

Aflatoxins in Pistachios and their Adverse Health Effects

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Pistachios (*Pistaciavera L.*) are among the major export products in the world, especially in Iran [1]. Pistachio trees resist harsh conditions, such as aridity, hot and dry climates, and salt water. On the other side, over two-thirds of Iran is located in deserts and semi-deserts. Against this background, this product is cultivated in various regions of Iran, including the provinces of Kerman, Semnan, and Yazd [2, 3].

Pistachio contamination with aflatoxins is considered one of the major challenges to this strategic product, having a high economic value, which affects its exportation [3, 4]. Aflatoxins are a group of mycotoxins that are produced by some species of *Aspergillus*, including *Aspergillus flavus* and *Aspergillus parasiticus*. In fact, b1, b2, g1, and g2 are the major types of aflatoxins [5, 6]. Aflatoxin contamination of agricultural crops, such as pistachios, wheat, rice, corn, peanuts, and the like, is a public health threat to humans [7]. In addition, aflatoxin contamination of agricultural crops, especially pistachios (and more specifically early-split pistachios), occurs at different production stages, including planting, cultivating, harvesting, storage, transportation, and various stages of processing [3, 8]. Average aflatoxin contamination in pistachios in Iran is 16 ng/g. However, the US standard for aflatoxin contamination is 20 ng/g, with that of the Europe being 2-4 ng/g. This indicates that more attention should be given to aflatoxin contamination in pistachios in Iran [7].

Mutagenicity, teratogenicity, and carcinogenicity are among the most prevalent health effects of aflatoxins on human health [9]. Aflatoxins produce substances, such as aflatoxin epoxide in the body, especially in the liver, through enzymatic reactions, with carcinogenic properties. The production of such substances, their binding to the DNA, and disrupting functions of cells lead to their abnormal division, thereby causing various types of cancers in the body [7, 9]. Liver cancer is one of the most prevalent and dangerous cancers, being highly correlated with aflatoxin exposure [9]. In terms of teratogenicity of aflatoxins, 255 gr of newborns' weight was lost at birth in 54% of pregnant Kenyan women having aflatoxins in their blood. In addition, aflatoxins were observed in the umbilical cord blood of 37% of infants, having led to defects in 30% of newly formed fetuses [7]. In general, the disease caused by aflatoxins is named aflatoxicosis, which is caused by aflatoxin exposure. Acute aflatoxicosis leads to

death in 25% of cases, with some of its symptoms being hemorrhagic necrosis of the liver, proliferation of bile ducts, edema, and listlessness [10]. In addition to the abovementioned conditions, they can cause dermal, pulmonary, and gastrointestinal diseases [9].

Given the toxicity and pathogenicity of aflatoxins as well as the vulnerability of the pistachio crop to aflatoxin contamination due to its structural characteristics and conditions of the cultivation place, it is necessary to continually monitor aflatoxins in this crop and to employ efficient methods to reduce aflatoxin levels in various stages of pistachio production and processing [8]. Additionally, employing proper physical, chemical, and biological methods in various stages of the production process, including finding the correct location of cultivation, proper irrigation and fertilization, timely pruning and harvesting of the crop, as well as proper processing and storage can be effective in reducing aflatoxin contamination in pistachios [7].

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