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Aflatoxins in Hazelnuts and Their Effects

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Abstract

Hazelnuts are considered a significant component of human nutrition. They occupy a significant position in the classification of nuts, particularly with regard to production and consumption volumes. The leading producers of this commodity include Turkey, Italy, Azerbaijan, Georgia and other countries. Hazelnuts are consumed raw and also processed into a wide variety of food products. However, a significant challenge for hazelnuts and their products is the presence of aflatoxins. Aflatoxin and its metabolites pose a significant risk to human health as carcinogenic substances. Sensitive and rapid detection and detoxification of aflatoxins is invaluable in food safety, environmental monitoring and risk assessment. Aflatoxins produced by *Aspergillus flavus* and *Aspergillus parasiticus* are among the most toxic mycotoxins. And the formation of these mycotoxins is affected by many parameters such as environmental environment, temperature, humidity. In this context, the current research has compiled the presence of aflatoxins in hazelnuts and their products, detoxification methods and their effects on human health.

Key Words: *Hazelnut, aflatoxins, detoxification, health, nuts*

Introduction

Nuts are a class of foodstuffs that are included in human nutrition and possess both nutritional content and functional properties. Hazelnut (*Corylus avellana* L.), which occupies a significant position in this food group, is distinguished as one of the most produced and consumed nuts globally. As it is known, hazelnut is a plant from the birch family and among the most important producers are Turkey, Italy, Georgia, Azerbaijan, USA and other countries. Hazelnuts can be consumed both raw and used as raw material in many areas, especially in the chocolate industry. On the other hand, mycotoxins have been identified as a fundamental factor contributing to significant quality issues in hazelnut products, which are characterised by their high content of bioactive components, fatty acids, and antioxidants (Zhao et al., 2023; Savaş, 2024b, Savaş, 2024a).

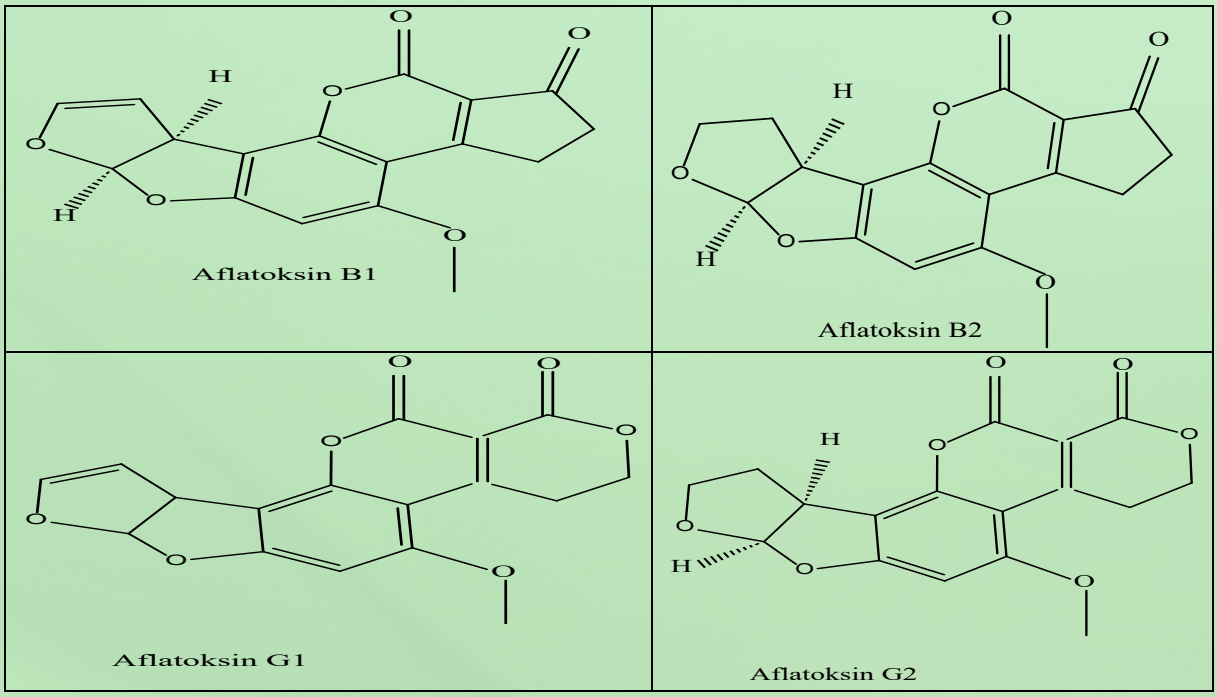
Figure 1. Hazelnut samples with and without aflatoxin

Mycotoxins are defined as secondary metabolites with the capacity to affect human health. To date, more than 400 mycotoxins have been identified, which have toxic effects on animals, including humans (Savaş, 2024; Pokoo-Aikins et al., 2024). The most well-known of these are aflatoxins (AFs), zearalenone (ZEA), deoxynivalenol (DON) and ochratoxin (OTA). Furthermore, these toxins have been observed to accumulate in the organs or tissues of animals upon ingestion, and consequently, they can be transferred to foods of animal origin(Juan et al.,

2019; Alaboudi et al., 2022). Especially among these mycotoxins, aflatoxins with difuran and coumarin skeletons are among the most toxic mycotoxin representatives(Yang and Wang, 2021; Kang and Zhao, 2025).

Aflatoxins, of which twenty types have been identified, are important toxins produced by *Aspergillus flavus* and *Aspergillus parasiticus*. The identification of aflatoxins is based on a combination of molecular differences, fluorescence properties under ultraviolet light, and chromatographic mobility (Catanante et al., 2016; Kang and Zhao, 2025). As has been demonstrated by numerous studies, the presence of aflatoxins has been identified in spices, nuts and fermented products, particularly in cereals. It has been asserted that the toxicity of aflatoxin B1 is significantly higher than that of potassium cyanide (10 times) and arsenic (68 times). Aflatoxin and its metabolites have been demonstrated to pose a significant risk to human health as carcinogens. Moreover, it is also stated that they have various effects such as hepatotoxic, genotoxic and mutagenic. (Kang and Zhao, 2025). However, aflatoxins, which are classified as hepatocarcinogens, are mostly stated to have uncertain effects on tissues other than the liver (Yang and Wang, 2021). In this context, Herzallah (2013) reported that aflatoxin B1 residues were detected in eggs and meat of chickens fed with aflatoxin B1-contaminated feed and egg production decreased. The chemical structures of the most common aflatoxins are presented in Figure 2.

Figure 2. Chemical structures of aflatoxin B1, B2, G1 and G2



The ingestion of aflatoxin-contaminated foodstuffs or animal products has been demonstrated to engender a range of health risks. The most prevalent methods of detoxification of aflatoxins are physical, chemical and biological. (Wang et al., 2025). Due to the thermal stability of aflatoxins, it is stated that AFB1 cannot be destroyed by normal cooking processes. However, various studies in the literature have reported that aflatoxins can be detoxified from different food products. For example, Wang et al. (2025) reported that AFB1 can be removed from peanut oil at different levels in their study. Şen et al. (2019) reported that cold plasma and gamma irradiation methods detoxify AFB1 at different levels in hazelnut samples. On the other hand, it has been revealed by various studies that aflatoxins can be detoxified. However, it is a fact that detoxification methods have various disadvantages in terms of high cost and side effects.

The impact of mycotoxins on human health has been elucidated through in vivo, in vitro and epidemiological studies. In particular, aflatoxins, which constitute one of the most significant toxic classes among mycotoxins, have been demonstrated to exert effects on reproduction and development, neurotoxicity, intestine and metabolism by in vivo, in vitro and epidemiological studies (Kousar et al., 2024; Wang et al., 2025). In this context, it is hypothesised that the consumption and formation conditions of foods containing aflatoxins should be prevented.

Conclusion

Nowadays, there is a growing interest in healthier, functional foods. However, various toxic compounds, including aflatoxins, may occur as a result of improper harvesting, storage, transport and applied processes. A review of the extant literature reveals numerous studies addressing the presence of aflatoxins in hazelnuts and various food groups. In particular, it is thought that the formation levels of aflatoxins should be at a minimum level due to their health effects and carcinogenicity, and more focus should be placed on control mechanisms and detoxification studies.

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