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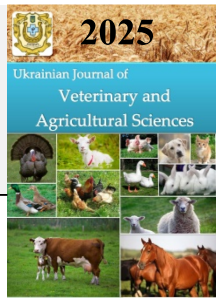

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Effect of buckwheat germ meal on the natural resistance and growth rate of laboratory animals

V. P. Lyasota[1], N. M. Bohatko[1], N. V. Bukalova[1], A. F. Bohatko[1], T. G. Mazur[1], O. A. Hitska[1], V. I. Dzhmil[1], S. A. Tkachuk[2], T. M. Prilipko[3], L. H. Bartkiv[4], V. A. Bolokhovska[5]

[1]*Bila Tserkva National Agrarian University, Cathedral Square, 8/1, Bila Tserkva, 09117, Ukraine*
[2]*National University of Life and Environmental Sciences of Ukraine, Heroiv Oborony Str., 15, Kyiv, 03041, Ukraine*
[3]*Higher Education Institution Podillia State University, Shevchenko Str., 12, Kamianets-Podilskyi, 32300, Ukraine*
[4]*State Enterprise "Kyiv Regional Scientific and Production Center for Standardization, Metrology and Certification", Sichnevyi Proryv Str., 84, Bila Tserkva, 09113, Ukraine*
[5]*Private Enterprise "BTU-Center", Vinnytsia Region, Ukraine*

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Correspondence author
Vasily Lyasota
Tel.: +38-098-334-63-91
E-mail: lyasota777@gmail.com

Contents

Abstract

In recent years, scientific research has shown growing interest in natural vitamin preparations, particularly those containing carotenoids. These biologically active compounds play a crucial role in antioxidant defense, support immune function, contribute to metabolic normalization, and reduce the risk of developing various chronic diseases. Significant scientific and practical interest in these compounds stems from the fact that some of them exhibit high biological activity, the ability to significantly modulate metabolic processes, prevent damage to cell membranes, and enhance the resistance of animals to adverse environmental factors. The aim of the study was to conduct a sanitary and hygienic assessment of the effect of the preparation "Buckwheat Germ Meal" on natural resistance and growth intensity of laboratory animals. The studies were conducted during 2022–2023 at the Department of Veterinary and Sanitary Expertise, Hygiene of Animal Products and Pathological Anatomy named after Y. S. Zahaievskyi, Bila Tserkva National Agrarian University; at the State Enterprise LLC "Bilotserkivkhliboprodukt" (Laboratory for Food Safety and Quality Control), Bila Tserkva, Kyiv region; and at the Fastiv District State Laboratory of the State Service of Ukraine on Food Safety and Consumer Protection, Kyiv region. Zoohygienic, zootechnical, morphological, biochemical, organoleptic, physicochemical, biochemical, and variation-statistical research methods were applied. The research substantiated the feasibility of using a new domestic biologically active preparation, "Buckwheat Germ Meal", as a preventive agent. Its positive effect on morphological, biochemical, and immunological blood parameters, enhancement of natural resistance, and increased growth intensity of laboratory animals was experimentally confirmed. The use of "Buckwheat Germ Meal" contributed to moderate activation of erythropoiesis in the peripheral blood of white mice: hemoglobin levels increased by 3.7 %, erythrocyte count by 10.0 % ($P < 0.05$), and hematocrit by 6.2 % ($P < 0.05$). Feeding "Buckwheat Germ Meal" at a dose of 2.0 g per animal for 30 days moderately activated metabolic processes in white mice: total protein content increased by 6.4 % ($P < 0.05$), total globulins by 16.6 % ($P < 0.05$), alanine aminotransferase activity by 8.6 %, and aspartate aminotransferase by 5.8 % ($P < 0.05$). No changes in serum cholesterol activity were detected. Administration of the preparation at a dose of 2.5 g per animal did not cause any adverse effects or negative changes in the clinical condition of white mice, such as increased body temperature or delayed growth and development; therefore, it can be recommended for use in farm animals. It was established that the growth energy of white mice in the experimental group increased dynamically, and by the end of the experiment (day 60), this parameter was 14.2 % higher compared to the control group. A preparation is considered active if the difference in average daily body weight gain between groups is at least 10 %. The economic efficiency of using "Buckwheat Germ Meal" is achieved through reduced morbidity of animals and poultry, increased survival rates, higher average daily weight gain, additional live weight gain, reduced costs per unit of production, and lower production costs of livestock products.

Keywords: animal husbandry; poultry farming; vitamin preparations; meat industry; laboratory animals; morphological; biochemical; physicochemical; chemical parameters; food product; consumer.

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1. Introduction

The search for effective, safe, and environmentally friendly agents capable of ensuring optimal growth, development, and enhancement of natural resistance in animals and poultry, especially at an early age, remains relevant in order to achieve high survival rates (Law of Ukraine, 2006; Law of Ukraine, 2017; Law of Ukraine, 2018; Svitovyi et al., 2022; Farafonov et al., 2025).

The use of various biologically active compounds during the rearing of young animals is one of the key approaches to increasing their survival and overall productivity. Until recently, plant-based sources of vitamin preparations–such as yellow maize, alfalfa meal, and grass meal–were predominantly used for these purposes. However, under conditions of intensive animal husbandry and increasing requirements for product quality, there is a growing need for more concentrated, stable, and biologically available forms of natural vitamins capable of effectively supporting metabolism and enhancing the natural resistance of the organism (Bai et al., 2021; Cheng et al., 2021; Musa-Veloso et al., 2021; Llanaj et al., 2022; Ciudad-Mulero et al., 2023; Huang et al., 2025).

Existing sources of carotenoids are either relatively expensive or limited in production capacity. Therefore, the search for new, accessible, and effective sources of these compounds is ongoing. Among promising approaches, some authors highlight microbial and chemical synthesis of carotenoids. At the same time, modern technologies in animal production should consider not only the requirement for vitamin A, but also the provision of sufficient amounts of carotenoids in animal diets, which contributes to improved natural resistance and productivity (Galanakis, 2022; Guo et al., 2023).

Studies have shown that feeding broiler chickens with biomass of the fungus *Blakeslea trispora* in combination with a standard compound feed at a specified dose per 1 kg of feed promotes increased average daily weight gain, live body weight, and poultry survival. In addition, a reduction in feed consumption per 1 kg of live weight gain and a slight improvement in nutrient digestibility were observed, indicating the effectiveness of including this biomass in poultry diets (Bai et al., 2021; Xochitl et al., 2021).

Particularly valuable are recent research findings demonstrating that feeding quails with a vitamin complex in the form of tomato powder and calendula extract at doses ranging from 20 to 2 g/kg of diet significantly increases the content of lycopene and lutein in egg yolk, as well as the level of coenzyme Q in the liver of newly hatched quail chicks, without affecting the concentration of vitamin E in the yolk and liver (Cheng et al., 2021).

New data indicate that the administration of lycolin to broiler chickens stimulates body weight gain by 8.3 % compared to the control group. The positive effect of lycopene on metabolic processes and live weight gain in broiler chickens is consistent with findings reported by other authors. The inclusion of lycocinol stimulates growth in young cattle, which is associated with activation of protein and carbohydrate metabolism and increased vitamin concentrations in the body. In addition, supplementation of sow diets with lycocinol positively affected piglet survival and body weight gain. The difference in average daily body weight gain between piglets of different groups reached 15.8 %, while offspring survival increased by 6.7 % (Aparicio-García et al., 2021; Laito et al., 2022).

It was found that after male volunteers consumed eggs obtained from Japanese quails fed lycopene at doses of 100 and 200 mg/kg of feed, an increase in serum lycopene concentration and a decrease in malondialdehyde levels were observed, indicating the antioxidant effect of these eggs (Lee et al., 2021; Valido et al., 2021; Dong et al., 2023).

The presented data indicate that biologically active supplements containing natural vitamin components improve the clinical condition and metabolic parameters of animals, enhance the supply of fat-soluble vitamins, and intensify the conversion of carotenoids in eggs (Hu et al., 2020; Wang et al., 2022; Li et al., 2024; Song et al., 2024; Liu et al., 2025).

Thus, the use of preparations containing vitamins – particularly lycopene – has a positive effect on animal and poultry productivity, allowing for increased body weight gain in calves by 6.1–9.5 %, piglets by 18.9 %, and chicks by 5.9–9.9 %, as well as improved survival rates up to 91–99 % (Gao et al., 2020; Musa-Veloso et al., 2021; Yu et al., 2021; Lee et al., 2022; Li et al., 2022; Wang et al., 2023; Kei et al., 2024).

The aim of the study was to conduct a sanitary and hygienic assessment of the effect of the biologically active preparation *"Buckwheat Germ Meal"* on natural resistance and growth intensity of laboratory animals.

2. Materials and methods

The studies were conducted during 2022–2023 at the Department of Veterinary and Sanitary Expertise, Hygiene of Animal Products and Pathological Anatomy named after Y. S. Zahaievskyi, Bila Tserkva National Agrarian University; at the State Enterprise LLC "Bilotserkivkhliboprodukt" (Food Safety and Quality Control Laboratory), Bila Tserkva, Kyiv region; and at the Fastiv District State Laboratory of the State Service of Ukraine on Food Safety and Consumer Protection, Kyiv region.

Experimental studies were carried out in accordance with the Order of the State Department of Veterinary Medicine of the Ministry of Agrarian Policy of Ukraine No. 7 dated February 17, 1999, "On Strengthening Control over the Quality and Safety of Veterinary Medicinal Products and Feed Additives," as well as in compliance with international standards, taking into account the principles of Good Laboratory Practice (GLP).

Standard laboratory animals were used in the experiment – white mice (*Mus musculus* L.), improved conventional animals (Minimal Diseases, MD), free from pathogenic microflora, housed under barrier conditions in an improved conventional system. A total of 30 animals were included in the study.

Peripheral blood served as the material for morphological and biochemical analyses. Blood samples were collected from animals of the experimental and control groups at the end of the experiment following administration of the preparation.

Characteristics of the biologically active preparation "Buckwheat Germ Meal". The biologically active preparation *"Buckwheat Germ Meal"* was developed by the State Enterprise LLC "Bilotserkivkhliboprodukt", Bila Tserkva, Kyiv region.

The preparation is a gray-colored powdered substance containing a complex of biologically active compounds, including amino acids such as lysine, histidine, arginine, threonine, serine, glutamic and aspartic acids, proline, glycine, alanine, cystine, valine, methionine, isoleucine, leucine, tyrosine, and phenylalanine, as well as B-group vitamins, vitamin E, vitamin PP, and carotenoids. The preparation may exhibit adaptogenic and antioxidant effects.

Amino acids are involved in the synthesis of hormones, enzymes, and vitamins, contribute to the renewal of structural proteins, and represent one of the most important factors of animal metabolism.

According to biochemical analysis, 1 g of the preparation contains: lysine – 0.57 mg%; histidine – 1.50 mg%; aspartic acid – 398.75 mg%; threonine – 5.41 mg%; serine – 14.78 mg%; glutamic acid – 10.33 mg%; glycine – 11.81 mg%; alanine – 9.15 mg%; cystine – 3.91 mg%; valine – 3.21 mg%; methionine – 0.90 mg%; isoleucine – 3.74 mg%; leucine – 0.35 mg%; tyrosine – 0.52 mg%; and phenylalanine – 5.31 mg%.

Analysis of biochemical parameters showed that 1.0 g of the preparation contains B-group vitamins, namely vitamin B_1 – 0.23 µg/g, vitamin B_2 – 0.27 µg/g, vitamin B_{12} – 0.0015 µg/g, carotenoids – 3.9 µg/g, and vitamin E – 2.82 µg/g (TU U 20608169.003–2023).

The presence of carotenoids and vitamins of groups B and E in the preparation is of particular importance, as they are among the most active antioxidants and cofactors.

The scheme of administration of the preparation *"Buckwheat Germ Meal"* under vivarium conditions is presented in Table 1.

Experimental animals were provided with appropriate laboratory conditions, including cage housing, balanced feeding and water supply, adequate ventilation, and regular removal of excreta.

The biologically active supplement *"Buckwheat Germ Meal"* was administered daily to experimental white mice for 30 days at doses ranging from 0.3 to 3.5 g per animal once daily in combination with the basic diet (hereinafter BD). Water was supplied via nipple drinkers. Throughout the experiment, animals were monitored for general behavior, clinical condition, feed and water intake, morbidity, reproduction, growth energy, and development.

Peripheral blood was used for morphological and biochemical studies. In white mice, blood samples were collected by decapitation using a guillotine knife after preliminary anesthesia (approximately 0.5–1.0 cm3 per animal), while in rabbits blood was collected from the ear vein after completion of the experiments (approximately 3–5 cm^3 per animal). Collected blood samples were placed into tubes containing anticoagulant for morphological analysis and into dry tubes for biochemical studies, followed by storage at 4 °C until analysis.

Table 1
Scheme of administration of the preparation "Buckwheat Germ Meal" to white mice

Group	Number of animals, n	Dose, g/animal + BD	Frequency per day	Feeding duration, days	Observation period, days
Experimental 1	5	0.3	Once daily	30	60
Experimental 2	5	1.0	Once daily	30	60
Experimental 3	5	1.5	Once daily	30	60
Experimental 4	5	2.5	Once daily	30	60
Experimental 5	5	3.5	Once daily	30	60
Control	5	–	Basic diet (BD)	–	60

Note. Basic diet (BD): crushed wheat grain, compound feed, water *ad libitum*.

The basic diet (hereinafter BD) of white mice consisted of freshly crushed wheat grain and compound feed in the control group, while in the experimental groups buckwheat germ meal was added to the basic diet. According to organoleptic characteristics (color, odor, structure, consistency, presence of microscopic fungi, and mechanical impurities), the feeds complied with sanitary and hygienic requirements.

In the first experiment, in order to assess housing, feeding, and watering conditions of laboratory animals, studies of the air environment, feeding technology, and the quality of feed and drinking water were conducted.

The aim of the second experiment was to investigate the safety and biological activity of the new biologically active preparation *"Buckwheat Germ Meal"* using white mice as a laboratory test model.

The aim of the third experiment was to study the effect of the new biologically active preparation *"Buckwheat Germ Meal"* on morphological and biochemical blood parameters in white mice.

The aim of the fourth experiment was to evaluate the effect of the preparation *"Buckwheat Germ Meal"* on survival dynamics and growth intensity of white mice.

Zootechnical methods: survival rate and live body weight gain of laboratory animals.

Zoohygienic methods: assessment of housing conditions, building materials, air temperature (°C) measured using a mercury thermometer; relative humidity (%) measured with an August psychrometer; air velocity (m/s) measured using a ball katathermometer; concentrations of harmful gases – carbon dioxide (%), ammonia and hydrogen sulfide (mg/m^3) – measured using a UG-2 gas analyzer; artificial lighting (W/m^2, lux) measured with a Yu-116 luxmeter. Microclimate parameters were assessed three times during the experimental period.

Drinking water was analyzed in accordance with the requirements of DSTU 7525. Feed quality was evaluated by organoleptic methods.

Clinical and physiological methods: assessment of the general clinical condition of animals, including behavior, feed intake, reproductive performance, and the functional state of the cardiovascular system and gastrointestinal tract (Kotsyumbas et al., 2006).

Morphological methods: determination of hemoglobin concentration, erythrocyte count, hematocrit, erythrocyte sedimentation rate (ESR), leukocyte count, and lymphocyte count using generally accepted standardized methods (Kotsyumbas et al., 2006).

Biochemical methods: determination of total protein and protein fractions; activity of transaminases (ALT, AST); glucose and cholesterol levels (Kotsyumbas et al., 2006).

Economic efficiency of the use of biologically active preparations was calculated according to the method proposed by I. Ya. Kotsyumbas (Kotsyumbas et al., 2006).

Variation–statistical processing of experimental data was performed using computer software packages *Microsoft Excel* and *Maple 12* (Maplesoft, 2008). Statistical significance was assessed using Student's *t*-test, with significance levels set at $P \leq 0.05$ and $P \leq 0.01$.

3. Results and discussion

3.1 Results

Under modern conditions, the preservation and enhancement of animal productivity remains one of the most pressing scientific and practical problems, integrating both biological and economic aspects. The use of natural biologically active substances and preparations contributes to strengthening natural resistance, optimizing metabolic processes, and increasing growth energy in farm animals, thereby ensuring efficiency and sustainability of production.

The vivarium of the Fastiv District State Laboratory of the State Service of Ukraine on Food Safety and Consumer Protection, Kyiv region, is located on healthy soils and enclosed by a metal fence with a height of 140 cm. The distance from the nearest settlement (the city of Fastiv) is 2,000 m. The entire territory is landscaped with tree plantations and a dense grass cover. The level of groundwater lies more than 2 m below the lower foundation base.

The premises used for housing laboratory animals are of a standard type, constructed of brick, single-story, well illuminated by sunlight, and located on flat terrain. No disinfection mat was present at the entrance to the building. Laboratory mice were housed in a separate room.

The results of the assessment of the main housing parameters for laboratory mice and environmental indicators in the premises are presented in Table 2.

Table 2
Housing standards for white mice in cages in accordance with sanitary and hygienic requirements

Parameter	Standard value	Actual value	Deviation
Minimum cage floor area per animal, cm^2	180	182	+4
Minimum cage height, cm	12.0	13.0	+1.0

As shown in Table 2, the housing standards for laboratory mice in metal cages complied with sanitary and hygienic requirements, indicating that appropriate living conditions were provided for the animals.

The study of physical microclimate parameters in the room where white mice were kept showed that they met sanitary and hygienic requirements. Both natural and artificial lighting (fluorescent lamps) were used. Ventilation in the animal housing area was natural (Table 3).

Table 3
Microclimate parameters in the premises for housing white mice

Parameter	Sanitary–hygienic standards	Actual value
Temperature, °C	20–24	23.1 ± 1.11
Relative humidity, %	55.0–60.0	56.2 ± 3.15
Air velocity, m/s	0.3–0.4	0.31 ± 0.02
CO_2 concentration, %	0.10–0.15	0.12 ± 0.003
NH_3 concentration, mg/m^3	5–10	1.90 ± 0.03
H_2S concentration, mg/m^3	5	not detected
Illumination, lux (1 m above floor)	200	198.0 ± 7.01
Photoperiod, h (light:dark)	12:12	12:12
Air exchange rate, h^{-1}	10–15	10

During the assessment of sanitary and hygienic indicators of tap water in the vivarium, it was established that according to organoleptic parameters (color, odor, turbidity, color intensity, presence of mechanical impurities), the water met the sanitary and hygienic requirements of DSTU 7525. The test results are presented in Table 4.

Table 4
Physical, chemical, and biological parameters of tap water in the vivarium

Parameter	Unit	DSTU 7525 standard	Actual value
Color	score	≤2	1.1 ± 0.02
Odor	score	≤2	1.5 ± 0.03
Turbidity	mg/dm^3	≤1.5	0.3 ± 0.04
Color intensity	degrees	≤20.0	7.0 ± 0.05
Mechanical impurities	–	not allowed	not detected
pH	–	6.0–9.0	7.1 ± 0.03
Total hardness	mmol/L	≤7.0	7.3 ± 0.05
Chlorides	mg/dm^3	≤350.0	157.0 ± 5.6
Ammonia	mg/dm^3	≤0.5	not detected
Nitrates	mg/dm^3	≤45.0	15.4 ± 3.2
Nitrites	mg/dm^3	≤5.0	0.7 ± 0.04
Manganese	mg/dm^3	≤0.1	0.04 ± 0.002
Sulfates	mg/dm^3	≤500.0	27.9 ± 1.5
Total iron	mg/dm^3	≤0.3	0.07 ± 0.001
Oxidizability	mg/dm^3	≤4.0	3.8 ± 0.3
Coliform index	–	≤3	3
Total microbial count	CFU/cm^3	≤100	51.50 ± 2.30

Evaluation of the physicochemical parameters of the water showed that they also complied with the sanitary and hygienic requirements of DSTU 7525. The degree of water contamination with organic substances was assessed based on the coliform index, total microbial count per 1 cm^3 of water, and oxidizability. The results indicate that drinking water samples were free from organic contaminants and were not contaminated with pathogenic microorganisms in accordance with DSTU 7525 requirements.

Thus, the tested water meets sanitary and hygienic standards in terms of organoleptic, chemical, and biological properties and is suitable for consumption by animals.

Physiological and morphological assessment of the effects of preparations plays an important role in predicting potential adverse impacts on the organism of humans, laboratory animals, and farm animals.

Changes in behavior and body weight (reduction) of experimental animals compared with the control group are very important indicators, the disturbance of which reflects the degree of damage to organs and specific physiological functions (Table 5).

Table 5
Integrated assessment of behavioral parameters of white mice after administration of buckwheat germ meal (M ± m, n = 5, observation time: 5 min)

Parameter	Experimental group	Control group
Body temperature, °C	37.0 ± 0.53	37.8 ± 1.1
Horizontal locomotor activity	33.2 ± 1.27	33.1 ± 1.25
Vertical locomotor activity	17.5 ± 1.51	17.3 ± 1.17
“Burrowing reflex”	12.5 ± 1.03	12.3 ± 1.31
Integrated activity	63.0 ± 2.27	62.7 ± 1.17

The study of the integrated behavioral parameters of white mice following administration of buckwheat germ meal revealed no differences between the experimental and control groups in body temperature, horizontal and vertical locomotor activity, integrated activity, or the “burrowing reflex.”

Physiological, morphological, and biochemical assessment of the effects of medicinal products is one of the key approaches in evaluating their safety and efficacy. This assessment allows not only the identification of direct therapeutic effects but also the timely prediction of potential adverse reactions in humans, laboratory animals, and farm animals. Analysis of changes in physiological status, morphological structures of organs and tissues, as well as biochemical parameters of blood and metabolism, enables evaluation of the degree of influence of pharmacological agents on vital functions. A comprehensive assessment based on morphological and biochemical criteria is an integral stage of preclinical and experimental studies of medicinal products and feed additives, ensuring a high level of scientific justification for their use in veterinary practice.

As a result of experimental studies, it was established that on day 60 after feeding the biologically active substance, the erythrocyte count increased by 7.6 % (8.4 ± 0.17 in the experimental group versus 7.8 ± 0.25 in the control group, T/L, P < 0.05; Table 6). An effect on hemoglobin concentration was also observed, with an increase of 4.7 % (111.0 ± 2.14 in the experimental group versus 106.0 ± 3.21 in the control group, g/L). Accordingly, the hematocrit percentage increased in experimental animals by 6.0 % (44.2 ± 2.10 in the experimental group versus 41.0 ± 1.34 in the control group, P > 0.1).

Table 6
Effect of the “Buckwheat Germ Meal” supplement on morphological parameters of peripheral blood in white mice (M ± m, n = 10, day 60 of the experiment)

Parameter, unit	Experimental group	Control group	%
Hemoglobin, g/L	113.0 ± 1.14*	107.0 ± 3.17	105.6
Erythrocytes, T/L	8.8 ± 0.12*	7.1 ± 0.23	124.0
Hematocrit, %	43.7 ± 2.18	41.8 ± 1.33	104.5
Leukocytes, G/L	6.4 ± 0.61	6.3 ± 0.51	101.5
Neutrophils, %	11.2 ± 2.01	11.0 ± 1.75	100.0
Basophils, %	0.5 ± 0.003	0.5 ± 0.001	100.0
Lymphocytes, %	38.7 ± 2.13	38.3 ± 3.27	100.0

Note. P < 0.05

The obtained results indicate an activating effect of buckwheat germ meal on erythropoiesis. No differences were observed in leukocyte and lymphocyte counts between experimental and control animals.

Thus, the results of morphological studies in white mice indicate that buckwheat germ meal exhibits an activating effect on erythropoietic processes. Its administration for 30 days at a dose of 2.5 g per animal does not suppress the myeloid or lymphoid lineages of hematopoiesis, and the effect of the preparation persists up to 60 days.

Studies aimed at determining the effect of buckwheat germ meal on biochemical parameters of blood serum were conducted in the same animals. The results of the studies are presented in Table 7.

The data in the table indicate that under the influence of the biologically active preparation, the total protein content gradually increased, and on day 60 it reached 65.0 ± 2.14 g/L in the experimental group compared with 62.0 ± 3.07 g/L in the control group (increase of 4.8 %, P < 0.05).

Table 7
Effect of “Buckwheat Germ Meal” on biochemical parameters of blood serum in white mice (M ± m, n = 10, day 60 of the experiment)

Parameter, unit	Experimental group	Control group	%
Total protein, g/L	66.0 ± 2.17*	61.0 ± 3.17	108.1
Albumins, %	53.0 ± 2.14	56.0 ± 3.25	94.6
Globulins, %	48.0 ± 2.18*	42.0 ± 2.33	114.2
Transaminase activity, U/L	–	–	–
ALT	0.6 ± 0.03*	0.58 ± 0.04	100.0
AST	0.7 ± 0.02*	0.7 ± 0.03	100.0
Total cholesterol, mmol/L	18.0 ± 1.11	18.0 ± 1.43	100.0

Note. P < 0.05

It can be assumed that these changes represent the main factors contributing to increased intensity of growth and development in animals. At the same time, the proportion of globulins increased by 9.3 % (48.0 ± 2.14 in the experimental group versus 42.0 ± 2.33 in the control group, *P* < 0.05).

Concurrently, a decrease in the percentage of albumins was observed in experimental animals, reaching 53.0 ± 2.14 %. It should be noted that the obtained results indicate an enhancement of humoral immunity in animals of the experimental group.

The biologically active compound did not affect the activity of enzymes belonging to the transferase class. It was found that at the end of the experiment, alanine aminotransferase and aspartate aminotransferase levels in experimental mice did not differ from those in the control group. The increase in enzyme activity within physiological limits following administration of buckwheat germ meal indicates activation of the organism’s energy and plastic demands, as well as the formation of key metabolic pathways.

The results of serum cholesterol analysis in mice indicate that metabolic changes in the experimental animals occurred predominantly through anabolic processes, as no differences in this parameter were observed between the experimental and control groups.

Changes in body weight of experimental animals, particularly its reduction compared with the control group, are among the most informative indicators when assessing the effects of medicinal products or feed additives.

As a result of experimental studies, it was established that on day 14 after administration of the preparation, the increase in growth intensity of white mice amounted to 9.5 % (Table 8). Animals actively consumed both the basic diet and the feed additive. Thus, in the experimental group, growth intensity on day 14 of observation was 230.0 ± 1.30 mg compared with 210.0 ± 1.02 mg in the control group.

The average live body weight per animal in the experimental group on day 30 of observation was 20.0 ± 0.59 g compared with 18.0 ± 0.84 g in the control group. Growth intensity of live body weight in the experimental group was 230.0 ± 2.04 mg versus 209.0 ± 2.72 mg in the control group ($P < 0.05$). The increase in growth intensity per animal amounted to 10.0 %.

Buckwheat germ meal was administered for 30 days, while observations continued until day 60, i.e., for an additional 30 days after cessation of feeding.

At the end of the observation period, the average live body weight per animal in the experimental group was 23.0 ± 1.04 g compared with 20.0 ± 1.30 g in the control group. Growth intensity of live body weight in the experimental group was 240.0 ± 1.40 mg compared with 210.0 ± 2.86 mg in the control group ($P < 0.05$). The increase in growth intensity per animal reached 14.2 %.

The study of internal organ weights in white mice showed that no significant differences were found in the weights of the thymus, liver, spleen, thyroid gland, or kidneys between experimental and control animals (Table 9). According to their physiological state, internal organs were within normal limits.

The biological activity of buckwheat germ meal was studied in the same white mice of the same sex (females) with an initial live body weight of 15.0 g. It was established that growth intensity in mice of the experimental group increased dynamically, and by the end of the experiment (day 60), this indicator was 24.3 % higher compared with animals of the control group.

Table 8
Live body weight of white mice and weights of internal organs after feeding buckwheat germ meal (M ± m, n = 10)

Parameter	Study day	Baseline	14	%	30	%	60	%
Survival rate	–	–	100	–	100	–	100	–
Live body weight, g	Control	15.0 ± 0.75	16.0 ± 0.37	–	18.0 ± 0.74	–	20.1 ± 1.07	–
	Experimental	15.0 ± 0.54	17.5 ± 0.18	12.5	22.5 ± 0.19*	–	25.0 ± 1.14*	24.3
Growth intensity, mg	Control	–	211.0 ± 1.01	–	212.0 ± 2.2	–	214.0 ± 2.8	–
	Experimental	–	235.0 ± 1.20*	11.3	237.0 ± 2.1*	11.7	246.0 ± 1.3*	14.9
Thymus weight, mg	Control	–	–	–	–	–	30.0 ± 2.0	–
	Experimental	–	–	–	–	–	32.0 ± 2.3	6.6
Liver weight, g	Control	–	–	–	–	–	1.15 ± 0.03	–
	Experimental	–	–	–	–	–	1.18 ± 0.02	2.6
Spleen weight, g	Control	–	–	–	–	–	0.17 ± 0.01	–
	Experimental	–	–	–	–	–	0.17 ± 0.05	–
Thyroid gland, mg	Control	–	–	–	–	–	4.1 ± 0.02	–
	Experimental	–	–	–	–	–	4.1 ± 0.03	–
Kidney weight, g	Control	–	–	–	–	–	0.15 ± 0.03	–
	Experimental	–	–	–	–	–	0.15 ± 0.01	–

Note. Numerator – control; denominator – experimental; $P < 0.05$.

It should be noted that experimental animals readily consumed feed and water. Their behavior was normal (active and mobile).

Table 9
Relative weights of internal organs of white mice after feeding buckwheat germ meal (M ± m, n = 10, day 60 of the experiment)

Internal organ	Experimental group	%	Control group	%
Thymus, mg	33.0 ± 2.3	0.01	31.0 ± 3.0	0.01
Liver, g	1.21 ± 0.05	4.60	1.15 ± 0.04	5.2
Spleen, g	0.18 ± 0.02	0.74	0.18 ± 0.03	0.80
Thyroid gland, mg	4.0 ± 0.06	0.01	4.0 ± 0.05	0.01
Kidneys, g	0.15 ± 0.03	–	0.15 ± 0.07	–

Thus, the experimental studies demonstrated that feeding buckwheat germ meal at a dose of 2.5 g per animal did not cause any adverse effects. Body temperature of animals remained within normal limits, and white mice did not lag behind the control group in growth and development. The behavior of experimental animals was normal – animals were active and mobile. Visual examination showed that the condition of internal organs was within physiological norms.

3.2 Discussion

The successful development of animal husbandry is largely determined by the efficiency of livestock production systems. Modern approaches should combine not only high productivity indicators but also the formation of increased natural resistance of the organism to various stress factors and causative agents of infectious and invasive diseases (Gao et al., 2020; Musa-Veloso et al., 2021; Ciudad-Mulero et al., 2023). An optimal balance between productivity and disease resistance is a prerequisite for the stable functioning of the sector, as it reduces economic losses, improves product quality, and ensures efficient use of feed and veterinary resources (Andrienko, 2019; Llanaj et al., 2022; Kei et al., 2024; Song et al., 2024).

Animal husbandry development in Ukraine poses a number of pressing challenges for veterinary science, among which herd preservation and productivity enhancement are of particular importance (Zurbau et al., 2021; Dyuba & Lyasota, 2023).

One of the key factors complicating the solution of these problems is the insufficient development of a hygienic and environmental control system that covers both animal health status and the quality of animal-derived products (Dong et al., 2023). At most stages of the technological chain – from rearing and feeding to processing and marketing of finished products – adequate monitoring is lacking, which hinders the timely identification of risks associated with the spread of infectious diseases, exposure to stress factors, residual levels of veterinary drugs, or toxic substances in food products. In this context, both theoretical and practical significance is attached to the search for and implementation of veterinary preparations capable of enhancing the natural resistance of animals under adverse environmental conditions (Andrienko, 2019; Blayda, 2021).

Among such agents, various specific and non-specific biologically active preparations have become widespread, including immunoglobulins, vitamins, macro- and microelements, tissue preparations (particularly thymus and bone marrow extracts), prebiotics, probiotics, and symbiotics. Their use can significantly increase natural resistance and productive performance of animals (Lee et al., 2021; Li et al., 2024).

The effectiveness of a new biologically active preparation derived from buckwheat germ, which represents a natural medicinal product characterized by cation-exchange and adsorption properties, remains insufficiently studied. This complex preparation contains a range of amino acids—lysine, histidine, arginine, threonine, serine, glutamic and aspartic acids, proline, glycine, alanine, cystine, valine, methionine, isoleucine, leucine, tyrosine, and phenylalanine – as well as B-group vitamins, vitamin E, vitamin PP, and carotenoids. The preparation exhibits adaptogenic and antioxidant properties.

The newly developed preparation *"Buckwheat Germ Meal"* is recommended for preventive therapy as one of the approaches to preventing non-infectious diseases in human medicine. Addressing this issue in cattle breeding was the focus of the present study (Dyuba & Lyasota, 2023).

Within the framework of this research, a preclinical evaluation of the effect of the new biologically active preparation *"Buckwheat Germ Meal"* on the natural resistance of laboratory animals was conducted for the first time. It was established that the preparation exerts a stimulating effect on metabolic processes, promotes increased growth energy and development in white mice, and does not cause adverse effects or toxic reactions. The obtained results indicate the prospects of using the preparation to enhance overall physiological activity and immune resistance of animals, opening new opportunities for its application in veterinary practice and experimental research models (Dyuba & Lyasota, 2023).

Administration of the preparation resulted in moderate activation of erythropoiesis in laboratory mice, evidenced by increased hemoglobin levels ($P < 0.05$), erythrocyte counts ($P < 0.05$), and hematocrit values ($P < 0.05$). No differences were observed between experimental and control animals in leukocyte, neutrophil, basophil, or lymphocyte counts in peripheral blood.

Feeding buckwheat germ meal at doses of 0.8–2.5 g per animal for 30 days moderately activated metabolic processes in laboratory mice, as indicated by an increase in total protein content by 7.9 % ($P < 0.05$) and total globulins by 37.5 % ($P < 0.05$). No changes in total cholesterol activity in peripheral blood were detected.

The administration of the preparation did not induce adverse effects in laboratory mice, such as elevated body temperature or retardation of growth and development.

It was established that the growth energy of white mice in the experimental group increased dynamically, and by the end of the experiment (day 60), this parameter was 14.2 % higher compared with control animals. According to the existing methodology (Kotsyumbas et al., 2006), a preparation is considered active if the difference in average daily body weight gain between groups is at least 10 %.

The use of *"Buckwheat Germ Meal"* promoted activation of proliferative erythropoietic processes and maturation of these cells compared with the control group. Within physiological limits, increases were observed in erythrocyte counts ($P < 0.05$), hemoglobin levels ($P < 0.05$), leukocytes ($P < 0.05$), segmented neutrophils ($P < 0.05$), lymphocytes ($P < 0.05$), monocytes ($P < 0.05$), and total protein ($P < 0.05$).

Activation of transamination processes was noted, as evidenced by increased activity of aspartate aminotransferase and alanine aminotransferase within physiological limits by 17.4–26.2 % ($P < 0.05$). This reflects improved energy and plastic functions of the organism and the formation of key metabolic pathways.

Cholesterol levels did not exceed those of control animals, indicating that metabolic activation occurred primarily through anabolic processes.

The use of the preparation contributed to improved survival and increased average daily body weight gains over 30 days of observation by 14.8 % ($P < 0.05$). The additional body weight gain per animal during the experimental period amounted to 1.2 kg without additional feed costs. By the end of the experiment, no gastrointestinal dysfunctions were observed in experimental animals.

Several authors (Gao et al., 2020; Yu et al., 2021; Zurbau et al., 2021; Li et al., 2022; Wang et al., 2022; Dyuba & Lyasota, 2023) indicate that dietary supplementation of calves, piglets, turkey poults, and chicks with vitamin preparations enhances natural resistance and subsequently improves slaughter characteristics, organoleptic properties, and technological quality of meat, particularly poultry meat. In the meat of experimental turkey poults and broiler chickens, a slight decrease in water content, increased fat content, and higher biological value were observed. Poultry meat from animals receiving biologically active preparations met veterinary and sanitary safety and quality requirements and showed no microbial contamination.

Thus, the use of *"Buckwheat Germ Meal"* promoted activation of transamination processes, improving metabolic functions in animals and poultry, stimulating more intensive muscle tissue growth, and consequently increasing body growth energy in laboratory animals.

The effect of the preparation on natural resistance can be explained by its composition, which includes a complex of biologically active substances – amino acids, vitamins, and carotenoids. These components exhibit general tonic, adaptogenic, and antioxidant effects, contributing to enhanced non-specific resistance and improved physiological status of the organism. In addition, the preparation influences intestinal microflora: beneficial bacteria included in its composition compete with opportunistic pathogenic strains, exerting non-specific control over pathogenic microflora by displacing it from the intestinal ecosystem and suppressing its pathogenicity. This action supports optimal microbial balance in the intestine, thereby increasing overall natural resistance in animals.

Therefore, the obtained experimental and scientific-production results are not final. Further studies should focus on the effect of *"Buckwheat Germ Meal"* on metabolism in farm animals. Of particular scientific interest would be investigations into its impact on antigen-nonspecific and antigen-specific immunity, as well as a wide range of biochemical parameters. Equally important is the assessment of the preparation's influence on the quality and safety of animal-derived products for human consumption.

4. Conclusion

The research substantiated the use of a new domestic biologically active preparation, *"Buckwheat Germ Meal"*, as a preventive agent. A positive effect of the preparation on morphological, biochemical, and immunological blood parameters, as well as on the enhancement of natural resistance and growth intensity of laboratory animals, was demonstrated.

Administration of *"Buckwheat Germ Meal"* contributed to moderate activation of erythropoiesis in the peripheral blood of white mice: hemoglobin levels increased by 5.6 %, erythrocyte count by 24.0 % ($P < 0.05$), and hematocrit by 4.5 % ($P < 0.05$). No differences were observed in leukocyte, neutrophil, basophil, or lymphocyte counts in the peripheral blood of experimental animals.

Feeding *"Buckwheat Germ Meal"* at a dose of 2.5 g per animal for 30 days moderately activated metabolic processes in white mice: total protein content increased by 8.1% ($P < 0.05$), and total globulin content by 14.2 % ($P < 0.05$). No changes were detected in alanine aminotransferase, aspartate aminotransferase, or cholesterol activity in blood serum.

The use of *"Buckwheat Germ Meal"* at doses of 0.8–3.5 g per animal did not cause any adverse effects in white mice, such as elevated body temperature or retardation of growth and development; therefore, the preparation may be recommended for use in farm animals.

It was established that growth energy in white mice of the experimental group increased dynamically, and by the end of the experiment (day 60), this indicator was 24.3 % higher compared with animals of the control group.

The economic efficiency of using *"Buckwheat Germ Meal"* is achieved through reduced morbidity in animals and poultry, increased survival rates, higher average daily body weight gains and additional live weight gain, reduced costs per unit of production, and lower production costs of livestock products.

Conflict of interest

The authors of this study declare no conflict of interest.

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