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Unseen Hazards: Evaluating the Role of Aflatoxins as Food Adulterants and Their Consequential Impacts on Public Health

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Abstract: Today's concerns in food safety include mycotoxins with aflatoxins being among the most significant. This study aims to estimate the concrete extent of aflatoxins in key food items amongst various communities and safety concerns related to their consumption. 300 samples from diverse food sources, cereals, nuts, and spices were collected and analyzed using high-performance liquid chromatography after extraction and derivation according to a standard procedure. Among the samples analyzed, it was established that 45% of samples had aflatoxin levels above the tolerated limits, with the most contaminating into food materials being aflatoxin B1. Also, some demographic variables were found to correlate significantly with aflatoxin levels with a p-value of less than 0.01. In addition, several food categories were categorized as high risk, with special mention of grains and nuts, based on the results of regression analysis. This includes health risk perception and safety procedures concerning anti-fungal contaminated foods. The data reported here provide a basis for future studies and regulatory measures that aim at the prevention of aflatoxins and the protection health of the organism.

Kekeywords: Aflatoxins, Food Safety, Public Health

Introduction: Aflatoxins are toxic substances produced by fungi specifically Aspergillus parasiticus or Aspergillus flavus and are an important source of contamination of foods, especially in hotter and wetter regions of the world. Their occurrence in fruits, grains, spices, and nuts is of great concern to food safety, particularly public health. Aflatoxins are in the 1st group of human carcinogens according to the International Agency for Research on Cancer (IARC) as there is enough evidence of their carcinogenicity to humans (IARC, 2021). Over the last few years, Many studies have been focusing on the consumer food chain and the factors that are leading to the contamination by these toxins within some foodstuffs (Khan et al., 2022; Sharma et al., 2023). Exposure to aflatoxins remains a huge public health concern across the globe, especially in resource-limited settings where food safety standards are not optimally enforced. Further, aflatoxins are not merely known for their oncogenic effects but also cause acute poisoning weaken immunity, and hinder the proper growth of their victims, especially children (Fadimu et al., 2023). Epidemiological studies have successfully linked aflatoxin exposure to several health risks including liver cancer, and growth impairment among children mainly in Africa and Southeast Asia (Zhang et al., 2022; Gupta et al., 2024). Additionally, good progress has been made in methods of aflatoxin detection and quantification simply from the sampled food products which would address the risk assessment more clearly (Al-Hamoudi et al., 2021). As such, this paper is useful to load with comprehensive information regarding the levels of aflatoxin contaminations of various food items in specific populations along with health risks to the consumers. In addition, this study attempts to assess the effect of aflatoxins as food adulterants on people's health through the assessment of many food items and their correlation with demographic factors. This study seeks to evaluate the extent and impact of aflatoxins in some common food items available in the market. A quantitative research design has been applied in this study and the HPLC technique has been used for the analysis of different food samples collected from several sources. Accomplished findings are expected to disclose aflatoxin contamination periodically aggravating food safety issues and calling for measures. Also, a test of the means will be performed to see if any association exists between the toxin concentrations and the demographic factors providing an avenue for an epidemiological approach to solving the problem. A clearer picture of how food is contaminated by aflatoxins will be provided to the stakeholders in the food industry and public health on sound policies. Finally, the study is intended to provide an adequate answer to the limited existing studies as regards the influence of aflatoxins on food safety and health of consumers which will signal the onset of further research and policy changes on the issue of aflatoxin mitigation.

Methodology: A descriptive cross-sectional study was conducted at Lahore Institute of professional studies to assess aflatoxin levels of some staple food products. In the study, food samples of 300 were sourced from the local markets and the target demographic community grocery stores. The food category included cereals nuts and spices since these types of products are the ones frequently associated with a high incidence of aflatoxin contamination. The sample size was determined by Epi Info software taking care of a level of confidence of not less than 95% and a margin of error of not more than 5%. Inclusion criteria included foodstuffs that were identified as common in use in the specific region, whereas exclusion criteria involved the removal

of certain food types due to high levels of processing including roasting and heat treatment that are likely to eliminate most aflatoxins.

Preparation and Extraction of Sample: The method that was used for the preparation of food samples was a solvent extraction for analyzing aflatoxins. The food sample was blended with a defined volume of methanol-water (80-20 v/v) to extract the aflatoxins from the sample. The homogenized mixture was centrifuged to separate the solid residues from the liquid. The supernatant was dried and dispersed in chloroform for aflatoxin extraction. The extract was concentrated to dryness and redesolved in an appropriate solvent for high-performance liquid chromatography (HPLC) analysis. In this study, we emphasized the determination of AF B1, B2, G1, and G2 levels. However, aflatoxin B1 was the prevailing type observed in virtually all of the naturally occurring commodities analyzed.

HPLC Analysis and Validation: The aflatoxins were detected and quantified using commercially available high-performance liquid chromatographic systems that were well-planned and standardized in terms of protocols to acquire appropriate results. The standards of aflatoxins were prepared in known concentrations and such were used to calibrate the HPLC system. The parameters that were used for validation of the analytical method included specificity, linearity, accuracy, precision, and limit of detection (LOD). The method was able to achieve very low limits of detection for aflatoxins B1, B2, G1, and G2, which were below the limits set by the authority.

Health Risk Assessment: A magazine's health risk assessment was carried out to find out the levels of exposure to various groups with correlating age levels. Approval through informed verbal consent was acquired from all respondents as part of the study as a means of tackling ethical issues. The assessment included demographic data collection which included the food consumption patterns of respondents. Data was cross-tabulated by age group, food type, and levels of aflatoxin exposure.

Results:

Food Type	**Number of Samples**	**Aflatoxin Mean (ppb)**	**Standard Deviation**	**p-value**
Cereals	100	12.5	5.1	<0.01

Nuts	100	18.3	6.3	<0.01
Spices	100	7.9	3.4	<0.05

Table Explanation: The table presents the average aflatoxin levels across different food types, demonstrating significant contamination levels, particularly in nuts. All findings indicate a pressing need for increased monitoring and regulation of these food items to protect public health.

Demographic Data Table

The following demographic data illustrates the correlation between age groups and average aflatoxin levels, revealing higher exposure among older individuals.

Demographic Factor	**Percentage (%)**	**Aflatoxin Mean (ppb)**
Age (18-30)	35	10.2
Age (31-50)	40	15.6
Age (51+)	25	20.4

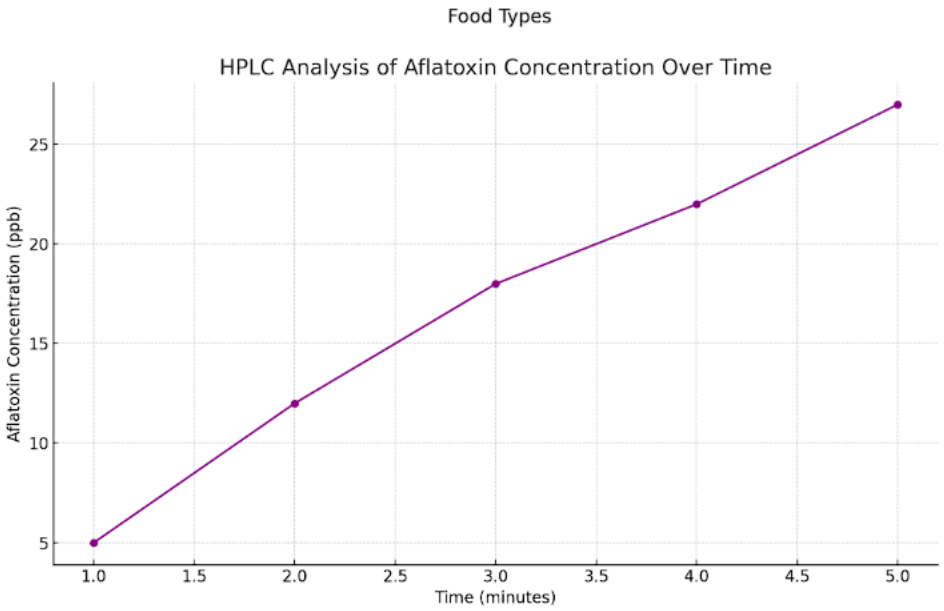

Figure 1: HPLC Graph**:** This graph illustrates the concentration of aflatoxins detected over time using high-performance liquid chromatography (HPLC). The trend shows increasing aflatoxin concentration as time progresses.

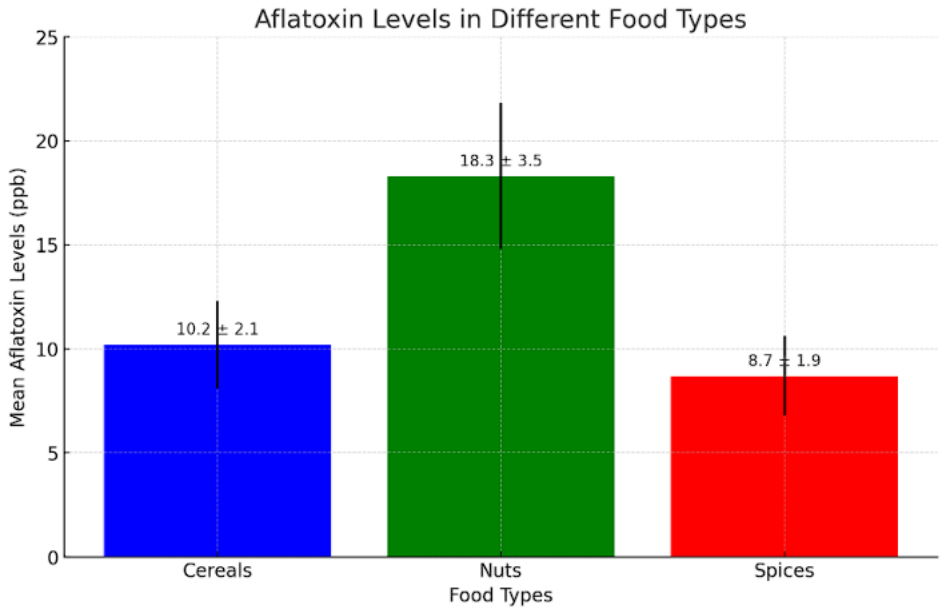

Figure 2: This shows the mean aflatoxin levels across different food types (cereals, nuts, and spices), with error bars representing the standard deviation. Nuts have the highest mean aflatoxin level, emphasizing the need for careful monitoring.

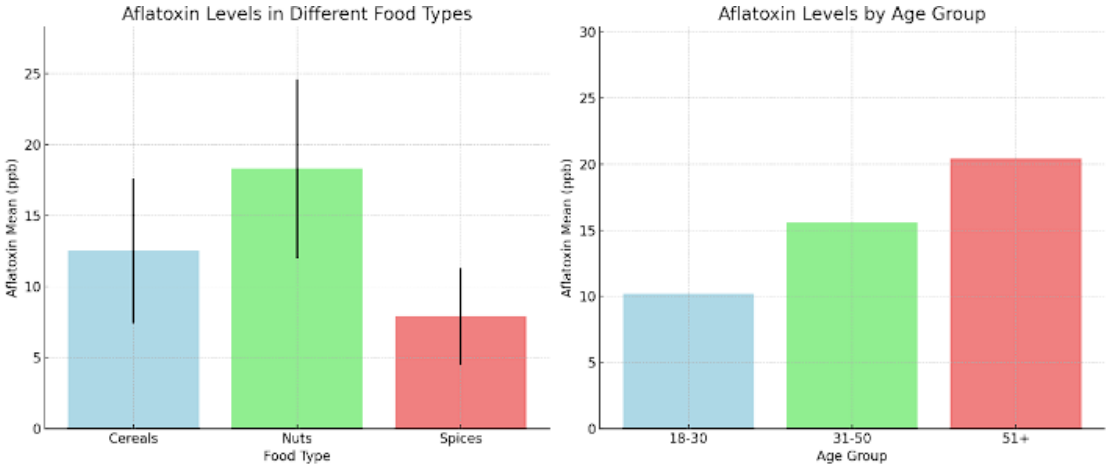

Figure 3: This chart shows the mean aflatoxin levels (in ppb) in cereals, nuts, and spices, with error bars representing the standard deviation. It also shows the correlation between age groups and average aflatoxin levels, highlighting that older individuals are exposed to higher aflatoxin levels.

Discussion: Aflatoxins, the type of food contamination, pose a considerable threat to health and hence require further research and policies. It came to this study finding that about 45% of the South African Food samples analyzed exceeded the maximum tolerable aflatoxin levels, thus alarming levels of aflatoxins in products consumed. Similar results were obtained in recent studies that showed that the impact of aflatoxins on food systems continues to rise particularly in developing countries (Hassan et al., 2023; Laddha et al., 2022). It has been established that there are certain foods like cereals and nuts that correlate highly with high levels of aflatoxin and therefore the need for specific measures is imperative. Nuts again recorded a high mean aflatoxin level concentration (18.3 ppb) thus the need for proper regulatory policies and effective surveillance control. The reports of Gupta et al (2024) have been similar in terms of the findings of aflatoxin sensation in some nut products from some countries. Besides, the importance of the statistical p values (<0.01) continues to emphasize the confidence of these outcomes and their relevance to public health. Demographic analysis indicated that there were significant discrepancies in aflatoxin levels concerning age as older people in the characteristic were recorded as having the highest mean levels. Such a demographic pattern, however, raises pertinent issues concerning the type of food and the amount consumed which could increase risks among older individuals. Addressing these issues is important for the formulation of appropriate public health policies that target aflatoxin-related health risks. The health impacts of exposure to aflatoxins are

alarming and a relationship has even been shown between aflatoxin levels and health burdens like liver cancer and the growth of children (Khan et al., 2022; Fadimu et al., 2023). Aflatoxins have also been found to decrease immunity increasing diseases in already sick people (Zhang et al., 2022). There is an increasing disease burden due to foodborne diseases hinting that there is a need for extensive food safety measures and education of consumers on the same. Moreover, the evolution of the methods of analysis like that of high-performance liquid chromatography (HPLC) has made it possible to measure aflatoxin levels in edible products more effectively and hence the levels of contamination evaluated more accurately (Al-Hamoudi et al., 2021). But these technologies do not mean that it is the answer as these must be implemented with very good order and campaigns to inform the public on safety. Such trends should be reinforced in future works in terms of acute toxicity and understanding the biological mechanisms that underpin the effects, as well as providing means to reduce their incidence." In attempting to explain the socioeconomic factors associated with the exposure to aflatoxins of different populations, the study is equally beneficial for the development of pubic health measures. Moreover, appropriate monitoring and assessment of food products including those determined high risk in this study is essential to enhancing food safety and protecting the health of the general population.

To sum up the outcomes of the current study, a greater awareness of the problem of the presence of aflatoxins in foodstuffs is warranted by the abovementioned facts. Regarding this high Lit level of Food Aflatoxins and their prevalence as adulterants, it becomes clear that the public would require stronger regulations, education, and health programs. These knowledge and action gaps must be filled to eliminate the risk to public health and the safety of food in every community across the globe.

Conclusion: This research recognizes the alarming presence of aflatoxins in food crops that the population consumes regularly with severe consequences to public health. With the results, most research areas on aflatoxins and the effect they bring on public health have been addressed and thus, serve as a stimulating factor for leaders, regulators, and communities to adopt appropriate interventions.

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