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Original Article

Contamination of Stored Corn With Mycotoxins and its Mitigation Policies: A Policy Summary

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Abstract

Among crops, corn ranks third in the world in terms of cultivated area. In 2002, it produced 600 million tons and yielded 4296 kg/ha, surpassing rice and wheat. The most important corn-exporting countries in the world are the United States, Argentina, France, and China, accounting for about 91.5% of the total global export of this product. Japan, South Korea, Mexico, and China are among the most important corn grain importers. The Food and Agriculture Organization has stated that worldwide, approximately 25% of agricultural products and raw materials are contaminated with fungi, causing the contamination of animal and poultry feed. Poor harvesting practices, improper drying, crushing, packaging, storage, and transportation conditions contribute to the growth of fungi, thereby increasing the growth and risk of mycotoxin production. Mycotoxins are the smallest chemical toxins produced as the secondary metabolites of several fungal species that are easily incorporated into agricultural products and cause contamination in the field or after harvest. Mycotoxins require sensitive and reliable methods for detection since they are toxic at extremely low concentrations. Due to the diverse structures of these compounds, it is impossible to use a standard method to detect all mycotoxins, and each one requires different reproducible methods with simple analysis. Today, worldwide, cost-effective methods can suggest such solutions using policy briefs. Therefore, for evidence-based policy choices, considering the existing challenges and opportunities, it seems necessary to use intervention techniques and recommendations to prevent fungal contamination in mass-produced products and to improve the level of farmers' literacy.

Keywords: Farmers, Mycotoxins, Corn, Policy Summary

Necessity of Writing a Policy Summary

With the advancement of technology and the widespread use of industrial agriculture and mass food production, the need to control products has become more important because contamination of products with toxins can lead to irreparable losses for the producer and endanger the health of a large number of consumers [1]. Corn and its derivatives are among the products that are widely used in

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natural and processed forms. During processing and subsequent storage, there is a possibility of problems such as the formation of mold in the storage process [2]. The emergence of some types of mold can lead to the production of toxins called mycotoxins, including aflatoxin. Among crops, corn ranks third in the world in terms of cultivated area. In 2002, it produced 600 million tons and yielded 4,296 kg per hectare, thus surpassing rice and wheat. The most essential countries in the world that export corn are the United States, Argentina, France, and China, which together account for approximately 91.5% of the total global export of this product. On the other hand, Japan, South Korea, Mexico, and China are among the most important corn grain importers [3]. It is predicted that the demand for corn grain will increase by 62% by 2020 compared to 2015 (from 5.5 million tons to 37.8 million tons), while the need for corn in developing countries will increase by 79% during the same period from 282 million tons to 504 million tons of wheat, 593 million tons of rice, and 600 million tons of corn [4]. The Food and Agriculture Organization has stated that approximately 25% of agricultural products and raw materials are contaminated with fungi worldwide, causing contamination of poultry and animal feed [5]. Poor harvesting practices, crushing, and improper drying, as well as packaging, storage, and transportation conditions, contribute to the growth of fungi, thereby increasing the risk and growth of mycotoxin production. Mycotoxins are among the smallest chemical toxins that are produced as the secondary metabolites of a number of fungal species that are simply incorporated into agricultural products and lead to contamination in the field or following harvest [6]. A toxin can be defined as a substance produced by plant/animal species or microorganisms that is harmful to other living organisms. Food contamination with mycotoxins is a major problem in areas where agricultural and storage conditions are favorable for fungal growth and toxin production [7]. The risk of mycotoxin contamination is a major concern for the food safety of a variety of crops and horticultural products. Mycotoxins are secondary metabolites of fungi that may have toxic, carcinogenic, and mutagenic effects [8]. The European Union has set limits for aflatoxin (AF) for peanuts, nuts, dried fruits, and cereals at 4 µg/kg and for AFB1 at 2 µg/kg. However, the global standard sets the acceptable range for AFB1 and total AF at 1–20 µg/kg and 0–35 µg/kg. The Iranian Standards and Industrial Research Institute has set the maximum tolerable level for aflatoxin AFB1 and total toxins in plant products at 5 µg/kg and 15 µg/kg, respectively [9]. Most mycotoxins are chemically stable, so that they tend to survive during storage and processing and even at high temperatures, such as temperatures considered for baking bread or producing cooked breakfast cereals [10]. Considering that mycotoxins are toxic at very low concentrations, they require sensitive and reliable methods for detection. Because of the diverse structures of these compounds, it is impossible to use a standard method to detect all mycotoxins, and each one requires different methods [11]. It is noteworthy that these methods should be reproducible, and their analysis should be simple. Various methods can be used to evaluate and measure AF in corn and corn products, including chemical adsorption, high-performance liquid chromatography, enzyme-linked immunosorbent assay, and thin-layer chromatography. Although these methods differ in some characteristics, the enzyme-linked immunosorbent assay method has been utilized in most studies and is reported to be popular among researchers due to its ease of use and rapid results [12]. In developing regions, improper storage, lack of proper control, and management regarding the permitted standard, ignorance of farmers, and unauthorized harvesting of products may be related to various reasons [13]. Despite the potential for mycotoxin assessment and control, inappropriate cultivation programs by farmers and improper storage and transportation, the threat to human health and the environment caused by mycotoxins continue [14]. Therefore, implementing policies to reduce the negative effects is a worthwhile goal. This study presented evidence-based policy options considering the existing barriers and opportunities to reduce exposure to toxic fungi and to enable health organizers and policymakers to plan and employ strategies with more confidence.

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Criticism of Current Conditions

According to studies, developing identification techniques for the possible presence of toxic mycotoxins in agricultural products can be used as a solution to avoid acute and chronic health complications due to exposure to contaminated products [15].

Policy Recommendations

1. Updating standard measurement methods related to mycotoxin residue levels in corn and corn-based products
2. Finding and listing types of toxic fungi with different strains producing mycotoxins and recommended products for their control
3. Issuing a Product Health Promotion Certificate in the Electronic Agricultural Licensing System in order to identify plant products in production units
4. Using a variety of high-precision and accurate techniques, as well as appropriate preparation methods, with the lowest cost and time to evaluate various mycotoxins

Recommendation (1)

Responsible Entity: National Standard of Iran

Determining the non-toxic exposure threshold in corn and corn-based products based on global protocols

Recommendation (2)

Responsible Entity: Ministry of Agricultural Jihad and Plant Protection Organization

Distributing instructions for standard protocols for dealing with toxic species and their disposal and informing about their toxic effects

Recommendation (3)

Responsible Entity: Ministry of Agricultural Jihad

Certifying all products distributed in the fields and food baskets of Iranian households

Recommendation (4)

Responsible Entity: University of Medical Sciences

Using trained staff, updated identification methods, and appropriate and well-equipped equipment and facilities for early detection of toxins and increased protection against the possibility of poison farmers

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Authors' Contribution

Conceptualization: Fereshteh Mehri.
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Visualization: Razieh Parvez.
Writing-original draft: Fereshteh Mehri.
Writing–review and editing: Fereshteh Mehri.

Competing Interests

There is no conflict of interest between the authors.

Ethical Approval

This study was reviewed and approved by the Ethics Committee of Hamadan University of Medical Sciences (IR.UMSHA.REC.1403.103).

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