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NUTRITIONAL PROPERTIES OF *Hermetia illucens* L., A NEW FEED PRODUCT FOR YOUNG PIGS (*Sus scrofa domesticus* Erxleben)

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Abstract

In connection with the proven possibility of industrial breeding of black lion larvae *Hermetia illucens* L. on various organic substrates, it is of interest to study their nutritional properties and the possibility of effective use as a new feed product for the Russian livestock in the diets of different farm animal species. This paper is the first report in Russia about *H. illucens* larvae effects on growth of young pigs. The aim of the work was to assess the biochemical composition and nutritional value of *H. illucens* larvae depending on the composition of the substrate on which they were grown and to estimate efficiency of these larvae as a substitution for dietary fish meal in pigs' (*Sus scrofa domesticus* Erxleben) feed. The fly *H. illucens* larvae were reared in the laboratory of the Institute of Ecology and Evolution RAS on different substrates, i.e. distillers dried grains with solubles, feed wheat grain, wheat bran, crushed corn, mix of fruit and vegetable waste with grain bran, mixture of bird manure with litter. Bioconversion of substrates by larvae ranges from 41 % (bird droppings) to 77 % (crushed corn). Also, the use of different substrates leads to a different yield of dry biomass of larvae, from 54 g/kg (bird litter) to 240 g/kg (grain-fruit-vegetable mixture). The most preferable substrates for growing larval biomass are grain and grain-fruit-vegetable mixtures. The nutritional value of fly larvae varies depending on the substrate of culture. The exchange energy is within 15.32-21.41 MJ/kg, the amount of protein is in the range of 35.5-48.3 %, and fat level is 20.6-45.5 %. The larval protein contains a complete set of amino acids characteristic of animal protein, and also depends on the substrate used. The larvae age had a significant impact on their biochemical composition. Dry prepupa (last instar stage), when grown on feed wheat grain, showed higher protein content and lower body fat compared to larvae, i.e. 42.8 and 31.9 % vs. 37.6 and 38.3 %, respectively. The study of the effect of substitution of fish meal (5 %) for flour from larvae (7 %) in feed included estimates of digestibility of nutrients, balance and use of nitrogen by pigs. Physiological tests on animals ($n = 6$) were conducted during rearing pigs (F_1 Large White × Landrace) in the conditions of physiological yard (Ernst Federal Science Center for Animal Husbandry). Compound feeds for animal experimental groups were balanced by nutritional and energy value, the level of minerals. The experiment was performed in two repetitions. It is shown that the replacement of fish meal with dry *H. illucens* larvae contributes to better use and deposition of nitrogen and, as a consequence, a higher bodyweight gain (504,95±17,94 vs. 475,92±22,93 g, $p > 0,05$). Dietary black soldier fly larvae had no statistically significant negative impact on the use of calcium and phosphorus by animals. Thus, the larvae of *H. illucens* fly can be considered as a rational alternative to traditional high-protein feeds that meet the nutritional needs of intensively growing young pigs.

Keywords: larvae, *Hermetia illucens*, feed, young pigs, digestibility, productivity

The development of new components of combined feed for farm animals is one of the relevant trends in the modern combined feed industry. The feed sup-

ply, which determines the largest object of expenditure, is represented by a variety of ingredients of plant and animal origin, as well as feed obtained by microbiological synthesis. At the same time, the search for new non-traditional components with a high concentration of protein is conducted, that can become a worthy alternative to soybean and fish meal. High-protein components are necessary to meet the protein requirements of animals, and therefore, for the full development of the body and obtaining the highest productivity with lower feed costs [1]. In the Russian feed industry, the production of animal feed is reduced; their price increases with deterioration in quality, and falsification products appear in the market. The grain group (barley, oats, wheat, corn, peas) serves as raw material for the production of not only feed but also food products, which causes competition for these sources of protein; large areas of arable land are allocated for the provision of animal husbandry with such feed, which could be used for food production. New alternative protein components can reduce the strain of these problems, which determines the relevance of the authors' experiments [2].

The base of non-traditional feed expands every year. In the works by Russian researchers, the high efficiency of the use of the larvae of synanthropic flies (*Musca domestica*) in feeding farm animals was established [3, 4]. More experiments with other biological objects are relevant to find candidate feed ingredients and to identify the most economically promising ones. Such objects should have high nutritional properties (primarily in protein and fat content), ensure rapid biomass accumulation, serve as sources of biologically active substances and be safe from the point of view of veterinary medicine and ecology. The black lion fly (*Hermetia illucens* L.), the larvae of which many authors propose to use in animal feed [5-7], meets these requirements. *H. illucens* biomass is produced by many companies, e.g. Hermetia Baruth GmbH (Germany), AgriProtein Technologies (South Africa), Enterra Feed Corporation (Canada), Protix (Netherlands), Bühler Insect Technology Solutions (Switzerland). Most of the companies that offer products of black lion *H. illucens* are located in Europe [8].

Various sources serve as the feed substrate for the larvae of this species of insects, such as: manure, unconditioned grain, and products of the agricultural and food industry, as well as food waste [9]. Every day, up to a third of the volume of manufactured products is thrown away as food waste, most of which are of plant origin (residues of fruits and vegetables, which is due to the complexity of their storage and transportation). Products decompose quickly and become unsuitable for further use. Bioconversion of waste when growing larvae on it partially solves the problem of utilization and allows obtaining high-quality protein feed product [10].

Black lion larvae are an economical way to convert residual organic biomass into a valuable source of biomolecules — proteins, lipids, and chitin [11]. It is estimated that by 2050 insect protein may account for 15% of the total protein produced in the world [12]. The appearance of black lion larvae in the market requires an assessment of the biological effectiveness of this feed product. In particular, there are works indicating the promising character of using *H. illucens* larvae in the diets of fish, pigs, and birds [13-15], in feeding calves [16], and also instead of soybean meal in the diets of cows [17].

However, the information on the effectiveness of the use of *H. illucens* larvae in feeding animals, in particular, intensively growing young pigs, is still not sufficient, and such studies have not been carried out in Russia before. In the presented work, the authors found that feeding young pigs with black lion larvae as part of balanced combined feed of complete ration (7.0%, or 70 kg/t of combined feed) positively affects the physiological processes in the animals' organisms, their productivity and reduces the cost of feed. It should be taken into account that in

the authors' experiments, depending on the used substrates, there was an almost two-fold difference in the nutritional value of the obtained additive.

The aim of the study was to assess the nutritional characteristics of *Hermetia illucens* larvae grown on various organic residues, as well as their effect when introduced into the diet of farm animals (using the example of young pigs).

Techniques. In the work, conducted in 2016-2017, the larvae and prepupae (larvae of the last instar stage) of the black lion *Hermetia illucens* L. were used, grown in laboratory conditions (Severtsov Institute of Ecology and Evolution RAS) on distillers dried grains, feed wheat grain, wheat bran, crushed maize, fruit-grain-vegetable mixture (apples, tangerines, wheat, bran, potatoes, carrots in equal quantities) or bird litter. The air temperature during the growth of the larvae was 20-21 °C; the humidity of the substrates in all variants was maintained within 70±5%. The temperature was controlled by a mercury thermometer; the moisture of the feed mass was controlled by an Eleks-7 device (Eleks Group of Companies, Russia). The substrates were colonized with 6-day-old larvae (5 larvae per 1 cm^2). All experiments were performed in 3 replications. The raw biomass was dried at 70 °C to constant weight on a wall-mounted SNOL drying unit (AB UMEGA, Lithuania). The samples were weighed to an accuracy of 0.005 g (CAS XE-300 scales, CAS, South Korea). The total substrate consumption (conversion) was estimated as the ratio of the difference between the initial mass of the dry substrate and the final dry residue (substance consumption) to the initial dry mass.

The chemical composition and nutritional value of dried black lion larvae were analyzed according to standard techniques described in GOST 54951-2012, 31640-2012, 32044.1-2012, 32905-2014, 31675-2012, 26176-91, 32904-2014, GOST R 51420-99, GOST 13496-17-95, GOST 13496.12-98 (Ernst Federal Science Center for Animal Husbandry), the exchange energy (EE) was determined by the calculation method [16]. The amino acid composition was evaluated in dried biomass of larvae grown on crushed corn using a liquid chromatograph LC-20 Prominence (Shimadzu, Japan). The results of repeated measurements were obtained under convergence conditions (confidence coefficient $P = 0.95$) [18].

The physiological experiment on hybrid young hogs (*Sus scrofa domesticus* Erxleben) (F_1 Large White × Landrace, 6 animal units with an average initial body weight of about 15 kg) was performed in the conditions of a physiological yard (Ernst Federal Science Center for Animal Husbandry). According to the principle of analogs (origin, age, and live weight), the animals of F_1 Large White × Landrace formed two groups of 3 animal units in each. The duration of feeding was 27 days, with 5-day reference period of the balance experiment. The animals of group I (control) received a full ration starter combined feed (SF-4) with 5% of bran and the addition of 5.0% of fish meal. The analogs from group II were given SF-4 with 3% of wheat bran and 7.0% of dry *H. illucens* larvae, grown on crushed corn. Antibiotics were not used in the composition of feed. According to the energy and nutritional value indicators, the SF-4 feed met the requirements for the specified age and weight parameters of animals [19]. The experiment was conducted in 2 replications. The main diet and the housing conditions of all groups of animals (temperature, humidity, light conditions and the gas composition of the air in the room) were the same and were within the limits of zoohygienic norms.

Upon completion of feeding, a balance experiment was conducted to assess the digestibility of the combined feed nutrients [20]. At the time of the experiment, the animals were transferred to special cells equipped with individual feeders and means for collecting feces and urine. The duration of physiological studies was 5 days.

At the beginning, at the end of the experiment and weekly in the morn-

ing before feeding, the animals were individually weighed to determine the absolute and average daily weight gain. The influence of the type of feed on its palatability was estimated on the basis of daily individual accounting of the feeds and their residues. After the end of the experiment, the average samples of feed, feces, and urine were subjected to chemical analysis by standard methods [21]. The measure of palatability and the feed-use efficiency of products was feed consumption per unit of increase in live weight.

The rate of exchange energy (EE) was calculated for digestible nutrients. The equation for full ration combined feed (pigs) was as follows [22]:

$$EE = 0.01924 \times CP + 0.03597 \times CF - 0.01430 \times CFi + 0.01494 \times NFES,$$

where EE is exchange energy, MJ per 1 kg of feed; CP is crude protein, g; CF is crude fat, g; CF_i is crude fiber, g; NFES is nitrogen-free extractable substances, g.

The obtained data were processed biometrically by the method of variance analysis (ANOVA) in the program STATISTICA 10 (StatSoft, Inc., USA). The arithmetic mean values (M), the mean square error (±MSE) and the level of statistical significance (p) were calculated.

Results. The composition of the feed in the rations is given in Table 1.

1. The composition and nutritional value of experimental batches of combined feed for young hogs (F_1 Large White × Landrace) (Ernst Federal Science Center for Animal Husbandry, 2016-2017)

Ingredient, %	Group	
	I	II
Larvae *Hermetia illucens*	0	7,0
Fish meal	5.0	0
Wheat	41.8	41,8
Barley	10.0	10,0
Corn	8.0	8,0
Wheat bran	5.0	3,0
Sunflower cake, CP 32%	16.0	16,0
Sunflower oil	4.0	4,0
Nutrient yeast, CP 34%	7.0	7,0
Salt	0.2	0,2
Tricalcium phosphate	2.0	2,0
Premix, P52-3	1.0	1,0
1 kg contains:		
EFU	1.32	1,33
exchange energy, MJ	13.23	13,34
dry matter, kg	0.843	0,845
CP, g	180.5	179,1
digestible protein, g	140.9	140,4
crude ash, g	54.0	53,5
NFES, g	527.7	522,0
starch, g	354.2	346,1
sugar, g	27.9	26,9
lysine, g	7.9	7,4
methionine + cystine, g	5.9	5,3
threonine, g	6.3	5,9
crude fat, g	66.0	71,3
crude fiber, g	54.6	52,7
calcium, g	10.0	8,2
phosphorus, g	8.5	7,5
Mg, g	1.9	1,8
S, g	1.0	0,8
K, g	5.4	5,0
Na, g	1.6	1,1
NaCl, g	4.1	4,1
vitamin A, thousand IU/kg	20.00	20,00
vitamin D_3, thousand IU/kg	2.00	2,00
vitamin E, mg/kg	20.00	20,00
Fe, mg/kg	80.00	80,00
Cu, mg/kg	10.00	10,00
Zn, mg/kg	60.00	60,00
Mn, mg/kg	40.00	40,00
Co, mg/kg	0.30	0,30
I, mg/kg	0.60	0,60
Se, mg/kg	0.20	0,20

N o t e. CP — crude protein, EFU — energetic feed unit, NFES — nitrogen-free extractable substances.

A distinctive feature of the black lion fly *Hermetia illucens* is the ability to exist in controlled artificial conditions. At the same time, the larvae can use various organic substrates as feed, which makes it possible to solve the problems of partial bio-utilization of organic wastes and to obtain the protein biomass of larvae. However, not all types of substrates were used equally by the larvae (Table 2), which is also noted in the literature [23]

2. Bioconversion of experimental substrates by *Hermetia illucens* L. larvae (per dry matter, *M*±MSE, Institute of Ecology and Evolution RAS, 2016-2017)

Substrate	Conversion, %	Larvae biomass yield, kg	
		per 1 kg substrate	per 1 m^2
Bird litter	41.0±1.6	0.054±0.017	0.6±0.2
Distillers dried grains	53.0±1.3	0.084±0.001	0.7±0.4
Crushed corn	77.4±0.9	0.180±0.008	3.4±0.4
Feed wheat grain	74.5±1.7	0.155±0.002	3.1±0.4
Wheat bran	72.2±0.6	0.137±0.001	1.7±0.3
Fruit-grain-vegetable mixture	65.3±0.8	0.240±0.009	3.3±0.5

Conversion of the presented substrates ranged from 41 (bird litter) to 77% (crushed corn). Also on different substrates, there was an unequal yield of dry biomass of larvae: from 54 (bird litter) to 240 g/kg (grain-fruit-vegetable mixture). Grain and grain-fruit-vegetable mixtures turned out to be the most preferred substrates for growing biomass of larvae. The authors did not use high-protein feed mixtures with animal protein in accordance with the recommendations of the EU Standing Committee on Plants, Animals, Food and Feed (SCoPAFF): insect protein is approved for use in the territory of the EU in feed (for example, aqua culture) under the condition that the larvae are grown on a plant substrate [24]. Although the limiting factor for larval biomass accumulation is the increased fiber content in the used feed [25], the introduction of wheat bran increased the biomass yield and the overall conversion of the substrate, apparently by improving the structure of the substrate, its moisture capacity, and aeration.

3. Biochemical composition of dried larvae *Hermetia illucens* L. grown on different feed substrates (*M***±MSE, Institute of Ecology and Evolution RAS, 2016-2017)**

Indicator	Feed substrate						
	1	2	3	4	5	6	7
Total moisture, %	6.28	7.45	8.19	2.78	0.88	2.18	7.68
Absolutely dry matter, %	93.72	92.55	91.81	97.22	99.12	97.82	92.32
Protein g/kg	482.9	375.7	427.87	452. 2	365.2	355.38	403.82
Fat, g/kg	205.6	382.9	318.70	194.5	455.4	261.38	221.14
Fiber (chitin), g/kg	81.4	51.9	64.60	70.2	88.8	79.63	36.48
NFES, g/kg	98.6	140.8	46.20	157.0	25.7	172.95	159.12
Ash, g/kg	67.7	36.2	60.7	71.2	38.5	67.40	102.6
Gross energy, MJ/kg	18.85	н/о	24.39	18.70	25.19	20.47	21.53
Exchange energy, MJ/kg	16.45	н/о	18.39	15.32	21.41	15.44	14.63
Energetic feed units	1.6	н/о	1.83	1.53	2.14	1.54	1.46
Digestible protein, g/kg	385.6	н/о	385.01	407.0	328.0	301.70	382.8
Calcium, g/kg	6.69	4.1	4.40	8.44	4.69	11.08	15.1
Phosphorus, g/kg	7.35	3.2	2.64	7.72	3.87	6.98	8.9

N o t e. 1 — distillers dried grains, 2 — feed wheat grain (larvae), 3 — feed wheat grain (prepupae), 4 — wheat bran, 5 — corn, 6 — fruit-grain-vegetable mixture, 7 — bird litter. The calculation of the exchange energy is given for pigs; n/d – not determined. The results of repeated measurements were obtained under convergence conditions (repeatability limit of 5%, confidence coefficient P = 0.95).

The types of substrates, on which the larvae were grown, significantly influenced their biochemical composition. The protein content in dried larvae varied from 35.5% (fruit-grain-vegetable mixture) to 48.3% (distillers dried grains) (Table 3). Digestible protein was 80% for growing the larvae on distillers dried grains, 85% for on the fruit-grain-vegetable mixture, and 90% for on grain, bran. Fat content ranged from 20.6% (distillers dried grains) to 45.5% (crushed corn). Most carbohydrates were present in the larvae grown on grain substrates. Corn

starch contributed to the accumulation of lipids in the bodies of larvae. It should also be noted that there was a significant variation in the content of calcium and phosphorus in dry larvae, depending on the type of the substrate. The age of the larvae also had a significant effect on the biochemical composition of the larvae. In the larvae of the final age (prepupae), the amount of protein increased and the mass fraction of fat decreased: dry larvae grown on feed wheat grain contained 37.6% of protein and 38.3% of fat, while in prepupae, those indicators were respectively 42.8 and 31.9%. This is due to the fact that at the prepupae stage, the larvae lose water, fat, and carbohydrates, thus the proportion of protein increases [26].

4. Amino acid composition of dried larvae *Hermetia illucens* L., soybean and fish meal (average sample, % of total protein)

Indicator	Soybean meal	Fly *Hermetia illucens* larvae	Fish meal
Aspartic acid	11.82	8.25	10.17
Threonine	4.08	3.97	4.57
Serine	5.46	4.49	4.35
Glutamic acid	18.22	12.85	14.35
Proline	5.50	6.02	4.73
Glycine	4.34	5.63	6.67
Alanine	4.42	7.25	6.70
Valine	4.70	5.12	5.32
Methionine	1.26	1.85	3.13
Cystine	1.52	0.85	1.00
Isoleucine	4.56	5.58	4.38
Leucine	7.66	12.24	7.92
Tyrosine	2.56	6.32	3.65
Phenylalanine	4.90	4.35	4.27
Histidine	2.54	4.21	3.17
Lysine	6.26	5.75	8.70
Arginine	4.30	4.20	6.48
Total of amino acids	98.10	98.93	99.56

N o t e. Reference data are given for soybean and fish meal [27]. The results of repeated measurements were obtained under convergence conditions (repeatability limit of 5%, confidence coefficient P = 0.95).

Regardless of the used feed substrate, the protein of fly *H. illucens* larvae contained all amino acids characteristic of animal protein, including irreplaceable ones. Compared to fish meal, the amino acid profile of the black lion larvae contained less aspartic acid, arginine, lysine, methionine and cystine, more proline, leucine, isoleucine, and tyrosine (Table 4). In general, the amount of lysine in the black lion was comparable to the content of this amino acid in soybean meal [27].

5. Growth dynamics of experimental hybrid young hogs (F_1 Large White × Landrace) with the addition of dry *Hermetia illucens* L. larvae to the diet (N = 12, M±MSE, Institute of Ecology and Evolution RAS, 2016-2017)

Live weight	Group	
	I	II
Initial weight, kg	15.72±1.08	15.63±0.95
At the end of the experiment, kg	28.09±1.57	28.76±1.36
Absolute gain, kg	12.37±0.60	13.13±0.47
Average daily gain, g	475.92±22.93	504.95±17.94
To the control, %	100.0	106.1

N o t e. For a description of the groups, see the Techniques section.

Pigs are omnivorous monogastric animals, which especially need animal protein. Depending on age, their combined feed should include 13-21% of crude protein [28]. The introduction of black lion larvae protein into the diet of pigs, containing the whole complex of natural essential and conditionally replaceable amino acids, as well as enzymes, biologically active substances, micro- and macroelements, can be effective with the full or partial replacement of fish or soybean meal. In the authors' experiment, the growth dynamics of young hogs when feeding with a full ration starter combined feed (SF-4) with the addition of 7%

of black lion larvae was positive compared to the control: the average daily weight gain in group II was 6.1% higher than in group I ($p > 0.05$) (Table 5).

6. Feed consumption when adding dry *Hermetia illucens* L. larvae to the diet of young hogs (F_1 Large White × Landrace) (*M*±MSE, Ernst Federal Science Center for Animal Husbandry, 2016-2017)

indicator	Group	
	I	II
The content of EE in 1 kg of combined feed, MJ	11.61	11.98
Feed spent for the period, kg	28.650	28.650
Spent per day:		
combined feed, kg	1.08	1.08
EE, MJ	12.59	13.06
Absolute weight gain for the period, kg	12.60±0.90	13.33±0.47
The cost of combined feed per 1 kg of gain, kg:		
total	2.26	2.11
to the control, %	100.00	93.36
EE costs per 1 kg of gain, MJ:	26.34	25.45
total		
to the control, %	100.00	96.62

N o t e. EE — exchange energy of digestible nutrients. For a description of the groups, see the Techniques section.

In terms of the cost of feed for obtaining a unit of products, the indicators in group II were lower compared to the control by 0.15 kg, or 6.6% (Table 6). That is, the animals from the experimental group better used nutrients of feed for live weight gain. In group I, the digestibility coefficients were 75.13% for the dry matter, 77.81% for organic matter, 72.27% for crude protein, 41.68% for crude fat, 41.85% for crude fiber, 84.77% for nitrogen-free extractable substances; in group II, these figures were 75.19; 77.14; 71.58; 38.52; 37.11 and 85.03%, respectively. Significant differences were not revealed when comparing nutrient digestibility ratios in animals of the experimental and control groups ($p > 0.05$). When 7% meal of fly larvae was included in the diet, crude fat and fiber were somewhat worse digested. Perhaps, this is due to a slightly higher content of fat in the experimental feed (see Table 1) and the presence of poorly digestible chitin of the larvae, determined in the total indicator of fiber content in the feed.

The rate of the utilization of a nutrient shows how efficiently the arrived and digested nutrient in the animal are used in metabolic processes. To study protein metabolism, the authors calculated the balance and use of nitrogen by young hogs during the period of the balance experiment. When comparing the amount of nitrogen in relation to the one which came with the feed and was digested, there is a tendency to an increase in indicators of the animals from the experimental group compared to the counterparts from the control group; however, this difference is slight and not statistically significant. Nevertheless, it was shown that the addition of fly *H. illucens* larvae to the combined feed contributed to better utilization and deposition of nitrogen and, consequently, to a higher live weight gain (504.95±17.94 vs. 475.92±22.93 g, $p > 0.05$) (see Table 5). The inclusion of black lion larvae in the diet of the group II did not have a negative or statistically significant effect on the use of calcium and phosphorus by animals.

The obtained results to some extent correlate with the data when partially defatted meal from *H. illucens* larvae was introduced into the diet of piglets, with 75% replacing soybean meal without balancing and with balancing of the amino acid composition by adding crystalline L-lysine, DL-methionine, and L-threonine [25]. The animals, the diet of which included black lion larvae and amino acid supplements, did not differ in the studied zootechnical parameters with control piglets. When replacing soybean meal with defatted black lion meal with basic amino acid content, there was a tendency for a slightly smaller growth of piglets, feed consumption and protein conversion. However, no significant

negative effect was noted. The authors concluded that partially defatted meal from *H. illucens* may be a promising alternative to soybean meal in the diets of young pigs. In this work, the zootechnical indicators of young hogs from the experimental group were similar to those of control animals. Moreover, there was a tendency to exceed the control indicators with the introduction of complete full-fat larvae flour into the feed without additional enrichment with synthetic amino acids. Larvae lipids seem to play a positive role, increasing the feed efficiency of the product based on the whole insect, since they contain biologically active components [29].

It should be noted that the biometric processing of the obtained data did not reveal statistically significant differences in the analyzed parameters, as well as in relation to the growth of animals and the digestibility of the nutrients of their diets. The absence of such differences suggests that replacing fish meal with dry larvae biomass does not lead to negative consequences and allows maintaining control values when raising young pigs, which should be evaluated positively. Thus, the nutritional value of the fly *Hermetia illucens* larvae is sufficiently high: the content of exchangeable energy in 1 kg, depending on the used feed substrate for growing the larvae, is 15.32-21.41 MJ, the amount of protein varies within 35.5-48.3%, fat is 20.6-45.5%. The amino acid composition of the larval protein contains a complete set of amino acids, including all essential amino acids. Feeding the young pigs with the black lion larvae in the composition of balanced full-ration combined feed (7.0%, or 70 kg/t of combined feed) has a positive effect on the physiological processes in the animals' bodies, their productivity, as well as the costs of feed. Fly *H. illucens* larvae can be considered as a rational alternative to traditional high protein feeds (including fish meal) in the diets of growing young pigs during the nursery period.

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