https://doi.org/10.26898/0370-8799-2022-6-13
УДК: 636.084
Тип статьи: обзорная
Type of article: review

ЭФФЕКТИВНОСТЬ ИСПОЛЬЗОВАНИЯ ПШЕНИЦЫ В ОРГАНИЧЕСКОМ ЖИВОТНОВОДСТВЕ

(✉)**Ермохин В.Г., Солошенко В.А., Соловьев К.А.**
Сибирский федеральный научный центр агробиотехнологий Российской академии наук
Новосибирская область, р.п. Краснообск, Россия
(✉)e-mail: v_ermohin_56@mail.ru

Для решения задачи органического производства продукции регионального животноводства и создания соответствующей кормовой базы необходимым этапом является концептуальное обоснование перечня основного кормового сырья, перспективного для реализации органических технологий в Сибири. Представлены результаты обоснованности применения модифицированной фуражной пшеницы в органическом производстве продукции животноводства. Предложены пути преобразования пшеницы, обеспечивающие повышение эффективности использования ее в кормлении животных. В задачи исследований входило изучение агротехнических возможностей возделывания пшеницы в Сибири по правилам органического производства, оценка масштабности использования ее на кормовые цели, определение аминокислотного состава региональных сортов пшеницы, обоснование эффективности получения из нее кормовой добавки, оценка возможности применения новой добавки в рационах животных, содержащихся по правилам органического производства. Урожайность яровой пшеницы, возделанной в Сибири по пару и нормам органического производства, составляет от урожайности пшеницы, возделываемой по обычной интенсивной технологии, в среднем 62,5%. Потеря 38% урожая, обусловленная органической технологией, может быть восполнена за счет увеличения площади ее посевов. Средние значения содержания нормируемых аминокислот в пшенице исследованных 82 районированных сортов сибирской селекции меньше справочных значений. Из пшеницы получена экспериментальная кормовая добавка с содержанием лизина порядка 20 г/кг в пересчете на сухое вещество. Это сопоставимо с содержанием лизина в мясокостной муке, шроте подсолнечном – традиционных белковых ингредиентах сибирских комбикормов для моногастричных животных, но не включенных в перечень сырья, разрешенного к использованию в органическом животноводстве. С использованием полученной добавки составлены полнорационные комбикорма для молодняка свиней и птицы. Экспериментально установлено положительное влияние полученной добавки из пшеницы на продуктивность подопытных животных, содержащихся по правилам органического производства.

Ключевые слова: органическое производство продукции животноводства, пшеница, добавка из пшеницы, нормируемые аминокислоты, лизин

EFFICIENCY OF WHEAT USE IN ORGANIC ANIMAL HUSBANDRY

(✉)**Ermokhin V.G., Soloshenko V.A., Soloviev K.A.**
Siberian Federal Research Center of Agro-BioTechnologies of the Russian Academy of Sciences
Krasnoobsk, Novosibirsk region, Russia
(✉)e-mail: v_ermohin_56@mail.ru

Conceptual justification of the basic feed raw materials list which is promising for the implementation of organic technologies in Siberia is a necessary step to solve the problem of organic production of regional livestock and the creation of an appropriate feed base. The results of the validity of the use of wheat in the organic production of livestock products are presented. The ways of transforming wheat to improve the efficiency of its use in animal feed are proposed. The objectives of the research included studying the agronomic possibilities of wheat cultivation in Siberia according to the rules of organic production, assessing the scale of its use for fodder purposes, determining the amino acid composition of regional wheat varieties, justifying the effectiveness of obtaining a feed additive from it, assessing the possibility of using the new additive in the diets of animals kept according to the rules of organic production. The yield of spring wheat cultivated in Siberia on fallow and organic production norms is 62.5% on average of the yield of wheat cultivated on conventional intensive technology. The loss of 38% of the yield due to organic technology can be compensated by increasing the area of its crops. The average values of the content of normalized amino acids in wheat of the studied 82 released varieties of Siberian breeding are less than the reference values. An experimental feed additive with a lysine content of about 20 g/kg in terms of dry matter was obtained from wheat. This is comparable with the lysine content in meat and bone meal, sunflower oil meal - traditional protein ingredients of Siberian feed for monogastric animals, but not included in the list of raw materials permitted for use in organic animal husbandry. Using the obtained additive full-fat mixed fodder for young pigs and poultry were composed. Positive effect of the obtained wheat additive on the productivity of experimental animals kept under the rules of organic production was experimentally established.

Keywords: organic production of livestock products, wheat, wheat additive, normalized amino acids, lysine

Для цитирования: *Ермохин В.Г., Солошенко В.А., Соловьев К.А.* Эффективность использования пшеницы в органическом животноводстве // Сибирский вестник сельскохозяйственной науки. 2022. Т. 52. № 6. С. 111–121. https://doi.org/10.26898/0370-8799-2022-6-13

For citation: Ermokhin V.G., Soloshenko V.A., Soloviev K.A. Efficiency of wheat use in organic animal husbandry. *Sibirskii vestnik sel'skokhozyaistvennoi nauki = Siberian Herald of Agricultural Science*, 2022, vol. 52, no. 6, pp. 111–121. https://doi.org/10.26898/0370-8799-2022-6-13

Конфликт интересов
Авторы заявляют об отсутствии конфликта интересов.
Conflict of interest
The authors declare no conflict of interest.

The State Duma Committee on Agrarian Issues of the Russian Federation has developed an interstate standard GOST 33980-2016[1] "Organic production. Production regulations, processing, labelling and implementation". The new GOST complies with the main provisions of the international standard Codex Alimentarius CAC/GL 32-1999 and was enacted in the Russian Federation from January 1, 2018.

It can be stated that the state has determined as promising the creation and sale of organically produced food in order to improve the quality of life, and longevity of the population. This task for the agro-industrial complex of Russia in all aspects is new and therefore attractive to both science and to the domestic market.

The latest research in the field of organic production in the country can be assessed as a positive prerequisite for the successful creation of domestic organic products [1-6].

Objective difficulties in the practical implementation of the rules and regulations of GOST 33980- 2016 is that this normative document contains a number of significant limitations. With regard to the designated topic of work to be performed, the main restrictions (designated in GOST 33980-2016) are the following:

– the use of mineral nitrogen fertilizers is not allowed (clause 5.1.4);

– the use of synthetic herbicides is not allowed (clause 5.1.5);

– synthetic amino acids are not allowed (clause 6.11.5).

n the list of feed raw materials (mandatory Appendix D [1]) permitted for use in organic livestock are absent:

[1]GOST 33980-2016. Products of organic production. Rules of production, processing, labeling and sale. Moscow: Standardinform, 2016. 41 p.

– oil cakes;

– meat (meat and bone) raw materials.

However, it should be noted that the list of feed additives and some substances used in animal feeding (mandatory Appendix E) includes enzymes (clause E.1.2).

Before modern science moves to the listed limitations of agricultural production, it is advisable to conduct a comprehensive study in conjunction with medical experts and economists to assess the merits and effectiveness of organic products.

Given that oil cakes (soybean, sunflower), meat and bone meal, and recently synthetic amino acids are widely used in animal husbandry [2-4], it is necessary to offer an adequate (comparable) in quality substitute. We need a feed additive that, firstly, can be produced in Siberia, secondly, it must meet the standards of GOST 33980-2016, and thirdly, be effective in feeding animals.

The purpose of the work is to identify promising forage raw materials to obtain livestock products of organic production in Siberia and to propose ways of its rational use.

Working hypothesis: wheat is a promising regional agricultural raw material for organic feed additives of appropriate quality (amino acid, easily accessible carbohydrate composition).

The research objectives are:

– study the agronomic possibilities of cultivation of wheat in Siberia according to the rules of organic production;

– evaluate the possibility of producing and using significant volumes of deep-processed wheat in the domestic market for animal feed;

– determine the amino acid composition of wheat varieties released in Western Siberia, assess the feasibility of breeding it according to its amino acid content;

– propose a method of obtaining a feed additive from wheat, expected to be effective in the organic production of livestock products;

– estimate the possibility of using the new additive in the formation of diets for animals kept on the technology of organic production;

– experimentally investigate the prerequisites for the use of wheat amino acid supplement in animal feed, taking into account the rules and regulations of organic production.

Wheat is the most common grain crop both in Siberia and Russia as a whole[5]. In recent years, all the needs of the Russian domestic market have been fully satisfied with wheat, so that a significant part of it is annually sold abroad.

Wheat is available in the country; its production is predictable and fairly stable. However, we are talking about a potential increase in the consumption of wheat in the domestic market in large quantities, so it is necessary to assess the rationality of the use of wheat in organic livestock production.

There is nothing new in the use of wheat in grain mixtures for feeding animals. In modern agriculture it is widely used for fodder purposes. For example, the recommended content of wheat in the recipes of full-fat mixed fodder for pigs and meat poultry is respectively up to 25-45% (see footnote 4). According to the recommendations of the VIZh (L.K. Ernst Federal Research Center for Animal Husbandry), the wheat content in mixed fodder for high-yield lactating cows ranges from 15.5% to 26.0%[6].

Literature analysis on the possibility of obtaining wheat by the rules of organic production was conducted since in organic production, wheat, like any other crop must be cultivated without the use of mineral nitrogen fertilizers and synthetic herbicides.

According to the results of the published modern experimental studies of the leading sci-

[2]The reference book of Siberian cattle breeder. Siberian Branch of the Russian Academy of Agricultural Sciences, SibNIPTIZh; edited by M.D. Chamukha, A.S. Donchenko. Novosibirsk, 2000. 220 p.

[3]Fisinin V.I., Egorov I.A., Draganov I.F. Feeding farm poultry. Moscow: GEOTAR-Media, 2011. 344 p.

[4]New in animal feeding: reference manual edited by V.I. Fisinin. M.: Publishing house of RSAU-MSKHA, 2012. 788 p.

[5]Kashevarov N.I. Problems of Agriculture and Fodder Production. Novosibirsk, 2016. 106 p.

[6] Golovin A.V., Vorobieva S.V., Perlov N.P., Anikin A.S. Peculiarities of feeding dairy cows with the milk yield of 8000-10000 kg of milk: analytical review. Dubrovitsy: Russian Agricultural Academy of Sciences, 2013. 56 p.

entists in Siberia [7-10], it was found that in the region the production of wheat that meets the norms of organic production (see footnote 1) is possible: the yield of spring wheat cultivated on fallow under organic production norms (i.e. without mineral nitrogen fertilizers and synthetic herbicides) is on average 62.5% of the wheat cultivated under conventional intensive technology (see Figure 1).

Obviously, this result is positive and opens the technological possibility of using wheat in Siberia for organic production.

However, it should be noted that the real success of organic production in crop production in Russia largely depends on the effectiveness of control (approved for organic production methods and means) of contamination of grains with mycotoxins. Studies in this direction have been conducted in the country [11-16], but radically positive results in this serious issue have not yet been obtained.

Considering the proposal to use more wheat for forage purposes, given that, according to the WHO about 800 million people in the world are starving, the question arises: How ethical is it to increase wheat consumption within Russia to feed farm animals at a time when a large part of the world's population is starving?

To answer the question, a macro-analysis of the world population's food supply was carried out. Taking into account modern world population of 7 billion 812 million people, annual gross output of just 5 leguminous crops amounts to about 3 billion 240 million tons (corn - 1 billion 102 million tons, wheat - 761 million tons, rice - 509 million tons, soybean - 343 million tons, barley - 154 million tons). According to calculations, this foodstuff (after taking into account carry-over stocks and the edible part of products) is enough to provide, on average, more than 2,800 kcal of energy and about 120 g of protein per day for each inhabitant of the planet. This total amount of protein of the world's integrated grain product (corn, wheat, rice, soy, barley) provides (according to Academician N.N. Lipatov's theory[7]

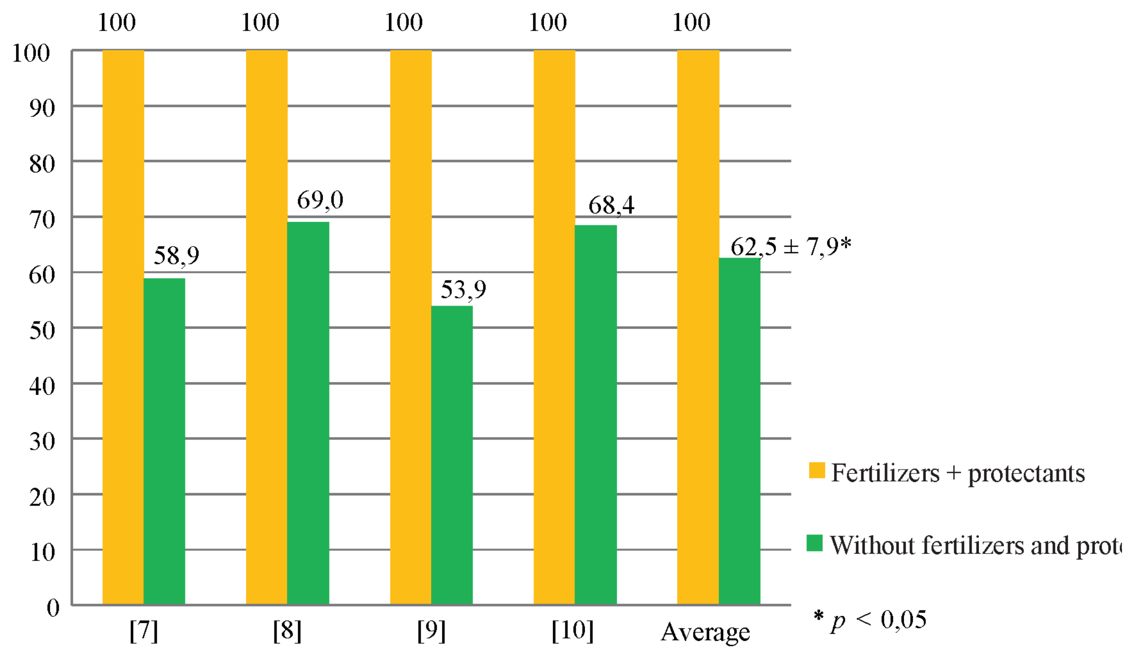

Рис. 1. Соотношение урожайности яровой пшеницы в Сибири по пару при различных вариантах применения минеральных (азотных) удобрений и средств защиты растений (гербицидов), %. [7], [8], [9], [10] – литературные источники, из которых взяты данные.

Fig. 1. Yield ratio of spring wheat in Siberia by fallow at different variants of mineral (nitrogen) fertilizers and plant protection agents (herbicides), %. [7], [8], [9], [10] - literature sources from which the data were taken.

[7]Lipatov N.N. Some aspects of modeling the amino acid balance of food products. Food and processing industry, 1986. pp. 48-52.

and the FAO/WHO protein standard[8]) about 74 g of protein per day, which is utilized by the human body. Taking into account that the Russian norm of protein consumption per day for an adult is 70 g, and energy consumption from 2100 kcal[9], then a conclusion suggests itself: the existing starvation of a significant part of the foreign population has no biological basis, but is caused exclusively by imperfections in the existing sociopolitical and technological world order. The obtained conclusion allows us to hope for the ethics of the potential large-scale use of the Russian wheat in the domestic organic production of livestock products, even under the current sanctions of the "collective West" against the Russian Federation.

Assessment of quality of fodders necessarily takes into account their protein (protein) nutrition. Thus, in modern animal breeding, according to the opinion of academician V.I. Fisinin, protein nutrition should be understood as the properties of feed to meet the need of animals for amino acids (see footnote 4). In a certain sense, speaking about protein, amino acids are meant, speaking about amino acids - protein is meant, so it is more correct to consider amino acid component of all the used feeds, including forage wheat.

It is known that methionine and lysine are the limiting essential amino acids for poultry, lysine, threonine and methionine for pigs (see footnote 4) and methionine for high-yielding lactating cows (see footnote 6). Therefore, the content of these essential amino acids in feeds should be known and taken into account when formulating appropriate diets.

If this state of affairs requires accounting for the amino acid content of wheat used for animal feed, the traditional analysis of the composition of wheat varieties (and other cereals, legumes), as a rule, does not take into account their amino acid content. A contradiction arises: modern zootechnics recognizes the usefulness of taking into account the amino acid composition of wheat, while in agronomic practice such accounting is not common. In this regard, it is advisable to carry out breeding work on fodder crops, taking into account not only the yield of these crops, but also their functional protein elements.

Assuming that wheat varieties have different amino acid content, the analysis of amino acid composition of wheat varieties released in Western Siberia was carried out. The main released wheat varieties of the leading originators in Western Siberia are: Siberian Research Institute of Plant Cultivation and Breeding (SibNIIRS) - branch of the Institute of Cytology and Genetics SB RAS (Novosibirsk), Federal Scientific Centre of Agrobiotechnologies (FSCA) (Barnaul), Omsk Agrarian Scientific Center, and Omsk SAU - were examined for amino acid content on a contract basis at the Integrated Analytical Center of the Siberian Federal Scientific Centre of Agro-BioTechnologies of the Russian Academy of Sciences (SFSCA RAS). The research was carried out on 82 wheat varieties.

Preliminary analysis showed the following results:

– average values of the standardized amino acids content of the wheat varieties of Siberian breeding under study are less than the reference values of amino acids in wheat (lysine by 24.4% on average, methionine by 38.9, threonine by 26.1%);

– some wheat varieties of Siberian selection have a higher content of normalized amino acids.

According to the results of the preliminary tests Novosibirskaya 32 (soft winter wheat of ICiG selection) exceeds the reference values for lysine by 55.6%, for threonine - by 38.4%. Novosibirskaya 22 (spring wheat of ICiG selection) differs from the tested samples by the highest methionine content: it exceeds the reference value by 122.2%.

Let us consider the potential effectiveness of the feasibility of determining the amino acid

[8]Energy and protein requirements. Technical Report Series No. 522. FAO Nutrition Report Series No. 52. Report of the Ad Hoc Joint FAO/WHO Expert Committee. World Health Organization. Geneva, 1974. 143 p.

[9]Methodological Recommendations MR 2.3.1.2432-08. Rational Nutrition. Norms of physiological requirements for energy and nutrients for different groups of population of the Russian Federation. 2008. 41 p.

composition of feed wheat by the example of diets for egg chickens. Let us analyze for lysine content the diets given in the reference book (see footnote 3) in comparison with the model.

The model ration is focused on organic livestock and has the following differences from the reference analogue:

– averaged (reference) wheat was replaced by Novosibirskaya 32;

– sunflower oil cake by sunflower oilseed meal;

– fodder yeast by baker's yeast;

– synthetic lysine is not used.

Replacement of oil cake by oilseed meal, fodder yeast by baker's yeast, exclusion of synthetic lysine from the model ration is due to the relevant standards of GOST 33980-2016.

As a result of calculations, it was found that the values of total lysine content in both diets are equal to each other (0.82% each) (see Fig. 2). However, the real difference is that the reference diet contains synthetic lysine, while the model diet does not. Consequently, by consciously using a wheat variety with high lysine content, it is possible to obtain a balanced feed without the use of synthetic lysine, which meets the requirement of the standard for organic production.

The calculated result obtained by the example of Novosibirskaya 32 indicates the feasibility of research to determine the amino acid content of wheat and evaluation of the new diet on the productivity of poultry, and in the future, in case of a positive result, it is possible to conduct breeding to create new varieties of wheat with increased lysine content.

It is well known from classic compound feed formulation that it is impossible to provide the normatively required content of protein (amino acids) and energy in the compound feed exclusively from any grains (or any combinations thereof). This is due to the fact that cereals contain relatively large amounts of energy and little protein (amino acids). In terms of dry matter, wheat contains the required energy level recommended for intensively developing animals, but the lysine content of wheat is several times lower than the standard level of lysine in full-fat mixed fodder.

Thus, even some of the most highly lysine wheat is not a priori comparable in amino acid quality with meat and bone meal, nor with oil cakes (soybean, sunflower). Without transforming the amino acid-energy composition of wheat, it cannot serve as an adequate substitute for traditional protein raw materials, which are not recommended for use in organic animal husbandry (meat and bone meal, oil cakes).

In this regard, it is necessary to create a feed additive from wheat, which would differ from standard wheat primarily by a higher content of limiting essential amino acids.

Such a problem was set and basically (in the first approximation) was solved[10]. A positive result was achieved by two-step sequential transformations: first enzymatic hydrolysis (mixture: crushed wheat + water + enzyme), then centrifugation. The enzyme of complex action Protosubtilin GZh produced by “Sibbiopharm” Ltd. (Berdsk, Novosibirsk Region) was used. As a result, two fractions of different content were obtained: one predominantly protein and the second one carbohydrate. Proteins are represented mainly by free amino acids, carbohydrates by medium molecular weight dextrins and sugars.

The lysine content in the experimental wheat additive is about 20.3 g/kg DM, which is comparable with its content in oil cakes (extruded soybean - 25.9 g/kg DM, sunflower - 13.3 g/ kg DM), meat and bone meal (25.8 g/kg DM)[11]. The content of methionine in the experimental supplement is about 1.47 g/kg DM.

Thus, an experimental feed ingredient containing high levels of lysine (the first limiting amino acid in feeding high-yielding monogastric animals) and at the same time meeting the requirements of organic production was obtained from the most common local grain raw material - wheat.

To estimate the potential effectiveness of the experimental wheat additive (by the example

[10]Production method of high-protein wheat grain base for food product preparation: patent: 2453126 Russian Federation: IPC A23J 1/12 / V.G. Ermokhin, T.T. Wolf, V.A. Uglov; № 2010141619/10. Application. 11.10.2010; Bulletin No. 17.

[11]Guidelines on feeding farm poultry. VNITIP. Moscow: Lika, 2018. 226 p.

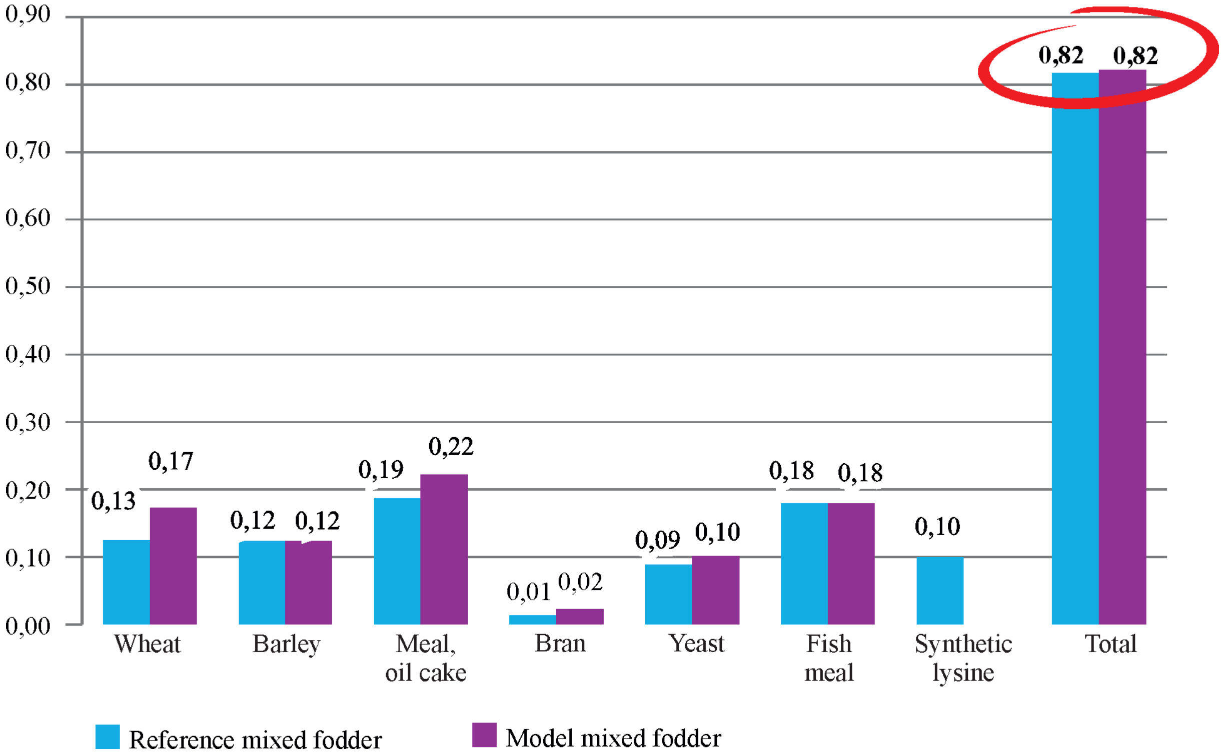

Рис. 2. Содержание лизина в справочном и модельном комбикормах для яичных кур (возраст 21–45 нед), %

Fig. 2. Lysine content in reference and model feeds for egg chickens (age 21-45 weeks), %

of pig production) model recipes of complete organic compound feed for growing pigs of different live weight (from 20-30 to 110-120 kg) were compiled (see Table 1).

The evaluated qualities of mixed fodders of all model formulas correspond to the basic norms of feeding growing pigs with the average daily growth for the whole period of fattening of 650 g.

The primary test of the effectiveness and safety for pigs of the experimental wheat feed additive was carried out at the pig farm of "Uchkhoz Tulinskoye" (Uchkhoz NSAU), Novosibirsk Region. The experiment was conducted on the piglets of EM-1 breed. Breeding sows of the control and experimental groups were selected with equal milk yield. Experimental piglets received 7% of the experimental wheat supplement in their diet. The amount of feed consumed per dry matter on average per one head of control and experimental piglets was equal. During the whole experiment (49 days) the piglets of the experimental group ate the feed noticeably more willingly than the piglets of the control group. The young piglets of the experimental group surpassed their counterparts of the control group in growth by 19,5%: average live weight of experimental piglets increased from 6,7 kg at the beginning of the experiment to 22,6 kg at the end, in the control group - from 6,6 to 19,9 kg (see Table 2) [17].

An experiment on preliminary evaluation of the feasibility of using the experimental wheat additive in the diet of quails reared for meat was carried out at the quail farm of the SibNIPTIZh SFSCA RAS.

The experiment was conducted for 6 weeks (42 days) according to conventional methods[12] on Japanese quails formed at the age of one day into two similar groups (control and experimental) with 45 birds in each group. The birds of both groups received full-rare mixed fodder prepared taking into account the age and physiological characteristics of the quails.

[12]Methodology of scientific and industrial research on the feeding of poultry: recommendations. VNIITIP. Sergiev Posad, 2004, 42 p.

Табл. 1. Модельные рецепты полнорационных комбикормов для растущих свиней различной живой массы

Table 1. Model formulations of complete feed for growing pigs of various live weights

*Significant at the 5% significance level	Composition of model mixed fodder, kg per 1 head per day						Daily consumption of mixed fodder per 1 head	
	Wheat additive	Barley	Dicalcium-phosphate	Chalk	Salt	Premix	natural humidity, kg	calculated per dry matter, kg
From 20 to 30	1,98	0,92	0,012	0,009	0,003	0,002	2,926	1,177
From 30 to 40	2,37	1,11	0,014	0,011	0,004	0,003	3,512	1,417
From 40 to 50	2,70	1,43	0,017	0,017	0,009	0,017	4,190	1,782
From 50 to 60	2,86	1,67	0,020	0,020	0,010	0,020	4,600	2,029
From 60 to 70	2,81	1,96	0,022	0,022	0,011	0,022	4,847	2,279
From 70 to 80	2,66	2,26	0,024	0,024	0,012	0,024	5,004	2,521
From 80 to 90	2,32	2,63	0,027	0,027	0,014	0,027	5,045	2,793
From 90 to 100	1,96	2,98	0,030	0,030	0,015	0,030	5,045	3,045
From 100 to 110	1,76	3,17	0,032	0,032	0,016	0,032	5,042	3,181
From 110 to 120	1,75	3,19	0,032	0,032	0,016	0,032	5,052	3,197

Note. Premix P51-I was used for piglets with live weight from 20 to 40 kg, premix P52-I for pigs with live weight from 40 to 120 kg; wheat premix moisture 82.3%; barley premix moisture 13.0%.

Табл. 2. Результаты испытаний экспериментальной добавки из пшеницы на поросятах

Table 2. Test results of an experimental wheat supplement on piglets

Indicator	Control group	Experimental group
Number of piglets in the group, heads.	10	10
Duration of the experiment, days	49	49
Live weight of one head, kg:		
at the beginning of the experiment	6,6 ± 0,6	6,7 ± 0,6
at the end of the experiment	19,9 ± 1,9	22,6 ± 2,6
Average daily gain, g	271 ± 36	324 ± 45*

*$p < 0{,}05$.

Табл. 3. Результаты испытаний экспериментальной добавки из пшеницы на перепелятах

Table 3. Test results of an experimental wheat additive on quail

Indicator	Control group	Experimental group
Number of quails in the group, heads	45	45
Duration of the experiment, days	42	42
Live weight of one head, g:		
at the beginning of the experiment	8,6 ± 0,2	8,6 ± 0,2
at the end of the experiment	139,8 ± 9,3	168,3 ± 7,8
Average daily gain, g	3,13 ± 0,21	3,80 ± 0,18*

*$p < 0{,}01$.

The diet of the young quail of the experimental group contained an experimental supplement of wheat (17.5% for quails aged 1-4 weeks and 18.0% for birds aged 5-6 weeks). Feed ingredients used in the diets of the experimental group birds corresponded to the list of feed raw materials approved for use in organic livestock production (see footnote 1).

According to the results of the experiment, the gain in live weight of the quails of the experimental group statistically significantly ($p < 0.01$) exceeded the gain in live weight of the control group by 21.4% (see Table 3). Biochemical blood parameters of the chicks were within the physiological norm.

Thus, according to the results of the experimental part of the work (primary practical experience based on the use of available laboratory equipment) it can be concluded that the developed wheat protein supplement is an appetizing feed for piglets and quail, has no adverse effects on their health, has a positive effect on productivity, so it can be used in further experimental studies on animals raised by the rules of organic production.

CONCLUSIONS

1. Modern agronomic techniques fundamentally allow to carry out industrial production of wheat according to the norms of organic production in the zone of Western Siberia.

2. According to preliminary data, some wheat varieties of Siberian breeding are high in essential amino acids limiting for animals, so they are of practical interest for use in animal husbandry.

3. Bio-fractionation of wheat makes it possible to obtain a feed additive of effective quality for use in animal husbandry.

4. Experimental wheat additive is calculated applicable for fattening pigs raised according to organic production standards.

5. The search experiments performed give grounds for deepening the research on the creation and use of wheat additives in the organic production of livestock products in Siberia.

СПИСОК ЛИТЕРАТУРЫ

1. *Чекмарев П.А., Глишушкина А.П., Старцев В.И.* Производство органической продукции – конкурентное преимущество АПК Российской Федерации // Достижения науки и техники АПК. 2018. № 3. С. 5–6.
2. *Лещуков К.А.* Научно-практические аспекты органического сельскохозяйственного производства // Вестник аграрной науки. 2019. № 2. С. 66–71.
3. *Нековаль С.Н., Беляева А.В., Маскаленко О.А., Чурикова А.К., Лукина А.Е., Горло В.Е.* Перспективы производства органической продукции в России // Агрохимический вестник. 2019. № 5. С. 77–82. DOI: 10.24411/0235-2516-2019-10080.
4. *Сайфетдинов А.Р., Сайфетдинова Н.Р., Ульянов А.В.* Тенденции развития и факторы эффективности производства продукции органического сельского хозяйства в России // Труды Кубанского государственного аграрного университета. 2019. № 76. С. 73–80.
5. *Шеленок А.В.* Оценка эффективности развития производства органической продукции растениеводства // Научное обозрение: теория и практика. 2020. № 5. С. 749–763. DOI: 10.35679/2226-0226-2020-10-5-749-763.
6. *Горбатов А.В., Горбатова О.А.* Производство органической продукции как фактор развития агропромышленного комплекса и укрепления продовольственной безопасности России // Фундаментальные исследования. 2020. № 11. С. 70–76. DOI: 10.17513/fr.42876.
7. *Шарков И.Н., Захаров Г.М., Крупская Т.Н.* Эффективность применения средств химизации под яровую пшеницу в лесостепи Западной Сибири // Земледелие. 2017. № 6. С. 16–18.
8. *Олешко В.П., Гаркуша А.А., Пургин Д.В., Кравченко В.И.* Продуктивность и экономическая эффективность зернопарового севооборота в Кулундинской степи в зависимости от агротехнологий // Земледелие. 2016. № 7. С. 27–30.
9. *Усенко В.И., Гаркуша А.А., Пургин Д.В.* Эффективность азотных удобрений и гербицидов в зернопаровом севообороте в зависимости от способа обработки каштановой почвы в Кулундинской степи // Земледелие. 2019. № 6. С. 33–39.
10. *Усенко В.И., Усенко С.В.* Эффективность применения минеральных удобрений под яровую пшеницу в зависимости от предшественника, обработки почвы и средств защиты растений в лесостепи Алтайского Приобья // Земледелие. 2016. № 8. С. 4–8.
11. *Мустафина М.А., Таракановский А.Н.* Защита от фузариоза колоса – определяющий фактор качества зерна // Защита и карантин растений. 2018. № 5. С. 14–16.
12. *Попов В.С., Самбуров Н.В., Воробьева Н.В.* Проблемы микотоксинов в современных условиях и принципы профилактических решений // Вестник Курской государственной сельскохозяйственной академии. 2018. № 3. С. 101–105.
13. *Гагкаева Т.Ю., Орина А.С., Гаврилова О.П., Аблова И.Б., Беспалова Л.А.* Характеристика сортов озимой пшеницы по устойчивости к фузариозу зерна // Вавиловский журнал генетики и селекции. 2018. № 6. С. 685–692. DOI: 10.18699/VJ18.411.
14. *Торопова Е.Ю., Воробьева И.Г., Мустафина М.А., Селюк М.П.* Грибы рода *Fusarium* на зерне пшеницы в Западной Сибири // Защита и карантин растений. 2019. № 1. С. 21–23.
15. *Митюков А.С., Торбаева А.А., Баракова Н.В., Нсемгумуремый Д.* Поиск новых ре-

шений в борьбе с микотоксинами // Генетика и разведение животных. 2020. № 2. С. 63–69. DOI: 10.31043/2410-2733-2020-2-63-69.
16. *Рудик Ф.Я., Моргунова Н.Л., Красникова Е.С., Фауст Е.А., Семилет Н.А.* Технология и средства механизации для обработки зерна // Хранение и переработка сельхозсырья. 2020. № 1. С. 137–147.
17. *Ермохин В.Г., Жучаев К.В., Богатырева С.Н.* Аминокислотно-сахаристая добавка из пшеницы в рационах свиней // Вестник НГАУ. 2014. № 2 (31). С. 73–77.

REFERENCES

1. Chekmarev P.A., Glishushkina A.P., Startsev V.I. Production of organic products is a competitive advantage of the agroindustrial complex of the Russian Federation. *Dostizheniya nauki i tekhniki APK = Achievements of Science and Technology of AIC,* 2018, no. 3, pp. 5–6. (In Russian).
2. Leshchukov K.A. Scientific and practical aspects of organic agricultural production. *Vestnik agrarnoi nauki = Bulletin of Agrarian Science,* 2019, no. 2, pp. 66–71. (In Russian).
3. Nekoval' S.N., Belyaeva A.V., Maskalenko O.A., Churikova A.K., Lukina A.E., Gorlo V.E. Perspectives of organic farming in Russia. *Agrokhimicheskii vestnik = Agrochemical Herald,* 2019, no. 5, pp. 77–82. (In Russian). DOI: 10.24411/0235-2516-2019-10080.
4. Saifetdinov A.R., Saifetdinova N.R., Ul'yanov A.V. Development trends and efficiency factors of organic agriculture in Russia. *Trudy Kubanskogo gosudarstvennogo agrarnogo universiteta = Proceedings of the Kuban State Agrarian University,* 2019, no. 76, pp. 73–80. (In Russian).
5. Shelenok A.V. Evaluation of the effectiveness of the development of organic crop production. *Nauchnoe obozrenie: teoriya i praktika = Scientific Review: Theory and Practice,* 2020, no. 5, pp. 749–763. (In Russian). DOI: 10.35679/2226-0226-2020-10-5-749-763.
6. Gorbatov A.V., Gorbatova O.A. Production of organic products as a factor of development of agricultural complex and strengthening of food security of Russia. *Fundamental'nye issledovaniya = Fundamental Research,* 2020, no. 11, pp. 70–76. (In Russian). DOI: 10.17513/fr.42876.
7. Sharkov I.N., Zakharov G.M., Krupskaya T.N. Efficiency of chemicals application for spring wheat in the forest-steppe of Western Siberia. *Zemledelie = Zemledelie,* 2017, no. 6, pp. 16–18. (In Russian).
8. Oleshko V.P., Garkusha A.A., Purgin D.V., Kravchenko V.I. Productivity and economic efficiency of grain-fallow crop rotation in the Kulunda Steppe depending on agricultural technologies. *Zemledelie = Zemledelie,* 2016, no. 7, pp. 27–30. (In Russian).
9. Usenko V.I., Garkusha A.A., Purgin D.V. Efficiency of nitrogen fertilizers and herbicides in grain-fallow crop rotation depending on the method of processing chestnut soil in the Kulunda Steppe. *Zemledelie = Zemledelie,* 2019, no. 6, pp. 33–39. (In Russian).
10. Usenko V.I., Usenko S.V. Efficiency of mineral fertilizers for spring wheat in dependence of the forecrop, soil cultivation and plant protection means in the forest- steppe of the Altai Ob Region. *Zemledelie = Zemledelie,* 2016, no. 8, pp. 4–8. (In Russian).
11. Mustafina M.A., Tarakanovskii A.N. Protection from the fusarium head blight – the determining factor of grain quality. *Zashchita i karantin rastenii = Plant Protection and Quarantin*, 2018, no. 5, pp. 14–16. (In Russian).
12. Popov V.S., Samburov N.V., Vorob'eva N.V. Problems of mycotoxins in modern conditions and principles of preventive solutions. *Vestnik Kurskoi gosudarstvennoi sel'skokhozyaistvennoi akademii = Bulletin of the Kursk State Agricultural Academy,* 2018, no. 3, pp. 101–105. (In Russian).
13. Gagkaeva T.Yu., Orina A.S., Gavrilova O.P., Ablova I.B., Bespalova L.A. Characterization of resistance of winter wheat varieties to Fusarium head blight. *Vavilovskii zhurnal genetiki i selektsii = Vavilov Journal of Genetics and Breeding*, 2018, no. 6, pp. 685–692. (In Russian). DOI: 10.18699/VJ18.411.
14. Toropova E.Yu., Vorob'eva I.G., Mustafina M.A., Selyuk M.P. Fungi of *Fusarium* genus on wheat grains in Western Siberia. *Zashchita i karantin rastenii = Plant Protection and Quarantin*, 2019, no. 1, pp. 21–23. (In Russian).
15. Mityukov A.S., Torbaeva A.A., Barakova N.V., Nsemgumuremyi D. The search for new solutions to fight mycotoxins. *Genetika i razvedenie zhivotnykh* = Animal Genetics and Breeding, 2020, no. 2, pp. 63–69. (In Russian). DOI: 10.31043/2410-2733-2020-2-63-69.
16. Rudik F.Ya., Morgunova N.L., Krasnikova E.S., Faust E.A., Semilet N.A. Technology

and means of mechanization for grain processing. *Khranenie i pererabotka sel'khozsyr'ya = Storage and processing of farm products,* 2020, no. 1, pp. 137–147. (In Russian).

17. Ermokhin V.G., Zhuchaev K.V., Bogatyreva S.N. Saccharine amino acid additive out of wheat in pig diets. *Vestnik NGAU = Bulletin of NSAU*, 2014, no. 2 (31), pp. 73–77. (In Russian).

ИНФОРМАЦИЯ ОБ АВТОРАХ

(✉)**Ермохин В.Г.,** кандидат технических наук, старший научный сотрудник; **адрес для переписки:** Россия, 630501, Новосибирская область, р.п. Краснообск, а/я 463; e-mail: v_ermohin_56@mail.ru

Солошенко В.А., доктор сельскохозяйственных наук, главный научный сотрудник; e-mail: soloshenko@sfsca.ru

Соловьев К.А., научный сотрудник; e-mail: vetvrach1@mail.ru

AUTHOR INFORMATION

(✉)**Vitaly G. Ermokhin,** Candidate of Science in Engineering, Senior Researcher**; address:** PO Box 463, Krasnoobsk, Novosibirsk Region, 630501, Russia; e-mail: v_ermohin_56@mail.ru

Vladimir A. Soloshenko, Doctor of Science in Agriculture, Head Researcher; e-mail: soloshenko@sfsca.ru

Konstantin A. Soloviev, Researcher; e-mail: vetvrach1@mail.ru

Дата поступления статьи / Received by the editors 18.06.2022
Дата принятия к публикации / Accepted for publication 15.11.2022
Дата публикации / Published 27.12.2022