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SCIENTIFIC FOUNDATIONS OF PROTECTING RABBITS FROM THE IMPACT OF ECOLOGICAL FACTORS

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Annatation. The article presents the results of an experiment aimed at determining the effect of external ambient temperature on the organism of rabbits in the conditions of conditionally adequate (Samarkand region), technogenic extreme (Navoi region) and strong extreme (Republic of Karakalpakstan) ecological zones of the Republic of Uzbekistan. Studies have shown that when the external temperature rises to 40^0C, compared to 20^0C, body temperature increases by 7.5-8.2%, pulse increases by 25.7-35.2%, breathing increases by 40.3-60.5%, negative changes are observed in morphological and biochemical parameters of the blood, appetite, growth and inflammation worsen. Such negative changes are more noticeable in severe extreme environmental conditions than in other conditions.

Key words. Rabbit. Ambient temperature. Clinical and physiological indicators. Morphological and biochemical indicators of blood. Productivity. Fertility.

Relevance of the Topic. In our Republic, large-scale reforms are being carried out to develop rabbit breeding, which is considered one of the important branches of animal husbandry. In particular, certain results have been achieved in increasing the number of pedigree rabbits, improving their productivity and fertility, as well as developing innovative methods aimed at enhancing their resistance to diseases. The "Action Strategy for the Further Development of the Republic of Uzbekistan" defines the tasks of "further strengthening the country's food security and expanding the production of environmentally friendly products." In this regard, various ecological factors are considered the main obstacles. Under the influence of such negative factors, the productivity, fertility, and disease resistance of rabbits decrease; the quality of meat, skin, and fur products obtained from them deteriorates; the incidence of diseases increases, which in a short period leads to a reduction in their population and, as a result, causes significant economic losses to farms. Therefore, the development of comprehensive measures to protect rabbits from extreme ecological impacts is one of the most urgent problems of today.

Degree of Investigation of the Problem. The influence of environmental factors on the organism of rabbits and the problems of metabolic disorders in rabbits have been thoroughly studied by a number of foreign scholars, including P.D. Gorizontov (1981), K.P. Danilov (1984), V.S. Alexandrova (1985), A.G. Vasilieva (1989), N.A. Balaksirev (2000), S.N. Alexandrov (2005), S.P. Zhukov (2005), M.V. Dorosh (2007), I.F. Draganov (2008), N.A. Cheremenina (2010), A. Shevchenko and L. Shevchenko (2011), Yu.A. Kalugin (2012), T.A. Ruleva (2016), E.V. Mironova (2017), A.V. Vostroilov, E.E. Kurchaeva, V.L. Pasenko (2018), N.A. Balakirev (2024), P.H. Dijk (1997), S.N. Hermida, M. Gonzalez, M. Miranda (2006), E.O. Ewuola (2010), G. Xiccato, A. Trocino (2010), and J. Henning (2015). From domestic scholars, U.H. Ballasov, Sh.K. Mamatiminov (2016), D.G'. Hayitov (2019), and U.T. Qashiyev (2024) have also conducted extensive research in this field.

However, literature data indicate that under the specific climatic conditions of the Republic of Uzbekistan, in-depth research has not been sufficiently carried out to evaluate the impact of adverse ecological factors on rabbits' organisms from clinical, physiological, biochemical, immunological, and veterinary-sanitary perspectives, as well as to develop comprehensive preventive measures against their consequences.

Research Objective. The aim of the study is to evaluate the effects of ecological, microclimatic, and feeding conditions on the organism of rabbits under the specific natural and climatic conditions of the Republic of Uzbekistan from clinical, physiological, biochemical, immunological, and veterinary-sanitary perspectives, and to develop comprehensive preventive measures to mitigate their consequences.

Research Tasks:

1. To evaluate the impact of ecological factors (temperature, air pollution) on rabbits under the natural and climatic conditions of Samarkand (adequate), Navoi (technogenically extreme), and Karakalpakstan (severely extreme) from clinical, physiological, biochemical, and immunological perspectives.
2. To assess the influence of microclimatic conditions on rabbits in Samarkand region using clinical, physiological, biochemical, and immunological parameters.
3. To investigate the effects of nutritional factors on rabbits with respect to clinical, physiological, biochemical, immunological, productive, and reproductive indicators.
4. To identify diseases caused by adverse ecological, microclimatic, and nutritional conditions, and to justify preventive measures including veterinary-sanitary examination of rabbit meat and meat products.
5. To develop and implement practical recommendations for protecting rabbits against unfavorable ecological factors through optimized microclimate parameters, improved feeding systems, and the use of probiotic and vitamin-mineral supplements, aimed at enhancing productivity, fertility, resistance, and disease prevention.

Objects and Methods of Research. The scientific studies were conducted between 2011 and 2025 within the framework of the MEGA PROJECT organized at Samarkand State University of Veterinary Medicine, Animal Husbandry and Biotechnologies (SamDVMCHBU), specifically in the vivarium of the Faculty of Veterinary Prophylaxis and Therapy, at the Department of Animal Feeding Technology and Zoohygiene, in the Hematology Laboratory of the Department of Internal Non-infectious Diseases, as well as in several rabbit-breeding farms: "Eshniyoz Bobo Chorva Dalasi" farm in Pastdargom district of Samarkand region, "Ilhon Rajabov" rabbit farm in Karmana district of Navoi region, and "Khojayli Gosht-Davkor" LLC rabbit farm in the Republic of Karakalpakstan. The number of animals used in experiments, the principles of analogy, and the methodological rules of research were strictly followed.

The "Eshniyoz Bobo Chorva Dalasi" rabbit farm (Pastdargom district, Samarkand region) was considered a conditionally adequate ecological zone for rabbits. This area is located in the central part of the Zarafshan Valley and is characterized by a sharply continental climate. Summers are hot with intense solar radiation and long-lasting high temperatures, while winters are cold. The average air temperature in spring (April–May) ranges from 14.8–23.2 °C, in summer (July–August) 28.8–41.2 °C, and in winter (December–January) 12.5–13.9 °C.

The "Ilhon Rajabov" rabbit farm (Karmana district, Navoi region) represents a technogenically extreme ecological zone. The climate is sharply continental, with most of the territory consisting of desert areas. Winters are cold, with the highest temperature recorded in July (46 °C) and the lowest in January (−28 °C). The average temperature is 29.2 °C in summer and 10.6 °C in winter, while the average annual precipitation is 310 mm. The territory is considered highly polluted with industrial waste.

The "Khojayli Gosht-Davkor" LLC rabbit farm in the Republic of Karakalpakstan is classified as a severely extreme ecological zone. The climate is sharply continental, with cold winters and desert-dominated landscapes. The maximum temperature reaches 48 °C in July, while the minimum falls to −31.0 °C in January. The average temperature is 30.5 °C in summer and 10.1 °C in winter. The average annual precipitation is 220 mm. The soil is strongly saline, and the vegetation is characterized by acidic conditions.

Research Results. In the conditionally adequate ecological zone, exposure to an ambient temperature of 40 °C compared with 20 °C resulted in an average increase of body temperature in experimental rabbits by 0.3 °C (7.5%), respiratory rate by 19.8 times (40.3%), pulse rate by 32 beats (25.7%), and a 20% increase in the number of animals with reduced appetite. In addition, decreases were observed in blood parameters such as hemoglobin, erythrocytes, leukocytes, glucose, total calcium, and inorganic phosphorus, while lymphocytes increased from 58.5 ± 0.90% to 62.6 ± 0.70%.

In the technogenically extreme ecological zone, exposure to 40 °C compared with 20 °C led to an average increase in body temperature by 0.3 °C (7.6%), respiratory rate by 27.1 times (50.0%), pulse rate by 44.5 beats (35.0%), and a 20% increase in the number of rabbits with decreased appetite. Blood tests showed reductions in hemoglobin (from 108.5 ± 3.30 to 100.8 ± 2.5 g/L), leukocytes (from 7.9 ± 0.10 to 7.2 ± 0.12 × 10^3/μL), total protein (from 58.5 ± 1.0 to 56.2 ± 1.1 g/L), glucose (from 3.00 ± 0.11 to 2.75 ± 0.17 mmol/L), total calcium (from 2.0 ± 0.10 to 1.8 ± 0.11 mmol/L), and inorganic phosphorus (from 0.8 ± 0.010 to 0.62 ± 0.010 mmol/L). Lymphocyte levels, however, increased from 56.5 ± 0.92% to 64.4 ± 0.74%.

In the severely extreme ecological zone, exposure to 40 °C compared with 20 °C caused an average increase in body temperature by 0.32 °C (8.2%), respiratory rate by 35.0 times (60.0%), pulse rate by 47.0 beats (35.2%), and a two-fold increase in the number of rabbits with reduced appetite. Blood analyses revealed declines in hemoglobin (from 98.5 ± 3.10 to 90.8 ± 2.1 g/L), erythrocytes (from 4.76 ± 0.9 to 4.25 ± 0.10 × 10^6/μL), total protein (from 54.5 ± 1.2 to 48.6 ± 1.5 g/L), glucose (from 2.80 ± 0.10 to 2.65 ± 0.11 mmol/L), total calcium (from 2.0 ± 0.09 to 1.7 ± 0.08 mmol/L), inorganic phosphorus (from 0.9 ± 0.010 to 0.7 ± 0.01 mmol/L), and T-lymphocytes (from 2.66 ± 0.01 to 2.16 ± 0.02%). Meanwhile, leukocytes (from 8.4 ± 0.15 to 9.2 ± 0.12 × 10^3/μL), lymphocytes (from 50.5 ± 0.91% to 66.4 ± 0.65%), and B-lymphocytes (from 18.2 ± 0.40% to 26.2 ± 0.55%) increased.

Overall, technogenically extreme and severely extreme ecological conditions led to a decrease in rabbits' productivity indicators by 7.4–10.9% on average, and a reduction in fertility rates by 10–30%.

Table 1. Experimental conditions aimed at developing a set of measures to control rabbit diseases

Groups		Experimental Conditions
Control group		At an ambient temperature of 20°C, room temperature of 5–15°C, relative humidity of 65–75%, air movement velocity of 0.1–0.3 m/sec, CO_2 concentration in the air of 0.09–0.11%, and NO_3 concentration in the air of 0.05–0.010 mg/l, the nutritional value of the diet was maintained, with the inclusion of hydroponic greens at a level of 15% of the total nutritional value (control variant – CV).
Experimental group	I	"In addition to the control variant (NV), the animals were given 1 g of monocalcium phosphate (MCP) per day together with the feed."
	II	"In addition to NV and MCP, Multivit Minerals+ was administered."
	III	"In addition to NV, MCP, and Multivit Minerals, the probiotic Innoprovet was added to the drinking water at a rate of 1 ml per 1 liter."

"Table 2. The effect of the set of measures against rabbit diseases on the incidence rate of rabbits."

Groups		"At the beginning of the experiment"	At the end of the experiment		
			Animal number	%	Regarding control,+-
"Diseases of the digestive system"					
Control group		3/30	2	-33,3	-
Experimental group	I	3/30	1	-66,6	+33,3
	II	3/30	1	-66,6	+33,3
	III	3/30	0	-100	+66,7
"Respiratory disorders"					
Control group		2/20	1	-50,0	-
Experimental group	I	3/30	1	-66,6	+16,6
	II	2/20	0	-100	+50,0
	III	3/30	0	-100	+50,0
"Diseases associated with metabolic disorders"					
Control group		5/50	3	-40,0	-
Experimental group	I	4/40	2	-50,0	+10,0
	II	5/50	2	-60,0	+20,0
	III	4/40	1	-75,0	+35,0

Research Results. The findings showed that among rabbits in the conditionally adequate zone, the incidence of metabolic disorders averaged **45%**, digestive system diseases **25–30%**, and respiratory diseases also **25–30%**. In the technogenic-extreme zone, the incidence of metabolic disorders was **50–55%**, respiratory diseases **20–30%**, and digestive system diseases **20–25%**. In the sharply extreme zone, the incidence of metabolic disorders averaged **50–55%**, respiratory diseases **20–25%**, and digestive system diseases **20–25%**.

The implementation of the complex of preventive measures led to a significant reduction in the incidence of non-infectious diseases in experimental rabbits. In particular, the prevalence of digestive and respiratory system diseases decreased by 100%, while metabolic disorders decreased by 75%, as confirmed by experimental results.

Regarding the effect of the preventive measures on changes in live body weight, the highest indicators were observed in Experimental Group III**.** In this group, during the 30-day experiment, an average total weight gain of 0.450 kg was achieved (daily growth 0.0150 kg**,** which is 13.8% higher compared to the control group).

The effect of the preventive measures on reproductive performance was also highest in Experimental Group III**,** i.e., under the following conditions: ambient temperature 20°C**,** indoor temperature 5–15°C, relative humidity 65–75%**,** air movement speed 0.1–0.3 m/sec**,** indoor CO_2 concentration 0.09–0.11%**,** NO_3 concentration 0.05–0.010 mg/l**,** with feed rations balanced and supplemented with 15% hydroponic greens**,** monocalcium phosphate (MCP)**,** Novo-Marks vitamin-mineral mixture**,** Multivit + minerals**,** and Innoprovet probiotic**.** In this group, the kindling rate of rabbits was found to be 16.6% higher than the control group.

The economic efficiency of the preventive measures amounted to 62,790 UZS, with a cost recovery ratio of 5.5 UZS**.**

Conclusion

1. The territory of Pastdargom district, Samarkand region is considered conditionally adequate for rabbits, Karmana district, Navoi region is classified as a technogenic-extreme zone, while the territories of the Republic of Karakalpakstan are categorized as sharply extreme zones.

2. Ambient temperature is one of the most critical ecological factors for rabbits. At **40°C**, compared to **20°C**, rabbits exhibited an increase in body temperature by **7.5–8.2%**, pulse rate by **25.7–35.2%**, respiratory rate by **40.3–60.5%**, and a decrease in appetite by **20–40%**, resulting in a reduction of average daily growth by **7.4–10.9%** and fertility by **10–30%**.

3. At an ambient temperature of **40°C**, adverse changes in blood morphophysiological parameters were most pronounced in the sharply extreme zone. In these conditions, compared to **20°C**, rabbits' blood indices decreased: hemoglobin (from 98.5 ± 3.10 to 90.8 ± 2.1 g/L), erythrocytes (from 4.76 ± 0.9 to 4.25 ± 0.10 mln/μL), total protein (from 54.5 ± 1.2 to 48.6 ± 1.5 g/L), glucose (from 2.80 ± 0.10 to 2.65 ± 0.11 mmol/L), total calcium (from 2.0 ± 0.09 to 1.7 ± 0.08 mmol/L), inorganic phosphorus (from 0.9 ± 0.010 to 0.7 ± 0.01 mmol/L), and T-lymphocytes (from 2.66 ± 0.01 to 2.16 ± 0.02%). At the same time, leukocytes (from 8.4 ± 0.15 to 9.2 ± 0.12 thous/μL), lymphocytes (from 50.5 ± 0.91% to 66.4 ± 0.65%), and B-lymphocytes (from 18.2 ± 0.40% to 26.2 ± 0.55%) increased.

4. Under extreme ecological, unfavorable zoohygienic, and feeding conditions, the prevalence of metabolic disorders in rabbits averaged **45–60%**, while digestive and respiratory system diseases ranged from **20–30%**.

5. Applying the complex **"Preventive measures against reduced productivity, fertility, and diseases in rabbits"**—which included maintaining ambient temperature at **20°C**, indoor temperature at **5–15°C**, relative humidity **65–75%**, air velocity **0.1–0.3 m/sec**, indoor CO_2 concentration **0.09–0.11%**, NH_3 concentration **0.05–0.010 mg/L**, ensuring feed nutritive adequacy supplemented with **15% hydroponic greens**, and adding **monocalcium phosphate (MCP)**, **Novo-Marks**, **Multivit + minerals**, and **Innoprovet probiotic**—resulted in the following outcomes:

- Reduced the incidence of metabolic disorders by **75%**, and digestive and respiratory diseases by **100%**;
- Increased average daily weight gain by **13.8–21.7%**;
- Increased fertility by **16.6–50%**;
- Increased average live weight of newborn kits by **16.1–19.5%**;
- Improved veterinary-sanitary indicators of rabbit meat;
- Yielded an economic efficiency of **37,128–62,790 UZS per rabbit per year**, with a cost recovery ratio of **3.35–5.50 UZS**.

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