International Journal of Research in Medical Sciences
Libamila HL et al. Int J Res Med Sci. 2025 Nov;13(11):4884-4889
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20253617

Systematic Review

Aflatoxin contamination in food crops in Kenya: a systematic review

Hans L. Libamila[1]*, Clevin A. Wakhisi[2], Allan K. Wanjala[1]

[1]Department of Clinical Medicine, Kenya Medical Training College, Kenya
[2]Department of Clinical Medicine, Karatina University, Nyeri, Kenya

Received: 20 July 2025
Revised: 19 August 2025
Accepted: 06 September 2025

***Correspondence:**
Dr. Hans L. Libamila,
E-mail: hlibamila@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Aflatoxins, a group of toxic secondary metabolites produced by Aspergillus flavus and A. parasiticus fungi species, is a sub-chronic and multifaceted agricultural productivity and public health problem in sub-Saharan Africa. The health impacts of aflatoxin exposure are severe and long-term. Characterization of aflatoxin forms is a valuable aspect of this challenge because different forms; aflatoxin B1, B2, G1, and G2 which vary in toxicity and occurrence according to environmental factors and processing conditions. This systematic review bridges the existing gaps by aggregating evidence of levels and extent of aflatoxin contamination of maize, wheat, sorghum, and groundnuts in Kenya from 2010 to 2025. This systematic review employs a narrative synthesis to analyze aflatoxin infestation of maize, wheat, sorghum, and groundnuts in Kenya based on the preferred reporting items for systematic reviews and meta-analyses (PRISMA 2020) standards. The search includes a number of electronic databases and grey literature sources. The four studies indicate that aflatoxin infestation of Kenyan maize remains a significant public health and food security concern, with infestation levels frequently being higher than the regulatory limit (10 µg/kg). The results quantify high infestation in the Rift Valley and Meru County, respectively, as well as associate extreme infestations in Eastern Kenya with associated health dangers like HCC. Regional disparities, driven by moisture, and problems such as broken kernels, insect damage, and excessive moisture levels continue to emerge as contamination drivers. These findings underscore the need for specific interventions to address the environmental and human-related causes of aflatoxin accumulation in maize.

Keywords: Aflatoxin, Contamination, Characterization, Wheat, Maize, Groundnuts, Sorghum, Kenya

INTRODUCTION

Aflatoxins, a group of toxic secondary metabolites produced by *Aspergillus flavus* and *A. parasiticus* fungi species, is a sub-chronic and multifaceted agricultural productivity and public health problem in sub-Saharan Africa. Being tolerant of warm humid climates, the mycotoxins have a penchant to thrive and thus find western Kenya counties like Kakamega, Bungoma, Busia, Vihiga, and Siaya, particularly vulnerable.[1] This is a major agricultural belt where maize, wheat, sorghum, and groundnuts are local staples in foods and economies. Reliance on these staple foods, along with traditional farming and storage methods, offers the best conditions for pre-harvest aflatoxin contamination due to drought stress and post-harvest due to poor drying and storage facilities.[2] The Kenya Bureau of Standards (KEBS) has established a tolerable limit of 10 µg/kg for total aflatoxins in foodstuffs to ensure consumer health, but there have been continuous exceedances, particularly in the case of maize and groundnuts, that indicate an immediate need for regional-level research.[3]

The health impacts of aflatoxin exposure are severe and long-term. Repeated intake of these toxins by prolonged consumption is strongly associated with hepatocellular carcinoma, a leading etiology of liver cancer in Africa, immune suppression, and childhood stunted growth.[4]

Aflatoxin contamination also exacerbates already existing widespread malnutrition and food insecurity in western Kenya, thereby potentially contributing to the high disease burden in the region. For instance, studies have found that children exposed to aflatoxins through contaminated staples can be stunted at higher than the national average, which underscores the need for intervention.[5] Besides the human health, the agricultural sector suffers too with massive losses, as the implicated crops are rejected by markets or discovered to be of inappropriate consumption, most notably hitting the smallholder farmers that make up the majority of the agricultural sector of the region.[6] Both livelihood and health impacts necessitate a better understanding of contamination processes to inform effective policy and practice.

Characterization of aflatoxin forms is a valuable aspect of this challenge because different forms; aflatoxin B1, B2, G1, and G2 which vary in toxicity and occurrence according to environmental factors and processing conditions. Aflatoxin B1, the most toxic and usually predominant form, has been classified by the International Agency for Research on Cancer (IARC) as a group 1 carcinogen and poses the greatest risk to human health.[5] In contrast, G1 and G2 genotypes can indicate contamination by diverse fungal strains or breakdown during storage, providing insights into sources and pathways of exposure.[3] Preliminary evidence from the region is that the levels and genres of contamination differ across crops and production phases. For example, maize is most susceptible to pre-harvest dry spells, while groundnuts are likely to produce aflatoxins during post-harvest storage due to their high oil content and water retention capacity.[2] However, the lack of a specific western Kenya-focused detailed synthesis limits the ability to determine these distinctions and their importance, leading to both scientific knowledge gaps and gaps in practicality.

Characterization of aflatoxin variants is a critical part of this issue as the different variants i.e. *viz*. aflatoxin B1, B2, G1, and G2, differ in their toxicity and occurrence depending on environment as well as processing conditions. Aflatoxin B1, which is most toxic and generally dominant, is a group 1 carcinogen as classified by the International Agency for Research on Cancer (IARC) and poses the greatest risk to human health.[5] On the other hand, G1 and G2 types can indicate contamination with different fungal strains or storage degradation, providing information on the sources and pathways of exposure.[3] Initial evidence in the field suggests that the degree and nature of contamination are different for various crops and production stages. For example, maize is particularly susceptible to pre-harvest drought, while groundnuts are able to produce aflatoxins during post-harvest storage due to high oil retention and water content.[2] However, the lack of an overview synthesis centered on western Kenya hinders it from being able to pinpoint these differences and their implications, which results in gaps in both the scientific community and in real-life application.

Control measures today for aflatoxin contamination in Kenya include improved drying practices, uptake of biocontrol agents like atoxigenic Aspergillus strains, and awareness. These have with varying success controlled aflatoxin level reductions, with drying attaining up to 30% reduction in some contexts but with their effectiveness in western Kenya not yet being fully comprehended due to heterogeneity in local practices and facilities.[2] Also, socio-economic context—namely, poor access to contemporary storage and dependence on traditional markets—prevails to hinder adoption of the interventions and necessitate a regional-level strategy.[6] Despite all these challenges, data on levels of contamination and types of aflatoxins in maize, wheat, sorghum, and groundnuts in western Kenya are yet scattered, with most studies tackling national trends or a single crop like maize, but not a full regional study.

This systematic review bridges the existing gaps by aggregating evidence of levels and extent of aflatoxin contamination of maize, wheat, sorghum, and groundnuts in Kenya from 2010 to 2025. It aims at estimating the prevalence of contamination, identifying types of aflatoxins (B1, B2, G1, G2) and their sources, and estimating associated health and agricultural impacts. By synthesizing current data, the review will provide a solid foundation for the evidence-based formulation of food safety policy, enhancing agricultural practice, and guiding subsequent research activity. In light of regional vulnerability and the potential for scalability of intervention, the work is timely and essential to increasing the welfare of western Kenya's populace and supporting its agricultural resilience.

METHODS

This systematic review applies narrative synthesis to critically review aflatoxin infestation of maize, wheat, sorghum, and groundnuts in Kenya based on preferred reporting items for systematic reviews and meta-analyses (PRISMA) 8 guidelines. The strategy attempts to choose, find, and synthesize a subset of studies upon which to draw detailed data and compare them through a systematic and clear process. The review includes observational studies (e.g., cohort, cross-sectional), experimental studies (e.g., intervention trials), and grey literature (e.g., theses, government reports) with primary evidence on aflatoxin contamination. It includes food samples (groundnuts, maize, wheat, sorghum) and, where relevant, human or animal groups that consume these crops in western Kenya, without age or gender restriction. The review interprets levels and types of aflatoxin contamination (B1, B2, G1, G2) in the target crops through laboratory techniques such as high-performance liquid chromatography (HPLC) or enzyme-linked immunosorbent assay (ELISA). The main findings are mean, range, and percentage of aflatoxin content above 10 μg/kg, aflatoxin strains (B1, B2, G1, G2), and sources of contamination (pre-harvest, post-harvest, storage). Secondary outcomes include health impacts (e.g., aflatoxicosis, liver cancer), agricultural impacts (e.g., crop damage), and efficacy of mitigation. The review includes studies published or conducted 2020 to 2025, limited to western Kenya (districts: Kakamega, Bungoma, Busia, Vihiga, Siaya). Studies outside western Kenya, on crops not specified (e.g., rice), or lacking primary data (e.g., review articles with no original findings) are omitted, as are systemic review articles. The search covers electronic databases, grey literature, and other materials such as citation bibliographies. The search process used keywords such as "aflatoxin," "contamination," "wheat," "maize," "groundnuts," "sorghum," "Kenya," "levels," "types," and "characterization." Databases searched were PubMed, Medline, Scopus, Google Scholar, and Science Direct, and the search started with a general title search yielding 11,593 articles. Refining the keywords using region, time frame, and publication date gave 5,666 articles after removing duplicates. Titles and abstracts were filtered out, excluding 3,927 articles that were not relevant to the intended crops or locales, leaving 1,739 articles. Full-text articles were assessed for eligibility criteria, excluding 922 articles, leaving 617 studies of possible eligibility. From them, 613 records were excluded, and 4 articles were intentionally chosen where recency was (2020–2025), more than one crop was included, and there was extensive aflatoxin information (levels and types). Two independent reviewers screened articles with Rayyan software, disagreements being resolved by a third reviewer as outlined in PRISMA 2020 flow diagram.

Data were extracted through a standard Excel form piloted on the 4 included studies and filled out by two reviewers with cross-checking to resolve disagreements, with the process allowing refinement of form based on emerging trends. Data extracted were study parameters (author, year, location of study, design, sample size), exposure data (crop type, detection method, level of aflatoxin, types, and sources of contamination), and outcome data (health impacts, agricultural impacts, intervention outcomes).

The 4 studies employed in this analysis from 2020 to 2025 and in western Kenya include cross-sectional (2), structured questionnaire (1), and case-control (1) designs with sample sizes between 10 and 400 food samples per study (Figure 1 and Table 1).

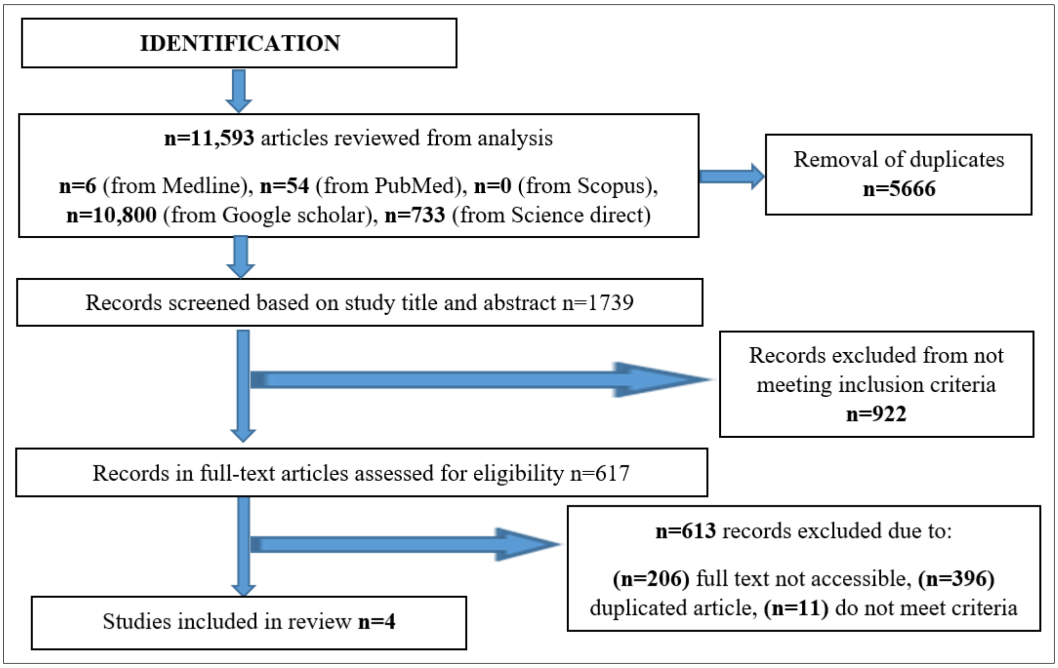

Figure 1: PRISMA flow diagram on the search and selection of studies.

RESULTS

The four articles by offer a comprehensive examination of aflatoxin contamination of maize, a primary staple food, in Kenya, and its implications for public health and food safety.[7,9-11]

The articles employ varied methods in ascertaining the contamination levels, determining contributing factors, and linking aflatoxin exposure to health risks, making thought-provoking contributions to this persistent issue in Kenya. Table 2 shows a summary of the results obtained from different authors.

Table 1: Relative risk of abnormal Doppler indices with adverse perinatal outcome.

Study	Year of publication	Study area	Study design	Method of aflatoxin detection	Sample size used	Crop
Kamano et al	2022	Eastern Kenya	Case control study	ELISA, HPLC	200 Food samples	Maize, groundnuts

Continued.

Study	Year of publication	Study area	Study design	Method of aflatoxin detection	Sample size used	Crop
Cherotich et al	2025	Meru, Kenya	Cross-sectional analytical study	ELISA	353 samples	Maize
Gashara et al	2022	Rift Valley, Kenya	Structured questionnaire	ELISA	212	Maize, sorghum, millet
Jacob et al	2022	Rift Valley, Kenya	Cross-sectional study		147	Maize

Table 2: Comparison of results published by the authors.

Study	Crop type	Study area	Types of aflatoxins	Aflatoxin levels	Source of aflatoxins	Health impact
Kamano et al	2022	Eastern Kenya	B1	1000 ppb, 200 ppb	Maize, groundnuts	HCC
Cherotich et al	2025	Meru, Kenya	B1, B2, G1, G2	200 ppb	maize	Aflatoxicosis
Gashara et al	2022	Rift Valley, Kenya	B1, B2, G1, G2		Maize, sorghum, millet	HCC, esophageal cancer
Jacob et al	2022	Rift Valley, Kenya	B1, B2, G1, G2	63.79 µg/kg	Maize	Carcinogenic effects

DISCUSSION

Jacob et al conducted a cross-sectional study in the Rift valley, analyzing 147 maize samples from Nakuru, Kajiado, and Trans Nzoia by high-performance liquid chromatography (HPLC) with fluorescence detection, a sensitive method for aflatoxins B1, B2, G1, and G2 detection. As per, researchers utilized closed spear techniques and composite sampling.[8] Their findings were a mean total aflatoxin concentration of 63.79 µg/kg, 89.93% contamination, and 58.5% over the limit of 4 µg/kg for aflatoxin B1. Higher contamination in Trans Nzoia and Kajiado than in Nakuru (5.02 µg/kg) was attributed to climatic variations and inadequate post-harvest handling. Decreased contamination at National Cereals and Produce Board shops, due to strict control of moisture (13%) and employment of sisal bags, underlines the significance of storage environment. But emphasis of study on comparatively fresh maize might miss contamination in longer-standing stocks, and the cross-sectional nature limits inferences regarding causality.[7]

Kamano et al employed a case-control study in Eastern Kenya, where 200 maize and groundnut samples were tested for aflatoxin B1 using both enzyme-linked immunosorbent assay (ELISA) and high-performance liquid chromatography (HPLC).[9] This double approach is more reliable since ELISA can be employed for screening rapidly and HPLC for precise quantification. They recorded alarmingly high aflatoxin B1 levels (1000 ppb and 200 ppb), way above Kenya's 10 µg/kg requirement, and indicating severe contamination in a wet region favoring Aspergillus growth. The case-control study effectively links exposure to aflatoxins to hepatocellular carcinoma (HCC) and thus establishes health risks further. Exclusively focusing on aflatoxin B1 may, however, attribute all the burden of aflatoxins low owing to exclusion of other aflatoxins (B2, G1, G2).[9]

Cherotich et al conducted a cross-sectional study in Meru County, analyzing 333 maize samples from nine sub-county informal markets during July 2022 using ELISA (kit cat. no. 941AFL01M.96). Aflatoxin level was categorized as low (<1 ppb), moderate (1–10 ppb), or high (>10 ppb), of which 17% of the samples, primarily from Tigania East, Tigania West, Imenti Central, and Igeribe South, had over 100 ppb, which rendered them unsafe. Physical factors, such as insect infestation and damaged kernels, were strongly correlated with aflatoxin content ($r=0.23$, $p=0.05$; $r=0.18$, $p=0.05$), while undamaged kernels were weakly negative correlated ($r=-0.064$, $p=0.23$). Moisture content (12.0–16.2%) was also strongly correlated with aflatoxin content. Nutritional factors (fat, protein, starch) were not shown to have significant correlation, while exposure to aflatoxins has been reported to impact nutrient intake. High sample size and focus on informal markets provide robust data, yet less precision of ELISA than that of HPLC and cross-sectional study design limit precision and causality assessment.[10]

Cherotich et al conducted a field survey in Rift Valley (Uasin Gishu and Elgeyo Marakwet), conducting face-to-face interviews among 212 smallholder and large-scale maize farmers, selected by GPS-based sampling under an agro-ecological setting. A structured questionnaire analyzed demographics, aflatoxin awareness, and post-harvest practices (PHPs). Results showed that 61.32% of the farmers had knowledge of the health risks of aflatoxin and 94.37% had knowledge of storage molds, but very few used effective PHPs: 17.8% dried maize well, 0.5% graded grains, and 0.5% stored in hermetic bags. Most of the farmers stored maize in leaking bags or substandard granaries that were risks for contamination. A Chi-square analysis showed a significant association between gender and knowledge of aflatoxin ($p<0.05$), but not education level or income level. The study indicates poor PHPs and storage structures as key contributors to contamination, validating conclusion on the influence of storage. Yet the absence of quantitative aflatoxin data in the research makes comparison with other studies difficult, and data from questionnaires may result in recall bias.[7,11]

Methodologically, Nicholas et al and Jacob et al take advantage of HPLC's high accuracy, and their quantitative results are therefore strong for determining the levels of contamination.[10] Utilization of ELISA gives precedence to cost-effectiveness and scalability, appropriate for high-volume screening in informal markets, but its lower sensitivity than HPLC has the potential to introduce variability.[11] survey approach provides critical qualitative data on farmer knowledge and practices but is limited in its ability to quantify contamination by its reliance on self-reported data and lack of aflatoxin measurement.[9] Case-control study design is the gold standard for establishing health outcome associations, while Jacob et al and Cherotich et al cross-sectional study designs are optimal for prevalence studies combined method provides contextual richness in that it correlates PHPs with risk of contamination.[7,10,11]

Maize is in each case cited as a significant source of aflatoxin contamination, and groundnuts are also affected.[9] Reported levels of aflatoxin—63.79 µg/kg, 1000 ppb and 200 ppb and >100 ppb in 17% of samples regularly exceed Kenya's 10 µg/kg regulatory limit, posing significant risks of HCC, aflatoxicosis, and esophageal cancer. Regional variations are evident, with Eastern Kenya and Meru County being more contaminated than Nakuru, perhaps a reflection of higher humidity, designation of broken kernels, insect damage, and moisture content as risk factors aligns with emphasis on inadequate storage practices, such as poorly sealed bags and low-quality granaries, highlighting the critical role of post-harvest handling.[7,9-11]

The limitations of Jacob et al and Cherotich et al cross-sectional designs are their lack of causal inference and ELISA's compromised precision in work. Focus on aflatoxin B1 may overlook the other aflatoxins, and lack of quantitative data and potential recall bias lower its comparability. Collectively, these studies indicate the need for improved post-harvest handling and storage facilities to mitigate aflatoxin contamination in Kenya.[7,9-11]

CONCLUSION

The four studies indicate that aflatoxin infestation of Kenyan maize remains a significant public health and food security concern, with infestation levels frequently being higher than the regulatory limit (10 µg/kg). High infestation was quantified in the Rift Valley and Meru County, while extreme infestations observed in Eastern Kenya with associated health dangers like HCC. Restricted use of proper post-harvesting practices, such as proper drying (17.8%) and hermetic bag use (0.5%), aggravates contamination, particularly in poorly constructed storage houses. Regional disparities, driven by moisture, and problems such as broken kernels, insect damage, and excessive moisture levels continue to emerge as contamination drivers.

Recommendations

These findings underscore the need for specific interventions to address the environmental and human-related causes of aflatoxin accumulation in maize.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Kilonzo RM, Okoth SA, Muthomi JW. Fungal contamination and aflatoxin levels in stored maize and groundnuts in Kenya. J Stored Prod Res. 2021;92:101803.
2. Mutiga SK, Were V, Hoffmann V, Harvey JW, Nelson RJ. Aflatoxin contamination and control in maize and groundnuts in Kenya: a review. Food Control. 2022;132:108532.
3. Ongoma V, Muthomi JW, Chemining'wa GN. Assessing aflatoxin contamination in cereal crops under climate variability in western Kenya. Agric Food Secur. 2023;12:15.
4. Kimanya ME, Shirima CP, Magoha H, Shewiyo DH, De Meulenaer B. Co-exposure to aflatoxins and fumonisins in children from Tanzania: impact on growth and health. Food Addit Contam Part A Chem Anal Control Expo Risk Assess. 2021;38(5):789-800.
5. Kiama TN, Lindahl JF, Sirma AJ, Senerwa DM, Ochola J. Aflatoxin exposure and its health impacts in Kenya: a review of recent evidence. Toxins (Basel). 2023;15(4):289.
6. Wagacha JM, Kimani J, Njeru EM. Socio-economic impacts of aflatoxin contamination on smallholder farmers in Kenya. Afr J Agric Res. 2022;17(9):1123-30.
7. Jacob NM, Madadi VO, Wandiga SO, Kariuki DK. Occurrence and prevalence of aflatoxins contamination in stored maize grains from the Rift Valley, Kenya. Afr J Phys Sci. 2022;7:54-71.
8. European Food Safety Authority (EFSA). Standard sample description for food and feed. EFSA J. 2010;8(1):1457.
9. Kamano HM. Efficacy of plasma technology in eliminating fungi and aflatoxins in maize in Makueni and Baringo Counties, Kenya [Dissertation]. Nairobi: University of Nairobi. 2022.
10. Cherotich C, Okoth MW, Go A, Kariuki SW, Omuse ER. Aflatoxin prevalence and association with maize grain physical and nutritional qualities in the informal

markets in Meru County, Kenya. Afr J Food Agric Nutr Dev. 2025;25(2):25861.

11. Gachara G, Suleiman R, El Kadili S, Ait Barka E, Kilima B, Lahlali R. Drivers of post-harvest aflatoxin contamination: evidence gathered from knowledge disparities and field surveys of maize farmers in the Rift Valley region of Kenya. Toxins (Basel). 2022;14(9):618.
12. Page MJ, McKenzie JE, Bossuyt PM. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.
13. Higgins JPT, Thomas J, Chandler J, editors. Cochrane Handbook for Systematic Reviews of Interventions. Version 6.3. London: Cochrane. 2022. Available at: https://training.cochrane.org/handbook. Accessed on 10 August 2025.

Cite this article as: Libamila HL, Wakhisi CA, Wanjala AK. Aflatoxin contamination in food crops in Kenya, a systematic review. Int J Res Med Sci 2025;13:4884-9.