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ANTIOXIDANT AND ANTI-STRESS EFFECTS OF NAX SEOLITE

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Abstract

This article analyzes the antioxidant and anti-stress effects of NaX zeolite. Due to its high adsorption and ion-exchange properties, NaX zeolite reduces free radical formation, limits the absorption of toxic substances, and mitigates the negative effects of stress factors on the organism. Special attention is paid to the prospects of using NaX zeolite in veterinary practice to stabilize metabolic processes, support immune function, and reduce oxidative stress in animals.

Keywords

NaX zeolite, antioxidant activity, anti-stress effect, oxidative stress, free radicals, adsorption, ion exchange, veterinary pharmacology, detoxification, immunity.

Introduction

Currently, the problems of stress and oxidative stress in the animal body are one of the most pressing issues in veterinary medicine and animal husbandry. As a result of a decrease in food quality, environmental factors, toxins and mycotoxins, the amount of free radicals in the body increases and metabolic processes are disrupted. Therefore, there is increasing interest in the use of natural and synthetic adsorbent substances. Among such substances is NaX zeolite, which has high activity. The study of its antioxidant and anti-stress effects is of great scientific and practical importance in veterinary pharmacy.

The research work was carried out on the basis of synthetic zeolite of the NaX type. NaX zeolite of the faujasite (FAU) type with a high degree of purity was selected as the research material. The zeolite sample was dried at a temperature of 105–110 °C before the start of the experiment, activated to increase adsorption activity and brought to the same granulometric size.

To assess antioxidant activity, the main biochemical indicators associated with oxidative stress were analyzed. In particular, the level of lipid peroxidation products, free radical formation, and the activity of the general antioxidant system were studied. In order to determine the anti-stress effect, physiological and metabolic changes were observed against the background of factors that artificially create a state of stress in the animal body.

During the study, control and experimental groups were formed, and NaX zeolite was used in different doses. The experimental results were statistically processed and the level of reliability was assessed. The effect of NaX zeolite on the body was monitored dynamically, that is, over time, and an attempt was made to determine its dose-dependent effectiveness. The results of the studies showed that NaX zeolite has a pronounced antioxidant activity. A significant decrease in the amount of free radicals and a slowdown in lipid peroxidation processes were noted in the experimental groups. This is directly related to the high adsorption

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properties of NaX zeolite, which binds toxins, mycotoxins and prooxidant substances that have entered the body, reducing their biological activity.

In the body under the influence of stress factors, metabolic processes are disrupted and oxidative stress is increased. According to the results of the study, a decrease in stress markers, stabilization of the general physiological state, and activation of adaptation mechanisms were detected in the groups where NaX zeolite was used. This confirms the anti-stress effectiveness of NaX zeolite.

The results obtained complement the information on the biological activity of zeolites presented in the scientific literature and further reveal the advantages of NaX zeolite. In particular, its support of the natural antioxidant system and mitigation of the negative effects of stress factors are important for veterinary practice.

NaX zeolite adsorbs toxins and prooxidant substances in the gastrointestinal tract and reduces the toxic load through ion exchange processes. As a result, the formation of free radicals is limited, oxidative stress is reduced. This leads to the activation of the antioxidant defense system, stabilization of metabolic processes, and the formation of effective adaptation mechanisms against stress in the animal's body.

Mechanism of action of NaX zeolite at the molecular level. NaX zeolite has a faujasite (FAU) type crystal lattice, is characterized by a wide pore (≈7.4 Å) structure and high surface activity. These structural features determine its interaction with biologically active substances at the molecular level.

Molecular interaction with toxins and free radicals. The porous lattice of NaX zeolite binds toxins, mycotoxins and prooxidant molecules by physical adsorption and electrostatic attraction. Negatively charged centers formed as a result of the charge imbalance between aluminum and silicon atoms participate in the binding of free radicals and reactive oxygen species (ROS). As a result, the concentration of ROS decreases and the lipid peroxidation chain reactions are interrupted.

Ion exchange and redox balance. Na^+ ions present in NaX zeolite enter into exchange with ions such as Ca^{2+}, Mg^{2+}, NH_4^+ in the body. This process stabilizes the ionic balance within the cell and ensures the normal functioning of enzymes.

Restoration of ionic balance:

- improves the activity of the electron transport chain in mitochondria
- limits the formation of ROS

As a result, redox homeostasis is restored.

Indirect effect on the activity of antioxidant enzymes. By reducing toxic and prooxidant load, NaX zeolite maintains the functional activity of enzymes such as:

- superoxide dismutase (SOD),
- catalase (CAT),
- glutathione peroxidase (GPx)

at the cellular level. These enzymes are the main defense system that neutralizes free radicals. As a result, endogenous antioxidant defenses are enhanced.

Membrane stability and attenuation of lipid peroxidation. Lipid peroxidation disrupts the structure and function of cell membranes. NaX zeolite:

- slows down lipid peroxidation,
- maintains the integrity of the phospholipid layer,
- normalizes membrane permeability.

As a result, cellular metabolism and signal transduction processes are normalized.

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Scientific innovation

As a result of this study, the following scientific innovations were substantiated for the first time or systematically:

1. The antioxidant activity of NaX zeolite was experimentally confirmed by reducing oxidative stress markers.
2. It was scientifically substantiated that the anti-stress effect of NaX zeolite is associated with the stabilization of metabolic processes in the body and the activation of adaptive mechanisms.
3. It was shown that the adsorption and ion exchange properties of zeolite are an important mechanism in supporting the antioxidant defense system.
4. The dose-dependent biological efficacy of NaX zeolite was determined and optimal directions for use were determined.
5. The results of the study scientifically substantiated the possibility of using NaX zeolite as a biologically active substance against stress and intoxication in veterinary pharmaceuticals.

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