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Evaluating the role of Ultraviolet Radiation and Ozone gas in reducing Aflatoxin in Rice

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ABSTRACT

The use of chemicals to break down and reduce aflatoxin, including ozone gas, is the most efficient and effective in breaking down aflatoxin, followed by ultraviolet radiation, an effective physical method means of breaking down and reducing mycotoxins. Our study aims to find a way to reduce mycotoxins in some types of rice using ultraviolet radiation (U.V) and ozone gas (O3) . The results showed that when all types of rice (white, kulbahar, amber) were exposed to ultraviolet radiation for 60 minutes, the reduction percentage of (25.00, 12.45, 11.76)%, respectively. When exposed to ozone gas for 10 minutes, the results showed the highest percentage of reduction in aflatoxin concentration (27.50, 26.01, 34.64)%, respectively.

Introduction

Cereals are considered one of the economically important crops in the world [1]. The consumption of grains and their products is an essential source of energy and food, especially in low-income countries because of their cheap price. The contamination of crops, especially grains, by molds during the pre- and post-harvest stages It can lead to toxic secondary metabolites known as mycotoxins such as aflatoxins and ochratoxins, and are of great source of concern due to their frequent presence in foods [2] , and deoxynivalenols, and trichothecenes [3,4]. Rice is one of the most cultivated and consumed grains all over the world, reaching 496.9 million tons, produced in 2019-2020 and it is grown in Spain, Africa, Australia, Europe and America [5]. Rice production in China (147 million tons), India (118 million tons), and Bangladesh (36 million tons) is considered one of the first countries in rice production in the world, and the main sources are China, the Philippines, and the European Union [5], there are two types of rice grown all over the world, Oryza sativa, two subspecies (Japonica, Indica), and O.glaberrima, which grows in some African regions.

Recently, there are seven registries that have licensed genetically modified rice, especially Oryza Sativa, to be fit for consumption through its resistance to insects and resistant of pesticides, and the rice known as golden contains vitamin A [6] .Aflatoxins were isolated from rice, and the two main fungi that produce aflatoxin are (A. flavus and A. parasiticus). Improper drying is the cause of rice contaminated ,fungi and color change.[7]

Aflatoxins are known as mycotoxins that are common in many countries and are produced by fungi of the genus of A.Flavus, and A.Parasiticus [8]. To reduce aflatoxin contamination, ultraviolet radiation was used, it breaks unsaturated bonds and changes the chemical structure and properties of aflatoxin, leading to inhibition and a significant decrease in the cytotoxicity and mutagenicity of aflatoxin treated with ultraviolet radiation.[9,10]

Ozone has also been used as a powerful oxidizing agent to control aflatoxins in food [11]. Ozone has been approved since 1997 by the Food and Drug Administration and is considered safe [12] ,and cannot cause harm to health due to its short half-life. 15-30 minutes [13] Ozone decomposes and destroys AFB1 and AFG1 through interaction with the double bond in C8-C9 of the lactone ring and it is rearranged into monoderivatives, which are aldehydes, ketones, acids, and carbon dioxide [14]

Therefore, our study aimed to study mycotoxins in some types of rice, and how to reduce it through physical and chemical methods, and evaluate their efficiency in eliminating mycotoxins.

Materials and methods

Samples Collection: Samples of three types of rice (white, kulbahar, and amber) of 250 grams for each sample from the markets of Mosul city. They were placed in sterile nylon bags. They were numbered, and information related to each sample was included. They were tightly closed and then transported to the laboratories of the Agricultural Technical College. Plant Production Techniques Department and the samples were kept at room temperature. Until tests are done and check for mycotoxins.

Detection of aflatoxin: Aflatoxin was estimated in types of rice (white, kulbahar, amber) using ELISA technology according to the method manufactured by (SUNLONG BIOTECH, Cat. No: SL0004Ot).

Testing the effect of ozone gas and ultraviolet radiation on destroying and reducing aflatoxin in rice.

Ultraviolet test: Placed 100 grams of three types of rice powder under study in a glass containers and exposed to 360 nm ultraviolet radiation for 60 minutes, after which the samples were stored in the refrigerator at a temperature of 4°C until tests were conducted on them.

Ozone gas(O3) : Placed 100 grams of rice powder under study in a two-hole glass flask with a capacity of 1 liter, at a rate of 3 repetitions per treatment, and it was exposed to ozone gas at 2 mg/min for 10 minutes from one of the two holes, and the gas exited from the other hole. After that, the samples were stored in the refrigerator at 4°C until the procedure was performed tests on it.

Statistical Analysis: The SPSS statistical analysis system was used to analyze the results of the study statistically, the least significant difference at the probability level of 0.05 was used to compare the arithmetic means of the studied traits [15]

Results and discussion

Due to the spread of mycotoxins in field crops and grains as a result of poor storage conditions and high humidity, our study included investigating mycotoxins in some rice (white, kulbahar, amber) and finding the best way to reduce these toxins without affecting its nutritional value by using physical methods, such as ultraviolet radiation. And chemical methods such as using ozone gas.

Experiments on three types of rice (white, kulbahar, and amber) showed that the best and most efficient method is to use ozone. We obtained the highest reduction percentage of mycotoxins, which was 34.64% in amber rice, while in white rice the percentage was 27.50%, and the lowest percentage

26.01% in Gulbahar rice compared to ultraviolet radiation, where the reduction in white rice reached 25.00%, while in Gulbahar rice it was 12.45%, and finally in Amber rice it was 11.76% as shown in Table (1) and Figure (1).

Table 1. The effect of ozone gas (2 mg/min) for 10 minutes, UV (360 nm/hour), on reducing the concentration of aflatoxin in all types of rice.

Rice	Aflatoxin(ppm)	Ozone %	U.V %
White	8.00	27.50	25.0
Gulbhar	8.11	26.01	12.45
Amber	6.12	34.64	11.76

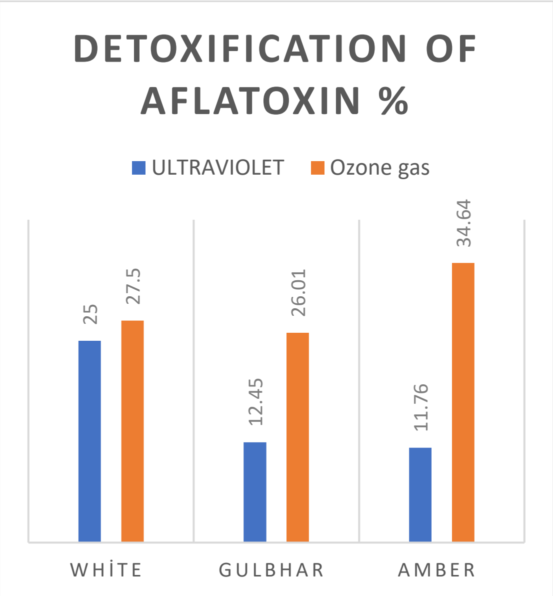

Figure 1. Detoxification of aflatoxin % using ultraviolet and ozone gas in types of Rice

This study agreed with several countries in the world, including Pakistan, Brazil, Indonesia, and China, and India, Korea, and Austria reported the presence of aflatoxin in rice samples ,A study in Pakistan showed that 72 samples out of 208 were contaminated with AFB1 at a concentration of (3.60) g/kg [16],while a study in Canada showed that the average concentration of AFB1 toxin in rice imported from the United States of America and Asia was approximately (0.34) g/kg and (0.39) g/kg [17].

A recent study in Iran showed that (24) samples of rice flour were contaminated with AFB1 at concentrations of (0.46 and 10.16) g/kg [18]. It was also observed in China [19] that 370 rice samples contaminated with aflatoxin were collected from six different species in different regions, and among these samples it was found that 63.5% were infected with AFB1.

In another study, aflatoxin was detected in 75 samples of boiled rice found in fiber in the United States of America, with a percentage ranging from 0.052 to 2.58 micrograms/kg for aflatoxin in general and a percentage of 0.014 to 0.123 micrograms/kg for AFB1[20].

A study conducted in Brazil showed that 187 samples of rice in the field and processing markets were analyzed in wet and dry lands for fungi. Five species of fungi were identified: A. flavus, A. cae latus, A. novoparasiticus, A. arachidicola, and A. pseudo caelatus,, and 14% of the samples were positive. for aflatoxin with two samples exceeding the Brazilian regulatory limit of 5 µg/kg [21].

In another study conducted in Guyana on 186 samples of rice contaminated with aflatoxin, among these samples it was found that 16 samples contained aflatoxin in high concentrations higher than the United States and European Union regulatory limits, respectively [22].

The reason for the reduction of aflatoxin by ozone is due to the electrophilic attack on the double bond in the difuran ring, forming a primary ozonide, followed by the reorganization of molosonide into secondary products represented by ketones, aldehydes, and organic acids [23], and the high moisture content is the main factor preventing the destruction of the resulting aflatoxin. Regarding ozone, some studies have shown that ozone changes the chemical composition of fatty acids and protein contents in processed foods [24,25], and this is consistent with testing the decomposition of aflatoxin induced by ozone on different foodstuffs, especially in wheat and corn. Peanuts, pepper, and a clear decrease in the percentage of aflatoxin [26], while the lowest reduction percentage was obtained using ultraviolet rays. The reason is attributed to the fact that ultraviolet rays break down unsaturated bonds and change the chemical composition and properties of aflatoxin, which leads to inhibition and decrease. On the cytotoxicity and mutagenicity of aflatoxin treated with UV radiation [27,28].

CONCLUSION

It is concluded from our study that by exposing the three types of rice (white, kulbahar, and amber) to ultraviolet radiation and ozone, we obtained the highest percentage of decrease in amber rice using ozone and using ultraviolet radiation in white rice.

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References

[1] Haggag, W. M., Diab, M. M., Al-Ansary, N. A., Ibrahim, M. I., Khattab, A. E. N. A., Abdel-Wahhab, M. A., & Ali, M. K. (2024). Molecular identification and management of mycotoxigenic fungi in stored corn Grains. Cereal Research Communications, 1-14.

[2] Silva, J. V. B. D., Oliveira, C. A. F. D., & Ramalho, L. N. Z. (2021). An overview of mycotoxins, their pathogenic effects, foods where they are found and their diagnostic biomarkers. Food Science and Technology, 42, e48520.

[3] Lima, C. M. G., Costa, H. R. D., Pagnossa, J. P., Rollemberg, N. D. C., SILVA, J. F. D., Dalla Nora, F. M., ... & Verruck, S. (2021). Influence of grains postharvest conditions on mycotoxins occurrence in milk and dairy products. Food Science and Technology, 42, e16421.

[4] Khorshidi, M., Heshmati, A., Hadian, Z., Smaoui, S., & Mousavi Khaneghah, A. (2022). The occurrence of aflatoxin M 1 in doogh, kefir, and kashk in Hamadan, Iran. Food Science and Technology, 42, e42022.

[5] IGC Five-year Baseline Projections of Supply and Demand for Wheat, Maize (Corn), Rice and Soyabeans to 2025/ 26; International Grains Council: 2021; p 8.

[6] ISAAA,GMApprovalDatabase.https://www.isaaa.org/gmapprovaldatabase/cropslist/default.asp 2021 (accessed April 2021).

[7] Mahato, D. K., Lee, K. E., Kamle, M., Devi, S., Dewangan, K. N., Kumar, P., & Kang, S. G. (2019). Aflatoxins in food and feed: An overview on prevalence, detection and control strategies. Frontiers in microbiology, 10, 483502.

[8] Rushing, B. R., & Selim, M. I. (2019). Aflatoxin B1: A review on metabolism, toxicity, occurrence in food, occupational exposure, and detoxification methods. Food and chemical toxicology, 124, 81-100.

[9] Mao, J., He, B., Zhang, L., Li, P., Zhang, Q., Ding, X., & Zhang, W. (2016). A structure identification and toxicity assessment of the degradation products of aflatoxin B1 in peanut oil under UV irradiation. Toxins, 8(11), 332.

[10] Guo, Y., Zhao, L., Ma, Q., & Ji, C. (2021). Novel strategies for degradation of aflatoxins in food and feed: A review. Food Research International, 140, 109878.

[11] Novak, J. S., & Yuan, J. T. (2007). The ozonation concept: Advantages of ozone treatment and commercial developments. Advances in Thermal and Non-Thermal Food Preservation, 185-193.

[12] Liu, Z., Gao, J., & Yu, J. (2006). Aflatoxins in stored maize and rice grains in Liaoning Province, China. Journal of stored products research, 42(4), 468-479.

[13] Freitas-Silva, O., & Venâncio, A. (2010). Ozone applications to prevent and degrade mycotoxins: a review. Drug metabolism reviews, 42(4), 612-620.

[14] Li, H., Xiong, Z., Gui, D., Pan, Y., Xu, M., Guo, Y., ... & Li, X. (2019). Effect of ozonation and UV irradiation on aflatoxin degradation of peanuts. Journal of food processing and preservation, 43(4), e13914.

[15] Haaland, P. D. (2020). Experimental design in biotechnology. CRC press.

[16] Iqbal, S. Z., Asi, M. R., Hanif, U., Zuber, M., & Jinap, S. (2016). The presence of aflatoxins and ochratoxin A in rice and rice products; and evaluation of dietary intake. Food chemistry, 210, 135-140.

[17] Ndagijimana, R., Shahbaz, U., & Sun, X. (2020). Aflatoxin B1 in food and feed: an overview on prevalence, determination and control tactics. JAIR, 8, 144.

[18] Mottaghianpour, E., Nazari, F., & Hosseini, M. J. (2021). Determination of aflatoxin B1 contamination in wheat and rice flour collected from Iranian market using simple and reliable HPLC method. Journal of Food and Nutrition Research, 9(1), 50-54.

[19] Lai, X., Liu, R., Ruan, C., Zhang, H., & Liu, C. (2015). Occurrence of aflatoxins and ochratoxin A in rice samples from six provinces in China. Food Control, 50, 401-404.

[20] Al-Zoreky, N. S., & Saleh, F. A. (2019). Limited survey on aflatoxin contamination in rice. Saudi Journal of Biological Sciences, 26(2), 225-231.

[21] Katsurayama, A. M., Martins, L. M., Iamanaka, B. T., Fungaro, M. H. P., Silva, J. J., Frisvad, J. C., ... & Taniwaki, M. H. (2018). Occurrence of Aspergillus section Flavi and aflatoxins in Brazilian rice: From field to market. International journal of food microbiology, 266, 213-221.

[22] Morrison, D. M., Chester, L., Samuels, C. A., & Ledoux, D. R. (2016). The Determination of Aflatoxins in Paddy and Milled Fractions of Rice in Guyana: Preliminary Results. International Journal of Agricultural and Biosystems Engineering, 10(11), 725-729.

[23] Jalili, M. (2016). A review on aflatoxins reduction in food. Iranian Journal of Health, Safety and Environment, 3(1), 445-459.

[24] Brodowska, A. J., Nowak, A., & Śmigielski, K. (2018). Ozone in the food industry: Principles of ozone treatment, mechanisms of action, and applications: An overview. Critical reviews in food science and nutrition, 58(13), 2176-2201.

[25] Ianni, A., Grotta, L., & Martino, G. (2019). Feeding influences the oxidative stability of poultry meat treated with ozone. Asian-Australasian Journal of Animal Sciences, 32(6), 874.

[26] Diao, E., Hou, H., Chen, B., Shan, C., & Dong, H. (2013). Ozonolysis efficiency and safety evaluation of aflatoxin B1 in peanuts. Food and Chemical Toxicology, 55, 519-525.

[27] Mao, J., He, B., Zhang, L., Li, P., Zhang, Q., Ding, X., & Zhang, W. (2016). A structure identification and toxicity assessment of the degradation products of aflatoxin B1 in peanut oil under UV irradiation. Toxins, 8(11), 332.

[28] Guo, Y., Zhao, L., Ma, Q., & Ji, C. (2021). Novel strategies for degradation of aflatoxins in food and feed: A review. Food Research International, 140, 109878.