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Invisible toxins, visible concern: mycotoxin awareness and food safety perceptions in Cameroon

Abstract

Introduction: Mycotoxin contamination of staple foods is a significant public health threat in Cameroon. However, data on consumer awareness, risk perception, and preventive practices remain limited, hindering effective risk mitigation**.** *Objective*: This study assessed the socio-demographic profile, dietary habits, food storage practices, and awareness of mycotoxins among Cameroonian consumers and documented self-reported health symptoms. *Methodology*: A cross-sectional survey was conducted among 91 adults. Data on demographics, dietary patterns, food sources, grain storage, familiarity with mycotoxins, and health symptoms from the preceding year were collected and analysed using descriptive statistics. *Results*: Participants were predominantly female (60.4%), and highly educated (94.2% university level). Diets commonly included groundnut products, cereals, fruits, and vegetables, primarily sourced from markets, most of which were stored at room temperature. A critical disconnect was observed: while 92% were familiar with the terms "fungi" or "mycotoxin," only 35.2% were aware of the specific food safety risks associated with these terms. Frequently reported health symptoms included fatigue (59.3%), abdominal pain (42.9%), and diarrhoea (38.5%). *Conclusion*: The study reveals a significant gap between general awareness of mycotoxins and specific knowledge of risk and safe storage practices. This underscores an urgent need for targeted food safety education, practical interventions to improve post-harvest storage, and enhanced risk communication to reduce mycotoxin exposure in Cameroon.

Keywords: mycotoxins, food safety, dietary exposure, grain storage, Cameroon

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Introduction

Food safety remains a critical global public health concern, especially in regions where staple crops are vulnerable to contamination by naturally occurring toxins. Among the most widespread and dangerous food contaminants are mycotoxins, which are toxic secondary metabolites produced by particular toxigenic fungi species of, notably *Aspergillus* and *Fusarium* (Achidi et al., 2024; Ahmed Adam et al., 2017).[1,2] In many African countries, including Cameroon, dietary staples like maize, groundnuts, and other cereals are often contaminated with mycotoxins, mainly aflatoxins and fumonisins. These two mycotoxins are widely studied and frequently contaminate foods such as cereals and nuts, which are dietary staples in many African countries, including Cameroon (Abia et al., 2017; Abia et al., 2013a).[3,4] Long-term dietary exposure to these toxins has been linked to serious health issues, including hepatocellular carcinoma, liver cancer, immunosuppression, growth impairment in children, and a higher risk of neural tube defects (Abia et al., 2013b; Adaku Chilaka & Mally, 2020; Ahmed Adam et al., 2017; Gong et al., 2016).[2,5-7] The simultaneous presence of aflatoxins and fumonisins in the same food items is particularly concerning due to their potential for synergistic or additive liver toxicity and carcinogenic effects, which can increase the overall health risk (Marin et al., 2013; Smith et al., 2015).[8,9]

This global health burden is acutely felt in Cameroon, where climatic conditions, agricultural practices, and often suboptimal post-harvest storage create an environment conducive to fungal proliferation and mycotoxin production (Abia et al., 2013a; Monono et al., 2024; Njobeh et al., 2010; Tchana et al., 2010).[4,10-12] Studies have documented concerning levels and frequent co-occurrence of aflatoxins and fumonisins in everyday foods, sometimes exceeding international regulatory limits (Abia et al., 2017; Tchana et al., 2010).[3,12] Human biomonitoring has confirmed significant internal exposure in the population (Abia et al., 2013b; Njumbe Ediage et al., 2013),[5,13] underscoring the transition from contamination to a genuine public health threat. Yet, a critical barrier to mitigating this well-characterized risk is low public awareness and risk perception. Effective management of the mycotoxin challenge requires complementing technical solutions with behavioral change, which is predicated on understanding and effective risk communication (Stepman, 2018).[14] In low- and middle-income countries, such as Cameroon, where food safety systems are often under-resourced, consumer awareness and preventive practices become the paramount first lines of defense (Fundikira et al., 2025).[15] However, the socio-behavioral dimension, specifically the awareness, perceptions, and concerns regarding mycotoxin contamination, remains poorly characterized, forming a significant gap in the data necessary to design effective, community-tailored interventions.

Therefore, this study aimed to assess the awareness, perceptions, and concerns of Cameroonians regarding food contamination with aflatoxins and fumonisins, and to identify associated sociodemographic and behavioral factors. Through a cross-sectional survey, dietary habits, food storage practices, knowledge levels, and self-reported health symptoms potentially linked to the consumption of contaminated foods were evaluated. The findings identified critical gaps in public understanding and provides essential evidence to inform targeted risk communication strategies and public health interventions, thereby contributing to efforts towards the reduction of mycotoxin exposure and enhance food safety in Cameroon.

Materials and methods

Study site

This study was conducted in Cameroon, a country characterized by significant agro-ecological and cultural diversity. Its five major

agro-ecological zones (**Figure 1**) create varied climates that influence fungal growth and mycotoxin production in staple crops. Furthermore, the country's linguistic and cultural diversity influences food handling, storage, and consumption patterns. Together, these factors lead to heterogeneous dietary exposure to mycotoxins, such as aflatoxins and fumonisins, across the population, making Cameroon a pertinent setting for a national assessment of consumer awareness. This context is supported by studies documenting widespread mycotoxin contamination in Cameroonian food commodities (Abia et al., 2013a; Njobeh et al., 2010)[4,11] and confirmed human exposure (Abia et al., 2013b).[5]

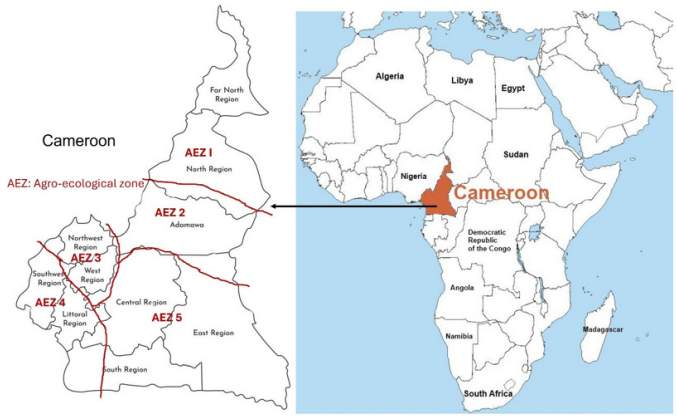

Figure 1 Map of Cameroon showing the agro-ecological zones (not to scale).

Study population

The target population was adults aged 18 years and above residing in both urban and rural areas of Cameroon. Participants were recruited through various channels, including social media platforms, community outreach initiatives, and local organizations. Informed consent was obtained via a written statement presented at the beginning of the questionnaire, and participation was entirely voluntary.

Study design

This study employed a cross-sectional design to assess dietary exposure to assess consumer awareness and practices related to dietary exposure to aflatoxins and fumonisins in Cameroon. Data was collected between March and April, 2025 using a structured questionnaire.

To ensure national accessibility, the instrument was developed in both English and French and administered in the participant's preferred language, either online (via Google Forms) or in-person. Interviewers entered offline responses directly into the digital platform.

The questionnaire was designed to capture demographic characteristics, dietary habits (with a focus on staple foods prone to contamination), knowledge of mycotoxins, and food safety practices. Before full deployment, it underwent pre-testing for clarity and cultural relevance with a purposive sample of 15 adults from the target population, resulting in revisions that improved comprehension and validity.

Survey

The structured questionnaire was designed to gather data across five domains: (1) Demographic Information (age, gender, education level and occupation); (2) Dietary Habits (frequency and types of food consumed e.g., maize, peanuts, rice, etc); (3) Knowledge and Awareness (participants' understanding of aflatoxins and fumonisins, including their sources, health implications, and methods of prevention); (4) Food Safety Practices (questions about food storage, preparation methods, and awareness of food safety standards); and (5) Self-Reported Health Symptoms (participant-identified symptoms subjectively linked to food consumption).

Data collection employed a mixed-mode approach. Participants were recruited both online (via social media platforms, including WhatsApp) and in-person at community events. All participants received a link to the Google Form questionnaire with detailed instructions. Weekly reminders were sent to improve response rates, and each participant was permitted a single submission. All responses, including those collected offline and entered by interviewers, were automatically compiled in Google Sheets. The dataset underwent quality checks to flag incomplete or inconsistent entries, followed by cleaning and coding in preparation for analysis.

Statistical analysis

Basic descriptive statistics, including frequency distributions, means, and standard deviations, were used to analyze data obtained from the survey. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) Version 27.

Results

Socio-demographic variables

The survey collected responses from 91 participants. The cohort was characterized by high educational attainment and a predominance of students and professionals. Most participants were female (60.4%), aged 18-30 (61.5%), and held a university degree (94.2%). Fourty-five percent (45.1%) were university students (Table 1).

Table 1 Demographic and dietary characteristics of survey respondents

Characteristic	Category	Frequency (%)
Age range (years)	18-30	56 (61.5)
	31-45	27 (29.7)
	>45	8 (8.8)
Gender	Women	55 (60.4)
	Men	36 (39.6)
Education Level Completed	Primary school	0 (0)
	Secondary school	5 (5.8)
	University/Undergraduate	47 (51.6)
	Postgraduate	39 (42.6)
Occupation	University students	41 (45.1)
	Lecturers, Laboratory technicians, Researchers	18 (19.8)
	Food business operators	14 (15.4)
	Public health professionals	8 (8.8)
	Others	10 (11)

Dietary habits

Staple foods known to be susceptible to mycotoxin contamination were commonly consumed. Over half of the participants reported frequent consumption of vegetables (57.1%), groundnut-based oil (63.7%), fruits (54.9%), and groundnut-based foods (52.7%). In contrast, canned or processed foods were rarely consumed by 46.7% of participants (Table 2).

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Table 2 Food consumption patterns

	Very often	Often	Occasionally	Rarely	Never	Missing responses
Fruits (fresh)	8	50	10	18	0	5
Vegetables (e.g., dark green leafy vegetables)	9	52	11	16	0	3
Canned or Processed foods	0	16	12	42	14	7
Red palm oil	8	45	8	23	0	7
Groundnut-based cooking oil	10	58	7	11	3	2
Cereal grains or cereal-based foods	6	42	12	23	3	5
Groundnut or groundnut-based foods	7	48	14	17	3	2

The majority of the participants sourced their food from the market (83.5%). Most participants consumed three meals per day (56%) while 4.4% went on a meal per day (Table 3).

Table 3 Source of food and number of meals per day

Characteristic	Category	Frequency (%)
Source of food	Market	76 (83.5)
	Farm	15 (16.5)
Meals consumed per day	1 meal	4 (4.4)
	2 meals	33 (36.3)
	3 meals	51 (56.0)
	More than 3 meals	3 (3.3)

Most participants reported storing grains and nuts at room temperature (80%), while only 2% used sealed containers. The shelf life for most stored foods was less than six months (79%). A high proportion (92%) reported removing visibly spoiled grains before consumption (Figure 2 A-C).

Despite high formal education, a gradient of awareness was observed. While 92% of participants were familiar with the general terms 'fungi' or 'mycotoxin' (Figure 2D), familiarity decreased when considering the specific toxins relevant to Cameroon: 58.3% were at least familiar with the terms 'aflatoxin' or 'fumonisin' (Table 4). Crucially, awareness of the specific food safety risks associated with these toxins was even lower (35.2%). Half of the participants (50.5%) nevertheless expressed concern about dietary exposure. The primary source of information for those with knowledge was non-specific (84.3%).

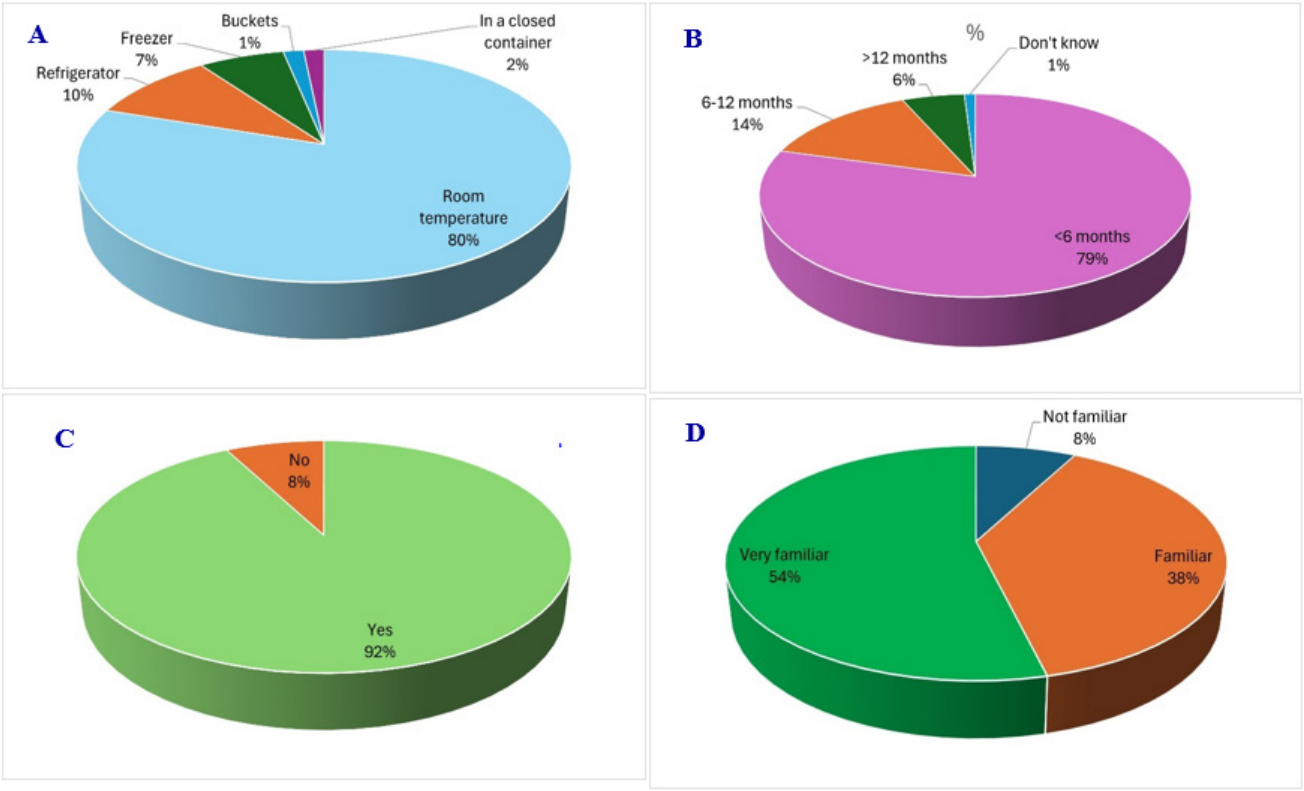

Figure 2 Grain storage (A), shelf life (B), sorting (C) and awareness on fungi and mycotoxin (D).

Table 4 Participant knowledge and awareness of aflatoxins and fumonisins

Characteristics	Category	Frequency (%)
Familiarity with the term "aflatoxin" and or "fumonisin"	Very familiar	26 (28.6)
	Familiar	27 (29.7)
	Not familiar	38 (41.8)
Are you aware of the food safety risks linked to aflatoxins and or fumonisin exposures	Yes	32 (35.2)
	No	59 (64.8)
What are the sources of information (among those who learned)	Reading of literature (e.g., articles)	9 (9.4)
	Seminars	6 (6.3)
	Non-specific sources	77 (84.3)
Are you concerned about aflatoxins in your foods/ diets	Yes	46 (50.5)
	No	13 (14.3)
	Unsure	32 (35.2)

Self-Reported Health Symptoms

Figure 3 presents the frequency of self-reported health symptoms over the past 12 months. Fatigue (59.3%) and gastrointestinal issues such as abdominal pain (42.9%) and diarrhea (38.5%) were commonly reported. Malaria was reported by 52.7% of participants. Severe conditions like cancer and convulsions were rarely reported (1.1% each).

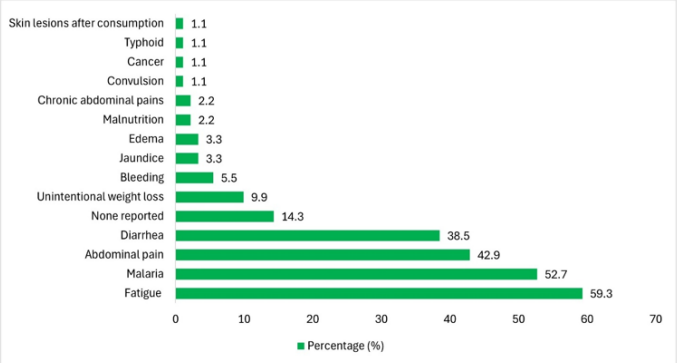

Figure 3 Self-reported health symptoms/conditions experienced after suspecting intake of contaminated foods in the past 12 months.

Discussion

This exploratory study provides a critical snapshot of awareness, practices, and concerns related to mycotoxin exposure among a convenience sample of adults in Cameroon. The central finding is a pronounced disconnect between general awareness and specific risk knowledge, as well as between awareness and the adoption of safe storage practices; a knowledge-practice gap with significant public health implications.

Socio-demographic context

The surveyed cohort was predominantly young, highly educated, and urban-leaning, a direct result of the convenience sampling strategy. This profile inherently limits the generalizability of findings to the broader Cameroonian population, particularly to rural smallholder farmers who face the highest exposure risk. However, it establishes a crucial "best-case scenario" benchmark. The observation that awareness and practices remain suboptimal even within this highly educated segment strongly suggests that gaps in the general population are likely more severe. This pattern, where formal education does not automatically translate to food safety literacy, is noted across African contexts (Stepman, 2018)[14] and underscores the specialised nature of required risk communication.

Dietary habits and Exposure Pathways

Dietary patterns revealed a high intake of staple foods that are primary vectors for aflatoxins and fumonisins in Cameroon, including groundnuts, maize, and their derivatives. This consumption aligns with extensive documentation of mycotoxin contamination in these commodities within the national food system (Abia et al., 2013a; Njobeh et al., 2010),[4,11] at times exceeding regulatory limits (Abia et al., 2017).[3] The predominant reliance on fresh, market-sourced food (83.5%) suggests that interventions targeting market value chains could have a broad reach. While most reported stable meal frequency, the subset consuming only one meal daily (4.4%) hints at economic constraints that can heighten vulnerability by limiting dietary diversification, a concern noted in other local studies (Metuge et al., 2025).[16]

The Critical Knowledge-Practice Gap in Storage and Awareness of Mycotoxins

Post-harvest practices emerged as a significant risk factor. Storing grains at ambient temperature (80%) creates ideal conditions for fungal growth and mycotoxin production in Cameroon's climate (Wagacha & Muthomi, 2008).[17] Although most participants (92%) removed visibly spoiled grains, a positive step, this is insufficient, as toxins can also permeate visually sound produce. This underscores a fundamental challenge: translating basic awareness into effective prevention. The data reveals a steep gradient in understanding, ranging from high familiarity with "fungi/mycotoxin" (92%) to moderate knowledge of specific toxin names (58.3%) and low awareness of concrete health risks (35.2%). This progression highlights a profound deficit in actionable knowledge. The heavy reliance on non-specific information sources (84.3%) partly explains why familiarity fails to drive safer practices; a gap also identified among Cameroonian farmers (Abia, 2024; Ntsoli et al., 2024).[18,19] This regional challenge is mirrored in West Africa; for instance, studies in Northern Ghana detail how local knowledge of contamination in groundnuts often exists alongside limited adoption of technical mitigation strategies, pointing to similar barriers in translating awareness into action (Abdul-Majeed Ibrahim).[20] This disconnect is especially concerning given the documented presence of toxigenic fungi in ready-to-eat foods within the same region (Achidi et al., 2024).[1]

Concerns about health impacts

Aflatoxins are Group 1 human carcinogens (IARC, 2012), and their frequent co-occurrence with fumonisins is associated with esophageal cancer and neural tube defects, presenting a compounded health threat (Smith et al., 2015).[9] Biomonitoring confirms internal exposure in Cameroon (Abia et al., 2013b; Njumbe Ediage et al., 2013).[5,13] In this context, the frequent self-reporting of non-specific symptoms like fatigue (59.3%) and gastrointestinal distress (abdominal pain: 42.9%, diarrhea: 38.5%) is notable. However, this cross-sectional design cannot establish causality; symptoms are multifactorial. The high report of clinically diagnosed malaria (52.7%) underscores the complex disease burden, where infectious and environmental risks intersect. The finding that 50.5% of participants expressed concern about dietary mycotoxins, despite low specific knowledge, reveals a receptive audience for risk communication. This latent demand for safer food is consistent with consumer studies in West Africa, which

show that when awareness is raised, a significant willingness to pay for safety can emerge (Adama, 2009).[21]

Implications for Public Health and Future Research

The findings converge on an urgent need to bridge the gap between abstract awareness and practical, preventive behavior. Interventions must be evidence-based and context-specific, moving beyond terminology to demonstrate low-cost solutions through trusted local channels. The high education level of groups like this sample could be leveraged for peer-led education. Future research must address key limitations: (1) employing representative sampling to reflect national demographics; (2) integrating biomarker-based exposure assessment to link practices and symptoms to internal dose objectively; and (3) designing intervention trials to test the efficacy of communication tools and storage technologies. Ultimately, managing this threat requires a systemic, multi-sectoral approach—integrating policy, agriculture, and public health—as highlighted in situational analyses from neighboring countries (Omari et al., 2020).[22] Success depends on transforming general concern into the widespread adoption of simple, effective practices.

Therefore, food safety and health-focused non-governmental organizations, as demonstrated by CDC (CDC, 2004, 2005) following the aflatoxicosis outbreak in Kenya, and replicated by the Integrated Health for All Foundation (IHAF) in Cameroon (Abia, 2024),[18] may constitute an important stakeholder in this process.

Conclusion

This study, conducted with a highly educated convenience sample in Cameroon, reveals a critical disconnect. While consumption of mycotoxin-susceptible staples is common and awareness of general terminology is high, specific knowledge of associated health risks remains low, and storage practices are often inadequate. This knowledge-practice gap persists despite a high level of concern about food contamination. The findings highlight that general education does not automatically confer food safety literacy. They underscore the imperative for targeted, practical, and evidence-based interventions that translate awareness into action, focusing on improving post-harvest management and building risk communication channels that resonate with local contexts. Addressing this gap is essential to mitigate the silent and chronic public health threat posed by dietary mycotoxin exposure.

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None.

Conflicts of interest

The authors declare that there are no conflicts of interest.

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