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RADIOLYTIC DESTRUCTION OF OCHRATOXIN IN DAMP BARLEY GRAINS

Mamedov Kh. F.

*Institute of the Radiation Problems, National Academy of Sciences, Department of the Complex
Researches of the Azerbaijan Republic, Baku, Azerbaijan
E-mail: xagani06@mail.ru*

The destruction of ochratoxin in damp grains of barley under the influence of ionizing radiation of ^{60}Co has been studied. The possibility of “radiolytic detoxification” of barley has been determined at the various degrees of grains’ humidity and at the different values of absorbed dose of ionizing radiation. It is defined that, the doses 10-25 kGy is quite sufficient, also for full sterilization of grains.

Keywords: grains, barley, mycotoxin, destruction, ionizing radiation.

INTRODUCTION

The ionizing radiation of ^{60}Co sources have been successfully used for enlarging the shelf life of fruit, vegetables and grains without losses, for improving their properties, for disinfection, pasteurization, sterilization, preservation and conservation of the foodstuff [1–3].

The carcinogenic properties of natural toxins are not less than such properties of anthropogenic xenobiotics. Pollution of foods by bacterial toxins leads to strong food poisoning [4, 5]. About 300 species of derivative metabolites, i.e. mycotoxins synthesized by more than 350 kinds of microscopic fungus are known. Mycotoxins can penetrate into the deeper layers of food. Low concentration of natural toxins can become the poisoning reason.

Synthesized by fungus *Aspergillus* and *Penicillium* the Ochratoxin is characterized by teratogenic properties and doesn’t decay at 250°C . Contamination of foods and forages by ochratoxin can be reason of human and animal poisoning.

The aim of this research work is to explore the destruction of ochratoxin in water solution and damp grains of barley under the influence of ionizing radiation of ^{60}Co .

MATERIALS AND METHODS

Microorganisms were investigated by using special nutrient mediums of Hi-Media (India) and Condalab (Spain). The enzyme immunoassay testings, LC-MS and LC-MS/MS methods have been used for estimations of mycotoxins [6, 7].

Absorbed in substances ionizing dose rate of radiation from ^{60}Co sources were 0.33 Gy/s. The studied substances have been irradiated by the doses up to 25 kGy.

RESULTS AND DISCUSSION

The high concentration of ochratoxin (0.25 mg/kg) has been revealed in damp barley grains. Damp grains of barley (5 and 20% humidity) and water solution of ochratoxin have been irradiated by ionizing radiation.

Numerous information about the sterilization, disinfection, disinsection of the products are known [1–3].

The possibility of radiolytic decomposition of various natural toxins synthesized by *Aspergillus*, i.e. the dependence of ochratoxin's quantity from the absorbed dose has been studied. Decrease of ochratoxin's concentration in water solution and in damp barley grains under the influence of ionizing radiation of ^{60}Co are presented in the Table 1.

Table 1.
Radiolytic destruction of ochratoxin in water solution and damp barley grains

The absorbed dose of ^{60}Co ionizing radiation, kGy	0	1	2.5	10	25
Ochratoxin in barley (5% humidity), mg/kg	0.25	0.18	0.12	0.08	0.05
Ochratoxin in barley (20% humidity), mg/kg	0.25	0.15	0.08	0.03	0
Ochratoxin in water solution, mg/kg	0.25	0.11	0.05	0.01	0

The reduction of *Aspergillus* fungi under the influence of ionizing radiation of ^{60}Co are shown in the Table 2.

Table 2.
The reduction of *Aspergillus* fungi under the influence of ^{60}Co radiation

The absorbed dose of ionizing radiation, kGy	0	1	2.5	25
The <i>Aspergillus</i> count in 1 g of barley grains	600	1200	740	0

By comparison of the Table 1 and Table 2, it seems that the rate of ochratoxin's destruction is lower than the rate of microorganism death.

The calculation of radiation-chemical yield of ochratoxin's destruction in water solution and in barley grains are presented below:

- 1 kGy of absorbed dose of ionizing radiation is equivalent 6.241×10^{21} eV/kg;
- the concentration of ochratoxin in a water solution decreased from 250 $\mu\text{g}/\text{kg}$ to 110 $\mu\text{g}/\text{kg}$, i.e. on 140 $\mu\text{g}/\text{kg}$, during absorption of 1 kGy dose, that is equal to decomposition of 210×10^{15} molecules in 1 liter or 1 kg of water (the relative molecular weight of ochratoxin is 400);

- decrease of ochratoxin's concentration equal to 70 and 100 µg/kg during absorption of 1 kGy dose obtained at 5% and 20% humidity of grains, that is equal accordingly to decomposition of 105×10^{15} and 150×10^{15} molecules of ochratoxin in 1 kg of barley grains;
- the calculation of ochratoxin's destruction is possible from the above-stated results at absorption by systems 100 eV energy of ionizing radiation. The values of radiation-chemical yields are equal to 210×10^{15} molecules/kg x $100 \text{ eV} / 6.241 \times 10^{21} \text{ eV/kg} = 0.34 \times 10^{-2}$ molec./100 eV for water solution, 0.17×10^{-2} and 0.24×10^{-2} molec./100 eV for damp grains (accordingly at 5% and 20% degree of humidity).

These values show to high stability of ochratoxin's molecules. The value of radiation-chemical yield of ochratoxin's destruction in a water solution is 2 and 1.4 times more than in barley grains accordingly at 5% and 20% humidity. This fact specified the formation of e^-_{aq} at the radiolysis of water solutions and participation of these hydrated electrons in the further destruction of ochratoxin. Radiolysis of water is described by a following equation:



All free-radical products of water solutions (e^-_{aq} , H, OH, O, H^+_{aq} , OH^-_{aq}) can take part at the destruction of mycotoxin. Insignificantly low quantities of uncarcinogenic compounds (methylcyclopentan, benzoic aldehydes, small fat acids and spirits) have been elicited at the radiolytic sterilization of barley grains.

Existing methods of detoxification (mechanical, chemical and physical/thermal/) are characterized by many deficiencies [8, 9, 10]. The significant destruction of ochratoxin is observed in studied substances under the influence of ionizing radiation of ^{60}Co source.

The destructions rate of ochratoxin in water solution and in damp barley grains are too low and the values of radiation-chemical yields of ochratoxin's destructions vary in the range $\approx 0.17 \times 10^{-2} - 0.34 \times 10^{-2} / 100 \text{ eV}$. But, absorbed dose of ionizing radiation equal to 10-25 kGy, leads to the decrease of any concentration of ochratoxin to the values lower than permitted concentration of ochratoxin in cereals (0.01 mg/kg). Radiolytic destruction, i.e. "radiolytic detoxification" by absorbed doses equal to 10-25 kGy doesn't hold to any negative changes in organoleptic and chemical properties of barley grains.

CONCLUSION

Absorbed dose of ionizing radiation equal to 10-25 kGy leads to the ochratoxin's destruction in water solution and in polluted barley grains to the values lower than permitted concentration of ochratoxin in cereals.

The method of "radiation detoxification" is more effective than other traditional methods of detoxification. Absorbed dose equal to 10-25 kGy used for "radiation detoxification" are enough also for the full sterilization

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Мамедов Х.Ф. Радиолитическое разложение охратоксина во влажных зернах ячменя / Х.Ф. Мамедов // Ученые записки Таврического национального университета им. В.И. Вернадского. Серия «Биология, химия». – 2012. – Т. 25 (64), № 2. – С. 233-236

Изучено разложения охратоксина во влажных зернах ячменя при облучении их ионизирующим излучением ^{60}Co . Установлены возможности «радиолитической детоксикации» ячменя при различных степенях влажности зерен и при разных значениях поглощенной дозы ионизирующего излучения. Определены, что поглощенные дозы, равные 10–25 кГр вполне достаточны также для обеспечения полной стерилизации зерен.

Ключевые слова: зерна, ячмень, микотоксин, разложение, ионизирующее излучение.

Мамедов Х.Ф. Радиолітичного розкладання охратоксину у вологих зернах ячменю / Х.Ф. Мамедов // Вчені записки Таврійського національного університету ім.В.І.Вернадського. Серія „Біологія, хімія”. – 2012. – Т. 25 (64), № 2. – С. 233-236.

Вивчено розкладання охратоксину у вологих зернах ячменю при опроміненні їх іонізуючим випромінюванням ^{60}Co . Встановлено можливості «радіолітичного детоксикації» ячменю при різних ступенях вологості зерен і при різних значеннях поглиненої дози іонізуючого випромінювання. Визначено, що поглинуті дози, рівні 10-25 кГр цілком достатні також для забезпечення повної стерилізації зерен.

Ключові слова: зерна, ячмінь, мікотоксин, розкладання, іонізуюче випромінювання.

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