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Mycotoxin prevalence in red pepper, sesame and soya bean in Northwest Ethiopia

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This brief presents the findings of the prevalence of aflatoxins and ochratoxins in red pepper, sesame and soya bean in Northwest Ethiopia.

Introduction

Mycotoxins are compounds that are naturally produced by certain types of fungi that grow on numerous foodstuffs and produce toxins which can cause adverse health effects and pose a serious health threat to both humans and livestock (WHO, 2023).

Mycotoxins occur in a wide range of commodities, particularly where post-harvest management is inadequate (Marroquín-Cardona et al., 2014). Their chronic adverse health effects, including stunting and various cancers, are well documented (Liu & Wu, 2010; Mamo et al., 2020), although direct correlations are not always obvious (Ayelign et al., 2017). Consumers, while exposed to multiple foods containing a range of mycotoxins, have limited awareness about mycotoxin contamination and its potential health risk (Ayele et al., 2022; Carballo et al., 2019).

In countries such as Ethiopia, mycotoxin monitoring is largely limited to export commodities, while domestically consumed produce is rarely assessed. Available data are mostly from isolated studies on cereals (maize, wheat, and sorghum) and occasionally coffee and groundnuts, frequently reporting a high proportion of samples exceeding maximum limits (ML) (Ayelign & De Saeger, 2020; Mamo et al., 2020).

The prevalence of mycotoxins is exacerbated by a general lack of awareness among farmers regarding the associated health risks and the essential pre- and post-harvest management practices necessary to mitigate these risks (Sadik et al., 2023; Sadik et al., 2025; Bereka et al., 2021; Girma et al., 2020). Recent research underscores the importance of targeted training programs as a means to significantly enhance farmers' understanding and implementation of effective post-harvest management strategies (Girma et al., 2020). By equipping farmers with the requisite knowledge and skills through these specialized programs, there has been a notable reduction in mycotoxin contamination risks, thereby contributing positively to food safety and public health outcomes (Girma et al., 2020).

To obtain a better understanding of how to manage mycotoxins, this study determined the prevalence of aflatoxins and ochratoxins in red pepper, sesame and soya bean Northwest Ethiopia. Interviews were conducted with farmers to evaluate their level of awareness and their practices before and after harvest.

KEY messages

- Contamination levels of aflatoxin and ochratoxin in red pepper, sesame, and soya bean samples exceed permissible limits. Immediate action is required to mitigate contamination, safeguard consumer health, and minimize economic losses by enhancing national food safety systems and implementing measures in production and marketing sectors.
- Awareness of mycotoxins is limited among sesame and soybean farmers, with only a few red pepper growers being informed.
- Watering red pepper to boost profits is a common malpractice leading to fungal growth and mycotoxins, harming consumer health and reducing marketability internationally. Strong regulatory measures are needed to prevent this and restore Ethiopia's market position.
- Traditional pre- and post-harvest practices dominate among farmers, with minimal adoption of advanced handling technologies and inspection methods. This limits effective management of fungal infections and mycotoxin contamination in commodity value chains.
- Accurate moisture measurement is crucial to prevent fungal growth and mycotoxin contamination. Manual detection is common but imprecise; using a moisture tester is essential for precise determination.
- Mycotoxins in domestic produce are not prioritized by the current food control system, yet they urgently need attention due to significant health risks.

Methodology

he study was conducted in the Amhara region, purposive sampling of woredas considering the respective importance in the production of pepper, sesame and soya bean. The target sample woredas were Bure Zuria, Wonberma and Mankusa for red pepper; Mirab Armachiho for sesame; and Jawi and North Achefer for soya bean. Using a systematic random sampling method, 100 farm households for each of the three commodities were selected, of which 100 farm households for red pepper, 100 for sesame and 100 for soya bean were able to provide product samples for the determination of mycotoxin prevalence. The questionnaire was administered with all sampled farm households to determine farmers' knowledge, perception and practices about mycotoxin. For the determination of mycotoxin prevalence, samples for each commodity were taken from farmers' stores. Both total aflatoxin (AFT) and ochratoxin A (OTA) were determined by a competitive direct ELISA method.

Mycotoxin prevalence

Ninety-two per cent of the red pepper samples contained AFT exceeding the EU ML of 10ppb, for OTA, this was almost 94% of the EU ML of 20 ppb (which was used as there are no MLs set for red pepper for total aflatoxin A and ochratoxin A in Ethiopia but have ML for berbere powder). For soya bean the ML was exceeded for AFT and OTA in 9% and 46.4% of the samples. The incidence of MLs above the set level was lowest in sesame, with about 4% and 8% of the sample for AFT and OTA, respectively (Table 1).

Table 1. Percentage of samples with levels of AFT and OTA exceeding the ML (ET standard for AFT for sesame and soya bean; otherwise the EU standard).

Commodity	AFT			OTA		
	ML EU* (ppb)	ML ET (ppb)	≥ ML %	ML EU (ppb)	ML ET (ppb)	≥ ML %
Red pepper	10	***	92	20	***	93.9
Sesame	15†	10 **	3.8	(5)††	***	7.9
Soya bean	4	10 **	9.1	5	***	46.4

* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02006R1881-20140701
** ES 1082:2017 for sesame and ES 82:2023 for soya bean, *** No ML set, † 15 ppb is the EU standard for whole oilseeds
†† No ML set, 5ppb used as a proxy

Figure 1: Storage practices of red pepper (left), sesame (centre) and soya bean (right)

management practices (Sadik et al., 2023; Sadik et al., 2025; Bereka et al., 2021; Girma et al., 2020). Research indicates that targeted training programs can significantly improve farmers' knowledge and practices related to post-harvest management (Girma et al., 2020). Equipping farmers with the necessary knowledge and skills through targeted training programs has contributed to mitigating the risks associated with mycotoxin contamination, thereby enhancing food safety and public health (Girma et al., 2020).

To obtain a better understanding of how to manage mycotoxins, this study determined the prevalence of aflatoxins and ochratoxins in red pepper, sesame and soya bean of farmers in NW Ethiopia. In addition, farmers were interviewed to assess their awareness and the pre- and post-harvest practices.

Table 2: Farmers' knowledge about mould, mycotoxins and impact on health (%)

Farmers knowledge		% Respondents		
		Red pepper	Sesame	Soya bean
Knows about the cause of mould (Yes)		97	1	100
Cause of mould	Rain before harvest	46	0	85
	Poor drying	79	1	100
	Poor storage	79	0	37
Heard about mycotoxin		18	0	0
Knowledge about the impact of consuming contaminated food (yes)		74	1	0
Impact on health of consuming spoiled food (Yes)	Liver cancer	44	0	0
	Immune suppression	54	1	0
	Stunted growth	30	0	0
	Death	21	0	0

With regards to knowledge about the impact of consuming spoiled food, it is only farmers engaged in pepper production have reported that they are aware of the impact (74%), and only 18% of pepper producers have heard about mycotoxin. Specifically, 44% of pepper producers reported the impact of consuming spoiled food as liver cancer, 54% Immune suppression, 30% stunted growth, and 21% death (Table 2).

Few farmers had received training on the topic of post-harvest management, resp. 9% of sesame farmers, 17% of red pepper farmers and 19 % of those producing soya bean. Of the farmers that did receive training, harvesting and drying were the most common topics. Only red pepper farmers received training on transportation and none of the trained farmers received moisture management information on moulds and their management.

Perception prevalence of fungal infection

Farmers' assessment of fungal infection, both in the field and in storage, varied widely per commodity. Farmers producing red pepper rated fungal infection in store higher than in the field; the same is true for those farmers producing sesame, where very few farmers (5%) indicated that there was fungal infection in store (Table 3). While farmers producing soya bean indicated that field level infection was moderate (65%), in store, this was only just over 11%, the majority indicated limited fungal infection in store (86.9%). This can most likely be explained by the occurrence of soya bean rust in the field, a field-based fungal infection that affects leaves and pods, but is as such not a storage disease affecting harvested and cleaned beans.

Table 3: Farmers' qualitative assessment of fungal infection in the field during storage

Location	Severity of fungal infection	% respondents		
		Red pepper	Sesame	Soya bean
Fungal infection in the field	Not severe	47	99	31
	Moderately severe	45	1	65
	Severe	8	0	4
Fungal infection in storage	Not severe	26	95	85
	Moderately severe	49	5	11
	Severe	25	0	4

Post-harvest management practices

The different post-harvest practices vary by crop types. While those farmers producing soya beans did not dry their produce after harvest, the beans are dry at harvest time, farmers producing red pepper (99%) and sesame (100%) did dry the produce, which is the majority of the ground (Table 4). Bags, either woven polypropylene or woven plastic, were the highest (95%) preferred storage method for sesame, followed by red pepper (38%), and lowest in soyabean farmers (15%). The majority of the red pepper and soyabean farmers preferred traditional storage structures, either *gota* or *gotera* (Figure 2), on the other hand, sesame farmers did not use these traditional structures. As long as the produce is stored under clean conditions and at the correct water content, this should not be a problem in relation to mycotoxin development. However, moist and dirty conditions will be a compounding factor to the development of moulds and hence mycotoxins.

Most farmers would inspect their produce one to two times while in store, although producers of red pepper did so up to four times, checking mainly done visually and by smell and for red pepper also by sound as an indicator for dryness. Moisture content was assessed by applying pressure by hand as an indicator although soya bean farmers did not check the moisture in store. Potential development of mould during storage was done to a mixed set of parameters, discolouration, dampness and smell (Table 4).

Farmers' storage practices

The results indicate that storage practices in terms of the number of months the respective commodity is stored vary by commodity. The majority of sesame-producing farmers (96%) reported that they store from 6 to 12 months, and the rest store more than 12 months. The storage practices of red pepper producers indicate considerable diversity, where 27% reported storing for less than 3 months after harvest, 32% between 3 and 6 months, 30% between 6 and 12 months, and the rest 11% store more than 12 months. The majority of soya bean producers (59%) reported storing less than 3 months, 19% between 3 and 6 months and the remainder between 6 and 12 months (Table 5).

Figure 2: Traditional gota

Table 4: Post-harvest practices

Post harvest practices	% respondents		
	Red pepper	Sesame	Soya bean
Drying	**99**	**100**	
On the ground (sun)	99	100	
Flatbed dryer	1	0	
Storage			
Traditional (gota or gotera)	85	0	94
Bags (fertilizer or woven plastic)	38	95	15
Hermetically sealed bag	4	0	0
Warehouse	1	6	0
Inspect in store	89	100	100
Visual	97	95	100
Smell	29	33	2
Taste	2	7	0
Sound	16	4	0
Measure moisture content	40	100	1
Biting	38	6.3	1
Pressing with hand	4	58.3	0
Both methods	0	35.4	0
Indication of mould development			
Discoloration	87.1 ()	85	94.9
Presence of insects	14.3	0	2
Mouldiness/wetness	55.7	1	67.7
Mouldy smell	32.9	32	83.8

Table 5: Storage practices in terms of number of months stored (% of farmers)

Storage length	% respondents		
	Red pepper	Sesame	Soya bean
Less than 3 months	27	0	59
3 to 6 months	32	0	19
6 to 12 months	30	96	22
More than 12 months	11	4	0

Red pepper – the practice of adding moisture to pods post-harvest

Just under half of red pepper farmers (47%) practice sprinkling water on the harvested and dried produce. They do this for a variety of reasons (Table 6), mainly to protect from the pods splitting and breaking, but also to increase the weight of the produce so that they receive a higher price. This practice is detrimental, as the development of mycotoxins increases substantially.

Table 6 Percentage of farmers sprinkling water on dry, harvested red peppers and the reason why

Activity	% respondents
Sprinkle water	47
Increase weight	36
Increase price	7
Protect from breakage	76
Colouring	7

Figure 3: Wetting of red peppers

Conclusion & discussion

The findings of this study on levels of mycotoxins are in line with earlier reported levels. Berbere, a spice mix of red pepper powder, collected from markets in Addis Ababa were found to contain levels of both aflatoxin B1 (83%) and total aflatoxin (97%) above the ML (Aberedew & Ayelign, 2023). Farm collected sesame samples did contain mycotoxins, however for about 97% this was below the ML (Alemayehu et al., 2024). Soyabean is a less studied commodity; however, analysis of samples in Yemen showed that 27.6% of samples exceeded the EU ML for total aflatoxin (Ahmed Abdullah Murshed et al., 2019). The high level of contamination and above the maximum level indicated that the current practices among the farmers were conducive to fungal development. This difference in compliance requires strict follow-up and taking action to meet the requirements and protect community health impacts. Moreover, exposure led to liver damage, nervous system toxicity, cancer-causing effects, and suppression of the immune system (Shekhar et al., 2025).

In this study, the ML for sesame for both AFT and OTA were relatively low, 3.8 and 7.9 >ML, respectively. similar to other studies (Aberedew & Ayelign, 2023). This could be explained by the time of sampling, in this study, between 2 and 4 months after harvest. As the majority of sesame farmers indicated that they keep the seeds in store for a long time, sampling just before the produce is marketed might have given a different result. Weather conditions, both temperature and humidity, while the crop is in the field, can also affect mycotoxin development during storage (Casu et al., 2024). The same is true for pest damage that might serve as entry points for mycotoxin-producing fungi.

Farmers have various levels of knowledge and perception about mycotoxins and their health impacts. They also employ diversified per- and post-harvesting management practices both in field and stores which potentially leading to fungal contamination. This could be explained through lack of customized guidelines, training manuals, inadequate capacity building efforts made, low extension service provided and weak enforcement measures taken especially on those farmers and traders sprinkling water on dried pepper pods. This finding aligns with other studies (Bila et al., 2025) where 97.8% of farmers had limited knowledge on fungal growth and mycotoxin contamination in food crops. In Cameroon, only 12% of groundnut farmers are aware of mycotoxins, and only 7.1% of these farmers know about the effects of mycotoxins on consumer health (Ntsoli et al., 2024). This implies that limited knowledge about the development and health risks of mycotoxins increases contamination levels at the farm level and primary stores, which can trigger health impacts and economic loss.

The findings highlight that inadequate drying and storage practices remain critical drivers of fungal growth and mycotoxin contamination (Costa et al., 2019). Farmers in the northwest commonly sun-dry red pepper and sesame directly on the ground, exposing the produce to fungal spores. In Cameron groundnut farmers sun-dry their crops on ground (Ntsoli et al., 2024). Drying on the ground is a critical factor in fungal contamination in which the soil is a good reservoir for Aspergillus flavus and Aspergillus parasiticus spores (Gachara et al., 2022). The traditional storage structures and jute or polypropylene bags create conditions that favour increases in temperature, moisture, fungal growth and toxin accumulation (Alemayehu et al., 2024; Alemayehu et al., 2020). Therefore, proper management of temperature, moisture, and humidity remains one of the most effective and widely recommended strategies for reducing mycotoxin contamination in stored agricultural commodities (Shekhar et al., 2025). However, farmers continue to rely on subjective manual methods to assess moisture content, which are low in accuracy leading to storing commodities before they reach safe moisture levels, thereby increasing the risk of fungal growth and mycotoxin development during storage.

Recommendations

The findings of the study were validated in a stakeholder workshop (April, 2024), representing both public and private sector actors. Key priority challenges were identified for knowledge, attitude, and practice and the following recommendations were proposed by the experts to address these challenges.

Community specific strategy

The high prevalence of mycotoxin contamination in the evaluated commodities signals the need for developing commodity specific strategies with targeted actions across the value chains including strengthening the regulatory system. Mycotoxin contamination and risk assessment studies should cover more areas with significant number.

Enhance awareness

Awareness creation should not only consider producers, rather it should include traders, processors, consumers, and policy makers as mycotoxin contamination is prevalent in the whole value chain.

Post-harvest technologies

Use of improved pre- and post-harvest technologies such as locally manufactured moisture tester, driers, hermetic bags, storage and transportation facilities, integrating with Good Agricultural Practices and Good Handling Practices would significantly contribute to minimize fungal infection and hence mycotoxin contamination.

Extension and advisory support

The extension service would include post-harvest management support to producers, storage service providers, transporters and processors to minimize fungal infection and mycotoxin contamination.

Strong food safety platform

Establish a strong, sustainable, and accountable multi-sectoral food safety platform to coordinate food safety initiatives, strengthen regulatory enforcement to curb the unsafe practices such as sprinkling water on dried pepper pods and elevate the mycotoxin issues to the national policy agenda.

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