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RECYCLING OF ORGANIC WASTE BY USING THE TECHNOLOGY OF OBTAINING FODDER PROTEIN FROM INSECTS *Hermetia illucens*

Abstract: One of the latest innovations in the agro-industrial complex - the technology for obtaining fodder protein from insects - solves two pressing problems at once: the utilization of organic waste and replenishing the deficiency of fodder protein. And the environmental safety of the technology makes it doubly attractive. And as an outcome receiving biofertilizer for soil and plants.

Key words: organic waste recycling, technology of processing, biofertilizers, agriculture innovation, Kazakhstan, farming, insects, flies, *Hermetia illucens*

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Introduction

Already now, the livestock and poultry production in many countries is experiencing a shortage of feed protein, the main sources of which are legumes, meat and bone and fish meal.

Fishmeal is an important component of feed for birds, pigs and fish, but its cost is steadily increasing year by year, and the increase in production volumes is limited. All this forces scientists and agricultural producers to look for alternative sources of protein. However, the history of our project began with completely different goals and objectives.

This invention relates to agricultural production. The method includes bioconversion of a wide range of agricultural (organic) wastes, including manure and

dung, distillery stillage, brewer's grains, grain waste, illiquid seeds of various agricultural crops, waste from slaughterhouses, waste from sugar production, various cakes and meals, dairy production waste, food waste, etc., using larvae of the fly *Hermetia illucens*.

The proposed method involves the processing of organic waste with obtaining a protein product (protein content over 40%) and biohumus.

The main purpose of this method is to obtain high quality protein product as the main alternative to fishmeal or its partial replacement and environmentally friendly biofertilizer suitable for organic farming.

A known method of obtaining vermicompost by processing manure farm animals and mixtures based

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on manure with cellulose filler using compost worms (*Eisenia fetida*, *Eisenia anrei*). The disadvantages of this method include the duration of the process processing (2-6 months) and the need for preliminary preparation of the substrate by composting or washing with water until key parameters are achieved (acidity, ammonia content, alcoholic fermentation) to the threshold of normal activity of compost worms. There are also methods for cultivating synanthropic fly larvae using multi-tiered transport devices in the form of conveyors as with partitions against the migration of larvae, and without them. Transporters located in insulated channels blown by a heated air stream. However, these are rather bulky and expensive designs; in addition, there are disadvantages associated with the separation of larval biomass and certain limitations - with the moisture content of the feed substrate.

There is a way to process manure directly in the manure removal channels pigsties using a conveyor and portioned supply of processed manure, while there is no mixing of inhabited and uninhabited larvae substrate layers. Biomass of larvae in progress processing is concentrated in the upper layers of the substrate, which facilitates their separation.

Processing of pig manure in this way can be carried out directly inside pig complexes, so that there

is no need for extra costs for construction of facilities for the cultivation of larvae. However, this is enough a specialized method applicable in specific conditions on a specific food substrate.

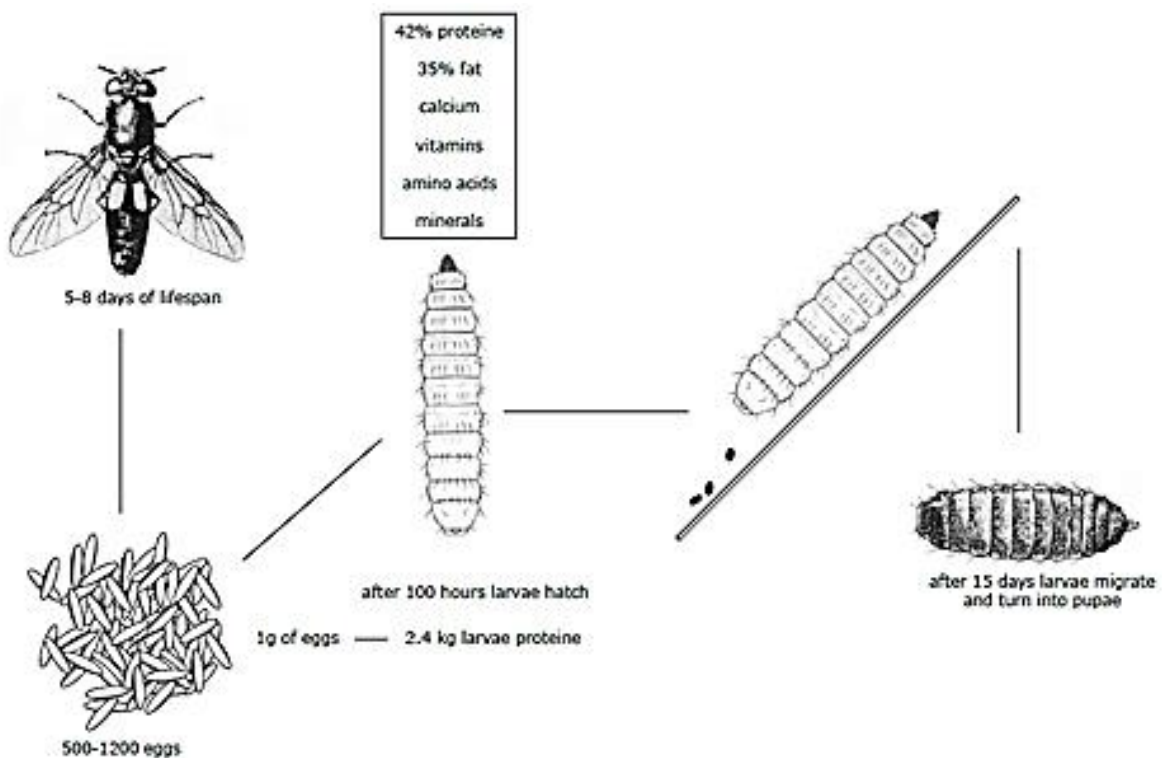
Diptera larvae are known to produce food protein. Flour, obtained after drying the larvae, contains 48-52% protein and up to 27-35% fat. The resulting larval biomass is used in natural or dried form.

Scientific studies conducted on fish, poultry, pigs confirm the possibility of using flour from fly larvae in their diet. In addition, there is method for producing a probiotic feed additive containing fly larvae protein.

Hermetia illucens grown on grain wheat.

This method showed the effectiveness of the use of larvae for enrichment probiotic preparation, which affected its biological activity and corroborated by the material presented.

A known method of processing organic waste (pig manure) by larvae flies *Hermetia illucens* ("black lion", "black soldier"), which contain imago (adult flies) in an insectarium, oviposition is obtained, those formed from eggs are placed larvae into the manure tank, stand the mass for manure processing and separate larval biomass.



Picture 1.

A known method of cultivation of synanthropic fly larvae on native swine manure with obtaining biomass of larvae for fodder purposes, as well as biofertilizer. The essence of this method is to obtain

oviposition of flies in the reproducer, incubation and undergrowth of larvae in the pre-cultivator, processing of feed substrate and accumulation of larval biomass in the cultivator, with subsequent

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separation of the larvae of the last age from biohumus. Thanks to the stage 2-stage cultivation of larvae, this method allows you to reduce the total time bioconversion process, as well as the working area of the cultivator. This method is not devoid of some disadvantages, in particular it is not suitable for the

processing of substrates with a high content of vegetable polymers (cellulose, hemicellulose, lignin), since synanthropic (house) flies are not able to process vegetable polymers. In addition, the housefly is a potential peddler bacterial and fungal infections.



Picture 2.

Closest to the proposed is a method of processing organic waste by the larvae of the fly *Hermetia illucens* with the production of protein of animal origin and biohumus, which consists in preparing a substrate from cow manure, which dehydrated, fermented for 1-2 days using fermented milk bacteria, colonize the resulting substrate with larvae of *Hermetia illucens* flies of age 3-4 days, carry out the bioconversion of the substrate for 5-6 days and separate the obtained biomass of larvae from the obtained biohumus. On a substrate obtained from 100 kg of cow manure, 20 kg of larvae are populated and after processing receive 32.3 kg of larval biomass, that is, there is an increase biomass of larvae only 1.6 times. The disadvantage of the known method is the low larval biomass yield. The technical problem solved by the proposed method is that in order to quickly and cost-effectively dispose of organic waste from a wide range of spectrum, including farm animal manure, poultry manure factories, into a highly efficient environmentally friendly fertilizer, to receive

the product animal origin with a high protein content, create a waste-free, highly profitable, environmentally friendly agricultural production. The technical problem is solved by the method of processing organic waste, consisting in the fact that the eggs of the flies *Hermetia illucens* are obtained, then the eggs are incubated and grow larvae on a nutrient medium, separate larvae of II-III age, colonize the substrate with these larvae with a density of 2.5-5.0 ind./cm², carry out bioconversion of the substrate within 7-14 days and separate the biomass of larvae from obtained biohumus.

At the same time, it is preferable as a nutrient medium for rearing larvae. use a cereal-based nutrient mixture. In addition, manure can be used as a substrate for processing, farm animals, or bird droppings, or a mixture of bird droppings with straw, or spirit stillage, or brewer's grains, or grain waste, or bran or non-liquid agricultural seeds, or cake, or meal, or food waste.

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Picture 3.

The technical result achieved by the proposed method is that the separation of larvae of II-III age and the colonization of the substrate by them provides more economical consumption of planting material, which is directly related to the amount queen cells, allows you to exclude from the calculation of unfertilized eggs, which, according to flies can lay off for various reasons, as well as accurately calculate the necessary number of larvae for settling a certain type of food substrate (ind/cm²). The proposed method for processing organic waste to obtain biomass insect larvae and biohumus consists of the following stages: obtaining fly eggs *Hermetia illucens*, incubation of eggs and undergrowth of larvae on a nutrient medium, separation larvae of II-III instars, colonization by these larvae of an organic substrate, located in stackable containers, bioconversion of the organic substrate, separation of biomass of larvae from biohumus, heat treatment of larvae, packaging biohumus. The introduction of the stage of separation of larvae of II-III instars allows more efficient use of planting material: exclude from calculation unfertilized and dead eggs, as well as accurately calculate the required amount larvae to populate a certain amount of food substrate, reduce the area uterine room. Thanks to the homogenization of the feed substrate and the control its humidity in the

process of processing separation of the biomass of larvae from biohumus carried out by sieving through a sieve, which simplifies the design of the installation and allows to structure biohumus.

In the proposed method, the eggs are first placed in an incubator on a specially prepared nutrient mixture from a ratio of 1 g of eggs per 0.15 kg of the mixture. Further carry out the separation of larvae, the separation of larvae of II-III age and their weighing to determine their number. The substrate is populated with larvae with a density of 2.5-5.0 ind/cm².

The process of bioconversion of organic waste by the proposed method continues from 7 to 14 days depending on the feed substrate and environmental conditions. Manure and other substrates are completely recycled, data on the conversion of various wastes are presented. The average weight of one larva of *Hermetia illucens* on nutrient substrates is 200 mg.

The proposed method provides the possibility of processing feed substrates with a high content of cellulose, since the characteristics of the digestion of fly larvae the black soldier fly (*Hermetia illucens*), unlike the larvae of house flies, allows digest substrates with a high content of cellulose. To initiate the process of reproduction and oviposition in the house fly, it a specific protein diet is required.

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The *Hermetia illucens* fly used in this method does not feed at the adult stage, for a successful breeding process, she needs a source of water and light, according to the spectrum close to natural light.

The life cycle of the fly *Hermetia illucens* (from egg to egg) is about 40 days.

On the second day after the appearance of the flies, they start mating, and after another 2 days - to lay eggs. Eggs are taken daily from the mother liquor, weighed and transferred to nutrient medium for incubation and growth of larvae up to II-III age. As nutrient medium for undergrowth of larvae use a mixture of crushed wheat with fodder yeast (5-7%), humidity 65%. Others may be used cereals. The duration of this stage is about 7 days. Larvae II-III age is separated using a hand sieve (mesh 2 mm) and populate (density 2.5-5 ind/cm²) for crushed and homogenized organic waste with moisture 65-80% that are in stackable plastic containers. Layer thickness waste is about 10 cm. As a result of microbiological processes the temperature of the feed substrate can rise up to 50°C at a temperature of room 20°C. The duration of the processing stage is 7-14 days, in dependence of the type of organic waste and abiotic conditions. Upon completion during the bioconversion process, the biohumus moisture content is less than 30%, and the biomass of larvae separated from it with a vibrating screen (cell 4 mm). Larvae (humidity of larvae 70%) is dried at 90°C, and biohumus is packaged. Conversion rates and biomass yield larvae obtained on different food substrates are

presented in Table 1. In as a result of waste processing in this way, the substrate decreases to 80% (by dry matter). From a ton of feed substrate it is possible to obtain up to 198 kg of larvae (dry matter).

According to the data presented in Picture 1, it can be seen that, although the lowest rates feed substrate conversions and larval biomass yield are observed on substrates with a high content of plant biopolymers, in principle it is possible to processing by the proposed method.

Conclusion.

A method of processing organic waste, which consists in the fact that they receive eggs of *Hermetia illucens* flies, then the eggs are incubated and the larvae are grown on nutrient medium, separate the larvae of II-III age, populate the substrate with these larvae with a density of 2.5-5.0 ind./cm², carry out the bioconversion of the substrate within 7-14 days and separate the biomass of larvae from the resulting biohumus.

2. The method according to p. 1, according to which, as a nutrient medium for growing larvae use a cereal-based nutrient mixture.

3. The method according to p. 1, in which as a substrate for processing use farm animal manure, or bird droppings, or a mixture of bird droppings with straw, or spirit stillage, or brewer's grains, or grain waste, or bran, or non-liquid seeds of agricultural crops, or cake, or meal, or food waste

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