საქართველოს მეცნიერებათა ეროვნული აკადემიის მოამბე, ტ. 20(194), №1, 2026
BULLETIN OF THE NATIONAL ACADEMY OF SCIENCES OF GEORGIA, vol. 20(194), no. 1, 2026

Biotechnology

Changes in Rat Organism Caused by Food Contaminated with Aflatoxin within a Short Time

Nino Karkashadze[*], Rusudan Uridia[*], Sophio Gvidani[**], Mtvarisa Kordzaia[**], Nana Tserodze[*], Leila Tatiashvili[*], Ramaz Gakhokidze[§]

[*] *P. Melikishvili Institute of Physical and Organic Chemistry, Ivane Javakhishvili Tbilisi State University, Georgia*
[**] *Al. Natishvili Institute of Morphology, Ivane Javakhishvili Tbilisi State University, Georgia*
[§] *Academy Member, Ivane Javakhishvili Tbilisi State University, Georgia*

Abstract. Mycotoxins are toxic compounds that are naturally produced by certain types of moulds (fungi). Moulds that can produce mycotoxins grow on numerous foodstuffs such as cereals, dried fruits, nuts and spices. Mould growth can occur either before harvest or after harvest, during storage, on/in the food itself often under warm, damp and humid conditions. Most mycotoxins are chemically stable and survive food processing. Research goal was to check adsorption properties of lignin treated with sodium hydro-carbonate and its effect on living systems. In particular, impact of food contaminated with aflatoxin placed in lignin on rat liver state. Obtained data allow us to make conclusion that a mouldy bread induces changes in normal structure and functions of stomach, intestines, and liver, while a mouldy bread held for 48 hours along with lignin treated with hydro-carbonate does not cause changes in normal structure and functions of stomach, intestines, liver, kidney, or duodenum. Mouldy bread placed for a short time to lignin treated with sodium hydro-carbonate has not caused changes in rats' organism. © *2026 Bull. Natl. Acad. Sci. Georg.*

Keywords: aflatoxin, mycotoxin, adsorption, lignin, rat

Introduction

The occurrence of mycotoxins in contaminated foodstuff can lead to serious health risks for both humans and animals, and this has attracted research interest in developing novel approaches to decontaminate mycotoxins for food safety. One of the effective ways to prevent food contamination against mycotoxins is based on efficiency adsorption. The removal of adsorbents in different food samples is a challenge that if addressed properly would enable us to overcome the contamination of multi-mycotoxins. Recently, nano-adsorbents and their various combinations seem to be a promising tool for capturing and removing mycotoxins from contaminated samples thanks to their excellent performance.

Mycotoxins, such as aflatoxins (AFs), deoxynivalenol (DON), zearalenone (ZEA/ZEN), fumonisins (FBs) and ochratoxins (OTs), pose a major concern for the safety of commercial food products and human consumption. According to statistics from the Food and Agriculture Organization (FAO) and revised data from researchers, more than 25% of the world's agricultural products are conta-

minated with mycotoxins each year (Elliott et al., 2020; Benkerroum, 2020). Studies have shown that ingestion of food and feed contaminated by mycotoxins results in adverse health problems for humans and livestock (Eskola et al., 2020)

Aflatoxin contamination is a worldwide problem that affects a wide range of agricultural goods. Aflatoxins are mainly produced by moulds belonging to *Aspergillus* sp. and have been shown as a major contaminant in foods such as oils, nuts and dairy products. In addition to their well-known carcinogenic, teratogenic and mutagenic properties, aflatoxins also have adverse effects on organisms such as immunotoxicity and genotoxicity (Karkashadze et al., 2024).

For the protection of consumers from the harms of aflatoxins agreements and standards are developed worldwide. Effective control of aflatoxin contamination is guided by important international organizations: Codex Alimentarius Commission (CAC); European Union (EU); United States Food and Drug Administration (FDA).

Unfortunately, it is impossible to eradicate the formation of mycotoxins in food thoroughly due to the complex storage environment, poor harvesting practices, inappropriate storage practices by consumers and improper transport conditions in food industry (Karkashadze et al., 2022; Luo et al., 2018). Therefore, decontamination of mycotoxins is a challenging issue and various strategies based on physics, chemistry and biology are developed for effective detoxification of mycotoxins. Among these, the adsorption method seems to be a promising direction to achieve the reduction in mycotoxins owing to its simple operation, high removal efficiency and low cost (Marroquin-Cardona et al., 2014). However, traditional mycotoxins adsorbents, including clays, activated carbon and biomaterials, are not fully satisfying for mycotoxin control in the food industry since they cannot meet the criteria for large-scale production of oils, beverages and wine. Hence, it is extremely urgent and important to develop novel adsorbents with high efficiency, green, safe, practical and economic characteristics for mycotoxins removal (Mironov, 2012; Park et al., 1999).

Agriculture is a rapidly developing sector of Georgian industry. This is why safe storage of agricultural cultivated plant production widespread in Georgia from harvesting to sale is of special importance for promotion of this branch of economy. At that time food products safety, which means biosafety of food products, acquires especial significance in order to protect agricultural crops from mycotoxins throughout a period from warehousing to sale.

Use of different-type adsorbents stands out with special efficiency when protecting vegetable and cereal crops from aflatoxins in storage facilities. The particular advantage of adsorption method lies in its accessibility and efficiency. Aflatoxin adsorbents are divided into several groups: mineral, carbon-bearing and mixed. For studies we have used lignin (sawdust) treated with sodium hydrocarbonate and have studied its adsorption properties (Ulger et al., 2020; Streit et al., 2013; Uridia et al., 2021).

The goal of the research was to check adsorption properties of lignin treated with sodium hydrocarbonate and its effect on living systems. In particular, impact of food contaminated with aflatoxin placed in lignin on rat liver state.

Experiments were conducted on male rats with 300-350g mass. Animals were divided into 3 groups. 3 rats of the I group (rats №1,2,3) took food (mouldy bread, wheat grains) contaminated by aflatoxin, 3 rats of the II group (rats №4,5,6) were fed by the same infected food placed in lignin, treated with sodium hydro-carbonate. Food was placed in lignin for no less than 48 hours. 3 rats of the III, control group (rats №7,8,9) were fed by healthy food. Observations were conducted during 4 weeks. Every seventh day from the onset of the experiment we controlled the animals' weight. Results are given in the Tables. After 4 weeks animals were put to sleep and their liver and visceral organs were studied.

Macroscopic changes were recorded in the liver of all three rats of the I group, namely: liver was

darker than usual, increased in size, with softened structure and thinned gastrointestinal walls. Fundal part of the stomach was dark, while cardinal part was whitish (light colored).

In comparison with rats of the I group, the liver of all three animals of the II group was relatively light-colored (naturally red). Sizes varied within the norm. Structure was normal. There were no visible injuries on gastrointestinal walls.

State of liver, stomach and intestines of rats from the III control group was within the norm.

Observation over rats' weight showed that as opposed to II and III groups, all animals of the I group have lost their weight during the first week, and afterwards kept on gaining their weight (Mironov, 2012).

Table 1. Weight change of rats in the group I resulting from 4-week observation

Observation time (week)	12.03	19.03	26.03	02.04	09.04
1	320 g	310 g	320 g	325 g	340 g
2	350 g	345 g	350 g	375 g	390 g
3	340 g	330 g	355 g	395 g	400 g

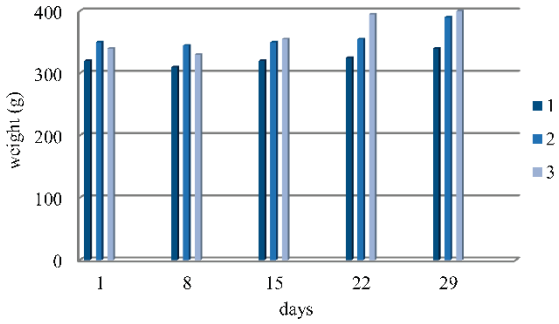

Fig. 1. Diagram of days dependence of mass change.

Table 2. Weight change of rats in the group II resulting from 4-week observation

Observation time (week)	12.03	19.03	26.03	02.04	09.04
4	310 g	325 g	325 g	345 g	350 g
5	340 g	345 g	350 g	360 g	390 g
6	340 g	360 g	365 g	380 g	410 g

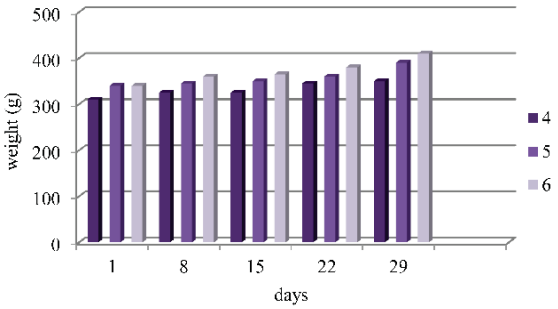

Fig. 2. Diagram of days dependence of mass change.

Table 3. Weight change of rats in the group III resulting from 4-week observation

Observation time (week)	12.03	19.03	26.03	02.04	09.04
7	310 g	320 g	330 g	345 g	350 g
8	350 g	360 g	370 g	375 g	385 g
9	300 g	320 g	335 g	350 g	360 g

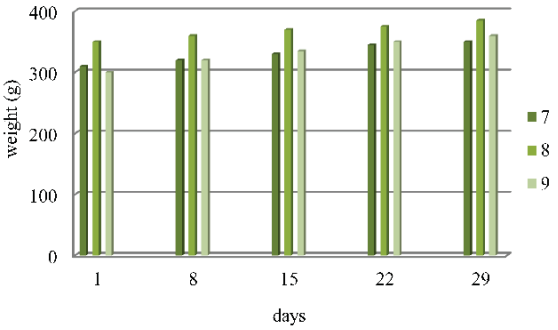

Fig. 3. Diagram of days dependence of mass change.

Discussion and Results

Stomach: through external inspection, a mucous coat of stomach of animals from both control and experimental groups is of a dark red color with multiple deepening (pits). Macroscopically, the stomach wall consists of three main coats: mucous, muscular and serous. From within, it is covered with one-layer cylindric glandular epithelium. Inner layer includes dark blackish mucosa, especially in its fundal and pyloric parts, which is clearly seen even during external examination. Glands of that part of stomach, which is directly adjacent to gullet, are of a small size. Mucous coat

is thinned, and submucosa coat is thickened. From outside, stomach is covered with a serous coat, with congested blood vessels and lymphatic ducts in its thickness.

Duodenum. Duodenum wall of animals of test and control groups consists of serous, muscular and mucous coats, as well as of mucous layer, which excretes mucous coat from muscular coat. Mucous layer of rats under study is relatively dark at the inner surface of duodenum. Its muscular coat is an extension of stomach's muscular coat. It consists of two-layer smooth muscle cells. They are disposed transversally on the external layer and circularly – on the inner one. Serous coat covers duodenum partly only, while the remaining parts are covered with spongy, fibrous tissue, which consists of clearly expressed blood vessels in large quantities.

Macroscopic structure of duodenum wall of animals of both test and control groups almost does not undergo structural changes.

Liver. Through external examination, livers of rats from test and control groups markedly differ from each other. Liver surface of rats of the control group is smooth, brownish-grey, and has no gall bladder. Liver is covered with thin connective tissue, so-called Glisson' capsule, which is easily disengaged from surface. It is represented by hepatic lobes: right lateral and medial, left lateral and medial (caudal). Liver keeps a structure peculiar to it. Lumens of portal vein and hepatic artery, as well as of glandular duct are disposed in the middle of so-called classic lobules.

Liver of the test animals is a dark brownish-grey swelled organ (by 4-6%), Glisson's capsule is glossy, glandular duct is easily disengaged from subhepatic tissues when cut. Blood vessels, as well as portal vein lumen are enlarged.

Hepatic lobes and liver weight. It can be concluded that after being fed by mouldy bread, rat's liver does not keep its peculiar structure and therefore its functions, as well.

Kidney. Macroscopically, rat's kidney is of a bean shape, consisting of one lobe only. It is covered with a thin connective tissue capsule, which is easily disengaged from renal corpuscle. Its cross-section includes 2 layers: external cortical layer and internal medullary substance. Medullary layer (area) of the study animals is a dark reddish, wide, cone-shaped striped pyramid. Its structure is preserved. Urine quantity in animals of both test and control groups is within the norm, which points at renal function.

As the macroscopic examination of kidney clearly showed that both anatomical organization and urinoexcretory function of kidney are completely preserved after food intake.

Conclusions

The obtained data allow concluding that a mouldy bread induces changes in normal structure and functions of stomach, intestines, and liver, while a mouldy bread held for 48 hours along with lignin treated with hydro-carbonate does not cause changes in normal structure and functions of stomach, intestines, liver, kidney, and duodenum. Mouldy bread placed for a short time to lignin treated with sodium hydro-carbonate has not caused changes in rats' organism.

ბიოტექნოლოგია

მოკლევადიან პერიოდში აფლატოქსინით დაბინძურებული საკვებით გამოწვეული ცვლილებები ვირთაგვების ორგანიზმში

ნ. ქარქაშაძე*, რ. ურიდია*, ს. გვიდანი**, მ. კორძაია**, ნ. წეროძე*, ლ. ტატიაშვილი*, რ. გახოკიძე§

* *ივანე ჯავახიშვილის სახ. თბილისის სახელმწიფო უნივერსიტეტი, პეტრე მელიქიშვილის სახ. ფიზიკური და ორგანული ქიმიის ინსტიტუტი, საქართველო*
** *ივანე ჯავახიშვილის სახ. თბილისის სახელმწიფო უნივერსიტეტი, ალ. ნათიშვილის სახ. მორფოლოგიის ინსტიტუტი, საქართველო*
§ *აკადემიის წევრი, ივანე ჯავახიშვილის სახ. თბილისის სახელმწიფო უნივერსიტეტი, საქართველო*

მიკოტოქსინები წარმოადგენს ტოქსიკურ ნაერთებს, რომლებსაც ბუნებრივად წარმოქმნის გარკვეული ტიპის ობის სოკოები. ობი წარმოიქმნება საკვებ პროდუქტებში, როგორიცაა: მარცვლეული, ჩირი, თხილი და სანელებლები. ობის წარმოქმნა შეიძლება მოხდეს როგორც მოსავლის აღებამდე, ასევე მოსავლის აღების შემდეგ, შენახვის დროს, თავად საკვებზე/საკვებში, უმეტესად თბილ, ნესტიან და ნოტიო პირობებში. დაბინძურებულ საკვებ პროდუქტებში მიკოტოქსინების არსებობამ შეიძლება სერიოზული რისკები შეუქმნას როგორც ადამიანებს, ასევე ცხოველების ჯანმრთელობას. ჩვენი სამუშაოს მიზანი იყო აფლატოქსინებით დაბინძურებული საკვების ზემოქმედება ვირთაგვების შინაგან ორგანოებზე. შემოწმებულ იქნა ჰიდროკარბონატით დამუშავებული ლიგნინის ადსორბციული თვისებები ცოცხალ სისტემებზე, კერძოდ, ლიგნინში მოთავსებული აფლატოქსინით დაბინძურებული საკვების გავლენა ვირთაგვების ღვიძლის მდგომარეობაზე. ამ მიზნით ჩატარდა მოკლევადიანი ექსპერიმენტი. მიღებული მონაცემებით დადგინდა, რომ ობიანი საკვები იწვევს კუჭის, ნაწლავების, ღვიძლის ნორმალური სტრუქტურის და ფუნქციის ცვლილებებს, ხოლო ობიანი საკვები, რომელიც იმყოფებოდა 48 საათის განმავლობაში ჰიდროკარბონატით დამუშავებულ ლიგნინთან, არ იწვევს შინაგანი ორგანოების სტრუქტურის და ფუნქციის ცვლილებებს. მოკლევადიან პერიოდში ნატრიუმის ჰიდროკარბონატით დამუშავებულ ლიგნინთან მოთავსებულმა დაობებულმა საკვებმა არ მოახდინა ცვლილება ვირთაგვების ორგანიზმზე.

REFERENCES

Benkerroum, N. (2020). Chronic and acute toxicities of aflatoxins: mechanisms of action. *International Journal of Environmental Research and Public Health, 17,* 423.

Elliott, C.T., Connolly, L. & Kolawole, O. (2020). Potential adverse effects on animal health and performance caused by the addition of mineral adsorbents to feeds to reduce mycotoxin exposure. *Mycotoxin Research, 36,* 115-126.

Eskola, M., Kos, G., Elliott, C.T., Hajslova, J., Mayar, S. & Krska, R. (2020). Worldwide contamination of food-crops with mycotoxins: Validity of the widely cited 'FAO estimate' of 25%. *Critical Reviews in Food Science and Nutrition, 60,* 2773-2789.

Karkashadze, N., Tserodze, N., Tatiashvili, L., Uridia, R., Gvidani, S., Gakhokidze, R. (2024). Aflatoxins Adsorption by Lignin Treated with Sodium Hydrocarbonate Using Technogenic Raw Materials. *Bull. Georg. Natl. Acad. Sci., 19,* 2, 115-119.

Karkashadze, N., Uridia, R., Tserodze, N., Tatiashvili, L, Ebralidze, K., Dolidze, L. (2022). Natural waste use for mycotoxins adsorption. *Georgian Scientists, 4,* 225-231.

Luo, Y., Liu, X. & Li, J. (2018). Updating techniques on controlling mycotoxins - a review. *Food Control, 89,* 123-132.

Marroquin-Cardona, A.G., Johnson, N.M., Phillips, T.D. & Hayes, A.W. (2014). Mycotoxins in a changing global environment - a review. *Food and Chemical Toxicology, 69,* 220-230.

Mironov, A. N. (2012). Guidelines for conduction preclinical studies of medicinal products. Part 1, 339.

Park, D.L., Njapau, H. & Boutrif, E. (1999). Minimizing risks posed by mycotoxins utilizing the HACCP concept. *FAO Food, Nutrition and Agriculture Journal, 23,*49-56.

Streit, E., Schwab, C., Sulyok, M., Naehrer, K., Krska, R. & Schatzmayr, G. (2013). Multi-mycotoxin screening reveals the occurrence of 139 different secondary metabolites in feed and feed ingredients. *Toxins, 5*, 504-523.

Ulger, T.G., Ucar, A., Cakiroglu, F.P. & Yilmaz, S. (2020). Genotoxic effects of mycotoxins. *Toxicon,* 185, 104-113.

Uridia, R.Z., Karkashadze, N.G., Tatiashvili, L.T., Tserodze, N.P., Mikadze, I.I., Tsiskarishvili, R.P. (2021). Research of adsorbtion aflatoxins by technical lignin. *World Science, 10***,** 71, 43-46.

Vila-Donat, P., Marin, S., Sanchis, V. & Ramos, A.J. (2018). A review of the mycotoxin adsorbing agents, with an emphasis on their multi-binding capacity, for animal feed decontamination. *Food and Chemical Toxicology, 114,* 246-259.

Received October, 2025