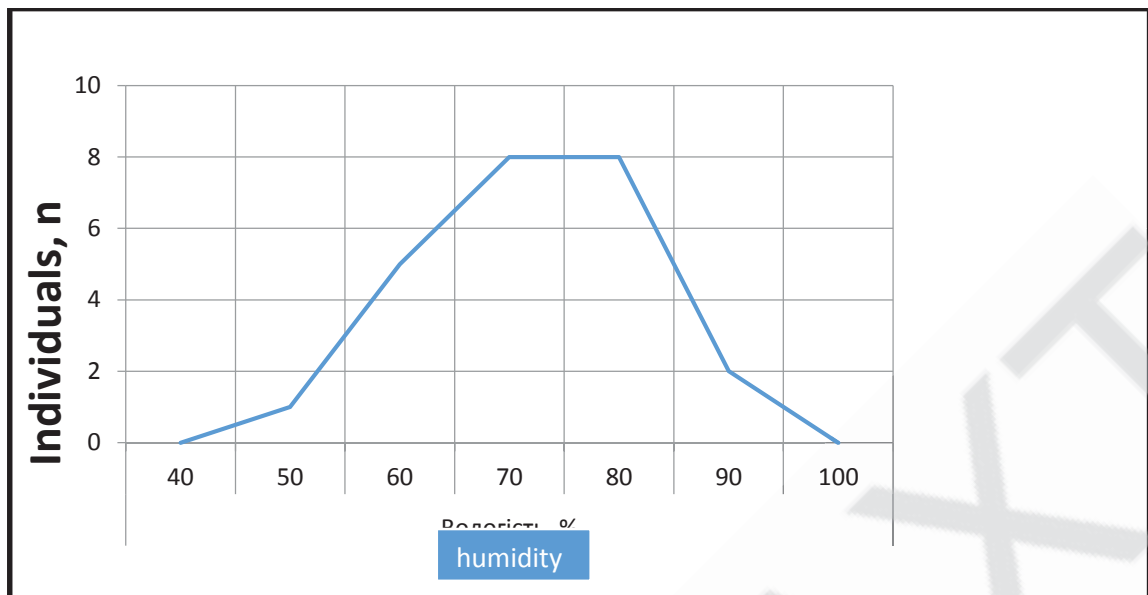


Fig. 3 - Effect of humidity on the number of individuals *Eisenia fetid*.

When growing earthworms in the laboratory, the maximum mass and production of biohumus are achieved with a humidity of the substrate, which varies in the range of 70 ... 80%, that is, is close to the water content in the body of the worm.

Research into the efficiency of food waste treatment. The studies have been conducted since September 2016 for three months. The cultivation of worms occurred in cultivators (plastic containers). The width of the container is 0.15 meters, the length is 0.25 meters, the height is 0.1 meters. In the container was placed the substrate, which was prepared in advance by grinding, moistening and natural fermentation using microorganisms, a layer of 2 cm, and introduced worms.

Preparing the substrate (feed) for feeding worms. Worm feed is a variety of high cellulose organic wastes that have undergone fermentation [1]. Raw vegetables, especially potatoes, should be cleaned thoroughly (through a meat grinder), otherwise they will not be processed. Under conditions of access of water and oxygen and under the influence of microorganisms-aerobes that are on the substrate (fungi, actinomycetes, bacteria), organic waste decomposes. Hydrolytic cleavage of high molecular weight compounds (proteins, fats, carbohydrates) produces intermediate and final low molecular weight products consumed by worms. Large organic waste particles need to be ground (up to 1 mm, not more) because they are not eaten by the worms[14].

Important is the condition that such a feed is free from harmful and toxic impurities.

There are the following requirements for the source organic substrate (waste) to produce quality feed for worms [1]: humidity 70–80%, pH 6.8–7.2, sufficient cellulose (20–25%), iron oxide content not more than 10%, no solid parts - metal, wooden, stones, glass, etc. Feed for worms should not contain pesticides, petroleum products, large amount of protein (not more than 25-30%), ammonia, methane, pathogenic microflora, eggs and helminth larvae. Worms are killed when 40% of the protein is in the feed.

At the beginning of studies to determine the increase in biomass for 2.5 months of substrate processing, the average weight of one adult adult worm was 0.15 g (Table

2). The largest increase in the average weight of the worm at the end of the experiment was found in option № 3 (0.36 g) and option 2 (0.31 g). The average earthworm biomass increase in version № 1 was 0.17 g. This substrate does not contain sufficient nutrients, so the biomass growth rate is negligible. It can be concluded that it is desirable to add coffee and tea to the main substrate.

Table 2 - Effect of substrate type on biomass production *Eisenia foetida*

Substrates variation	Duration of cultivation, days	Average biomass of an adult individual, g		Average biomass growth, g
		On the beginning	On the end of exploration	
№ 1	75	0,14±0,01	0,31±0,01	0,17
№ 2	75	0,15±0,01	0,47±0,01	0,32
№ 3	75	0,16±0,01	0,52±0,01	0,38

Thus, the data obtained indicate that the optimal substrate for vermicult propagation is substrate No. 3. The dynamics of change in the total weight of vermiculture, which was studied for 75 days is presented in Fig. 4, 5, 6.

The dynamics of change in the increase of total biomass of vermiculture are presented in Fig. 7, 8, 9.

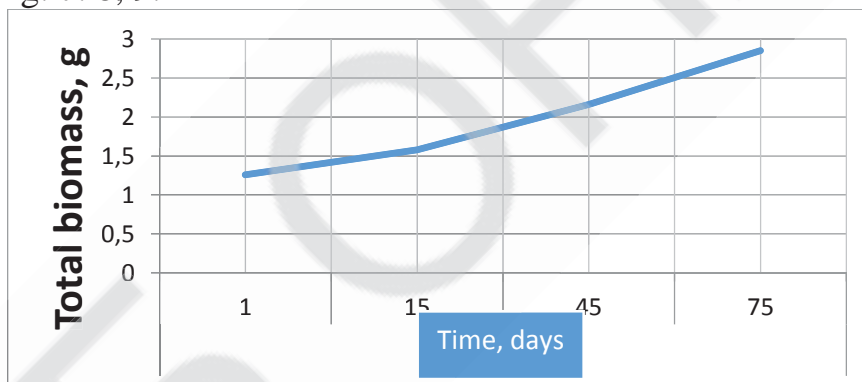


Fig. 4 – Integral dependence of change in total weight of *Eisenia fetida* for substrate №1 - potato peel, cabbage, apple peelin a weight ratio of 2: 1: 1

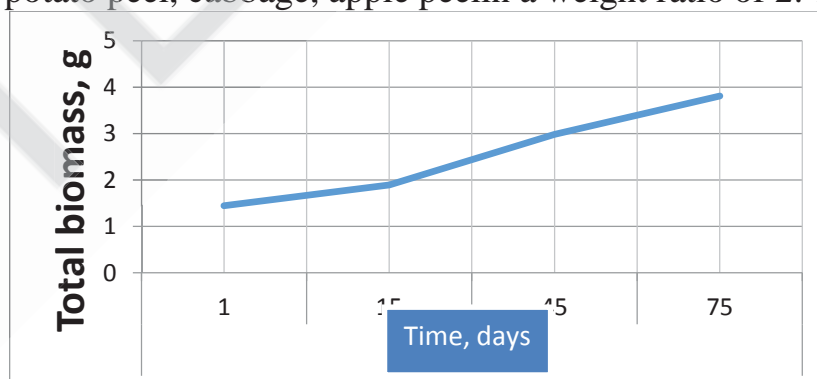


Fig. 5 – Integral dependence of change in total weight of *Eisenia fetida* for substrate №2 - potato peel, cabbage, apple peel, kava in a weight ratio of 2: 1: 1: 1

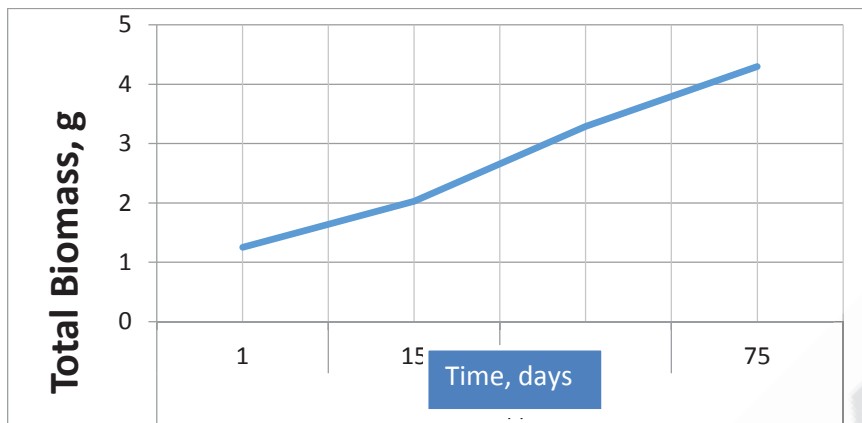


Fig. 6 – Integral dependence of change in total weight of *Eisenia fetida* for substrate №3 - potato peel, cabbage, apple peel, tea in a weight ratio of 2: 1: 1: 1

From the obtained data of the differential dependence, it can be concluded that the increase in biomass increases in direct proportion to time.

This graph shows the maximum increase after 45 days of cultivation, then the total increase is smaller, in connection with the physiological features of vermiculture.

In this graph, similarly, we observe the maximum increase after 45 days of cultivation, then the total increase decreases, due to the physiological features of vermiculture.

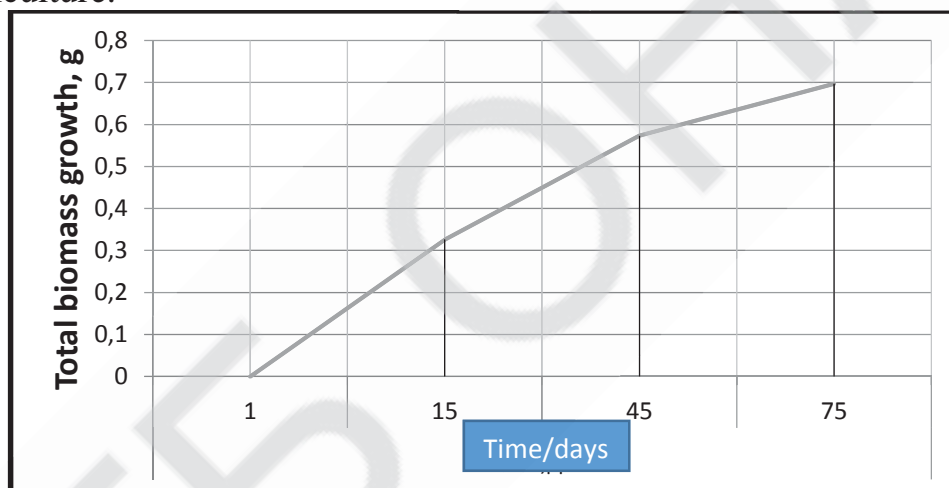


Fig. 7 – Dynamics of change of total biomass *Eisenia fetida* for substrate №1– potato peel, cabbage, apple peel in a 2: 1: 1 ratio

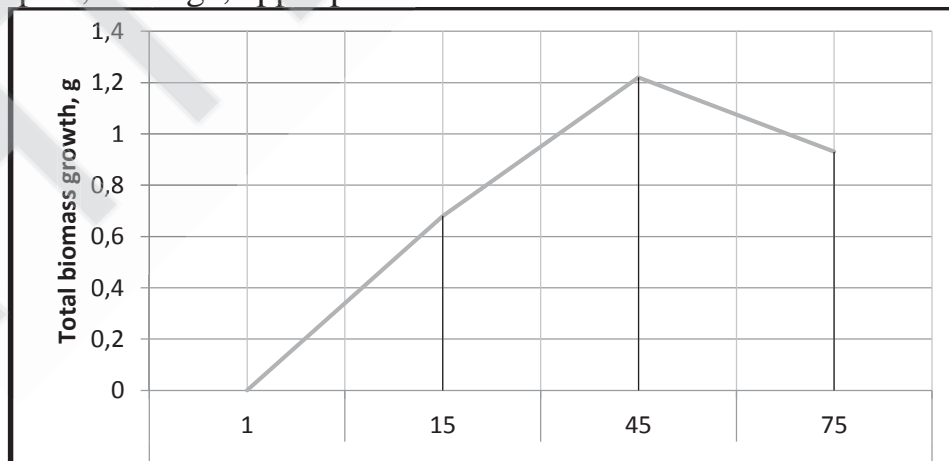


Fig. 8 – Dynamics of change of total biomass *Eisenia fetida* for substrate №2– potato peel, cabbage, apple peel, coffee by weight 2: 1: 1: 1

The formation of large quantities of highly concentrated sewage plants (MPPs) and the lack of efficiency of the methods used for their treatment pose a significant threat to the environment. The decisive role in the prevention of the pollution of reservoirs by sewage MSP belongs to and will certainly belong to the methods of biological sewage treatment, which is due to the technological, economic and environmental advantages of these methods over others.

The processing of this concentrated poly-mineral substrate and lignin wood with the help of earthworms into biohumus will allow to turn the production of biogas into a closed waste-free cycle, thus closing the natural cycle of substances[15]. Therefore, it is the process of vermicomposting of this substrate and will lead to the creation of valuable humic organic fertilizer. There is nothing left in the process of producing biogas that cannot be used and recycled. The obtained biohumus is a valuable natural highly efficient, environmentally safe, biologically active complex balanced humic organic fertilizer for all types of plants.

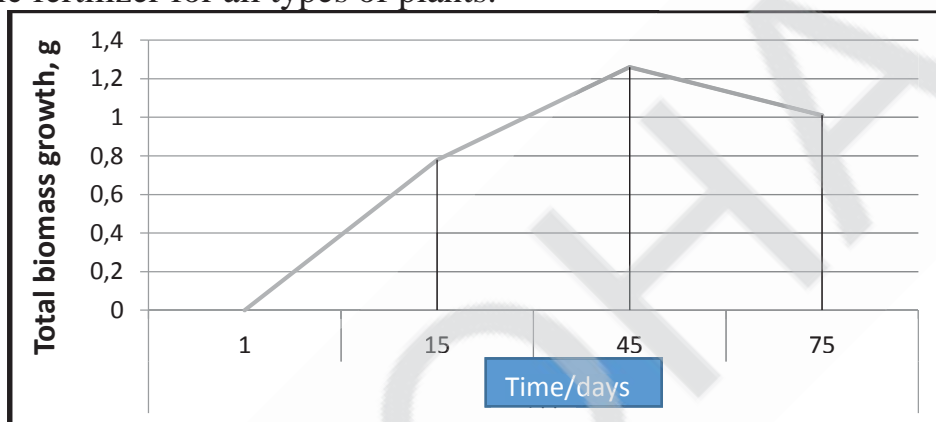


Fig. 9 – Dynamics of change in the growth of total biomass *Eisenia fetida* for substrate №3 - potato peel, cabbage, apple peel, tea in a weight ratio of 2: 1: 1: 1

The task is to create a method of treatment of fatty sewage sludge by aeration of a mixture of raw sludge and activated sludge with cellulose-containing filler and vermicult population to ensure the intensification of the process of biodegradation of sedimentary enrichment of the obtained organic fertilizer with biologically active substances. This problem is solved by the fact that in the method of processing fatty sludge provides the mixing of the sludge from the primary sedimentation tanks with activated sludge and aeration of air into the crude sludge and activated sludge enter cellulose-containing filler in different volumetric ratios, the resulting mixing and mixing is obtained humidity of 50 - 80%, after which they populate vermiculture and sustain for 30 - 60 days, maintaining humidity of 60 - 80% [9,16].

Raw fatty sludge is formed at the enterprises of meat and dairy, oil and fat processing industry of mechanical and physico-chemical methods of sewage treatment (in sedimentation tanks, grease traps, flotators, etc.). Sludge is a mass of paste-like consistency with an unpleasant odor and high fat content - 50 - 90% of dry matter.

Active sludge is a complex of colloidal type microorganisms with adsorbed and partially oxidized contaminants that are extracted from sewage by biological purification methods (in aeration tanks, etc.)[17].

This method of treatment of sewage sludge involves their aeration and processing vermiculture. Aeration is necessary for the decomposition of organic matter

sludge up to 4 simpler compounds consumed vermiculture.

A mixture of crude fatty sludge and activated sludge is prepared. Active sludge enriches a mixture of microorganisms that oxidize the organic matter of sediment in the presence of oxygen. However, the paste-like consistency of the mixture complicates the passage of air, so to give a structure that provides aeration, enter cellulose-containing filler. As cellulosic fillers can be used wood sawdust, crushed waste of wooden containers and trains of packaging materials, residues of plant materials (leaves, straw, waste of vegetables and fruits, etc.).

The prepared mixture is placed in containers and aerated. In the process of aeration there is intensive development and reproduction of microorganisms, with the temperature rising to 50-55 ° C. As the temperature accelerates the processes of oxidation and decomposition of organic matter precipitation, as well as the disinfection of the mass of the mixture.

Significant effect on the passage of oxidation processes has a moisture content of the mixture, because the nutrients dissolve in water, before they become available for consumption by microorganisms.

The influence of humidity on the processes of oxidation of organic matter during aeration was investigated. The data obtained presented in table 3.

Research data show that the rational humidity during aeration is 50-80%. An increase in humidity of more than 80% leads to inhibition of the oxidation processes in the mixture.

In the process of decomposition of the protein matter of wastewater, ammonia is formed, which adversely affects the vital activity of vermiculture.

The effect of aeration duration on the quality of the mixture was investigated. The obtained data are presented in table 4.

Table 3 – Influence of humidity on the processes of oxidation of organic matter during aeration

№	humidity, %	Substrates quality
1	30	Humidity does not contribute to the passage of biothermal processes, slows the development of microorganisms. The substrate is not suitable for oxidation.
2	50	Humidity provides the penetration of air into the voids in the substrate structure, sufficient for the passage of biothermal processes. The substrate is suitable for oxidation processes
3	65	Humidity provides access to oxygen to microorganisms. The substrate is suitable for oxidation processes.
4	75	Humidity provides access to oxygen to microorganisms. The substrate is suitable for oxidation processes.
5	85	The voids in the structure are filled with water. Which restricts the access of oxygen to microorganisms. The substrate is not suitable for oxidation.

Table4 – Influence of aeration duration on substrate quality.

№	Duration of aeration, days	Substrate quality
1	10	A significant amount of ammonia. The quality of the substrate for processing is poor.
2	15	Ammonia is minimal. The substrate is suitable for processing.
3	22	Ammonia is minimal. The substrate is suitable for processing.
4	30	No ammonia. The substrate is suitable for processing.
5	35	The substrate is suitable for processing, but extending the aeration term is not economically advantageous.

Studies show that the optimal aeration period is 15 - 30 days. After aeration, the substrate is inhabited by vermiculture. In the process of processing is swallowing pieces of organic matter worms and the formation in the intestinal cavity of humic substances. They markedly and for the better differ in chemical composition from the humus, which is formed with the participation of only microorganisms, because the intestines of the worms are the processes of polymerization of decomposition products of organics and formed molecules of humic acids, due to the intensive enzymatic and fermentative enzymatic activity. etc.), which accelerate germination of seeds, have a positive effect on the growth and development of plants, increase their resistance to disease. It is also important that microorganisms found in biohumus contribute to the conversion of toxic forms of metals to non-toxic, as well as block the inflow of plants and plant production of radionuclides [9].

The following were studies of the effect of humidity on the quality of processing of the mixture vermiculture. These studies are presented in table 5.

Table5 – Influence of humidity on the process of vermiculture.

Humidity, %	Substrates quality	Δ during 10 days, h
50	Humidity is insufficient. Vermiculture is motile. The substrate is not recyclable.	0
60	Humidity is sufficient. The substrate is suitable for processing.	0,1
70	Humidity is sufficient. Vermiculture is quite mobile. The substrate is suitable for processing.	0,15
80	Humidity provides comfortable cultivation. The substrate is suitable for processing.	0,15
85	Humidity is too high. Molds are developing.	0

These studies have shown that the rational humidity of the mixture in the processing of vermiculture is a humidity of 60 - 80% (table 6).

Table 6 - Effect of weight ratio of substrate components on biological efficiency

Substrates variation	Biological efficiency. h/t
1:2:2	0,07
1:1:2	0,075
1:2:1	0,05
1:1:1	0,06

The data obtained indicate that an increase in the amount of wastewater contributes to a decrease in the BA, as shown by the comparison of substrates 1: 2: 1 and 1: 1: 1. An increase in the amount of activated sludge contributes to an increase in BE, as shown by the comparison of substrates 1: 1: 2 and 1: 1: 1.

From the data obtained, we can conclude that the biological efficiency is greater in the variant of the substrate, where the content of activated sludge prevails.

The main indicator of the quality of the obtained biohumus is the release of free humic acids.

The results of the study of the influence of the weight ratio of components on the quality of biohumus are presented in table 7.

Table7 –Influence of weight ratio of substrate components on biohumus quality

Substrates variation	The yield of free humic acids,%
1:2:2	9,4
1:1:2	9,3
1:2:1	8,6
1:1:1	9,2

The data obtained indicate that an increase in the amount of wastewater contributes to a decrease in the yield of free humic acids, as indicated by the comparison of substrates 1: 2: 1 and 1: 1: 1. Increasing the amount of activated sludge contributes to an increase in the yield of free humic acids, according to a comparison of substrates 1: 1: 2 and 1: 1: 1.

Therefore, it can be concluded that the best variant of the substrate for the cultivation of *Eisenia fetida* and the processing of liquid organic waste is option number 2, in which the content of MSW wastewater is lower and the content of activated sludge is more prevalent.

The technological scheme of cultivation of red California worm (*Eisenia fetida*) on solid organic substrates is as follows, shown in Figure 10.

Using vermiculture different substrates, the technological scheme of processing may vary, but the main provisions are similar. Conducting an experiment with the different constituent composition of the substrate, we obtained different qualities of biohumus. The results are presented in table. 8.

Table8 – The influence of the ratio of substrate components on the quality of biohumus

Substrates variation	The yield of humic acids,%
Potato peel, cabbage, apple peelin a 2: 1: 1 ratio (control)	8,48
Potato peel, cabbage, apple peel, coffee in a 2: 1: 1: 1 ratio	8,76
Potato peel, cabbage, apple peel, tea in a 2: 1: 1: 1 ratio	8,98

Therefore, it is advisable to use 2 variant of the substrate, because the yield of free humic acids is the highest, which is the main indicator of the quality of biohumus. Functional technological scheme for the disposal of WFP waste and activated sludge by vermiculture method of red California worm (*Eisenia fetida*) includes the steps (Figure 11).

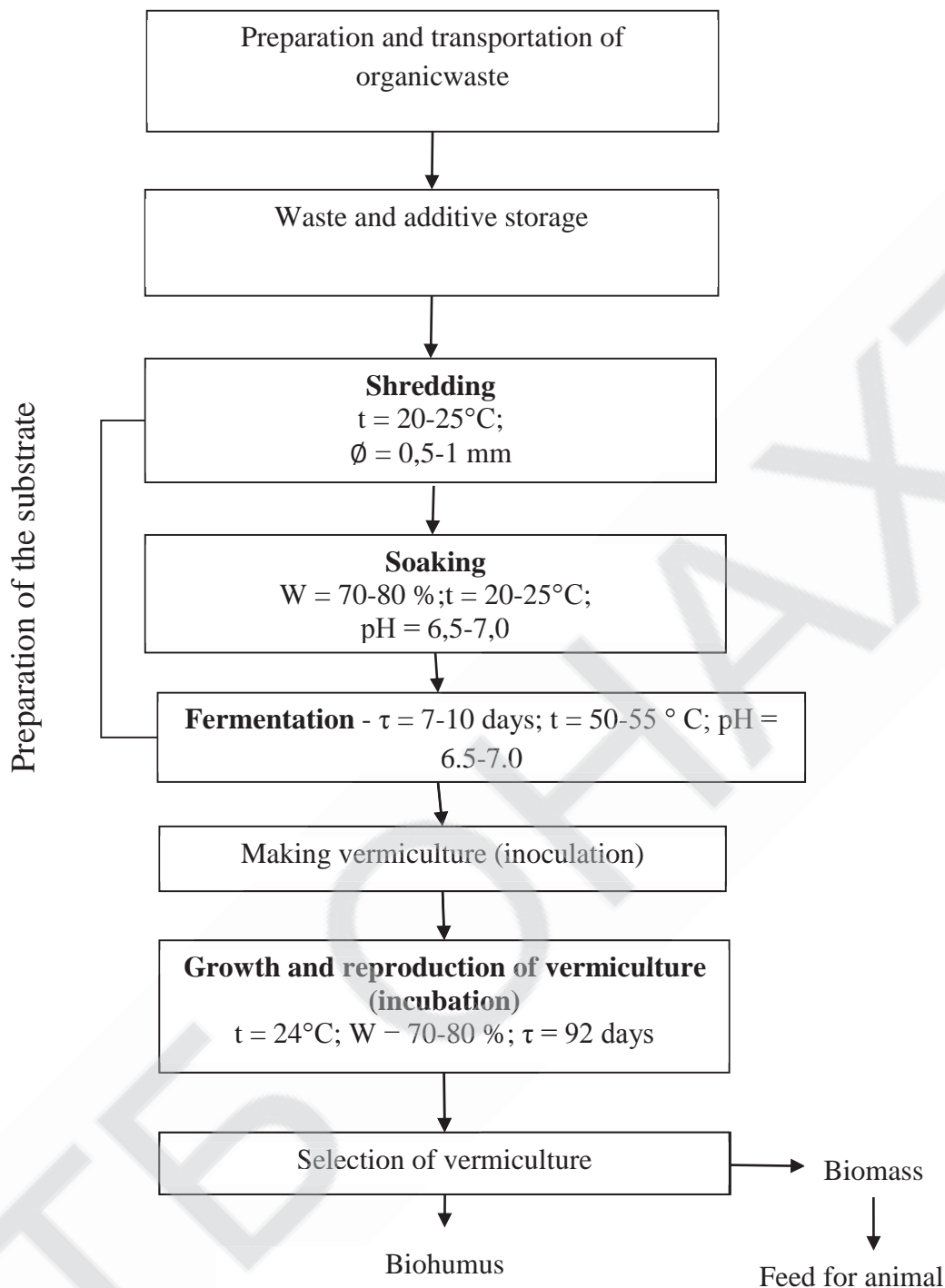


Fig. 10 – Technological scheme of organic waste disposal

The data obtained indicate that an increase in the amount of wastewater contributes to a decrease in the yield of free humic acids, as shown by the comparison of substrates 1: 2: 1 and 1: 1: 1 (table 9).

Increasing the amount of sludge in the biogas plant increases the yield of free humic acids, as shown by the comparison of substrates 1: 1: 2 and 1: 1: 1. Therefore, it can be concluded that the best variant of the substrate for the cultivation of *Eisenia fetida* and processing of liquid organic waste is option number 2, in which the content of wastewater MPP is less and the activated sludge is greater.

Table 9 – The influence of the ratio of substrate components on the quality of biohumus

Substrates variation	The yield of free humic acids,%
1:2:2	9,3
1:1:2	9,4
1:2:1	8,6
1:1:1	9,2

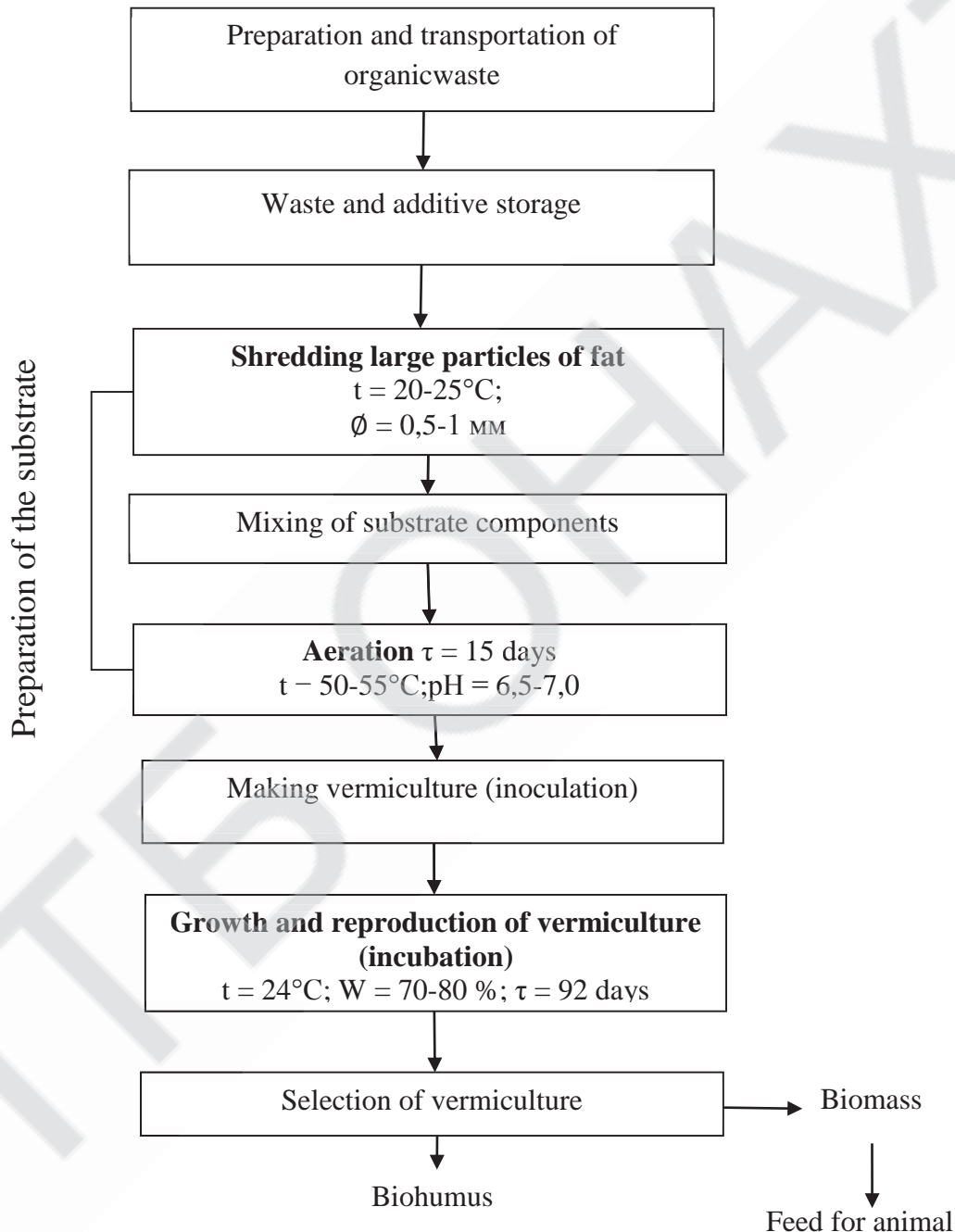


Fig. 11 -Technological scheme for waste management of MPP and activated sludge

V. Conclusions

1. Studies have shown that the process of artificial cultivation (*Eisenia fetida*) can be improved by determining the most rational parameters of the substrate on which the red California worm is cultivated.

2. It is found that the optimal temperature for the cultivation of the red California worm (*Eisenia fetida*) is 18-28 ° C.

3. Studies of the effect of substrate pH on the red California worm (*Eisenia fetida*) have shown that substrate acidification lowers worm's Biological efficiency, so vermicultivating is recommended on the substrates with a neutral pH.

4. When cultivating a red California worm (*Eisenia fetida*) on the basis of an organic substrate, the highest values of BE are recorded at a substrate humidity of 70-80%, so this moisture is considered rational for vermiculture.

5. It is established that the best version of the solid organic substrate on which the red California worm (*Eisenia fetida*) is cultivated, and also the most effective organic waste disposal is carried out, is option No. 3 (potato peel, cabbage, apple peel, tea in a weight ratio of 2: 1: 1: 1).

6. It is established that the best variant of the liquid organic substrate, in which the most effective utilization of waste is held, is the variant No. 2 - sawdust, sewage, activated sludge in a weight ratio of 1: 1: 2.

It has been proven that organic waste is degraded by the cultivation of the red California worm (*Eisenia fetida*).

VI. References

1. Lyashenko O.O., Movsesov G.E. Technology of accelerated biothermal composting of manure with organic moisture-absorbing wastes of agroindustrial complex. Recommendations. Institute of animal mechanization of UAAS. Zaporizhzhia BMI UAAN, 2007. 32s.

2. Maksimov S. L. Vermi Tekhnologii in Belarus. Organic agriculture of Belarus: development prospects: Materials of International scientific-practical conf. Composition presented: N. I. Perechina. Minsk: Donarit, 2012. P. 50–53.

3. Shevchenko I.A., Pavlichenko V.M., Lyashenko O.O. Ways of using organic animal husbandry waste. Mechanization, ecologization, and bioconversion of raw materials in animal husbandry: Collection of sciences works of the Institute of Livestock Mechanization of the UAAS. No. 1 (3–4). Zaporizhzhia: BMI UAAN, 2009. P. 3–16.

4. The technology of biocomposting of cattle manure with phosphorites under the influence of phosphate-mobilizing microorganisms: practical recommendations/structure: VV Volkogon, MV Gatsenko, NV Lutsenko, and others. Chernihiv, 2011. 17p.

5. Kasatikova S. M. Tests of vermicompost. Agrochemical Bulletin. 2002. No. 6. P. 29-30.

6. Yakushev A.V. Microbiological characteristics of vermicomposts: authorization dis. for the scientific degrees of cand. biol. Sciences: special. 03.00.07 "Microbiology". M., 2009.24 s.

7. Atiyeh, R. M. Effects of vermicomposts and composts on plant growth in horticultural container media and soil. Pedosphere biology. 2000. Vol. 44. P. 579–590.

8. Tiquia S.M. Microbiological parameters as indicators of compost maturity. *Applied Microbiology*. 2005. V. 99, № 4. P. 816 – 828. doi: 10.1111/j. 1365-2672.2005.02673
9. Patent No. 56619 of Ukraine (Declaration), INC 6 A 23 K 1/16. The method of obtaining feed additives / Kulyk OP, Garmash SM, Portnenko SV, Karlov AV - № 2002086404; claimed 08/01/2002; publ. 15.05.2003. Bul. № 4.
10. Patent No. 44169 of Ukraine (Declaration), INC 7 A 23 K 1/16. A method of obtaining feed additives for farm animals / Kulyk OP, Garmash SM, Portnenko SV, Karlov AV - № 2001064079; claimed 14.06.2001; publ. 15.01.2002 Bul. №1.
11. Vermiculture and Biohumus [Electronic resource]. - Access mode: http://ua-referat.com/Vermiculture_and_biogumus - Name from the screen .
12. Biotechnology: Textbook / V.G. Gerasimenko, MO Gerasimenko, MI Tsvilikhovsky, and others.; For the title. ed. V.G. Gerasimenko. - K: INKOS Firm, 2006. - 647 p.
13. Tables of the composition of products. [Electronic resource]. - Access Mode: <http://edimka.ru/tables/0-0-> Name of the screen.
14. Development of technology for processing organic waste using solid-phase fermentation and subsequent vermitransformation / [S. V. Soldatov, D. I. Stom, T. S. Prokhorova, T. F. Kazarinova] // Problems of taxonomy, ecology and toxicology of invertebrates. - Irkutsk: Nauka, 2000. - S. 113–115.
15. "The latest technologies of production and processing of livestock products": Abstracts of the state student scientific conference. - Bila Tserkva, 2012. - 61 p.
16. Bolshakov O.V., Stepanova O.A., Belova G.A. Wastewater treatment of meat industry enterprises. - M.: AgroNII, 1996.- 304 p.
17. Kulik A.P., Garmash S.N. Technology for processing agricultural waste // News of the Ukrainian Society of Engineers and Mechanics. Bulletin - 2000. - T. 2. - No. 1, 2. - S. 55-56. 35.

USAGE OF MODERN INFORMATION TECHNOLOGIES OF SOLVING THE OPTIMAL ALLOCATION PROBLEM INVESTMENTS IN THE ENTERPRISE Author: Anna Ignatenko Supervisor: Leonid Scherbak.....	463
4. POWER ENGINEERING AND ENERGY EFFICIENCY.....	472
EXPERIMENTAL PERFORMANCE ANALYSIS OF AN EJECTOR REFRIGERATION CYCLE IN CASCADE REFRIGERATION CYCLE Authors: Xinyue Xiao, Yifan Zhou, Yini Pan Supervisor: Guangming Chen.....	473
THERMODYNAMIC ANALYSIS OF PERIODIC OPERATION AMMONIA-WATER ABSORPTION REFRIGERATION UNITS IN ATMOSPHERIC WATER GENERATION SYSTEMS Author: Kravchenko Vladimir Supervisor: Vasyliv Oleh.....	491
DETERMINATION OF RATIONAL GEOMETRICAL RELATIONS OF SINGLE-PHASE ELECTROMAGNETIC SYSTEMS WITH RECTANGULAR CROSS SECTIONS OF RODS Author: Churilo Ruslan Supervisor: Sadovoy Aleksey.....	500
INVESTIGATION OF LED LIGHT SOURCES AND THEIR INFLUENCE ON THE POWER SUPPLY NETWORK Authors: Dmitriy Lira, Aleksandr Baran Supervisor: Aleksandr Baran.....	512
5. ECOLOGY AND ENVIRONMENTAL PROTECTION.....	522
ORGANIC WASTE DISPOSAL WITH USING OF IMPROVEMENT METHOD OF VERMICULTIVATION BY CALIFORNIAN WORMS (EISENIA FETIDA) Author: Elina Zaitseva Supervisors: Julien Castelin, Harkovych Oleksii.....	523
INVESTIGATION OF THE DESTRUCTION OF THE WINEMAKING SOLID WASTE THROUGH BIOCONVERSION PROCESSES Authors: Yevhen Alaibov, Stanisauskaite Karina Supervisors: Olga Sagdeeva, Laima Cesoniene.....	539
ECOLOGICAL ASPECTS OF NO-TILL TECHNOLOGY IN THE CONDITIONS OF SOUTHERN STEPPE OF UKRAINE Author: Oleksandr Herashchenko Supervisor: Boris Boincean, Tetiana Manushkina.....	552