

Part 1. Veterinary medicine

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ENVIRONMENTAL AND BIOETHICAL STANDARDS FOR THE TREATMENT OF METABOLIC ACIDOSIS IN WILD ANIMALS: EXPERIENCE WITH THE USE OF SODIUM BICARBONATE

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Summary. The article presents the results of a study on the effectiveness of the veterinary drug 'Acidostop' (60 mg/ml sodium bicarbonate) in treating metabolic acidosis in European fallow deer (*Dama dama*) in semi-free conditions. The study was conducted in aviaries on a private farm, utilizing both clinical and laboratory methods. Typical symptoms of acidosis, such as depression, diarrhea, and dehydration, were successfully alleviated within three to seven days of treatment. A comparative analysis with a 5% sodium bicarbonate solution revealed that 'Acidostop' has comparable therapeutic efficacy, is well tolerated, and does not cause adverse effects. The study was conducted in accordance with the requirements of GLP, GCP, and in compliance with the European Convention for the Protection of Vertebrate Animals. Special attention was paid to bioethical aspects: minimizing stress, environmental safety, and humane treatment of animals. The drug is officially registered in Ukraine for use in European fallow deer, has no analogues outside the country, which emphasizes its scientific novelty. The study has practical significance for ecology and veterinary medicine in conditions of semi-free keeping of wild animals. It is also a valuable teaching material for the educational programs 'Ecology', 'Veterinary Medicine', and 'Zoophysiotherapy'. The results obtained contribute to the formation of an environmentally responsible approach to the treatment of animals among students

Keywords: European fallow deer, 'Acidostop', hematological and biochemical blood parameters

Introduction. Hunting farms play an important role in preserving biodiversity, regenerating wild animal populations, and maintaining ecological balance in forest ecosystems (Di Minin et al., 2021; Kalábová et al., 2025). One popular species kept in semi-free or caged conditions is the European fallow deer, *Dama dama* (Linnaeus, 1758) (Artiodactyla: Cervidae), an animal with high adaptability and significant ecological value (Bijl and Csányi, 2022). However, even under appropriate conditions, these animals remain vulnerable to stress factors, feeding disorders, and infectious diseases (Tajchman et al., 2019; Ny et al., 2023). In hunting farm practice, metabolic disorders, including ketosis, acidosis, hypocalcemia, as well as bacterial and parasitic infections, are of particular concern. Insufficient control over the diet, excessive feeding of cereals or silage can provoke the development of diseases that, without timely diagnosis and correction, lead to animal losses (Campbell and VerCauteren, 2011; Vicente et al., 2014; Sultana et al., 2021; Huaman et al., 2023). In this context, the need to implement effective, environmentally safe, and bioethical approaches to treatment becomes paramount. Ensuring the environmental safety and bioethics of veterinary interventions in wild animal populations is of particular importance in the context of the current environmental crisis and anthropogenic pressure on natural ecosystems. An important aspect is the development and implementation of eco-oriented

standards for the diagnosis and treatment of diseases accompanied by metabolic disorders in wild animals. One of these conditions is metabolic acidosis, which occurs in animals with digestive disorders, intoxications, stressful influences, or feeding errors (Fox, 1995; Åkerfeldt et al., 2020; Hunchak et al., 2024).

Currently, there is a need for effective, environmentally safe methods to correct the acid-base state of wild animals in semi-free conditions or aviaries. 'Acidostop', a veterinary drug produced by DEVIE LLC in the form of an infusion solution, has been shown to positively impact the acid-base balance of European fallow deer, as evidenced by clinical study results.

Successful correction of metabolic acidosis in wild animals requires the pharmacological effectiveness of the drugs and consideration of the ethical aspects of therapeutic intervention. Basic requirements for veterinary drugs used in wildlife include conditions of detention, minimization of stress during manipulations, and an absence of side effects on the environment (Faria, 2023; Dougherty et al., 2024). Sodium bicarbonate, in the form of the drug 'Acidostop', meets these requirements since it is not toxic to the environment, is quickly excreted from the body, and does not accumulate in tissues. This allows treatment to be integrated into environmental protection programs without harming ecosystems and wildlife, which is an important condition for the sustainable development of veterinary science.

The drug 'Acidostop' has a valid state registration certificate (No. AB-09832-01-25 dated 04.06.2025), which meets the requirements of the current legislation of Ukraine and is a mandatory condition for compliance with modern environmental and bioethical standards of veterinary practice.

It should also be noted that the veterinary drug 'Acidostop' is the only officially registered in Ukraine for use specifically in European fallow deer. Currently, there are no analogues of this drug with a similar registration for this species of animals in any other country in the world, which emphasizes its uniqueness in the international context. This opens up broad prospects for further research, in particular, to study the adaptive potential of the drug when used in other species of wild animals kept in semi-free conditions.

The **purpose of this work** is to highlight the experience of using 'Acidostop' in the treatment of metabolic acidosis in wild animals, using the example of European fallow deer, and to formulate proposals for the implementation of environmental and bioethical standards in veterinary practice for wild fauna.

Materials and methods. Experiments were conducted in an aviary on a private farm in the Shubkiv Forestry Department of Rivne District in Rivne Region. The aviary housed 30 adult European fallow deer (ages 7–10 years), 18 young deer (ages 10–14 months), and 12 five-day-old deer. The fallow deer's diet consisted of 1.6 kg of grain, 0.7 kg of oats, 1.2 kg of corn, and 1.5 kg of silage. They were also given up to 7 kg of branches per day: willow (60.0% edible), mountain-ash (30.0%), and bird cherry (10.0%).

Eight European fallow deer, aged 9–10 years, exhibited the following symptoms: depression, loss of appetite, rumen atony (the rumen was dense and distended), tachycardia, teeth grinding, severe thirst, normal body temperature, cessation of chewing, and frequent defecation of watery feces, followed by dehydration. Analysis of the animals' diets revealed that large quantities of wheat and silage were included in the grain mixture fed to each animal daily, resulting in metabolic acidosis.

The diagnosis of metabolic acidosis was established based on the clinical picture of the disease and laboratory tests, which confirmed high acidity of urine — pH 5.6, rumen content — 5.3, and the level of lactic acid in the blood — more than 40 mg/%.

To correct metabolic acidosis in European fallow deer, the veterinary medicinal product 'Acidostop' (solution for infusion) was used in the study, containing sodium bicarbonate — 60 mg/ml as the active substance and auxiliary components: sodium acetate, sodium citrate, and water for injection. The drug belongs to the group of electrolyte solutions for intravenous administration (ATCvet code: QB05XA02).

'Acidostop' ensures the restoration of the alkaline state of the blood by increasing the level of bicarbonate in the plasma, binding hydrogen ions, normalizing the pH and volume of circulating blood. It has a diuretic and

expectorant effect, and helps to remove toxins from the body.

The therapeutic efficacy of the drug 'Acidostop' (solution for infusion) was studied in 9–10-years-old European fallow deer, suffering from metabolic acidosis, weighing from 68 to 72 kg, which were selected according to the principle of analogues and divided into two experimental groups ($n = 4$): animals of the first experimental group were intravenously administered the drug 'Acidostop' (solution for infusion) at a dose of 1.0 ml/kg of body weight; animals of the second experimental group were intravenously administered the comparison drug 'Sodium bicarbonate solution 5%' (solution for infusion) at a dose of 1.0 ml/kg of body weight. The drugs were administered to the animals once a day for 5 days.

The sick animals were treated with a complex treatment: washing the rumen through a probe with a soda solution at the rate of 450 g of the substance per 3 liters of water, oral calcium carbonate in the amount of 80 g per head, Ringer's solution intravenously in a dose of 500 ml. When the general condition improved, 100 g of yeast and 1 liter of milk were administered orally per animal. The doe was fed in the optimal ratio: 60% oats, 10% wheat, 30% corn, and no more than 0.5 kg of silage. The observation period for the animals lasted 14 days.

Laboratory studies of animal blood were conducted in the Laboratory for quality control, safety, and registration of veterinary drugs and feed additives of DEVIE LLC. In stabilized blood of animals, the number of erythrocytes, leukocytes, hematocrit level, and total hemoglobin content were determined using the automatic hematological analyzer BC-6000 (Mindray). In blood serum, the activity of indicator enzymes — alanine aminotransferase (ALT) and aspartate aminotransferase (AST), as well as the levels of total protein, glucose, total cholesterol, urea, and creatinine, were studied using the biochemical analyzer FUJI DRI-CHEM NX600, which works on the principle of 'dry chemistry' using slides. To determine the acid capacity, we measured the total CO_2 (TCO_2) parameter in serum, which is the total concentration of carbon dioxide in a biological sample and is important for assessing acid-base balance. The acid capacity was calculated using the appropriate formulas in laboratory conditions, taking into account the pH level, TCO_2 concentration, and, if necessary, the content of Na^+ , K^+ , Cl^- ions, and total CO_2 .

The determination of lactic acid was performed on the 'Accutrend Plus' device based on the enzymatic reaction with lactate oxidase, which oxidizes lactate to pyruvate with the formation of hydrogen peroxide. This product interacts with the chromogen in the test strip, causing a color change that is recorded photometrically. Capillary blood was used for the analysis, which was applied directly to the test zone of the strip. The device automatically calculates the lactate concentration and displays the result in mmol/l after 60 seconds (Kotsiumbas, 2009, 2013; Vlizlo, 2012).

Since the experiments involved concomitant treatment of animals, the use of veterinary medicinal products was carried out in accordance with the indications and protocols used in the farms for the relevant conditions.

Clinical studies of the veterinary medicinal product were conducted taking into account the guidelines for conducting clinical studies of veterinary medicinal products on target animal species and the requirements set out in the publication 'Guidelines for Conducting Clinical Trials of Veterinary Drugs on Target Animal Species' by Kotsiumbas et al. (2021).

It is important to emphasize that the treatment was carried out in compliance with the principles of humane treatment of animals in accordance with 'European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes' (CE, 1986) and Council Directive 2010/63/EU (CEC, 2010), and under Art. 26 of the Law of Ukraine No. 3447-IV of 21.02.2006 'About protection of animals from cruel treatment' (VRU, 2006) and basic bioethical principles (Simmonds, 2017).

The results obtained were processed by methods of variational statistics using the StatPlus 7.6.5.0 software package. Data were presented as mean values with standard deviation at a confidence level of 95%, and the reliability of the results was assessed using Fisher's exact test (Tian et al., 2022).

Results. During clinical trials in European fallow deer patients with metabolic acidosis, it was found that the use of the experimental drug 'Acidostop' (solution for infusion) and the comparison drug 'Sodium bicarbonate solution 5%' (solution for infusion) in the complex therapy regimen provided normalization of basic metabolic processes and eliminated metabolic acidosis (Table 1).

Table 1 — Comparative efficacy of drugs for the treatment of metabolic acidosis in 9–10-years-old European fallow deer (n = 4)

Indicator	Term of research, day	Group	
		Experimental 1	Experimental 2
Presence of clinical signs, %	1	100.0	100.0
	3	25.0	25.0
	5	missing	missing
	7	missing	missing

Notes: Experimental 1 — 'Acidostop' (solution for infusions); Experiment 2 — 'Sodium bicarbonate solution 5%' (solution for infusions).

The incidence of animals in the two experimental groups decreased by 75.0% on the 3rd day of treatment, and on the 5th day, the animals recorded complete recovery.

The results of clinical and biochemical blood tests of experimental European fallow deer before and after therapy are given in Table 2.

Table 2 — Level of hematological and biochemical blood parameters of 9–10-years-old European fallow deer during treatment of metabolic acidosis (M ± m; n = 4)

Research groups	Terms of research, day		
	before treatment	3	7
Total hemoglobin (HGB), g/l			
Experimental 1	120.17±2.89	119.79±2.38	114.93±2.07
Experimental 2	121.43±2.64	119.37±2.52	114.60±2.15
Reference level	110.0–130.0		
Erythrocytes (RBC), 10 ¹² /l			
Experimental 1	12.94±0.19	11.35±0.17*	10.81±0.14*
Experimental 2	12.82±0.17	11.21±0.18*	10.69±0.13*
Reference level	9.0–13.0		
Acid capacity, mg%			
Experimental 1	369.49±7.29	436.72±8.27*	457.62±8.65*
Experimental 2	370.12±8.67	435.96±8.34*	456.79±8.34*
Reference level	420.0–600.0		
Total proteins, g/l			
Experimental 1	67.73±0.84	69.58±0.75	69.89±0.83
Experimental 2	67.60±0.70	69.36±0.89	69.71±0.87
Reference level	68.0–72.0		
Urea, mmol/l			
Experimental 1	9.19±0.19	5.41±0.16*	4.68±0.15*
Experimental 2	9.21±0.17	5.45±0.13*	4.74±0.14*
Reference level	3.3–6.7		
Glucose, mmol/l			
Experimental 1	1.69±0.09	2.37±0.10*	2.51±0.11*
Experimental 2	1.63±0.10	2.31±0.11*	2.48±0.10*
Reference level	1.94–3.33		
Lactic acid, mg%			
Experimental 1	43.12±0.36	17.68±0.21*	11.27±0.11*
Experimental 2	42.98±0.41	18.13±0.23*	11.38±0.13*
Reference level	5.0–20.0		

Notes: Experimental 1 — 'Acidostop' (solution for infusions); Experimental 2 — 'Sodium bicarbonate solution 5%' (solution for infusions); * — the difference in the values of the indicators is significant at $p < 0.05$ relative to the corresponding indicators before treatment.

Thus, before treatment, the concentration of total hemoglobin and the number of erythrocytes in the blood were within the reference levels, but were slightly increased, while the acid capacity of the blood, the concentration of total proteins and glucose were reduced relative to the reference level, and the concentrations of urea and lactic acid exceeded it, which indicated the presence of minor dehydration and metabolic disorders of an acidogenic nature in the body of European fallow deer.

Starting from the 3rd day of the experiment, the average clinical and biochemical blood parameters of European fallow deer in both experimental groups came to the limits of the physiological level, but completely stabilized only on the 7th day after the start of treatment:

— with the introduction of the drug ‘Acidostop’ (solution for infusions) the number of erythrocytes, the concentration of total hemoglobin, the acid capacity, the concentration of total proteins and glucose increased by 14.4% ($p < 0.05$), 2.4%, 3.0%, 11.1% ($p < 0.05$), and 44.4% ($p < 0.05$) respectively, while the concentration of urea and lactic acid decreased ($p < 0.05$) by 45.1% and 66.4%;

— with the administration of the drug ‘Sodium bicarbonate solution 5%’ (solution for infusions), the number of erythrocytes, the concentration of total hemoglobin, acid capacity, the concentration of total proteins and glucose increased by 14.6% ($p < 0.05$), 3.7%, 2.9%, 12.0% ($p < 0.05$), and 46.9% ($p < 0.05$) respectively, while the concentration of urea and lactic acid decreased ($p < 0.05$) by 44.7% and 65.7%.

The use of ‘Acidostop’ in the complex therapy of metabolic acidosis in European fallow deer ensured the restoration of clinical and biochemical blood parameters to physiological limits without any detected side effects, which indicates its eco-safe nature.

Therefore, the veterinary drug ‘Acidostop’ (solution for infusions) in terms of therapeutic efficacy in the complex treatment of metabolic acidosis in European fallow deer is not inferior to the comparison drug ‘Sodium bicarbonate solution 5%’ (solution for infusions) and has a positive effect on the clinical and biochemical blood parameters of treated animals.

The use of ‘Acidostop’ in the complex therapy of metabolic acidosis in European fallow deer ensured the restoration of clinical and biochemical blood parameters to physiological limits without any detected side effects, which indicates its eco-safe nature.

All studies were conducted in accordance with the methodological recommendations for good Laboratory Practice (GLP) and good Clinical Practice (GCP) in veterinary medicine. The studies were conducted in compliance with the principles of the humane treatment of animals and the ethical standards defined by the ‘European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes’.

Special attention was paid to minimizing stress in animals, the ecological safety of the drugs used, and the absence of toxic effects on the environment. All manipulations were performed by qualified personnel in accordance with standard operating procedures and regulatory requirements. The studies were conducted with mandatory consideration of bioethical principles, including informed consent of animal owners. The results obtained have not only scientific value but also practical significance for the development of safe, ethical approaches in veterinary therapy.

This approach meets modern ecological and bioethical standards of veterinary practice and can become the basis for interdisciplinary research, taking into account the principles of bioethics, physiology, and animal rehabilitation.

In the context of the educational programs ‘Ecology’, ‘Veterinary Medicine’, and ‘Zoophysiotherapy’, such

studies play an important role in developing practical skills in animal diagnostics and treatment in compliance with ecological and bioethical principles. Their results are valuable educational material and a scientific basis for training a new generation of specialists.

Discussion of the results of the clinical use of the drug ‘Acidostop’ in the treatment of metabolic acidosis in European fallow deer allows us to better assess its effectiveness in the context of modern veterinary practice. Analysis of the obtained data in combination with literary sources allows us to determine the key aspects of the pharmacological action of the drug, its bioethical acceptability, and environmental safety. It is also important to consider the influence of housing conditions, feeding, and concomitant treatment on the clinical and biochemical parameters of animals.

The results of our study correlate well with the scientific observations presented in the work of [Tajchman et al. \(2019\)](#), which proved that disturbances in mineral metabolism, in particular calcium and phosphorus deficiency, can cause metabolic disorders in fallow deer. This point of view is also supported by the study of [Ny et al. \(2023\)](#), which noted the increased sensitivity of these animals to changes in feeding and immunological factors, which can negatively affect behavioral and physiological reactions.

In addition to physiological aspects, ethical requirements for the treatment of wild animals are no less important. The works of [Fox \(1995\)](#) and [Åkerfeldt et al. \(2020\)](#) emphasize that stress factors can change the results of therapy; therefore, a bioethical approach is critically important. A similar opinion is expressed by [Huaman et al. \(2023\)](#), emphasizing the need to use eco-safe drugs in the practice of keeping wild deer in captivity. Thus, the results obtained by us confirm the effectiveness and feasibility of using ‘Acidostop’, which not only does not cause side effects, but also complies with modern principles of veterinary bioethics. Separate attention should be paid to the potential of the drug within preventive programs. Based on the data obtained, it can be argued that ‘Acidostop’ is advisable to use not only for treatment, but also as a means of preventing metabolic disorders in animals that are subjected to increased feeding loads. This opens up new prospects for forming standards for keeping and caring for wild ungulates in aviary conditions while adhering to an eco-oriented approach.

Conclusions. The veterinary drug ‘Acidostop’ (a solution for infusion) is based on sodium bicarbonate. When used in complex therapy, it restores the acid-base balance of the blood in cases of metabolic acidosis and ketosis after calving in European fallow deer. Its effectiveness is comparable to that of the reference drug.

The uniqueness of ‘Acidostop’ lies in its official registration for use in wild ungulates, particularly fallow deer. This is an innovation in Ukrainian veterinary practice and has no direct analogues outside the country. This emphasizes the drug’s scientific and practical value for further developing eco-oriented veterinary medicine.

The study was conducted in accordance with the international GLP and GCP standards and in compliance with the European Convention for the Protection of Vertebrate Animals. Special attention was paid to bioethical aspects, such as minimizing stress, ensuring environmental safety, treating animals humanely, and obtaining informed consent from owners. These measures ensure the integration of veterinary interventions into the broader context of nature conservation and sustainable development.

The results are of great importance for the training of specialists in ecology, veterinary medicine, and zoophysiotherapy, contributing to the formation of environmentally responsible thinking and an interdisciplinary approach to the treatment of wild animals.

Therefore, 'Acidostop' is a promising, environmentally safe, and bioethically justified drug that can be recommended for widespread implementation in veterinary practice for the treatment of metabolic acidosis in wild animals in semi-free conditions.

Prospects for further research. Further scientific research should focus on improving treatment regimens for metabolic acidosis in animals, particularly regarding the dosage and frequency of eco-friendly drugs.

It is also promising to study the impact of adjusting the feeding ration on the prevention of acidosis in semi-free conditions for wild animals. Particular attention should be paid to the integration of the obtained results into the educational process within the educational program 'Zoophysiotherapy', which will ensure the formation of practical skills in the application of physiotherapeutic methods among students.

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