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DISPOSAL OF MANURE AT THE PIGGERY USING BIODESTRUCTORS OF DIFFERENT ORIGIN

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The development of biotechnological methods of disposal of pig waste products is relevant at the current stage. However, the high cost of investment and operation of such technologies limits their application. Therefore, owners of pig farms are constantly looking for compromise solutions that would, on the one hand, ensure compliance with technological requirements for manure removal, and on the other hand, not pollute the environment.

The purpose of the work is to improve existing technologies and develop innovative approaches to biotechnological methods of manure disposal.

Scientific research was carried out at the piggery of Agroprime Holding LLC of the Odesa region with a capacity of 30,000 heads per year. The considered technology of using biological preparations De-Scentase and Complesin for descentization of manure in underground baths, manure storages, manure sites of the complex. The content of gases in the manure subfloor bath of the piggery due to the use of biological preparations was determined. The conducted monitoring of unpleasant scents and harmful gases confirmed the expediency of using new methods of neutralizing unpleasant scents. It was established that the reconstruction of the separator station by installing a metal hangar and a water-dispersion filtration chamber ensured the neutralization and release of scentous gases into the environment and did not affect the ecological state of the environment negatively.

On the basis of the conducted research, the method of wide application of the biological preparation for the disposal of manure has been developed.

The improved technology of manure disposal at the piggery, which involves the addition of the microbial destructor drug Complesin to underground baths, as well as to manure storages and manure sites, helps to reduce the release of harmful gases and accelerates the disposal of manure.

The technology of utilization of liquid and solid fraction of manure by using biological preparation and vermiculture is highlighted. The experience of using equipment for underground application of liquid manure to fields is presented.

Key words: piggery, manure removal, utilization, ecology, harmful gases, biodestructors.

УТИЛІЗАЦІЯ ГНОЮ НА СВИНОКОМПЛЕКСІ ЗА ВИКОРИСТАННЯ БІОДЕСТРУКТОРІВ РІЗНОГО ПОХОДЖЕННЯ

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Актуальним на сучасному етапі є розробка біотехнологічних способів утилізації продуктів життєдіяльності свиней. Однак висока вартість інвестицій та експлуатації таких технологій обмежує їх застосування. Тому власники свинокомплексів постійно знаходяться в пошуках компромісних рішень, які б з одного боку забезпечували дотримання технологічних вимог щодо видалення гною, а з другого – не забруднювали навколишнє середовища.

Метою роботи є удосконалення існуючих технологій та розробка інноваційних підходів до біотехнологічних способів утилізації гною.

Наукові дослідження проведені на свинокомплексі ТОВ «Агропрайм Холдинг» Одеської області потужністю 30 000 голів у рік. Розглянута технологія використання біологічних препаратів Де-Одорази і Комплезіну для дезодорації гноївки у підпідлогових ваннах, гноєсховищах, гнойових майданчиках комплексу. Встановлено вміст газів у гнойовій підпідлоговій ванні свинарника за використання біопрепаратів. Проведений моніторинг неприємного запаху і шкідливих газів підтвердив доцільність застосування нових способів нейтралізації неприємних запахів. Встановлено, що реконструкція сепараторної станції шляхом встановлення металевого ангару і вододисперсійної фільтраційної камери забезпечило нейтралізацію та виділення сморідливих газів у навколишнє середовище і не впливає негативно на екологічний стан довкілля.

На основі проведених досліджень розроблено спосіб широкого застосування біопрепарату для утилізації гною.

Удосконалена технологія утилізації гною на свинокомплексі, яка передбачає додавання мікробного препарату-деструктора Комплезіну у підпідлогові ванни, а також у гноєсховища та гнойові майданчики сприяє зменшенню виділення шкідливих газів і прискорює утилізацію гною.

Висвітлена технологія утилізації рідкої і твердої фракції гною шляхом використання біопрепарату та вермикультури. Наведено досвід застосування обладнання для підземного внесення рідкого гною на поля.

Ключові слова: свинокомплекс, гноєвидалення, утилізація, екологія, шкідливі гази, біодеструктори.

Introduction. Waste from pig farming is considered as one of the most important factors of environmental pollution in most parts of the world. That is why scientists and practitioners of different countries of the world are intensively working on cost-effective methods of manure utilization (Postelga S. et al., 2019; Amon M., et al., 1995; Kyrylenko I. G., et al., 2020; Tokarchuk D. M. et al., 2021; Andretta I. et. al., 2021).

Most of the unpleasant scents coming from pig houses are a complex mixture of volatile gases that are products of animal life. These include ammonia, hydrogen sul-

fide, indoles, skatoles, phenols, mercaptans, and others. Most often, the scent is the result of uncontrolled anaerobic decomposition of manure.

There are many modern technologies for liquid manure removal and disposal and scent minimization, such as ration modification, ventilation, daily manure cleaning, application of biofilters of a vacuum manure removal system and its processing in biogas plants, covering lagoons with plastic film, aromatization of manure with microbial preparations, hydraulic dust capture (Voloshchuk V. M. et al., 2014; Le P. D. et al., 2007; Niraj B. et al., 2021; Norton T. et al., 2013; Zhang, G. et al., 2008).

Changing the diet of pigs to reduce crude protein from 16.5% to 12.5% reduced scent and ammonia emission ($p<0.01$) from pig manure by 12.5% (Yastrebov K. et al., 1997).

Other foreign authors came to the conclusion that feeding pigs with four types of feed with a crude protein content of 130, 160, 190, 220 g/kg increased the rate of scent emission compared to the first by 3.09, 49.22 and 32.60%, respectively, and the level of ammonia emission per animal also increased by 25.08; 89.38; 165.91% (Iregbu G.U. et al., 2014).

American scientists found that well-designed and managed biofilters in livestock complexes can reduce scents and hydrogen sulphide and ammonia by 95 and 80 percent, respectively (Hayes E. T., et al., 2004).

Biogas plants, which not only produce biogas, but also significantly reduce environmental pollution, are an effective means of manure utilization. Anaerobic processing of pig manure in biogas plants helps reduce environmental pollution, protects public health, and also provides valuable organic fertilizer and biogas (Ferrer I., et al., 2009; Gianni K. A., et al., 2012; Zubair M., et al., 2020). However, their wide application in farms is restrained by the economic feasibility of biogas production.

It is known that microorganisms play a leading role in the manure processing. According to Ukrainian scientists, in order to speed up the solution of the problem of manure processing at modern pig farms, a combination of anaerobic fermentation and accelerated biothermal composting technologies should be implemented (Shevchenko I. A., et al., 2012; Shumeiko K., et al., 2020).

It has been established that the microbiological drug TM "Vodogray" contributes to the removal of an unpleasant specific scent from the premises for several days. The author explains their ability to assimilate nitrogen from urea, disinfect the substrate from bacteria that cause purulent anaerobic processes from the release of ammonia and hydrogen sulfide, and insists that future innovations in manure storage, processing and wastewater treatment will be based on biotechnologies (Byedenkov E. L., 2015).

A number of Ukrainian scientists used the microbiological drug "Bioprogress"[1] to dispose manure.

For this, the slatted floor in the compartment for pigs is sprayed with a 50% aqueous solution of the biological drug "Bioprogress" at the rate of 300 g of solution per 1 head of pigs. Spraying is carried out once a week on a clearly defined day 1-2 days after washing away the waste. Next, the waste is sent for separation into fractions, and the liquid fraction is sent to lagoons, where 6 liters of Bioprogress are added to 1 ton of manure.

The disadvantage of this method is that before using the biological drug, firstly, it is necessary to reduce the alkalinity of fresh manure from (pH 8.0) to neutral (pH 6.1-

[1] Pat. 143443. Ukraine. The method of waste disposal of pig farms. Broschak I.S., Malyuta Yu.S., Guivan M.D. and others appl. 10.03.2020 publ. 27.07.2020, Bull. 14

7.0) with appropriate reagents, which increases the cost and complicates the technological operation.

On the basis of the above-mentioned materials, the development of biotechnological methods of disposal of pig waste products is currently relevant.

However, the high cost of investment and operation of such technologies limits their application. Therefore, the owners of pig farms are constantly looking for compromise solutions that would, on the one hand, ensure compliance with the technological requirements for manure removal, and, on the other hand, not pollute the environment.

The purpose of the work is to improve existing technologies and develop innovative approaches to biotechnological methods of manure disposal.

Research materials and methods. The research was conducted on the basis of "Agroprime Holding" LLC of the Odesa region in the sector of fattening young animals. Determination of the effectiveness of the descentization process of liquid manure was carried out in two experimental and one control bath, in the sector for fattening pigs. Complesin biodestructor was added to the first experimental bath (the drug is obtained by deep cultivation of B. Subtilis and B. Licheniformis bacterial associations with the addition of nutrients and minerals) at the rate of 10 liters of working solution per 1 m^3 of manure. In the second experimental bath, 3 g of De-Scentase, which is obtained from yucca extract, suspended in 10 liters of water, were added daily. No drugs were added to the control bath. The experiment lasted for 105 days. Every month, the content of carbon dioxide, ammonia and hydrogen sulfide was determined using a Dozor-S-M-4 gas analyzer.

The scent was assessed using an organoleptic method according to a five-point scale presented in Table 1. If the difference in the scent assessment by individual testers exceeded 1 point, the sample assessment was repeated no earlier than in 30 minutes. The final result of the test was taken as the arithmetic mean of the results of the evaluations demonstrated by the testers. The result was simplified to a whole number.

Table 1

Scale for evaluating the intensity of the scent of manure

Scent	Rating	Score
Scent not perceived	Perfectly	0
Scent perceived as not strong enough	Fine	1
Mild scent	Satisfactorily	2
Strong scent	Unsatisfactorily	3
Scent	unsatisfactorily	4

The research was conducted, and the results were processed according to well-known methods (Ibatullin I.I., et al., 2017).

Research results. The piggery of Agroprime Holding LLC of the Odesa region is an industrial specialized farm that provides continuous, rhythmic production of pork in a closed cycle with a capacity of 30,000 heads per year.

The manure removal system at the complex includes manure baths covered with a grid floor, a vacuum sewer, a separator station, a manure platform, and tanks for the accumulation of manure of various sizes (Fig. 1).

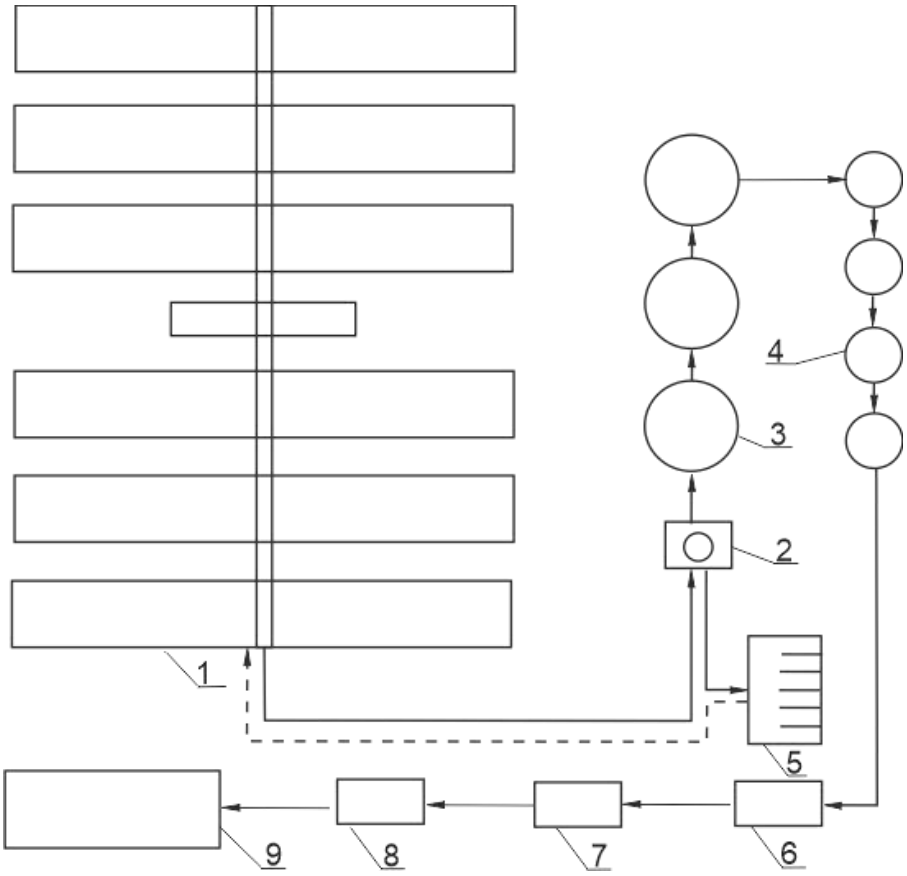

Fig. 1. **The scheme of manure removal and disposal at the piggery:** 1 – manure baths, 2 – separator station, 3 – large metal tanks, 5 – manure platform, 4 – small metal tanks, 6 – diesel pupming station for pumping manure, 7 – trailer conveyor of manure hoses A TOM -2000, 8 – injector cultivator for applying manure A TOM 7 DS, 9 – field.

The results of the use of biological drugs De-Scentase and Complesin for descentization of manure in underground baths are shown in Table 2. We found that during the monitoring process, no stinky scent was felt in the bath, which can be explained by the low level of unpleasant gases.

Table 2

The content of gases in the air of the manure subfloor bath of the piggery

Group	Content in the air		
	CO_2% v	**H_2S mg/m^3**	**NH_3 mg/m^3**
Control	0.14±0.012	6.71 ±0.251	8.13±0.621
1 experimental	0.05±0.002 ***	2.11±0.033 ***	1.21±0.017***
2 experimental	0.07±0.013	3.15±0.054	2.46±0.036

*Note: ***p<0.001.*

These tables indicate the effectiveness of the use of biologics. The level of harmful gases due to the use of biologically active substances was probably lower (p<0.001) in the experimental manure baths than in the control ones. The average decrease in the

concentration of hydrogen sulphide and ammonia over a 2-month period decreased by 3.3, respectively; 2.14 and 6.71; 3.30 times. There was also a reduction in the stench in baths treated with Complesin and De-Scentaz.

The use of these biological drugs for manure disinfection improved the microclimate of the room and had a positive effect on the growth energy and body weight of pigs, but the difference was unlikely (Table 3).

Table 3

Feeding qualities of experimental young pigs

Indicator	Underfloor baths of the piggery		
	Control	1 experimental	2 experimental
Livestock, head	30	30	30
Age of animals at the beginning of the experiment, days	70	70	70
Body weight at the beginning of the experiment, kg	27.54±0.81	27.22±0.79	27.48±0.68
Age of animals at the end of the experiment, days	175	175	175
Body weight at the end of the experiment, kg	105.55±1.46	107.95±1.54	108.75±1.86
Average daily increase, g	780.13±15.01	807.34±1726	812.71±16.17

The technological process of manure removal at the pig farm is as follows. Pig excrement falls through the slatted floor into the tubs, which are partially filled with water. Every two weeks, the stop plug is opened and the manure flows through the pipes into the manure storage (manure bath), which is located in the separator station. Next, the manure is fed to an auger, which separates it into liquid and solid fractions.

In order to reduce the scent from the waste products of pigs, we reconstructed the separator station. For this purpose, the manure storage and the platform for the separator were covered with a hangar made of corrugated metal sheets, and a water-dispersion filtration chamber was also installed, which ensured the neutralization and release of scentous gases into the environment (Fig. 2).

The essence of air purification is as follows. In the water-dispersion filtration chamber, fans pump polluted air through the pipes from the manure storage and the platform for the separator. In the upper part of the chamber, nozzles are installed that spray a water-dispersed mixture with which the polluted air mixes and enters the water bath. Next, the purified air is removed from the separator station by an exhaust fan.

The solid fraction of manure in the separator station is additionally treated with Complesin and taken to the manure site, where final disposal takes place in bags and large-sized packages. When adding Complesin to the fresh solid fraction of manure, the disposal process lasted 65-70 days, and without adding – 150-155 days.

The implementation of new innovative solutions in the manure disposal technology at the piggery contributed to the reduction of unpleasant scents from 3 to 1-0 points, which indicates an improvement in the environmental situation.

The liquid manure fraction is poured into tanks, where it is disposed by Complesin microorganisms, which came from underground baths. In order to increase utilization, the working solution of Complesin is additionally introduced into the tanks. Af-

ter the end of the aerobic microbial process, manure is introduced into the soil. For this, we use a pump-diesel station for pumping manure, a trailed manure hose transporter A TOM-2000, an injection cultivator for applying manure A TOM 7 DS, and thus the final disposal of manure occurs and product recycling is achieved (Fig. 3).

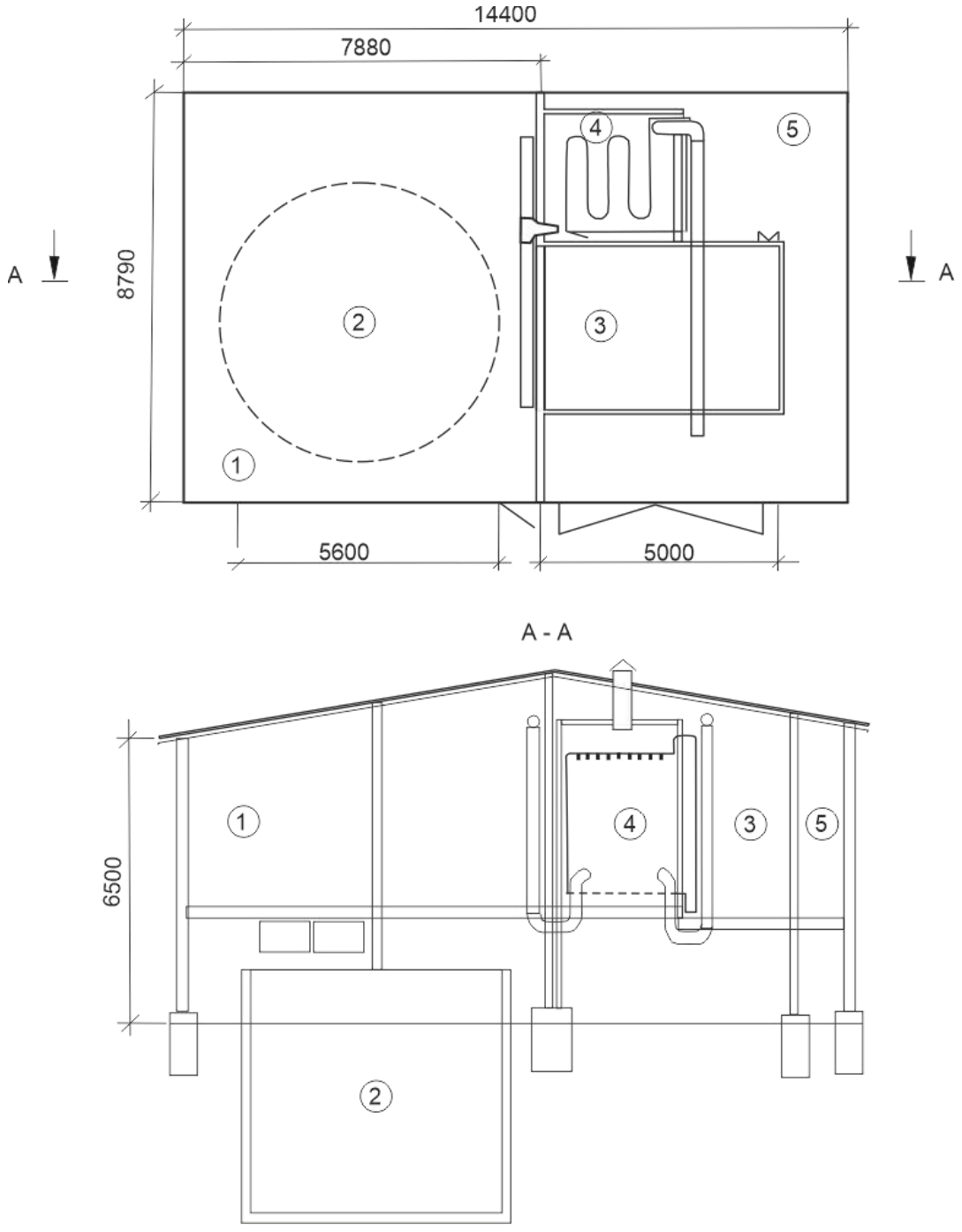

Fig. 2. **Separator station:** 1 – hangar, 2 – manure storage, 3 – site for separator, 4 – water dispersion filtration chamber, 5 – site for technological equipment.

Fig. 3. **Equipment for applying liquid manure to the fields**: 1 – diesel pumping station, 2 – trailed manure hose transporter A TOM-2000, 3 – injector cultivator for applying manure A TOM 7 DS.

The experience of using underground application of liquid manure (to a depth of 20 cm) has shown that in this way nitrogen losses are minimized and unpleasant scents are practically absent.

Discussion. The use of such biodestructors as Complesin and De-Scentase in the technological process of manure disposal at the piggery had a positive effect on the descentization of liquid manure. The obtained data are consistent with a number of foreign authors (Amon M., et al., 1995). It should be noted that the effectiveness of biological drugs is not over with the aromatization of manure. Complesin, in particular, has a prolonged positive effect on other stages of manure disposal.

Conclusions.

1. The technology of manure disposal at the piggery is improved, which involves the addition of the destructor drugs Complesin and De-Scentase to the underground baths, probably helps to reduce the release of harmful gases.

2. It has been proven that the addition of the Complesin biodestroyer to manure, which is in manure storages and manure sites, accelerates manure disposal two times faster than with a traditional manure disposal system.

3. It was established that the improved separator station for separating the solid and liquid fractions of pig manure prevents the spread of foul-scenting gases into the environment and does not negatively affect the ecological state of the environment.

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