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PROCESSING OF LOW-GRADE AND SMALL MERCHANTABLE WOOD INTO ENTEROSORBENTS FOR AGRICULTURE BY THE METHOD OF CONCURRENT PROCESSING OF CARBONATION–ACTIVATION ON MODULAR INSTALLATIONS IN FIELD CONDITIONS

In this work, the need to add enterosorbents to animal fodder is justified; effectiveness of active charcoal use as enterosorbents produced in the concurrent processing of pyrolysis–activation of soft-leaved and off-grade wood is proved experimentally.

Keywords: animal diseases, mycotoxins, enterosorbents, active charcoal, pyrolysis–activation of charcoal.

Health conditions caused by micromyces, such as mycoses, mycotoxicoses, allergic reactions, are a major concern for modern veterinary medicine. The increase in the incidence of fungal infections is associated with the immunosuppressive effect of modern industrial civilisation on animals. Environmental pollution, increased background radiation, the use of pesticides and fertilisers in agriculture and use of immunosuppressive, cytostatic drugs, corticosteroids and broad-spectrum antibiotics in veterinary medicine undermine the host defences in animals and contribute to development of diseases. Of all the natural intoxicants that contaminate agricultural stock and foodstuffs, the most dangerous for human and animal health are those produced by microfungi, i.e., mycotoxins. These have general toxical, cytotoxical, mutagenic, embryotoxic, teratogenic and carcinogenic properties, are strong immunosuppressants that undermine immunity, the effectiveness of vaccination and resistance to non-communicable diseases. The extent of mycotoxin distribution is very high: they contaminate foodstuffs, feed and food stock at every stage of production, transportation, storage and sales.

The open challenge represented by mycotoxins is often underestimated and results in huge losses and costs that companies are sometimes unable to cover. These losses are made up of major damage caused by mass animal diseases and deaths, reduced performance, factor infections, disposal of low-grade foods used in vast quantities, etc.

The treatment for mycotoxicoses in animals is an important problem for veterinary mycotoxicology. This can be explained by the lack of effective specific medicines for preventing and treating microfungi poisoning in animals, as well as by antidote development challenges. In order to reduce mycotoxin susceptibility, animals are fed chemical substances that act as antidotes, as well as herbage or vitamin E which facilitate oxidation processes and quickly remove mycotoxins from the body. Sorbents like zeolites that have proven effective in combating T-2 toxicosis, afla-, patulin and fuzariotoxicosis have become increasingly popular in recent years. One of them is gastrointestinal sorbent B obtained from vermiculite.

Charcoal has long been known as an effective feed supplement [3, 4]. Active charcoal is a finely dispersed porous material that has an impressive surface area and possesses a unique ability to absorb large amounts of substances of different types from gaseous, vaporised and liquid media. Animal-fed activated charcoal dynamically absorbs gases produced in the gastrointestinal tract, stops undesirable fermentation processes, facilitates healthy digestion and promotes body weight gain.

Not only is activated charcoal capable of absorbing large quantities of gas, it can also absorb bacteria, preventing their spread in the body. It absorbs microbial poisons and other toxic substances transferred to or produced within the intestines.

One is particularly interested, therefore, in use of activated charcoal in production of an activated charcoal feed supplement for preventing and treating poisoning of farm animals with mycotoxins and other harmful substances. We believe that this problem can be resolved by creating activated charcoal fine industries and mobile units using local raw materials.

Using the concurrent carbonisation and activation procedure we are currently developing [1, 2, 5], activated charcoals can be obtained from soft-leaved, low-grade and small merchantable wood. These charcoals may later be used to produce an activated charcoal feed supplement that will facilitate removal of toxins from the animal’s body and increase the resilience of animals to adverse environmental effects.

Under laboratory conditions, we obtained control samples of activated charcoal from different wood species (pine, aspen, birch, hornbeam) and tested them to determine the characteristics of the porous structure and adsorption properties and to compare them against GOST 6217–74 requirements (table 1).

Table 1

The Characteristics of the Porous Structure and Adsorption Properties of Activated Charcoals from Different Wood Species

Properties of activated charcoals	The property values of charcoals from			
	pine	aspen	birch	hornbeam
Micropore volume, cm^3/g	0.24	0.23	0.23	0.26
Iodine adsorption,%, minimum	70	65	75	100
Methylene blue adsorption, mg/g, minimum	280	250	300	300

Based on these results, one may reasonably conclude that this technology allows activated charcoals with enhanced adsorption properties to be produced.

The Federal Centre of Toxicological and Radiation Safety of Animals conducted several studies to investigate the possibility of using activated charcoal in animal husbandry to protect animals against toxic microfungal metabolites (mycotoxins and other toxic agents) and obtain green, safe and competitive products.

Screening tests helped establish the safety of activated charcoal for animals. According to GOST 12.1.007.76, charcoal belongs to class 4, which includes low-hazard substances. Charcoal does not cause irritation, allergies and is not accumulated in the body. The concentration of heavy metals in the charcoal samples does not exceed the maximum permissible level; pesticides, pyrethroids, etc. were not found. Charcoal is not toxic for infusoria.

The health condition of laboratory animals (white rats) that received 6,000 mg/kg of charcoal with their daily meals for 30 days did not deteriorate. The biochemistry (serum total protein, protein fractions, glucose, triglycerids, calcium, inorganic phosphate, urea, etc.), activity of enzymes (aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, creatine kinase), haematology (number of red blood cells, white blood cells, Hb level, WBC differential count, etc.), nonspecific resistance characteristics (lysozyme activity, phagocytic activity, phagocyte number, phagocytic index, phagocytic capacity, etc.) changed insignificantly and remained within normal physiological limits. Charcoal had a positive influence on the dynamics of weight gain in laboratory animals. The histological examinations of organs in laboratory animals did not reveal any negative impact of charcoal.

The T-2 mycotoxin adsorption capacity of gastrointestinal sorbents [6] was tested in vitro. The choice of mycotoxin can be explained by its extreme toxicity and by the fact that it is the least adsorbable mycotoxin. The results are shown in table 2.

Table 2

Comparative Analysis of Adsorption Capacity of Gastrointestinal Sorbents Tested

Sample number	Sorbent	Adsorption		Desorption	True sorption
		pH 2	pH 7		
		%			
1	Charcoal + HCl; pH 4.5; fraction < 0.1 mm	89.0	89.0	–	89.0
2	Charcoal + H_2O (1:4); pH 7.8; fraction < 0.1 mm	92.5	94.0	–	92.5
3	Charcoal + clay + bran (33%; 33%; 33%)	83.5	83.0	–	83.5
4	Charcoal + white clay + bran (50%; 25%; 25%); pH 7.8	82.5	81.5	–	82.5
5	Activated charcoal produced by Pharmstandard-Leksredstva	85.0	81.0	2.6	82.4
6	Mycosorb	54.4	59.2	11.0	43.4

It has been established that the tested gastrointestinal sorbents demonstrated no desorption and a consistently high T-2 mycotoxin adsorption activity at 37–39 °C in vitro, which is equal to 82.5–92.5%; changes in environmental pH do not affect the degree of adsorption. Sample 2 has the highest adsorption activity.

The adsorption capacity of the gastrointestinal sorbents was tested in 110 white non-pedigree rats of both sexes with a body weight of 150–170 g. The rats were assigned to control and experimental groups, each consisting of ten animals, based on the principle of counterparts. The first group was the biological control and received an appropriate amount of 5% aqueous alcoholic solution not containing T-2 mycotoxin. An aqueous alcoholic solution of T-2 toxin, 1/10 LD50, was administered intragastrically to animals in groups 2–10, following which the animals received 0.5% and 1% of gastrointestinal sorbents (on a diet dry matter basis): groups 2 and 3 – sample 1; groups 3 and 4 – sample 2; groups 5 and 6 – sample 3; groups 7 and 8 – sample 4; groups 9 and 10 – activated charcoal (produced by Pharmstandard-Leksredstva) taken as a reference drug. Animals in group 11 received an aqueous alcoholic solution of T-2 toxin in the same amount but did not subsequently receive the gastrointestinal sorbent. Based on the clinical, haematological and biochemical data, it was established that sample 2 was most effective for subacute T-2 mycotoxicosis and demonstrated the biggest potential for further study.

The tests have shown that activated charcoal feed supplement has no negative effect on the animal’s body or single-celled organisms, has a high mycotoxin adsorption capacity and protects organisms against toxic poisoning.

The data were used in studies of activated charcoal feed supplement added to feeds of plant origin fed to the breed herd of the Vladimir Lenin Stud Farm (Nizhny Novgorod region, Kovernino district). The results were as follows:

– where 4 kg of activated charcoal was introduced per 1 tonne of grain mixture fed to cattle and pigs, the abortion and stillbirth rate in cattle decreased by 10%, the number of deaths of piglets inside the birth nest decreased by 3%;
– calves that received 15 g of charcoal daily were less susceptible to dyspepsia (by 20%) and gained 50 g a day more weight than the control group;
– the average daily gain for growing pigs was 340 g, for fattening pigs – 420 g, the control group gain was 320 g and 400 g, respectively.

The Toxout additive produced by Biomix (USA) was used as the control. This is a light brown powder with a neutral odour containing the following ingredients (in %): sodium and aluminum silicate – 60, calcium and aluminum silicate – 25, silica dioxide – 12, an immune-boosting complex of prebiotic, probiotic and organic acids – 3.

The T-2 toxin adsorption capacity for Toxout is 82.0–85.0%, whereas that for activated charcoal feed supplement is 92.5–93.0%.

The studies of use of our activated charcoal-based feed supplement have shown that it is more effective than the Toxout feed additive manufactured abroad.

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Processing of Low-grade and Small Merchantable Wood into Enterosorbents for Agriculture by the Method of Concurrent Processing of Carbonation-activation on Modular Installations in Field Conditions

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