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Natural waste use for mycotoxins adsorption

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Abstract

Food safety is one of the top-priority directions. In the developed countries the international standards are observed via systematic monitoring and protection of corresponding conditions that to a considerable degree eliminates toxins penetration into the food. However, in the developing countries there is no possibility of using the international regulations, so the food is stored under unacceptable conditions that leads to its contamination. Based on the above mentioned, the considerable part of spread of strong mutagens – aflatoxins falls on storage conditions. Mycotoxins are excreted by molds, so they are the natural pollutants of food products, which may accumulate during storage period, as well. At that time, mycotoxins may enter the food chain: plant – biomass – animal – human. Therefore, the goal of our work is creation of optimum storage conditions for agricultural products in order to not promote development of microscopic fungi entered from the environment and to deliver food products to the customer in unharmed marketable condition. Mycotoxins are one of the most important biogenic toxins, which infect food, and causes mycotoxicosis – toxification of humans and animals when entering their organisms [1,2].

Key words: *Lignin, aflatoxin, mycotoxin, adsorption, technical lignin*

Introduction

Reasons of mycotoxins genesis: unfavorable climate conditions, inadequate conditions of food and grains storage, high temperature and humidity, violation of sanitary standards, availability of harmful living objects during grains seeding.

There are some difficulties when identifying mycotoxins: they are differed by inhomogeneous distribution, concentration of mycotoxins in the grains of the same batch substantially varies, that is

why the one and the same analysis conducted according to the up-to-date methods doesn't give a guarantee that there will be no mycotoxins in the food.

Taking into account the synergetic relation of mycotoxins, a ready-to-eat food may be toxic, even if mycotoxins quantity doesn't exceed maximum permissible concentration, which is established separately for each type of mycotoxins.

One and the same species of mold may induce production of different types of mycotoxins. Therefore, availability of one toxin may testify the existence of other toxins, as well. [3]

Toxins availability	Corresponding available toxins	Reason
Aflatoxin	Ochratoxin, citrinin, CPA	Aspergillus
Ochratoxin	Aflatoxin,citrinin, CPA	Penicillium, Aspergillus
ToxinT-2	ToxinHT-2, DAS, fusaric acid	Fusariumtricinctum
DON	Zearalenone, fusaric acid, nivalenol	Fusariumgraminearum
Fumonisin	DON, zearalenone, moniliformin	Fusariummoniformen

Mycotoxins taken by animals and hazard for humans:

- Food intake reduction or food refusal;
- decrease in food nutritional value, nutritive substancesadsorption and metabolism;
- negative effect on endocrine and exocrine glands secretion;
- weakened immune system;
- embryonic demise;
- decline in milk nutritional value;
- fertility disorder.

Hazardous toxins:

Toxin T-2 , ZEA, DON –immunodepression , ZEA –prolapse, embryonic demise, DON–ovarian cyst, Aflatoxin, DON, toxin T-2 –less hazardous, Toxin T-2 –gastroenteritis, bleeding, Toxin T-2 , DON – reduction in nutritional requirement, Patulin, PR toxin, roquefortine – antibiotic effect.
Many toxins may be detoxified and become less hazardous or completely safe under influence of cattle microflora, provided that animal is healthy.
Zearalenone: May derive α-zearalenone and β-zearalenone. β-zearalenone toxicity is low, while α-zearalenone toxicity is much higher, but its absorption by the digestive tract is low.
Ochratoxin: May derive α-ochratoxin, its toxicity is low.

Fumonisin: The major part of fumonisin is not adsorbed and is not transformed and releases from the organism with excrements.

Toxin T-2: Is used as an energy source by some bacteries. May transform into HT-2 toxin – a less toxic form.

Deoxynivalenol: May transform into DOM-1 – a less toxic form.

Thus, zearalenone, DON, ochratoxin, fumonisin and toxin T-2 didn't pose a great danger for sucklinganimals (of course, if we don't deal with a large amount of these toxins, or animals have health-related problems).

Mycotoxin detoxification degree among cattle:

Aflatoxin– 0-10%, zearalenone– 0-40%, ochratoxin – 50-100%, deoxynivalenol– 0-50%, toxin T-2 – 0-70%, fumonisin– 0-35%. Some mycotoxin metabolites penetrate into milk, and from milk get into human organism.

Aflatoxin M-1 is the most hazardous among them:

- Among all biologically derived toxins,aflatoxin is the strongest hepatocarcinogen discovered up to date.
- Is stable even in case of thermal treatment of the product.
- 70-90% of aflatoxin is rapidly absorbed by the cow organism, and only 10% may be detoxified by a calf.
- Aflatoxin may be absorbed at the expense of passive diffusion already at the calf's small bowel wall.
- Aflatoxin B1 transforms into toxin M-1 in the liver or small bowel and releases with milk and other biological liquids. [4]

Mycotoxin extraction and metabolism with milk

Mycotoxins	Toxin quantity moved from the food to milk, %
Aflatoxin	1.7% (1-2% range)
Deoxynivalenol	<0.02%
Zearalenone	<0.70%
Toxin T-2	<0.20%
Fumonisin	<0.01%
Ochratoxin	<0.03%

Continuous export and import of grain crops between countries, definite climate changesthroughout the world, regular use of fungicides and pesticides causes increase in mycotoxins genesis. This fact leads to food contamination with different mycotoxins raises as well. At that, the concentration of a separate

mycotoxin may be less than the maximum permissible concentration, that complicates diagnosing, causes cattle infection and economic losses. The food is frequently infected by fungi of *Fusarium* and *Aspergillus* families, which produce more or less hazardous mycotoxins: mycotoxin T-2 and aflatoxin B1 [2].

There are many preventive measures against mycotoxin, such as: agrarian method, proper storage of food, treatment with biological and chemical preparations etc. In the recent period, the intestinal sorbents of vegetable origin have been widely used. These adsorbents have an ability to digest preventive substances.

There is an important requirement to the presented mycotoxins adsorbents, namely their enzyme resistance and retention of adsorptive properties in relation to mycotoxins when transferring adsorbents to ruminant animals.

It is very prospective to use lignin for mycotoxin adsorption, which has surface pores having high adsorptive capacity towards substances of different classes, and is not treated in human and animal organisms. [5]

The presented work deals with adsorptive properties of technical lignin towards mycotoxins and aflatoxins. As far as mycotoxins are biological contaminants, microscopic fungi are natural pollutants, which cause animal intoxication when entering the food.

Based on this fact, the **research goal** is provision of maximum protection of agricultural crops in order to preventthe products from pollution with microscopic fungi, make their commodity value high and the product harmless both for humans and cattle. [6]

Research results

Roughly 300-400 mycotoxins are known as of today, which may origin both prior to harvesting and after it, may accumulateduring storage, so a continuous monitoring of food is necessary [5]. Aflatoxins, T-2 toxin, zearalenone and other mycotoxins are highly toxic and hazardous for humans. These substances are highly resistant to environmental conditions effect and are not decomposed even in case ofthermal treatment.

Therefore, when assessing risks according to HASSP system, in case of mycotoxins availability, 7 critical control points have been revealed, which need adoption of proper measures for avoiding contamination, namely: determination of seed material quality, soil treatment degree, plant growth period, crop harvesting, period after harvesting, storage and processing. It is necessary to observe technical standards in order to avoid mycotoxin contamination of the harvest kept. If contamination still happens, then it is necessary to adopt the decontamination standards, in order to prevent the use of toxic food.

Mycotoxins are synthesized by the different species of fungi. Toxic action is mainly caused by protein synthesis inhibition. The majority of studied mycotoxins is formed resulting from action of three types of molds: Aspergillus, Penicilliumand Fusarium. [7].

Among them the most dangerous is mycotoxin, which is developed at the harvest surface due to inappropriate storage conditions. Such mycotoxins and ochratoxins damage liver and have an expressed carcinogenic action.

Thin-layer chromatography with different sampling options is frequently used for determination of mycotoxins. Thin-layer chromatography makes it possible to simultaneously identify up to 30 different mycotoxins.

Fluorescent detector is used for quantitative determination of mycotoxins . Concentration gain of the samples under study at the plate provided their fast and better division (5 μ). Thin-layer chromatography is use fulalmost for all mycotoxins. [8]

The goal of our work was to improve the agricultural products storage conditions in order to preventgoods from further pollution and to provide conditions inhibiting microscopic fungi development. For that purpose, we set a goal to improve these conditions using sulfate lignin.

On this basis, one sample has been placed in the exiccator, while the second one was put in the exiccator along with sulfate lignin. Samples have been observed and analyzed every week during a month.

Research results showed that a piece of bread placed in the exiccator without lignin, has experienced gradual surface contamination by microscopic fungi. In its turn, a piece of bread with lignin has remained unchanged for the same time period. In parallel, lignin humidity was determined, which showed that lignin humidity has been gradually increased, but after 4 weeks it became constant.

At the same time, the treatment of a sample of pieces of bread and lignin showed that there were no toxins in either of them.

At the next stage, lignin was put into infected exiccator. Along with it, we have placed fresh and infected pieces of bread. Study results showed that after 4 weeks, one and the same toxin was discovered in lignin and infected bread (Fig.1), while the healthy piece of bread visually kept its initial form that was confirmed by the analysis, as well. There were no toxins in it (Fig.2), (Table.1).

Fig.1. Toxins in bread

Fig.2. No toxins in bread

Table 1. Results of representatives of Aspergillus genus

Week	I	II	III	IV
Humidity on sulfate lignin (g, %)	2.14 ≈4	2.82 ≈4	3.41 ≈5	4.62 ≈7
Toxin quantity in bread (mcg/l)	0.0019	0.0021	0.0025	0.0031
Toxin in lignin	0.0020	0.0022	0.0027	0.0032

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ბუნებრივი ნარჩენების გამოყენება მიკოტოქსინების ადსორბციისთვის

ნინო ქარქაშაძე, რუსუდან ურიდია, ნანა წეროძე, ლეილა ტატიაშვილი, ქეთევან ებრალიძე, ლიპარიტ დოლიძე

ივ. ჯავახიშვილის სახელობის თბილისის სახელმწიფო უნივერსიტეტი, პეტრე მელიქიშვილის სახ. ფიზიკური და ორგანული ქიმიის ინსტიტუტი, თბილისი, საქართველო

აბსტრაქტი

სურსათის უვნებლობა ერთ-ერთი პრიორიტეტული მიმართულებაა. განვითარებად ქვეყნებში სისტემური მონიტორინგისა და სათანადო პირობების დაცვით ხდება საერთაშორისო ნორმების განხორციელება, რაც მნიშვნელოვან წილად გამორიცხავს ტოქსინების გავრცელებას საკვებში. განვითარებად ქვეყნებში არ არის შესაძლებლობა გამოყენებულ იქნას საერთაშორისო რეგულაციები, საკვები ინახება მიუღებელ პირობებში და შედეგად ხდება მისი დაბინძურება. აქედან გამომდინარე, ძლიერი მუტაგენების - აფლატოქსინების გავრცელების მნიშვნელოვანი წილი მოდის შენახვის პირობებზე. მიკოტოქსინებს გამოყოფენ ობის სოკოები და ისინი საკვები პროდუქტების ბუნებრივი დამაბინძურებლები არიან, რომელიც შესაძლებელია დაგროვდეს შენახვის პერიოდშიც. ამ დროს მიკოტოქსინი შესაძლოა მოხვდეს კვებით ჯაჭვში: მცენარე-ბიომასა-ცხოველი-ადამიანი. აქედან გამომდინარე, ჩვენი სამუშაოს მიზანია სასოფლო-სამეურნეო პროდუქტის შესანახად ოპტიმალური პირობების შექმნა, რათა ხელი არ შეეწყოს გარემოდან მოხვედრილი მიკროსკოპული სოკოების განვითარებას და მომხმარებლამდე მიწოდებულ იქნას საღი სასაქონლო სახით. მიკოტოქსინები წარმოადგენენ ერთ-ერთ მნიშვნელოვან ბიოგენურ შხამს, რომელიც ასნებოვნებს საკვებს, ადამიანისა და ცხოველის ორგანიზმში მოხვედრისას იწვევს მოწამვლას - მიკოტოქსიკოზს [1,2].

საკვანძო სიტყვები: *ლიგნინი, აფლატოქსინი, მიკოტოქსინი, ადსორბცია, ტექნიკური ლიგნინი*