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NEW METHODS OF MANURE DISPOSAL AND USE OF PROCESSING PRODUCTS IN PIG BREEDING

Mykhailo FOMICHENKO, getter
https://orcid.org/0009-0006-3750-5821
Institute of Pig Breeding and Agro-Industrial Production of NAAS,
Poltava, Ukraine

The research was conducted in the laboratory of innovative technologies and experimental facilities of Institute of Pig Breeding and AIP NAAS and in the conditions of LIGA COJIAP LLC. In the course of the research, they evaluated and improved the "stepping technology" of vermiculture, developed a method of extracting young dungworms from compost, determined the possibility of vermiculture in large-sized packages of the "Big-Bag" type, and the expediency of using vermighumus and "Nanoverm" in the rations of young pigs. Vermihumus was obtained by utilizing manure in a continuous reactor to obtain vermiproduction using California worms (Eisenia Foetida). Raw vermighumus was extracted in the ABC-100 vortex bed apparatus and the biological preparation "Nanoverm" was obtained. It is determined that the technology has been developed vermiculture in containers compared to that in the fields in open ground increases the output of vermiculture by 14.78% and vermihumus by 23.36%.

The developed method of extracting young worms from compost, compared to the known one, ensures the separation of young individuals from sexually mature ones from compost. allows to separate young individuals from sexually mature ones. For the effective disposal of manure as a biological reactor for the production of compost and vermiproduction, a large-sized package "Big-Bag" was used, as well as a thermal case, which is four horizontally stacked reconstructed used truck ramps, covered with a polyurethane cover, in the middle of which a thermostat and a two-meter heating cable are installed. The developed device provided air temperature in the zone of vital activity of worms in the cold period of the year within the range of 13-18℃. Before feeding, raw vermighumus was mixed with compound feed and placed in the feeder, and "Nanoverm" - in a trough with water. For weaned piglets, the dose of vermighumus was 80-120 g per head per day at the age of 28-45 days, and Nanoverm - 2 ml, for 46-60 days 2.5 ml, 61-75 days - 3 ml. It was determined that the introduction of vermighumus and "Nanoverm" into the diet of weaned piglets had a positive effect on their growth energy and survival. In terms of live weight, the piglets outnumbered the control analogues at the age of 60 days by 13, 11 and 6.96%, and at the age of 90 days - by 14.2 and 11.52%, respectively. The cost of additional main products obtained from feeding vermihumus and "Nanoverm"

to piglets was UAH 343.3/head in the first experimental group, and UAH 278.53/head in the second.

Key words: disposal, vermicomposter, vermihumus, "Nanoverm", weaned piglets, living mass, preservation, interior.

НОВІ СПОСОБИ УТИЛІЗАЦІЇ ГНОЮ ТА ЗАСТОСУВАННЯ ПРОДУКТІВ ПЕРЕРОБКИ У СВИНАРСТВІ

Михайло ФОМІЧЕНКО, здобувач[i]
https://orcid.org/0009-0006-3750-5821, e-mail: richsoil.ua@gmail.com
Інститут свинарства і АПВ НААН, Полтава, Україна

Дослідження проведенні в лабораторії інноваційних технологій та експериментальних об'єктів Інституту свинарства і АПВ НААН та в умовах ТОВ «ЛІГА СОЛІАР». В процесі дослідження проводили оцінку та удосконалення «крокуючої технології» вермикультивування, розробляли спосіб виїмки молодняку гнойових черв'яків із компосту, визначали можливість вермикультивування у великогабаритних упаковках типу «Big-Bag», та доцільність застосування вермигумусу і «Нановермі в раціонах молодняку свиней. Вермигумус отримували шляхом утилізації гною у реакторі неперервної дії для отримання вермипродукції з використанням каліфорнійських черв'яків (Eisenia Foetida). Вермигумус-сирець екстрагували в апараті вихрового шару АВС-100 і отримували біопрепарат «Нановерм». Встановлено, що розроблена технологія вермикультивування в контейнерах порівняно з такою у в буртах на відкритому грунті є підвищує вихід вермикультури на 14,78% і вермигумусу на 23,36%.

Розроблений спосіб виїмки молодняку черв'яків із компосту, порівняно із відомим, забезпечує відділення із компосту молодих особин від статевозрілих. дозволяє відділяти молодих особин від статевозрілих. Для ефективної утилізації гною в якості біологічного реактора для виробництва компосту та вермипродукції була застосована великогабаритна упаковка «Big-Bag, а також термо футляр, який являє собою чотири горизонтально складені реконструйовані вживані скати вантажних автомобілів, накритих кришкою з поліуретану, в середині яких установлено термостат і нагрівальнтй двометрового кабель. Розроблений пристрій забезпечував в в зоні життєдіяльності черв'яків температуру повітря в холодний період року в межах 13-18^{0}С. Вермигумус-сирець перед годівлею перемішували із комбікормом і вносили у годівницю, а «Нановерм» - у корито з водою. Для відлучених поросят доза вермигумусу склала на голову за добу у віці 28-45 днів 80-120 г , а «Нановерму -2 мл, на 46-60 днів 2,5 мл, 61-75 днів - 3 мл. Встановлено, що введення в раціон віднятих поросят вермигумусу і «Нановерму» позитивно вплинуло на їх енергію росту і збереженість. За живою масою відняті поросята переважали контрольних аналогів у віці 60 днів на 13, 11 і 6,96 %, а у 90-денному – відповідно на 14,2 і 11, 52 %. Вартість додаткової основної продукції, отриманої від згодовування вермигумусу і «Нановерму» поросятам склав у першій дослідній групі 343,3 грн/гол, а в другій – 278,53 грн/гол.

[i] *Науковий керівник - Іванов Володимир Олександрович, доктор сільськогосподарських наук, професор, головний науковий співробітник Інституту свинарства і АПВ НААН України*

Ключові слова: утилізація, вермикомпостер, вермигумус, «Нановерм», відняті поросята, жива маса, збереженість, інтер'єр.

Introduction. The modern practice of industrial complexes and farms highlighted one of the environmental problems associated with the utilization of animal waste products (Ivanov V.O., Voloshchuk V. M., 2019; Maksym V., D. Solomonko Lytvyn R., 2021). One of the progressive methods of manure disposal is vermicomposting. The development of this direction in agro-ecological production makes it possible to develop a system of diversification of vermitechnologies for obtaining organic products in the field of pig farming, as well as to solve a number of urgent environmental problems, namely: utilization of manure by vermicomposting, obtaining high-quality, environmentally friendly organic fertilizer, increasing soil fertility, strengthening the fodder base, obtaining safe organic pork (Senchuk M.M. Senchuk M.M., 2018; Senchuk M.M., 2020).

In the process of processing biohumus, earthworms (vermiculture) release a valuable product - caprolite, which was named vermihumus (Sherman R.. 2018). According to a number of scientists, an important characteristic of vermighumus as an environmentally friendly fertilizer is its macro- and microelement composition (from 14 to 18 and 25%) of nitrogen, phosphorus, calcium, magnesium, copper and zinc. The highest content of Mn (94–148 mg/kg) and Fe (74–195 mg/kg), less Zn, S, B, and the amount of Co and Cu did not exceed 1 mg/kg were noted in the vermihumus obtained after the processing of cattle manure. By means of vermicomposting, high-quality, environmentally friendly organic fertilizer (vermighumus) is obtained, which is used to increase soil fertility, strengthen the fodder base and grow safe organic pork (Maxim V., et. al., 2021; Przemieniecki, S.W. et. al., 2021).

One of the features of vermighumus is that it significantly reduces emissions of polluting gases (Naushin Y. et. al., 2022; Spiehs M.J. et. al., 2019). In this connection, vermiculture should be considered a new element of the technological process of production and processing of pig products. Bioprocessing of agro-industrial complex waste by the vermicomposting method helps to improve the ecological condition of the environment, as well as to obtain effective ecologically safe bioadditives (Dyudiaeva O.A., Rutta O.V., 2024; Maksym V. et. al., 2021). Along with this, there is more and more information in foreign and domestic literature that vermihumus is an effective source of protein replenishment in fodder production and animal feeding (Shatalin D.B., 2017; Hesami Y. et. al., 2020).

Analyzing the state of existing technologies in pig breeding, it should be noted that the recycling system and the diversification system are practically not developed for obtaining organic products of fodder and pork in conditions of agro-ecological production

In this regard, (Valyavska K.V. et. al., 2023; Zhuk P.V., 2022, Hussein I.A., Mona S.M.M., 2018) the further improvement of vermiculture technology through the development and implementation of new technical means for deep processing of vermihumus and the use of the resulting products in animal husbandry and fodder production, solving a number of important environmental problems, is urgent.

The purpose of the research is to develop new methods of manure disposal and the use of processing products in pig breeding.

Research materials and methods. Experimental research was conducted in the period 2020-2024. at "LIGA SOLAR" LLC, Zaporizhzhia, OJSC "Agroprime Holding". and in the laboratory of innovative technologies and experimental livestock facilities of the Institute of Pig Breeding and APV of the National Academy of Sciences, Research

took place in four stages. At the first stage, evaluation and improvement of the "stepping technology" of vermiculture was carried out.

At the second stage, a method of extracting young dungworms from compost was developed. At the third stage, the possibility of vermiculture in large-sized packages of the "Big-Bag" type was determined. At the fourth stage, the expediency of using vermihumus and "Nanoverm" in the diets of young pigs was determined. Vermiculture technology was carried out in accordance with methodological recommendations (Senchuk M.M. Senchuk M.M., 2018; Senchuk M.M., 2020, Sherman R.. 2018).

Vermiproduction was obtained by using vermiculture technology in continuous reactors (fig. 1).

Fig. 1. **3The content of humic substances in vermihumus was: humic acids-3.6% or 36.0 g/l, fulvic acids-3.0% or 30.0 g/l, humic substances-6.6% or 66.0 g/l.**

Biopreparation "Nanoverm" was obtained by extracting the obtained vermighumus in the ABC-100 vortex bed apparatus (fig. 2).

Fig. 2. **General view of the equipment for obtaining "Nanoworm"**

In "Nanoverm" the content of humic substances was: humic acids-0.56% or 5.6 g/l, fulvic acids-3.53% or 35.3 g/l, humic substances-4.09% or 40.9 g/l.

To determine the expediency of using vermighumus and "Nanoverm" in the rations of young pigs, three sub-experimental groups were formed (table 1).

Table 1

Scheme of feeding weaned piglets

Group	n	Feeding conditions of weaned piglets
Control	30	Standard combined feed according to existing norms
I-Experimental	30	Standard combined fodder + vermighumus (80-120 g per head per day)
II-Experimental	30	Standard compound feed + dietary supplement ("Nanoverm" 3-4 g per head per day)

The fattening productivity of young animals was determined according to the relevant methodical recommendations of Institute of Pig Breeding and AIP NAAS. The economic efficiency of research results was determined according to (Andriychuk V. G. (2002). The research results were processed using the methods of variational statistics (Chepur S.S., 2023).

Research results. "Stepping technology" allows vermicomposting to be carried out both outdoors and indoors (*Fig.* 3). It consists of several operations: preparation of the substrate, formation of the starting edge, settlement of the edge with a population of worms, control of adaptation, feeding, collection of worms, raw vermicompost, creation of conditions for humification and mineralization of vermicompost. separation of vermicompost and its storage.

Fig. 3. **Sides of the "stepping technology" of vermiculture in open ground and indoors**

Preparation of the substrate consists in preliminary natural composting of humus for 2-3 months outside in open ground. First, the basic substrate is prepared from the pre-fermented organic substrate, and a pillow of the future vermiburt is arranged from it on the concrete floor. A starting deck made of substrate with a width of 80-100 cm and a height of 20-30 cm is laid out on it. The length depends on the size of the room or composting area.

Then this substrate is inhabited by a population of compost worms of the Eisenia fetida species, at the rate of 2-2.5 kg of compost per 1m2. After 7-10 days, a 7-10 cm

layer of fodder substrate is layered on top of the burt and moistened. These operations are repeated regularly until the height of the side reaches 60-90 cm. From this moment, layering of the prepared fermented fodder substrate for compost worms and moistening is carried out only on one side of the formed stationary side. Also, fertilizing vermiculture with fodder substrate is started by layering only on one side.

Periodically moisten with water by sprinkling or spraying (humidity of the substrate should be 75-85%). The burt, which is in the room, is covered with agrofibre, and if it is outside - with straw. The layer of straw is 10-15 cm in summer, and 50 cm in winter. Periodically moisten with water by sprinkling or spraying (humidity of the substrate should be 75-85%). The burt, which is in the room, is covered with agrofibre, and if it is outside - with straw. The layer of straw is 10-15 cm in summer, and 50 cm in winter. In this method, compost worms continuously migrate for the nutrient substrate from one side of the burt to the other, forming an active zone of vermicomposting and vermiculture (Birnbaum J. A., 2015).

It should be known that after the formation of vermihumus, the next layer of top dressing must be applied, into which compost worms also continuously migrate, forming the next active zone of vermicomposting and vermicultivation, while a layer of finished vermihumus is removed from the opposite, respectively left or right, side of each side. The raw vermicompost collected from the sides is sent to the fermentation and humification area (closed soil; ventilated room without direct sunlight). It is stacked at a height of 1.5-2 m for further ripening and slow natural drying to a humidity of about 40% for 1-2 months. The disadvantage of this method is that compost worms are tasty food for rats and mice (Zaitseva V.G., Nesterenko O.V., Chernyshenko G.O., etc., 2020). As a result, the output of vermihumus and vermiculture decreases. The basis of the useful model is the task of improving the method by preventing contact between rodents and worms.

This task is achieved by forming ridges from separate grid containers filled with compost and vermiculture, and after completion of vermicomposting and vermiculture, new containers filled with nutritious substrate without worms are placed next to them (Fig. 4).

To implement the method, a container (fig. 1-5) was developed, which consists of a metal frame (1), in the whole bent pyramidal trapezoid, four walls (2), which are made of lattices, and the fifth - contains a hinged door (3) with a latch (4) and movable hinges (5). Fig. 1 shows the device in an axonometric projection in working condition, in fig. 2 - in a non-working condition, with the door open, in Fig. 3 - a cross section of a row of containers filled with compost and vermiculture, in figs. 4 and 5 - a diagram of filling a container with compost and vermiculture. Example 1. A substrate of organic composition made of pre-fermented organic material (cow, pig manure or other organic waste) is placed through the open door (2), which is fixed on the frame (1), into a container (fig. 1, 2), inserted into a support (fig. 4, 5), and from one of the walls (2) a population of compost worms is planted in the substrate.

Next, a self-propelled stacker forms ridges with a certain distance between them on an open site for vermicomposting. After the completion of vermicomposting and vermiculture and the formation of fresh vermihumus in the container, a second container filled with fresh nutrient substrate is tightly placed next to it, where the worms from the first container migrate. from the first container, forming the next active zone of vermicomposting and vermiculture (3).

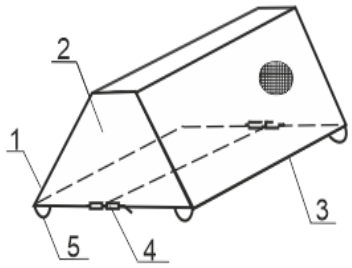


fig. 1

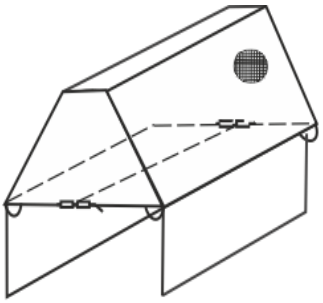


fig. 2

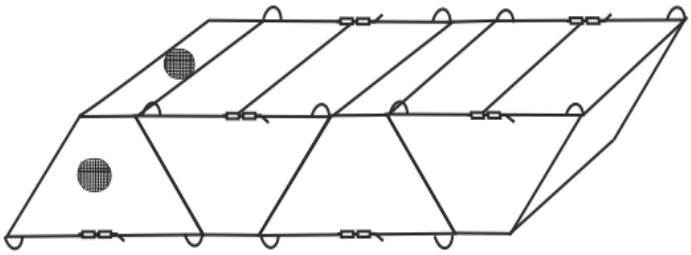
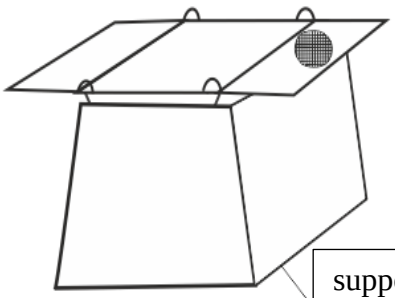
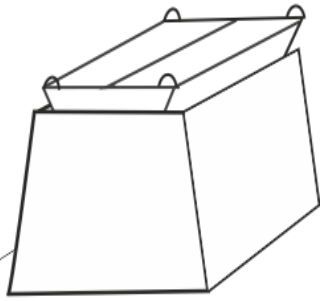


fig. 3





support for the container

fig. 4

fig. 5

Fig. 4. **General appearance of containers for ridge vermitechnology**

After the completion of vermicomposting and vermiculture and the formation of fresh vermihumus in the second container, a third container with a nutrient substrate is tightly placed to it again, where the worms from the second container migrate, etc. Containers with missing worms and ready biohumus are lifted by self-propelled stacker by hinges (5) and transported as intended. New containers with fresh substrate are placed in place of the evacuees and the vermicomposting process continues.

Given that the cells of the latticed metal wall (2) have a small size (up to 1 cm in diameter), the worms are completely protected from the penetration of rats and mice, which significantly increases the yield of vermiculture and vermihumus. Comparative characteristics of the efficiency of different methods of vermiculture and vermicomposting are given in table 2.

The data in table 2 indicate that the use of a new method of vermiculture and vermicomposting increases the output of vermiculture by 14.78% and vermihumus by 23.36%.

Table 2

Effectiveness of different methods of vermiculture and vermicomposting

Indicator	Prototype	Proposed method
The volume of manure in the container, m^3	1.0	1.0
Introduced vermiculture, kg	1.5	1.5
Received vermiculture, kg	11.5	13.2
Output of vermighumus, kg	50.5	62.3

A number of methods are used to quickly collect vermoproducts (Sherman R., 2018). For example, in the USA, a method of collecting dung worms from compost has been developed, which consists in adding bait - peat, rotten pieces of vegetables, coffee grounds, pieces of paper - to individual mesh bags used in households to store various vegetables, and then placing them in the top layer of compost, into which vermiculture was previously loaded for processing (Evans T., 2015). In the process of vermicomposting, worms from the compost crawl into mesh bags, where they consume the bait described above. After processing humus and bait, bags with worms at different stages of development (young, sexually mature) are removed from the processed compost and sent to their destination. The disadvantage of this method is that it does not allow separating young individuals from sexually mature ones. In scientific and industrial practice, such a technological operation is absolutely necessary.

Therefore, in order to improve the method, the bait is placed in bags made of mosquito net (the size of the cells is no more than 1.4 mm), and rotten fruits (pears, apples, apricots, plums) with a moisture content of no more than 70% are used as bait. In addition, the bag's stay in the compost should not exceed 5 days.

Example. Prepared compost with vermiculture (dung worms Eisenia fetida) is placed in bags made of mosquito net (the size of the cells is no more than 1.4 mm), filled with bait - rotten fruits (pears, apples, apricots, plums) with a moisture content of no more than 70%. Such humidity provides optimal conditions for the life activity of worms. Observations showed that worms consumed rotten fruits (pears, apples, apricots, plums) much better than rotten vegetables (table 3). Observations showed that young worms (up to 20 days old) freely penetrate through the cells of the mosquito net (diameter of the cell 4 mm), and at the age of 40-45 days they penetrate through the cells with tension, changing the thickness of the body due to its significant elongation. Periodically, but no later than 5 days, the bags were taken out of the compost and sent to their destination, and the formed vermicompost was sifted through a vibrating screen and thus received pure vermicompost and adults. Why do you need to remove the bags from the compost no later than 5 days? This is due to the fact that after 4-5 days, young worms become adults (puberty in worms also occurs at the age of 50-60 days). If the age at the time of introduction of worms into the bag is 45 days, and the period of stay is more than 5 days, the young individuals at the age of 45 days will become sexually mature (5+45 = 50 days), which will nullify the success of the method. This method of extracting young worms from compost can also be used for worms of other species under conditions of similarity of morpho-physiological parameters (age, body length, body thickness, sexual maturity).

The advantage of the proposed method is that it ensures the separation of young individuals from sexually mature ones from the compost. Therefore, recently, scientific institutions of various countries of the world have been intensively searching for methods and ways of removing, processing and using manure from large pig farms, which involve its complete utilization. The solution to this problem lies primarily in the fact that

livestock complexes become a source of raw materials for obtaining additional agricultural products (Bogatova D. R., 2018; Skorobogatov M.M., Kutserubova O. I., 2011).

Table 3

The attractiveness of the bait for worms according to the prototype and the new method

Indicator	Type of bait in a bag	
	moss, rotten vegetables, coffee grounds, pieces of paper	**rotten fruits (pears, apples, apricots, plums)**
The number of young worms in the bag 5 days after applying the worm bag, %	38	52
The number of young worms in the bag 10 days after applying the worm bag, %	64	88

The modern stage of manure disposal using vermiculture is a significant and effective biological method. In this connection, the further development and improvement of new technical means of vermiculture is relevant. As a biological reactor for the production of compost and vermiproduction, we used a large-sized package "Big-Bag" (0.75 x 0.75 x 1.25), which is widely used for packaging packaged and bulk building materials, ore, vegetables, fruits, mineral fertilizers, etc. (Fig. 5).

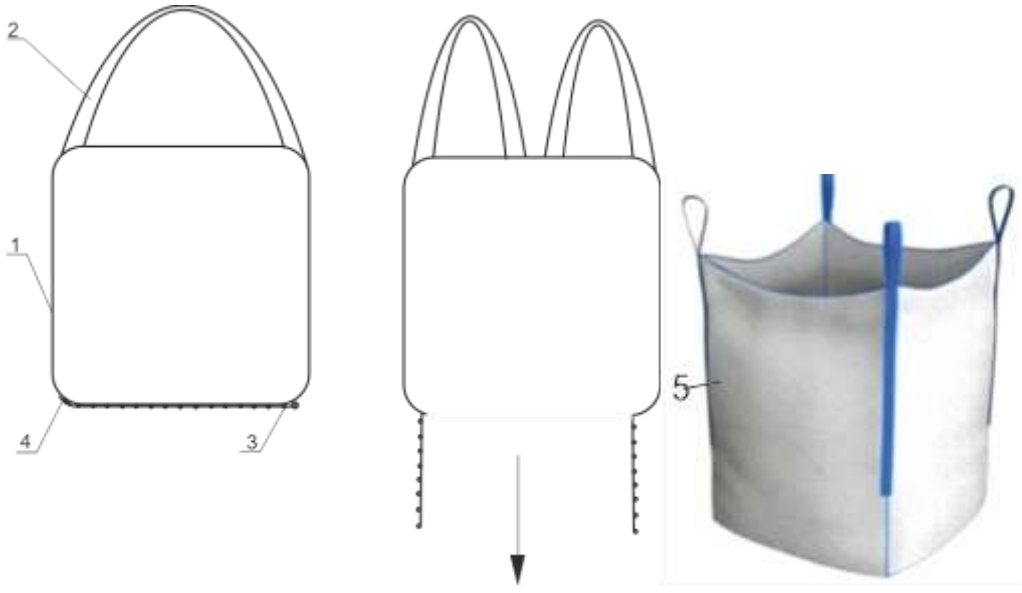


Fig. 5. **Vermicomposter with flexible walls: 1-case with polypropylene walls, 2- handles for gripping with a crane, 3- rings, 4-cord, 5- "Big-Bag" packaging.**

The task is implemented in the following way. With the help of a conveyor, fresh manure is loaded in layers through the neck of the package and watered with an aqueous solution of the biological preparation "Complesyn" on top. which is intended for quick processing of manure and obtaining vermihumus suitable for the settlement of

vermiculture. The drug was first diluted with warm water (20 g per 1 liter) and after 15 minutes evenly sprayed manure, which was added to the package at the rate of 10 liters per 1 m^3 of manure. According to the manufacturer's recommendations, the composting process should be carried out in the spring-autumn period, which takes place within 6-8 weeks, depending on the outside temperature. In our research, an additional task was set: to carry out composting in the cold period of the year (autumn-spring). A case was used to store each package, which is four horizontally stacked reconstructed used truck ramps, covered with a polyurethane cover (Fig. 6).

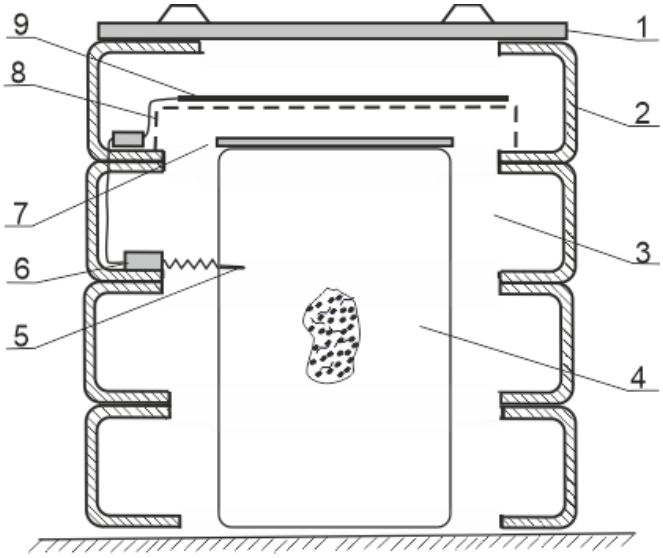


Fig. 6. **Case for packaging "Big-Bag with substrate": 1 - cover, 2 - slope, 3 - cavity, 4 - packaging, 5 - capillary tube, 6 - thermostat, 7 - polyurethane board, 8 - grid, 9 - heating element.**

An installation consisting of a thermostat and a two-meter heating cable (30 W/m) was used to heat the substrate. The thermostat contains a case with a handle, a canister with freon, connected to a spring and a capillary tube and designed to maintain a temperature in the range of -30...+ 30 ^{0}C. To prevent the manure from drying out in the "Big-Bag" packaging, a wooden board was placed on it, and a heating unit was placed on top. A capillary tube was inserted into the substrate and a temperature of 30 ^{0} C was set on the body using a handle. With this parameter of the thermostat and the average temperature of the outside air in the range of +0.4...-3 ^{0}C, the composting process lasted five weeks.

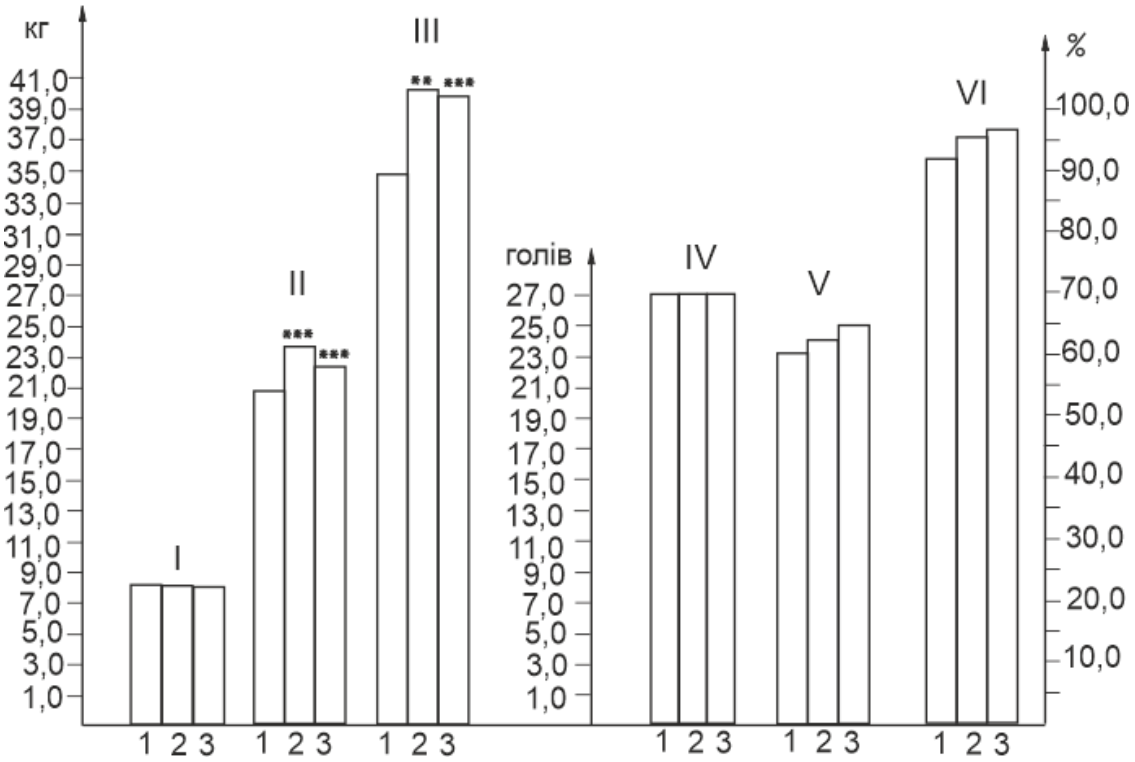
Next, a brood box with California worms (0.78 kg) was added to the prepared compost (70-80%) from above. The temperature in the living area of worms, depending on the temperature of the outside air, fluctuated between 13-18 ^{0}C.

The vermicomposting process lasted five months. At the end of vermicomposting, the mass of worms was 5.48 kg, and the mass of vermihumus was 0.5 m^3 .

To obtain liquid vermighumus or "vermichayu"several liters of specially purified structured water are poured onto the substrate, which flows through the entire substrate, is saturated with living microflora, soil microorganisms, spores, soil antibiotics, micro- and macroelements, humates, fulvic acids, amino acids, phytohormones, enzymes, vitamins, plant growth and development hormones and drains through the spill valve located at the bottom of the package . After the end of the compost processing process, the mother vermiculture is selected for further breeding.

To do this, a box with a new nutrient substrate is placed on the surface of the formed vermighumus, to which the worms willingly move. Next, the box with the mother culture is placed in a large package with prepared compost. Vermighumus, together with cocoons and other worms, is poured into vehicles, taken to fields to improve soil fertility, or used as a feed additive.

In order to establish the possibility of using feed additives from vermighumus and "Nanoverm" in the rations of young pigs, we conducted a production inspection. The results of the research are shown in Fig. 7.



*Note. **P>0.99, ***P>0.999 compared to the control group*

Fig. 7. **Indicators of productivity and survival of weaned piglets: I- number of piglets at the time of rearing (28 days), goal, II- live weight of piglets at the age of 28 days, kg, III- live weight of piglets at the age of 60 days, kg, IV- live weight of piglets at the age of 90 days, kg, V- Number of piglets at the age of 90 days, goal VI- Survival at the end of the 3-month age %.**

It was found that the weaned piglets of the first and second experimental groups exceeded their peers at the age of 60 days by 13.11 and 6.96% in live weight, and at the age of 90 days by 14.12 and 11.52%, respectively. The animals of the experimental groups also had a higher survival rate by 4.3 and 8.9%, respectively, which also confirms the biological activity of humates in growing young pigs. The cost of additional main products obtained from feeding vermighumus and Nanoverma" to piglets was 343.3 UAH/head in the first experimental group, and 278.53 UAH/head in the second. The results of hematological studies of young pigs showed that when adding vermigums in the amount of 50-80 g/head per day and "Nanoverm - 1-2 ml/ head per day to the main compound feed of suckling piglets of the first experimental group at the age of 90 days, the hemoglobin content increases by 6.27% and 8.75% compared to the control.

Table 4

Biochemical indicators of blood, g/l

Group	Age, days	Indicator		
		total protein	albumin	globulin
Control	28	42,21±2,43	25,25±3,92	14,68±3,24
	60	43,32±2,45	26,45±1,21	16,45±1,57
	90	54,02±2,24	28,01±1,96	22,41±2,02
1-experimental	28	47,21±2,23	28,25±2,02	16,68±1,24
	60	49,32±2,45	27,81±1,21	18,45±1,44
	90	59,71±2,74	34,21±1,36*	25,47±2,02*
2-experimental	28	47,21±2,13	29,25±1,91	18,68±1,34
	60	45,32±2,25	30,1±2,11	21,45±1,57
	90	62,14±2,14*	34,82±2,04*	28,47±1,12*

*Note. *P≤0.05; compared to the control group*

At the age of 90 days, the level of hemoglobin increases by 8.75% ($p<0.01$) compared to the indicators of the control group. Our data are consistent with the materials of foreign authors (Kovacik A, Sladecek T., Massán M. et.al., 2022). Feeding vermigmus and Nanoverm to piglets had a positive effect on protein metabolism and some indicators of animal resistance. (table 4).

Discussion. Improving technologies for the utilization of farm animal manure is a logical development of agricultural production, the final link of which is recycling and diversification (Skorobogatov M.M., Kutserubova O.I., 2011, Hussein I. A.S., Mona S.M. M. (2018). In our opinion, most of all, this process will be accelerated due to the introduction of innovative methods and techniques (Ivanov V.O., Voloshchuk V. M., 2019). Based on the goal, at the first stage of research, technological solutions for the production of vermihumus and worm products were evaluated. It should be noted that they were held in the nursery of LLC "Liga Solar" (Zaporizhia), which in its production activities is engaged in deep processing of manure and sale of the obtained products. When comparing the two most common technologies ("stepping edges" and "stationary edges") it was established that they have common opportunities for implementation both in open areas and in closed places without additional financial investments due to the rapid growth of the worm population. the technology of vermiculture in stepping edges compared to stationary ones in the calculation per 1 m^2 allows to increase the production of vermihumus by 1.68 times, vermiculture by 1.87 times. According to a number of authors (Zaytseva V.G., Nesterenko O.V.,. Chernyshenko G.O, etc., 2020), the considered technologies have a general drawback, which is due to the fact that worms attract rats and mice, which significantly reduce the yield of vermiculture. Therefore, in order to prevent contact with rodents, we have developed a method and a device for its implementation. Its essence is that the ridges are formed from separate lattice containers filled with compost and vermiculture, and after completion of vermicomposting and vermiculture, new containers filled with nutritious substrate without worms are placed next to them. In addition to the above-mentioned technologies, a new method was developed that allows you to lure worms from vermighumus, separating young individuals from sexually mature ones. In contrast to the known method (Evans T. 2015), we proposed a more perfect method because it ensures the separation of young individuals from sexually mature ones from the compost. This does not happen in the known method. Worms at various stages of development crawl into the mesh bags.

At the next stage, the large-sized packaging "Big-Bag" was studied as a biological reactor for the production of compost and vermiproduction in warm and cold seasons. The obtained vermighumus was used in feeding pigs. In the course of the study, it was established that the young of the II and III experimental groups exceeded their counterparts in terms of live weight by 4.02 and 8.76%, respectively. %. There are a number of reports in the scientific literature that confirm the positive effect of vermiguvmus on the results of pig breeding (Valyavska K.V., Geysun A.A., Matrosov O.S., 2023; Shatalin D.B., 2017).

An innovative method was used to obtain the biologically active substance - "Nanoverm" (trade name) from vermighumus - extraction in the AVS-100 vortex field apparatus. This method increases the content of humic substances in the finished product, compared to the prototype, 3.32-9.98 times higher. The introduction of "Nanoverm" into the diet of young pigs helped to increase their growth energy and the humoral defense of the body, which affected their survival. As you know, globulins provide humoral protection of the animal body. According to the content of globulin days, the piglets of the experimental groups slightly exceeded the control analogues, which can be explained by the influence of vermighumus and nanoverm, which were fed during the post-weaning period, which caused an increase in the synthesis of immunoglobulins. Our conclusions are consistent with research (Valyavska K.V., Geisun A.A., Matrosov O.S., 2023), which established that, due to the effects of sodium humate, succinic acid and trace elements, a probable increase in the proportion of T-lymphocytes was observed, which indicates an increase in the ability of the cellular link of immunity to respond to antigenic stimulation. The obtained data on the positive effect of humic substances are consistent with research conducted by domestic and foreign researchers (Byambas P., Hornick J.L., Marlier D. et.al., 2019; Rai S.N., 2019). The issues considered in the article give reason to consider them as an example of diversification in the agricultural sector, which is fully confirmed with the opinion of Bogatova D. R. (2018).

Conclusions

1. The technology of vermicomposting of "stepping edges" has been improved, which consists in the fact that ridges are formed from separate lattice containers filled with compost and vermiculture, and after completion of vermicomposting and vermiculture, new containers filled with a nutrient substrate without worms are placed next to them, as a result of which the output of vermiculture increases by 14.78% and vermihumus by 23.36%.
2. A method of extracting, separating from compost, young individuals from sexually mature worms from vermighumus has been developed, which consists in the fact that the bait is placed in bags made of anti-mosquito mesh with a mesh size of no more than 1.4 mm, and rotten fruits (pears, apples, apricots, plums) with a moisture content of no more than 70% are used as bait. In addition, the bag's stay in the compost should not exceed 5 days.
3. The technology of vermicomposting in large packages of the "Big-Bag" type in the cold period of the year has been developed. It was established that the obtained vermighumus when introduced into the concentrate diet of fattening young pigs in a dose of 5 and 10% contributes to an increase in live weight by 4.02 and 8.76%, respectively.
4. The introduction of vermighumus (80-120 g/head) and "Nanoverm" (2.5 ml per head) into the diet of weaned piglets of the first and second experimental groups contributed to an increase in live weight at the age of 60 days by 13.11 and 6.96%, and at the age of 90 days by 14.12 and 11.52%, respectively. The animals of the experimental groups also had a higher survival rate by 4.3 and 8.9%, respectively, which also confirms the biological activity of humates in growing young pigs.

5. The experimental research materials given in the article should be considered as an example of diversification in the agricultural sector.

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