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Article

Investigating The Accumulation of Aflatoxin in The Serum of School Students

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Abstract: Mycotoxins are among the most important biological contaminants in food. Aflatoxins are considered the most dangerous due to their ability to accumulate in liver tissue and blood, and their carcinogenic and immunosuppressive effects. This study aimed to investigate the accumulation of aflatoxins in the blood serum of primary school students in Al-Sharqat City who regularly consume potato and corn chips. Blood samples were taken from 60 students and analyzed using an ELISA test to detect total aflatoxins, in addition to dietary data collected through a questionnaire. The results showed that 58.3% of the students regularly consume potato chips and the average aflatoxin concentration among regular consumers was 1.4 ng/ml, exceeding the internationally accepted limit 1 ng/ml. Furthermore, children who consume both potato and corn chips had the highest recorded concentrations 1.7 ng/ml. These results indicate a clear link between potato chip consumption and aflatoxin accumulation in the blood, reflecting the potential for contamination of these foods due to improper storage. This underscores the need for regular monitoring of popular food products and increased consumer awareness of their health risks.

Keywords: aflatoxin, mycotoxins, potato chips, corn, serum, food contamination

Introduction

Mycotoxins are among the most dangerous natural food contaminants produced by various types of fungi, particularly Aspergillus flavus and Aspergillus parasiticus [1], [2]. Aflatoxins are among the most common and widespread toxins, characterized by their high heat resistance and the difficulty in eliminating them during cooking or food processing [3], [4]. These toxins represent a global health problem due to their acute and chronic toxic effects, leading to liver damage, weakened immune systems, and an increased risk of liver cancer [5], [6].

Aflatoxins are primarily transmitted to humans through the consumption of contaminated foods such as grains, corn, and nuts, as well as products derived from them. In recent years, the consumption of potato chips and corn chips has become increasingly common among schoolchildren in Iraq [4], [7]. These snacks are often prepared locally or stored for extended periods under unsanitary conditions, creating an ideal environment for the growth of aflatoxin-producing fungi [8], [9].

The importance of this study stems from its focus on a vulnerable age group (primary school children) who may be exposed to unsafe levels of mycotoxins through the consumption of these foods [10], [11]. The research aims to detect the presence of aflatoxin in the blood serum of students who consume potato chips and corn as part of their dietary habits, as evidence of chronic exposure.

Materials and Methods

Experiment design: The study was conducted in primary schools in Al-Shirqat, Salah al-Din, Iraq, during the 2024–2025 academic year. It included 60 male and female students aged 7–12 years, after obtaining written parental consent. The students were divided into two groups:

Group 1: Students who regularly consumed potato and corn chips (3 times per week or more).

Group 2: Students who occasionally consumed potato and corn chips (less than 3 times per week).

Group 3: Students who did not consume potato and corn chips.

Three milliliters of venous blood were drawn from each student into anticoagulant-free tubes. The serum was then separated by centrifugation at 3000 rpm for 10 minutes, and the samples were stored at -20°C until analysis.

Aflatoxin Detection Test: An ELISA technique Rayto company (Germany) was used to detect total aflatoxin in serum, using a kit supplied by Sun long, China (www.sunlongbiotech.com). Absorbance was measured using a microplate reader at a wavelength of 450 nm, and the toxin concentration was calculated [12].

Dietary Questionnaire: A questionnaire was distributed to students to collect information on:

- Type of chips consumed (potatoes, corn, or both).
- Frequency of consumption per week.
- Source of purchase (school, street vendor, local market).
- Storage duration and method of preservation at home.

Statistical Analysis: Data were analyzed using SAS software (2003), Significance was tested using Duncan's Multiple Range Test (1955) to determine significant differences among treatments at a probability level of $P \leq 0.05$.

Results and Discussion

Table 1 shows that more than half of the students 58.3% regularly consume potato and corn chips, while 25% consume them occasionally, and only 16.7% never consume these types of foods.

Table 1. Distribution of students according to their potato and corn chip consumption habits

Category	Number of students	Percentage
Regularly consumed chips (≥3 times a week)	35±1.22 a	58.3±2.21 a
Occasionally consumed chips (<3 times a week)	15±0.76 b	25.0±1.98 b
Never consumed chips	10±2.1 c	16.7±2.43 c

*Different letters in the same column mean significant differences at the 5% probability level

These findings indicate the widespread consumption of chips among primary school students, reflecting its easy availability and low cost compared to healthier meals. The high percentage of regular consumers represents a potential risk indicator of ongoing exposure to mycotoxins, especially if the raw materials are contaminated or stored under unsuitable environmental conditions [13], [14], [15].

The data in Table 2 show that the mean serum aflatoxin concentration in students who regularly consumed chips was 1.4 ng/mL, exceeding the internationally accepted limit of 1 ng/mL. Eighteen out of 35 samples in this group also showed elevated concentrations. The group that

occasionally consumed chips showed lower mean concentrations (0.8 ng/mL), while the lowest levels were in the group that did not consume chips (0.5 ng/mL).

Table 2. Total serum aflatoxin concentrations (ng/mL)

Group	Minimum limit	Maximum limit	Mean	Number of samples exceeding the permissible limit (1 ng/ml)
Regularly consumed chips (≥3 times a week)	0.6±0.02 a	2.5±0.08 a	1.4±0.05 a	18.0±1.2 a
Occasionally consumed chips (<3 times a week)	0.3±0.01 b	1.2±0.06 b	0.8±0.08 b	5.0±2.1 b
Never consumed chips	0.2±0.03 c	0.8±0.09 c	0.5±0.03 c	1.0±0.9 c

*Different letters in the same column mean significant differences at the 5% probability level

These results indicate a correlation between the consumption of potato and corn chips and elevated blood aflatoxin levels. This is likely due to the consumption of contaminated food resulting from storage under unsanitary conditions, such as high humidity and high temperatures, which promote the growth of *A. flavus* [16], [17], [18].

Furthermore, the fact that more than half of the students in the regular consumption group exceeded the permissible limits suggests a real risk of chronic exposure to toxins, which could have future repercussions on the liver and immune system health of children [19], [20].

Table 3 shows that students who consumed both types of chips (potato and corn chips together) exhibited the highest average aflatoxin concentration (1.7 ng/ml), while levels were lowest in the corn chips group (1.3 ng/ml) and then the potato chips group (1.5 ng/ml).

Table 3. Distribution of Samples by Type of Chips Preferred

Type of chips	Number of students	aflatoxin levels
Potato chips	20±2.0 b	1.5±0.06 b
Corn chips	25±1.0 a	1.3±0.03 c
Potato and Corn chips	15±3.0 c	1.7±0.05 a

*Different letters in the same column mean significant differences at the 5% probability level

These results indicate that multiple exposures to different food sources of chips increase the likelihood of aflatoxin accumulation in the blood, possibly due to varying degrees of contamination among products and the diversity of consumption sources [21], [22].

The relatively high levels of aflatoxin in potato chips can also be explained by its association with frying in refined or reused oils, which may be susceptible to fungal contamination during storage or transport [23].

Corn chips is more prone to contamination during storage due to its higher moisture content, making it an ideal environment for aflatoxin-producing fungi.

Regular consumption of potato and corn chips has been shown to lead to a significant increase in serum aflatoxin concentration [9], [24].

Children who consume more than one type of chips have the highest levels of toxin accumulation [25]

The widespread consumption of these foods among schoolchildren is a health concern that necessitates regular monitoring and stricter controls on the quality of popular foods [26].

These findings are consistent with previous studies that have demonstrated aflatoxin contamination of corn and potato fried products in Middle Eastern countries due to improper storage and high humidity. These findings underscore the need to monitor popular foods consumed by children and to implement regular testing procedures for mycotoxins [27], [28].

Conclusion

Accumulation of aflatoxin was detected in the blood serum of several primary school students who regularly consume potato and corn chips. Increased blood concentrations of the toxin are linked to the consumption of uncovered or improperly stored food, highlighting the need to monitor popular foods consumed by children in schools and local markets.

Parents should be educated about the dangers of purchasing food from unreliable sources. Periodic testing of locally produced corn and potato products for mycotoxins is recommended.

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Ethical Considerations:

The study was conducted in accordance with established ethical principles and after obtaining approval from the Research Ethics Committee at the Technical Research Center. Written informed consent was also obtained from the parents of the participating students.

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