

Food Safety Risks from Mycotoxin in Sierra Leone Based on Multi Stakeholder Knowledge Attitudes and Practices

Dr. Patrick Maada Ngegba

patrickmaadangegba@gmail.com

Sierra Leone Agricultural Research Institute

Dr. Osman Nabay

Sierra Leone Agricultural Research Institute

Dr. Saffa Mohamed Massaquoi

Njala University

Mr. Suffian Mansaray

Sierra Leone Agricultural Research Institute

Mr. Alimu Mansaray

Sierra Leone Agricultural Research Institute

Dr. Martha Shirley Epiphaneia Williams-Ngegba

Sierra Leone Agricultural Research Institute

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Abstract

Chronic dietary exposure to mycotoxins poses a major food safety threat in sub-Saharan Africa, yet data on stakeholder awareness in Sierra Leone remain extremely limited. This study assessed knowledge, attitudes, and practices (KAP) related to mycotoxin contamination among consumers, farmers, traders, and health professionals. A cross-sectional survey was conducted in November 2025 across five representative districts of Sierra Leone. Probability sampling yielded 426 household consumers, while purposive sampling identified 113 key informants (45 farmers, 35 traders, 26 health professionals, 6 policy makers). Structured questionnaires captured demographic data, consumption patterns, storage practices, and awareness of mycotoxin risks. Data were analyzed using descriptive statistics and chi-square tests.

Only 4.2% of consumers recognized the term "mycotoxin," and just 39.8% knew that moulds can produce harmful substances. Awareness increased significantly with education (3.0% among those with no formal schooling vs. 17.2% with tertiary education; $p < 0.01$). Fewer than half (46.1%) believed mouldy food causes health problems, with most associating risks only with mild gastrointestinal symptoms. Risky practices were widespread: 61% cut off mouldy parts and consumed the remainder, 63% washed contaminated food, 68% re-dried mouldy items, and 64% fed mouldy food to animals. Only 28% discarded mouldy food immediately. Among farmers, 24.4% had heard of mycotoxin-related diseases; among health professionals, 15% recognized the term, and 85% rated mycotoxins as a "very significant" food safety issue after being informed. Only 23% of health workers had received training on mycotoxins. Storage practices were suboptimal: 42% used woven bags, 38% used plastic buckets, and only 6–7% used airtight containers.

Sierra Leone faces a critical gap in mycotoxin awareness and safe food handling practices. Urgent national awareness campaigns, integration into extension and health services, improved drying and storage infrastructure, and robust regulatory frameworks are essential. Coordinated public health interventions and policy reforms will be pivotal to reducing exposure, safeguarding nutrition, and protecting vulnerable populations.

1. Introduction

Globally, heightened attention to food safety and agricultural contaminants underscores the need for coordinated frameworks and collective action to mitigate adverse impacts on health, economic growth, and food and nutrition security. Mycotoxins are small, heat-stable, toxic compounds produced by certain moulds (fungi) in the genera *Aspergillus*, *Penicillium*, and *Fusarium* [1–3], posing a serious global food safety threat to public health, economic and livelihood of numerous small scale farmers in many tropical countries including Sierra Leone [1, 4, 5]. About 450 different types of mycotoxins have been documented; with nearly 25% of the crops commodities have been affected by mycotoxins worldwide [2]. For instance, about 25 to 50% of cereals crops are affected with fungi and 5 to 10% of these products are unsuitable for human consumption, contributing to notable economic losses [2]. A recent study

disclosed that about one-fourth of agricultural food commodities are affected with mycotoxins, as a result of saprophytic fungi infestation prior to harvest [6]. Food and Agriculture Organization (FAO) also documented that, about 1000 million metric tons of plant-based foods are affected yearly because of mycotoxins during storage [7]. Humans are exposed to these toxins via direct and indirect consumption of contaminated crops and animal products such as beef, milk, and eggs [2, 8]. The consumption of ground nuts, rice, maize, cassava, and sorghum, when they are not properly processed to remove mouldy, shriveled, and insect-damaged, significantly increases the risk of mycotoxin among human race [1, 5]. Further, exposure levels are higher in developing countries due to weak pest control, poor handling and storage practices, and consumption of inferior-quality foods [9].

Nonetheless, mycotoxins pose a serious public health concern due to their links with numerous adverse health outcomes, including carcinogenic, kwashiorkor, immune suppression, stunted growth in children, and teratogenic effects [10]. The International Agency for Research on Cancer (IARC) has concluded that mycotoxins are not only a cause of acute poisoning and cancer but also a likely contributor to the high levels of stunting in children in affected populations [4]. In Cameroon, Abia et al. investigated dietary exposure to neurotoxic mycotoxins and implications for brain development and neurodevelopmental disorders in children [11].

Despite the adverse effects of mycotoxins in sub-Saharan Africa (SSA), studies indicate that awareness of mycotoxins and their health risks remains critically low among stakeholders across the food value chain [12]. A systematic review in Malawi, which analyzed 36 peer-reviewed and grey literature sources published between 2009 to 2025, found a national average awareness level of only 24.5%. Interestingly, no measurable improvements in knowledge, attitudes, and practices (KAP) indicators were observed between 2012 and 2025, despite numerous interventions [13]. In the Democratic Republic of Congo, a study assessed knowledge, attitude, and practice of mothers and caregivers on mycotoxin contamination of infants and young children's porridge [5]. The study found significant gaps in awareness and practices related to mycotoxin prevention, highlighting the need for targeted interventions to protect vulnerable populations.

Sierra Leone's hot, humid climate, coupled with traditional post-harvest practices and inadequate infrastructure, and weak regulatory enforcement create highly favorable conditions for mould contamination in foods. In addition, the country's food safety management systems remain at rudimentary stage, and public awareness of hazards such as mycotoxins is still limited. In Sierra Leone, the consumption of maize, groundnut, sesame, and other staple foodstuffs results in chronic exposure to high levels of mycotoxin contamination. Yet, the majority of Sierra Leoneans remain unaware of what mycotoxins are or the health and economic challenges they pose. Indeed, low levels of public awareness regarding mycotoxin contamination in foods have spanned for more than four decades [14]. A recent survey of street-vended peanuts in Sierra Leone revealed alarmingly high levels of aflatoxin contamination, with mean concentrations of approximately 488 µg/kg far exceeding international safety limits [15]. Several studies on aflatoxins levels and high frequencies in various biofluid of newborns and children [16]. Serum, urine, and stool specimens of infants contained high concentrations of aflatoxins

94%, 100%, and 94% [17]. Also, aflatoxins were found 91% cord and 75% maternal blood samples at concentration levels of 0.4–9.0 µg/kg cord and 0.04–8.8 µg/kg maternal blood [18]; while breast milk samples contained 88% aflatoxins at concentration range of 0.05–372 µg/kg [19]. Aflatoxins contamination 99% was found in urine samples from schoolchildren aged 5 to 14, with levels of 0.5–374 µg/kg M1 (dry period), and 0.08–127µg/kg B1(rainy period) [20].

Though, several studies from other African countries have highlighted the positive impact of education and communication efforts on consumer awareness of mycotoxins. However, in Sierra Leone, consumer awareness of the effects of mycotoxins on staple foods such as rice, groundnut, and maize remains largely dearth from literature. Addressing this gap is critical for guiding public health interventions and policy measures. This study therefore seeks to evaluate consumer awareness and perceptions of mycotoxins, document attitudes and practices that influence exposure, and compare knowledge across demographic groups in Sierra Leone. Further, examine whether awareness varies by educational level, age, and gender. The findings provide a baseline for policymakers, health educators, and extension agents, supporting the design of effective interventions to reduce mycotoxin exposure, food safety risk, safeguard public health, and foster economic growth.

3. Materials and Methods

3.1 Study Design

A cross-sectional, descriptive study design was adopted, integrating quantitative household surveys with qualitative key informant interviews (KIIs). This mixed-methods approach enabled the collection of population-level data on knowledge, attitudes, and practices (KAP) while simultaneously capturing institutional perspectives on mycotoxin management, policy implementation, and stakeholder roles. The study was conducted in November 2025 across five districts of Sierra Leone, chosen to represent the country's main agro-ecological zones and urban-rural gradients. The design followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies.

3.2 Study Area

Sierra Leone is a West African nation with an estimated population of 9,092,113 according to the 2021 midterm national census; approximately 59% of the population resides in rural areas and 41% in urban areas [21]. The country has a tropical climate characterized by high temperatures and humidity, conditions that favour fungal proliferation and mycotoxin contamination. Five (5) districts were purposively selected to ensure representation across all administrative regions and to capture both rural and urban settings: Moyamba (Southern Province, population 318,588), Kenema (Eastern Province, 609,891), Kambia (North-West Province, 345,474), Koinadugu (Northern Province, 409,372), and the Western Area (capital region, with rural population 444,270 and urban population 1,055,964) as shown (Figure 1). The combined population of these districts was approximately 2,127,595. Together, they encompass diverse agro-ecological zones, ranging from coastal lowlands to inland savannah, and include major urban centres (Kenema Town and Freetown) as well as remote rural villages. This broad

geographic coverage ensured the inclusion of households and institutional stakeholders from all main regions of Sierra Leone.

3.3 Sample Size Determination

The required household sample size was calculated using [22] formula for proportions, appropriate for large populations:

$$n_0 = \frac{Z^2 p(1-p)}{e^2} \quad (1)$$

where Z is the z-score for the desired confidence level (1.96 for 95%), p is the estimated population proportion with the attribute of interest (set at 0.5 to maximize variability), and e is the desired margin of error (0.05 for $\pm 5\%$ precision). Substituting these values yielded:

$$n_0 = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2} = 384.16 \quad (2)$$

Thus, approximately 384 respondents were required for an effectively infinite population. Since the target population (the five districts) is finite ($N = 2,127,595$), the finite population correction was applied:

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}} \quad (3)$$

which gave $n \approx 384$. The adjustment was negligible owing to the large population size. Yamane's simplified formula yielded a comparable result. A target of 385 household respondents was therefore set. In practice, data collection achieved a larger sample of 426 household consumers, exceeding the target and providing additional statistical precision. This sample size provided sufficient power (80%) to detect moderate effect sizes between demographic subgroups (e.g., by education, gender, or district) at $\alpha = 0.05$.

For key informants, no formal sample-size formula was applied; instead, purposive sampling aimed to include all available officials and representatives from relevant sectors in each district. A total of 113 key informants were interviewed, comprising 45 farmers, 35 traders, 26 health professionals, 6 policy makers, and 1 food safety regulator. This approach is consistent with established qualitative research guidelines recommending saturation-based sampling for key informant interviews [23].

3.4 Sampling Procedures

3.4.1 Household Consumer Sampling

A multi-stage cluster sampling approach was employed. In the first stage, the five districts were purposively selected to represent Sierra Leone's administrative regions and ensure geographic diversity. In the second stage, within each district, clusters (chiefdoms or villages) were selected with probability proportional to population size (PPS), thereby giving larger settlements a proportionally higher chance of selection. In the third stage, households within each selected cluster were randomly selected using systematic random sampling. Within each selected household, one adult (≥ 18 years) was interviewed; no quota stratification by gender was imposed, so the gender of respondents was determined by availability, resulting in 226 female (53.1%) and 200 male (46.9%) participants among the 426 consumers. The final household sample distribution was: Kenema 103, Kambia 96, Koinadugu 96, Moyamba 88, and Western Area 43, roughly reflecting each district's share of the total population.

3.4.2 Key Informant Sampling

Key informants were purposively selected based on their institutional roles and expertise in food safety, agriculture, health policy, and food trade. Selection criteria included professional role in relevant sectors, knowledge of or involvement in food safety issues, geographic distribution across the five study districts, and willingness to participate. Informants were identified through official directories of district agricultural, health, and trade offices; stakeholder mapping conducted in collaboration with the Sierra Leone Agricultural Research Institute (SLARI); and snowball sampling, where initial informants recommended additional key participants.

3.5 Data Collection Instruments

A structured questionnaire was developed for the household consumer survey. It captured demographic information (age, gender, education, occupation, household size, district), consumption patterns (types and frequency of staple foods, sources), storage practices (methods, duration, container types), awareness of mycotoxins (knowledge of the term, health risks, information sources), attitudes (perceptions of food safety risks, beliefs about mouldy food, willingness to adopt safer practices), and practices (behaviours regarding mouldy food, sorting, washing, drying). The questionnaire was developed in English and translated into the four main local languages (Krio, Mende, Temne, and Limba) to ensure comprehension; back-translation was performed to verify accuracy. A semi-structured interview guide was developed for key informants, covering institutional knowledge of mycotoxins, awareness of health impacts, knowledge of regulatory frameworks, current policies and mitigation practices, perceived roles and responsibilities of different actors, challenges and barriers to mycotoxin management, and recommendations for interventions. The guide was designed to elicit both factual information and expert opinions, allowing in-depth exploration of institutional perspectives.

3.6 Data Collection Techniques

A team of 20 trained professional data collectors was recruited and trained over a three-day period (1–3 November 2025). Training covered study objectives, ethical considerations, questionnaire content and administration, use of the KoboToolbox mobile data collection platform, interview techniques, informed

consent procedures, and data quality assurance. Fieldwork was conducted from 4 to 28 November 2025. Data collectors, organized into four teams each supervised by a team leader, visited sampled villages, communities, and towns. Survey instruments were administered electronically using the KoboToolbox platform (<https://www.kobotoolbox.org/>), an open-source mobile data collection tool that offers offline capability, real-time validation, multilingual support, Global Positioning System (GPS) integration, and secure data storage. Household interviews were conducted face-to-face, each lasting approximately 30–45 minutes, in private settings to ensure confidentiality. Data were synchronized to the central server at the end of each day when internet access was available. Key informant interviews were conducted at participants' workplaces or at mutually agreed locations, with each interview lasting approximately 45–60 minutes. Interviewers took detailed notes, and with consent, audio-recorded the sessions to facilitate thematic analysis.

3.7 Data Analysis

Quantitative data were downloaded from KoboToolbox as CSV and Excel files. Data cleaning involved checking for completeness and consistency, correcting entry errors, and handling missing responses via listwise deletion. Quantitative analyses were performed using Microsoft Excel 2019, IBM SPSS Statistics 25, and Stata 17. Descriptive statistics (frequencies, percentages, means, standard deviations) were computed to summarize demographics, awareness levels, and behaviours. Bivariate associations between categorical variables (e.g., awareness by education level, gender, district) were examined using chi-square tests, with Fisher's exact test used when cell counts were below 5. Comparisons of continuous variables across multiple groups were conducted using Analysis of Variance (ANOVA). Pearson's correlation was used to examine relationships between continuous variables such as age and awareness.

Statistical significance was set at $p < 0.05$ (two-tailed). Qualitative data from key informant interviews were analyzed using thematic analysis following the six-step framework [24]. Transcripts and interview notes were read repeatedly for familiarization; initial open coding identified recurring ideas and concepts; codes were grouped into broader themes; themes were reviewed against original data, refined, and defined; and finally, illustrative quotes were selected for reporting. Coding was conducted manually by two researchers who independently coded a subset of interviews, compared findings, and resolved discrepancies through discussion, enhancing reliability and reducing bias. Integration of quantitative and qualitative findings occurred during the interpretation phase. Triangulation compared findings from different data sources to enhance validity; complementarity used qualitative insights to explain quantitative patterns (e.g., exploring why certain practices are common); and contextualization placed quantitative findings within the institutional and policy context revealed by key informants.

3.9 Quality Assurance and Study Limitations

Several measures were implemented to ensure data quality. The questionnaire was pretested with 20 households (four per district) and revised based on feedback. Comprehensive enumerator training reduced interviewer variability. Team leaders conducted spot checks and reviewed complete

questionnaires. KoboToolbox built-in validation checks minimized entry errors. Triangulation of quantitative and qualitative data enhanced validity, and all procedures are reported transparently to facilitate replication. The study had several limitations. First, reliance on self-reported data may have introduced social desirability and recall biases. Second, the cross-sectional design precludes causal inference. Third, purposive sampling of key informants may have introduced selection bias, potentially over-representing more knowledgeable stakeholders. Fourth, the Western Area contributed a relatively small proportion of the household sample (10.1%), which may limit the representativeness of urban perspectives. Fifth, despite translation, subtle linguistic differences may have affected response accuracy. These limitations were acknowledged and mitigated through rigorous quality assurance measures and methodological transparency.

4. Results

4.1 Socioeconomic Characteristics of Consumers

Results in Table 1 show that a slight majority of consumers were female (53.1%), except in the North-West region, where roughly two-thirds were male. About 59% of respondents were married, but this varied widely by region: the Northern and North-Western provinces had the highest marriage rates (over 85% married), whereas the Eastern and Southern provinces had a much larger share of single individuals (approximately 40–47% single). In the Western region, consumers were also predominantly married (69%), with an unusually high proportion of widowed individuals (23%) and very few singles.

Table 1
Socio-economic characteristics of consumers by region

Variable	North (n = 96)	North- West (n = 96)	South (n = 88)	East (n = 103)	West (n = 43)	Total (n = 426)
Gender						
Male	40 (41.7)	62 (64.6)	36 (40.9)	48 (46.6)	14 (32.6)	200 (46.9)
Female	56 (58.3)	34 (35.4)	52 (59.1)	55 (53.4)	29 (67.4)	226 (53.1)
Marital status						
Married	82 (85.4)	84 (87.5)	24 (27.3)	32 (31.1)	29 (69.0)	251 (59.1)
Single	8 (8.3)	7 (7.3)	41 (46.6)	45 (43.7)	2 (4.8)	103 (24.2)
Widow/widower	4 (4.2)	3 (3.1)	7 (8.0)	15 (14.6)	10 (23.8)	39 (9.2)
Separated/divorced	2 (2.1)	2 (2.1)	16 (18.2)	11 (10.7)	1 (2.4)	32 (7.5)
Age (years)						
18–35	45 (47.4)	42 (43.8)	41 (47.1)	48 (46.6)	17 (39.5)	193 (45.5)
36–50	27 (28.4)	34 (35.4)	30 (34.5)	37 (35.9)	16 (37.2)	144 (34.0)
51–60	11 (11.6)	12 (12.5)	9 (10.3)	9 (8.7)	5 (11.6)	46 (10.8)
> 60	12 (12.6)	8 (8.3)	7 (8.0)	9 (8.7)	5 (11.6)	41 (9.7)
Educational status						
None	31 (32.3)	31 (32.6)	19 (21.6)	24 (23.1)	26(60.5)	131(30.8)
Literate/Koranic	29 (30.2)	18 (18.9)	5 (5.7)	19 (18.3)	0 (0)	71 (16.7)
Primary	8 (8.3)	16 (16.8)	12 (13.6)	9 (8.7)	3 (7.0)	48 (11.3)
Junior high school (JSS)	15 (15.6)	13 (13.7)	21 (23.9)	13 (12.5)	6 (14.0)	68 (16.0)
Source: Survey data, 2025						

Variable	North (n = 96)	North- West (n = 96)	South (n = 88)	East (n = 103)	West (n = 43)	Total (n = 426)
Senior high school (SSS)	10 (10.4)	12 (12.6)	17 (19.3)	32 (30.8)	8 (18.6)	79 (18.5)
University	3 (3.1)	1 (1.1)	9 (10.2)	2 (1.9)	0 (0)	15 (3.5)
College/Technical	0 (0)	4 (4.2)	5 (5.7)	5 (4.8)	0 (0)	14 (3.3)
Source: Survey data, 2025						

Across regions, the age distribution of consumers was relatively young, with a mean age of 40.08. Around 45% of respondents were between 18 and 35 years old, and roughly one-third were 36–50 years old in every region. The Western region had comparatively fewer young adults (40% in the 18–35 category) and a slightly greater share of older people (about 23% above 50 years). The Northern region also showed a somewhat higher proportion of seniors (> 60 years, 13%) than other areas. Educational levels varied notably by region. Overall, nearly one-third of consumers had no formal schooling, and about 17% had only an informal (literate/Koranic) education. The Western region, in particular, had the highest percentage with no formal education (60%) and no respondents with any tertiary education. The Northern and North-Western regions likewise saw over half of their consumers with either no schooling or only Koranic schooling. By contrast, the Eastern and Southern regions were, on average, better educated. Roughly 31% of Eastern respondents had completed senior high school, and the Southern region had the highest share of university-educated consumers (around 10%) (Table 1).

4.2 Consumer Knowledge and Perceptions

4.2.1 General Awareness and Knowledge Gaps

Consumer awareness of mycotoxins was very low. Of the 427 survey respondents, only 170 (39.8%) were aware before the study explained that moulds growing on food can produce harmful substances (toxins) that could cause illness. In other words, two-thirds of people did not know that mouldy or spoiled foods could be poisonous beyond the obvious rot. Furthermore, an even smaller fraction was familiar with the specific term “mycotoxin”. Only 18 individuals (4.2%) answered “yes” when asked whether they had ever heard of “mycotoxins”. An additional 10.5% replied “not sure”, while the vast majority (85.3%) responded “no” (Fig. 2).

This indicates that the technical term “mycotoxin” is virtually unknown among the general public. Even among those who answered “yes”, specific knowledge was limited: when prompted to name types of mycotoxins, 14 of the 18 could identify aflatoxin (likely reflecting its presence in media or health messaging), but almost none recognized other toxin names. Only 3 knew ochratoxin, 1 person mentioned citrinin, and zero (0) named fumonisins or zearalenone. In fact, a few of those who said they had heard of “mycotoxins” could not correctly name any, suggesting possible confusion with other concepts. By contrast, basic awareness of mould in foods was somewhat higher, 29% of consumers

reported having seen mould on stored foods “often” or “sometimes”, and 46% acknowledged that certain foods can contain substances that cause illness, even if they didn’t know the term for it.

However, there were widespread misconceptions about the health risks of mouldy food. When asked, “Do you think eating food that has some mould can cause health problems?”, only 197 respondents (46.1%) answered “yes”, while 148 (34.7%) said “no” and 82 (19.2%) said they were “not sure”. In other words, more than half of consumers were unconvinced or unaware that consuming mould-contaminated food can be harmful. A follow-up question for those who answered “yes” (and some who were unsure) asked *which health problems they associate with mouldy food* (Fig. 3). The most commonly perceived issues were relatively mild: stomach pain (mentioned by 39% of all respondents) and diarrhoea (30%). Fewer linked mouldy food to severe illnesses; only 63 people (15%) mentioned liver cancer and 26 (6%) mentioned child growth stunting as possible outcomes, even though these are well-documented effects of certain mycotoxins. Interestingly, 145 individuals (34%) explicitly selected “no health effects” in this list, aligning with those who answered “no” to the previous question. This demonstrates a significant knowledge gap: a large proportion of Sierra Leonean consumers either believe that mouldy foods are harmless or only cause minor ailments, unaware of the potential for chronic, irreversible harm such as cancer or immune suppression. Qualitative comments from the survey reinforce this; many who consumed visibly mouldy items rationalized that “heat will kill the poison” or “a little won’t hurt.”

4.2.2 Demographic differences in knowledge

We observed variation in awareness and perceptions across demographic groups. Education level was a strong determinant of mycotoxin knowledge. Table 2 shows the breakdown: among respondents with no formal schooling or only informal Koranic education, only 3.0% had heard of mycotoxins. Those with primary or junior secondary education were similarly low (around 2–4% aware).

Table 2
Awareness of mycotoxins by education level

Education Level	Sample Size (N)	Heard of "Mycotoxins" (%)
No formal schooling or Koranic only	202	3.0
Primary schooling	48	2.1
Junior Secondary (JSS)	68	2.9
Senior Secondary (SSS)	79	5.1
Tertiary (College/University)	29	17.2
Source: Survey data, 2025		

In contrast, among the small subset with higher education (tertiary), 17.2% were aware, still low in absolute terms but significantly higher than others (χ^2 test, $p < 0.01$ for trend by education). Gender was not significantly associated with awareness in our sample: 5.0% of males vs. 3.5% of females had heard of mycotoxins ($\chi^2=1.98$, $p = 0.16$). Men scored slightly higher on specific knowledge; for instance, 8 of

the 15 individuals who could name aflatoxin were male, likely reflecting that men had, on average, slightly more formal education. Still, overall awareness was so low that both genders clearly need information. Urban vs. rural location likewise showed only a modest difference: intriguingly, none of the 16 respondents from the urban capital area knew the term “mycotoxin” (0%), whereas about 4.4% of rural respondents did. This could be due to the small urban subsample; it may also indicate that rural farmers have occasionally heard of aflatoxin via agricultural programmes, whereas city residents (who are more removed from farming) haven’t encountered the term. There was no significant urban–rural gap in the belief that mouldy food is dangerous; if anything, urban respondents were somewhat more likely to answer “yes” (56% vs 45%), though the sample size was limited. Age had no clear linear effect on knowledge: younger adults (under 30) were not more aware than older ones in this sample. In fact, awareness was uniformly low across all age brackets, suggesting an absence of mycotoxin education historically, both in schools and in community messaging.

4.3 Risk Perception and Attitudes

Beyond factual knowledge, we assessed risk perception and attitudes. Basic awareness of mould in foods was higher than technical toxin knowledge, but misconceptions were common. About 29% of consumers reported seeing mould on stored foods “often” or “sometimes,” and 46% acknowledged that foods can contain something that causes illness, yet over half did not understand the severity of the risk. When asked *“Do you think eating food that has some mould can cause health problems?”* fewer than half (only 46.1%) answered “yes,” while 34.7% said “no” and 19.2% “not sure”. In other words, more than half of consumers were unconvinced or unaware that eating mouldy food can be harmful (Fig. 4).

This is further reflected in their level of concern about food safety. In response to *“How concerned are you about mould/spoilage in the food you eat?”*, only a small fraction (3.5%) of consumers reported being very or extremely concerned, whereas the majority were “not at all concerned” (33.3%) or “a little concerned” (32.8%), with about 19.0% “moderately concerned”. This means two-thirds of consumers have low concern about food spoilage hazards. Consistent with that, trust in food safety appears to be moderate. When asked *who they believe is primarily responsible for ensuring food is free from such toxins*, the plurality (38.4%) put responsibility on government inspectors, while others pointed to farmers (17.3%), themselves as consumers (16.2%), or traders (15.0%) as primarily responsible, and 12.7% said “all of the above” should share responsibility (Fig. 5).

Thus, many consumers expect external entities (government or producers) to safeguard food, rather than feeling personally empowered to demand or ensure toxin-free food. This attitude may affect their behaviour. For example, if one assumes the government would prevent seriously harmful food from reaching the market, one might be less wary of mould at home.

4.4 Consumer Food Handling and Storage Practices

We found that household practices often fail to adequately prevent mycotoxin exposure and, in many cases, may contribute to it.

4.4.1 Behaviour when encountering mould

Consumers were asked a series of questions about *what they typically do if they notice that food, especially grains or staple foods, has mould or fungus*. Crucially, very few people consistently discard mouldy foods. While about 69% said they throw away foods with visible mould, further probing revealed this is situational rather than exclusive. Indeed, 69% reporting “yes” to discarding implies 31% never throw mouldy food away. Those 31% indicated that they always find an alternative use for spoiled items due to food scarcity or cost concerns. Moreover, even among the 69% who said they discard mouldy foods at times, many do so only when spoilage is severe. When presented with multiple potential actions, it became clear that most respondents employ a mix of salvage strategies short of full disposal. From the analysis, the proportion of consumers who acknowledged each behaviour (Table 3).

Table 3
Behaviour when encountering mould

Variables	Response	Frequency	Percent
Discard the item entirely	Yes	295	69.09
	No	131	30.68
Cut off the mouldy parts and eat the rest	Yes	261	61.12
	No	164	38.41
Wash or soak the food	Yes	270	63.23
	No	156	36.53
Feed it to animals	Yes	274	64.17
	No	153	35.83
Dry the food in the sun again	Yes	292	68.38
	No	135	31.62
Bury it, throw it away outside, or give it away	Yes	194	45.43
	No	233	54.57
Source: Survey data, 2025			

By specific analysis, *discarding the item entirely*: 69% (the highest single response). Notably, only about 28% said they usually discard first when they see mould, suggesting that for many, discarding is a last resort if other remedies fail. *Cut off the mouldy parts and eat the rest*: 61%. In practice, many people cut away visibly mouldy portions of bread, tubers, fruits, or even pick out mouldy kernels from grain, then consume the remainder. *Wash or soak the food (often in saltwater or warm water) “to make it safe”*: 63% reported doing this. For example, mouldy dried cassava or corn may be washed before cooking, under the false belief that washing removes toxins. *Dry the food in the sun again*: 68%. Sun drying is common

for damp or mouldy grains and peanuts; people hope to stop further mould growth, though by the time mould is visible, toxins may already be present. *Feed it to animals*: 64% admitted to feeding mouldy or substandard foods to livestock or poultry. This passes the toxins to animals, potentially entering meat, milk, or eggs, or at least indirectly into the food chain. It's seen as a way to avoid waste "If it's not good for us, we give it to the chickens," some said, not realizing the toxins can carry over. *Bury it or throw it away outside / give away*: 45%. This was the least common response. Some households toss spoiled food into the garbage pit or bury it (45% have done so), and a few mentioned giving it to neighbours or others (though this is rare and ethically troubling) (Fig. 6).

It is important to emphasize that these actions are not mutually exclusive; many participants reported using several of these methods depending on the situation. For instance, a person might sun-dry and store mouldy grain for animal feed, or cut off the mould from a tuber, then wash and cook the rest. Very few consistently threw away all mouldy items, even when spoilage was extreme. This behaviour is likely driven by economic necessity (food insecurity makes people reluctant to discard food) and a lack of awareness of the invisibility of toxins. As one mother explained, *"If the rice just has a bit of fungus on some grains, I pick those out. I can't afford to waste a whole pot."* Such practices, however, do not eliminate mycotoxins. Toxins can diffuse beyond the visibly mouldy area, are not reliably removed by washing, and are heat-stable (normal cooking won't destroy them). Our finding that 84% of respondents who recognized health risks would discard mouldy food, compared with only 53% of those who believed it harmless, underscores that knowledge influences practice. Those unaware of the danger tend to consume or repurpose mouldy foods much more often (this association was statistically significant, $p < 0.001$).

4.4.2 Sorting and cleaning practices

One positive finding is that most consumers clean and sort grains at some point. When preparing staples such as rice, maize or groundnuts, 83.6% said they sort or pick out discoloured or damaged pieces. However, the timing of sorting is suboptimal for prevention: 59.7% indicated they sort only "at the time of use", that is, right before cooking (Table 4).

Table 4
Sorting and cleaning practices

Variable	Frequency	Percent (%)
Do you sort or clean the grains?		
Yes	357	83.6
No	69	16.2
Missing	1	0.2
How often do you sort or pick through stored foods?		
Only at the time of use	255	59.7
Never	68	15.9
Every few months	23	5.4
Often – at least monthly	9	2.1
<i>Source: Survey data, 2025</i>		

Only approximately 7% sort their grains regularly during storage (monthly or every few months), and 16% said they never remove mouldy pieces. These were generally the same individuals who answered “no” to sorting. Because most sorting occurs just before cooking, mouldy kernels often remain in the stored bulk for weeks or months, where they can spread spores and toxins. Early removal (at harvest or soon after) is a known best practice to limit mycotoxin development but it appears uncommon in households, likely due to labour and time constraints. In line with this, only 9% of consumers reported using any preventive treatment or additive during storage (such as mixing grains with dried pepper, ash, or other traditional mould inhibitors). The vast majority store their staples in untreated form (Table 4).

4.4.3 Storage methods and duration

We asked how people store their staple crops or purchased grains. The most common storage containers were woven polypropylene or jute bags (used by 42% of households) and plastic containers (38%), such as buckets or drums. Only 6–7% used airtight containers (such as modern hermetic bags or sealed bins). Others kept food in open bowls or traditional woven baskets (around 7% combined). Storing in breathable bags or open containers in a humid tropical climate predisposes the contents to moisture uptake and fungal growth, particularly during the rainy season. Regarding storage duration, most households do not keep grains for very long. 40.5% consume stored grains within 1 month, and 41.9% within 1–3 months, but about 17.6% store for over 3 months (5% even beyond 6 months). Longer storage increases the risk of mould if preservation measures are inadequate. Indeed, roughly 80% of respondents said they sometimes or always find mould on their stored grains or nuts (16% “always” and 64% “sometimes”, versus 13% “rarely” and 7% “never”) (Fig. 7).

It's notable that 89% of respondents involved in farming answered "yes" to the question "*Do you dry your crops properly after harvest?*", suggesting awareness of the need to dry. However, "properly" is subjective; many likely sun-dry for a few days but may not achieve sufficiently low moisture content, especially when drying on the ground or if rain interrupts. Drying is often done in the open air 35% of consumers who farm cited "unpredictable weather" as the top challenge in preventing mould (sudden rains or high humidity can re-wet crops). Only 9 of 45 farmers in the consumer sample reported a lack of storage equipment as a challenge; most rural households rely on household bag storage. Taken together, these data suggest that while basic traditional practices such as sun-drying and hand-sorting are known and used, technical and resource limitations hinder optimal mycotoxin prevention. For example, few have access to drying tarps, moisture testers, or improved storage bags that could help keep mould at bay (Fig. 7).

5. Discussion

This study provides for first time a comprehensive assessment of consumer knowledge, perceptions, and practices related to mycotoxins in Sierra Leone. The findings reveal critical gaps in awareness, widespread misconceptions, and risky household behaviours that collectively heighten exposure to aflatoxins and other mycotoxins. The result depicted that education was the strongest determinant of awareness. Only 3% of respondents with no formal schooling or Koranic education had heard of mycotoxins, compared with 17% among those with tertiary education. This findings is consistent with study from Ghana, where higher education was directly associated with greater knowledge of aflatoxin occurrence and management [10]. Similarly, Chilenga et al. in Malawi reported that literacy and formal schooling significantly improved recognition of mouldy food as unsafe [13]. Gender and age, however, were not significant predictors in Sierra Leone, echoing findings from Cameroon where both men and women demonstrated uniformly low awareness [11]. These results underscore the pivotal role of education and extension services in shaping food safety knowledge.

Awareness of the term "mycotoxin" was virtually absent (4.2%), and even among those familiar, knowledge was limited to aflatoxin. More than half of consumers did not believe mouldy food could cause health problems, with many assuming that cooking or washing neutralizes toxins. These misconceptions are consistent with reports from Malawi and Cameroon, where consumers rationalized that "heat kills poison" or "a little mould won't hurt"[11, 13]. Such beliefs are dangerous given that mycotoxins are heat-stable and diffuse beyond visibly mouldy areas. The Sierra Leonean data therefore reinforce the urgent need for public health campaigns that emphasize the invisible and persistent nature of these toxins.

Only 3.5% of respondents expressed strong concern about food spoilage hazards, and most placed responsibility for food safety on government inspectors rather than themselves. Our finding corroborates with study in Cameroon where consumers expected traders and regulators to safeguard food quality [11]. Such attitudes reduce consumer vigilance and perpetuate acceptance of substandard products. In

Sierra Leone, this dynamic may explain why traders continue to monetize mouldy stocks through informal channels, inadvertently sustaining exposure.

Behavioural responses to mould were largely inadequate. While 69% reported discarding mouldy food, many admitted to cutting off mouldy parts (61%), washing (63%), or sun-drying (68%) contaminated items. Feeding mouldy food to animals was also common (64%), creating risks of toxin carry-over into meat, milk, and eggs. These practices are consistent with findings in Malawi, where economic necessity led households to salvage contaminated food rather than discard it [13]. Sorting and cleaning were widespread (83.6%), but mostly performed at the time of cooking rather than during storage, allowing mould to spread. Storage methods were dominated by woven bags and plastic containers, with minimal use of hermetic technologies. Similar reliance on traditional storage has been reported in Nigeria and Kenya, where inadequate drying and poor storage infrastructure exacerbate aflatoxin contamination [10].

6. Conclusion

This study demonstrates that consumers and key food-system actors have critically low awareness of mycotoxins, widespread misconceptions about their risks, and household practices that perpetuate exposure across the food chain in Sierra Leone. These troubling gaps mean that mycotoxin contamination remains largely uncontrolled from field to table, increasing the likelihood of chronic dietary exposure and associated health outcomes.

The findings underscore the urgent need to addressing consumer education is essential to correct misconceptions and increase risk perception through massive public awareness campaigns, economic and structural support is needed to reduce overreliance on traditional practices by subsidizing for hermetic bags, provision of drying tarpaulins, and community grain banks could mitigate food insecurity pressures that drive risky behaviours, and market regulation and trader engagement are crucial as traders act as gatekeepers but often re-channel mouldy products; training and certification schemes could incentivize safer practices. Without such interventions, chronic mycotoxin exposure will continue to undermine public health, food security, and international trade in Sierra Leone. Hence, the authors put forward the following actionable recommendations.

1. Launch and invest in a national, multi-sectoral awareness campaign leveraging mass media to promote food safety, mycotoxin risk and management across the food value chain.
2. Mycotoxin management strategies should be mainstreamed into national development frameworks to ensure food safety is integrated with agricultural extension, education, health, and economic development goals.
3. Strengthen regulatory enforcement through sustained investment in Codex-aligned standards, capacity-building for regulatory authorities, and innovative testing infrastructure to enable periodic monitoring of food and feed nationwide.
4. Stakeholder collaboration should be promoted through multi-sectoral platforms that integrate government, academia, private sector, and international partners to coordinate food safety

interventions.

5. Boost research and surveillance capacity to generate robust data on mycotoxin prevalence, impacts, and mitigation outcomes, supporting evidence-based policy decisions.

Declarations

Ethics approval and consent to Participate

The study was conducted in accordance with the Declaration of Helsinki and approved by Njala University Institutional Review Board (IRB) and Ministry of Health and Sanitation Ethics Committee. Informed consent was obtained from all participants.

Consent for publication

All participants were informed that anonymised data collected in the study could be used in scientific publications, and consent for publication was obtained.

Competing interests

The authors declare no competing interests.

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Author Contribution

P.M.N, M.S.E.W-N and O.N: Conceptualization, methodology, and software. O.N, P.M.N, M.S.E.W-N, S.M and A.M: Investigation, data curation, formal analysis, validation, and visualization. O.N, S.M.M, P.M.N, M.S.E.W-N, S.M, and A.M: Writing- original draft, writing review & editing. All authors read and approved the manuscript.

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Data Availability

Data will be made available on request.

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Figures

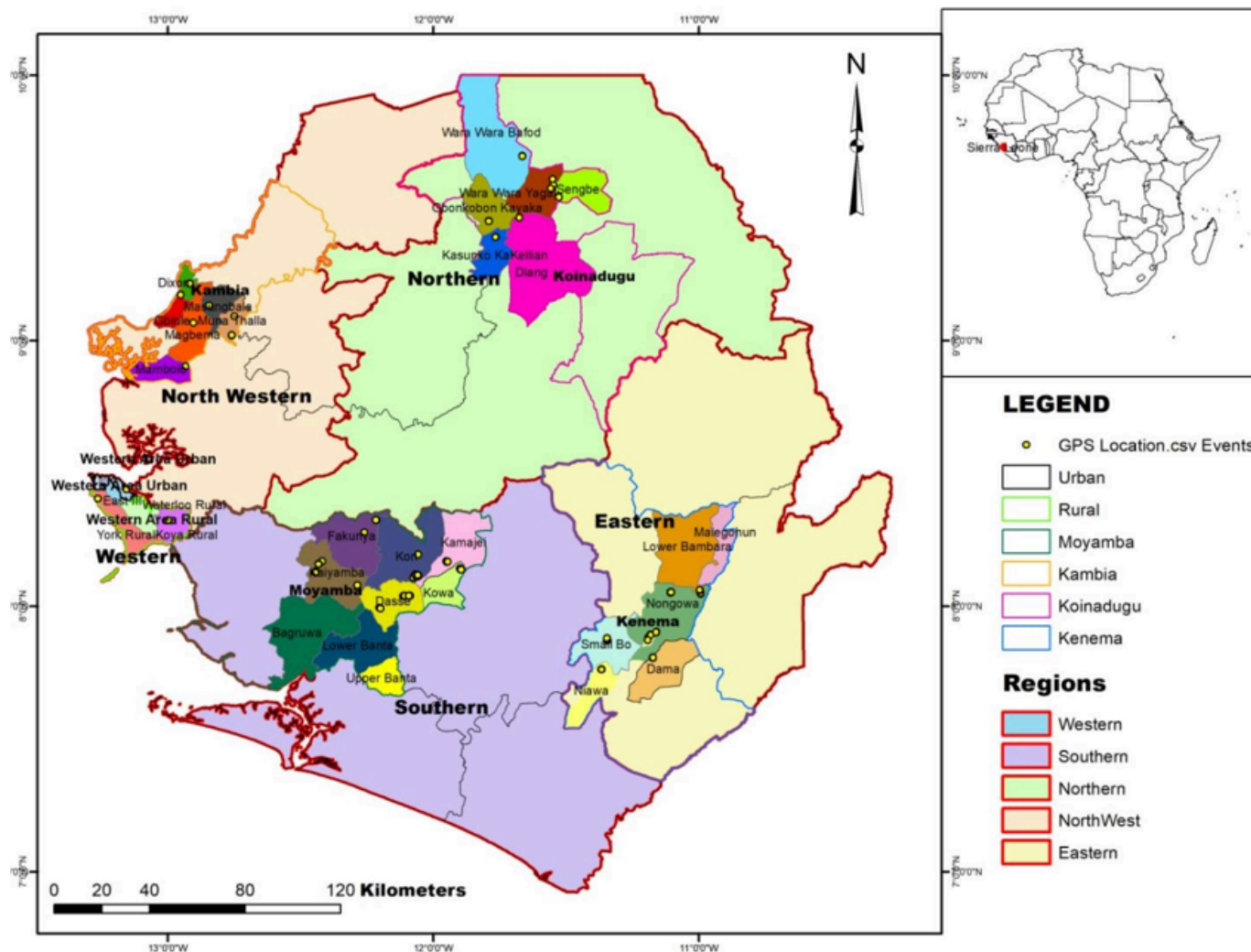


Figure 1

Map showing Study Areas

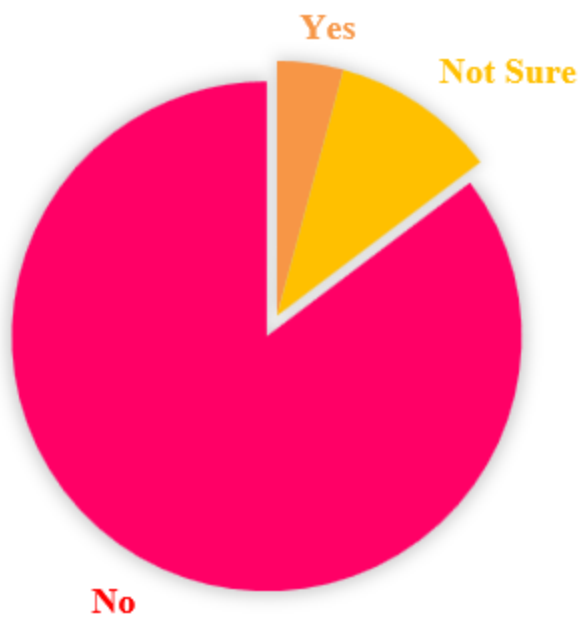


Figure 2

Awareness of mycotoxins among consumers

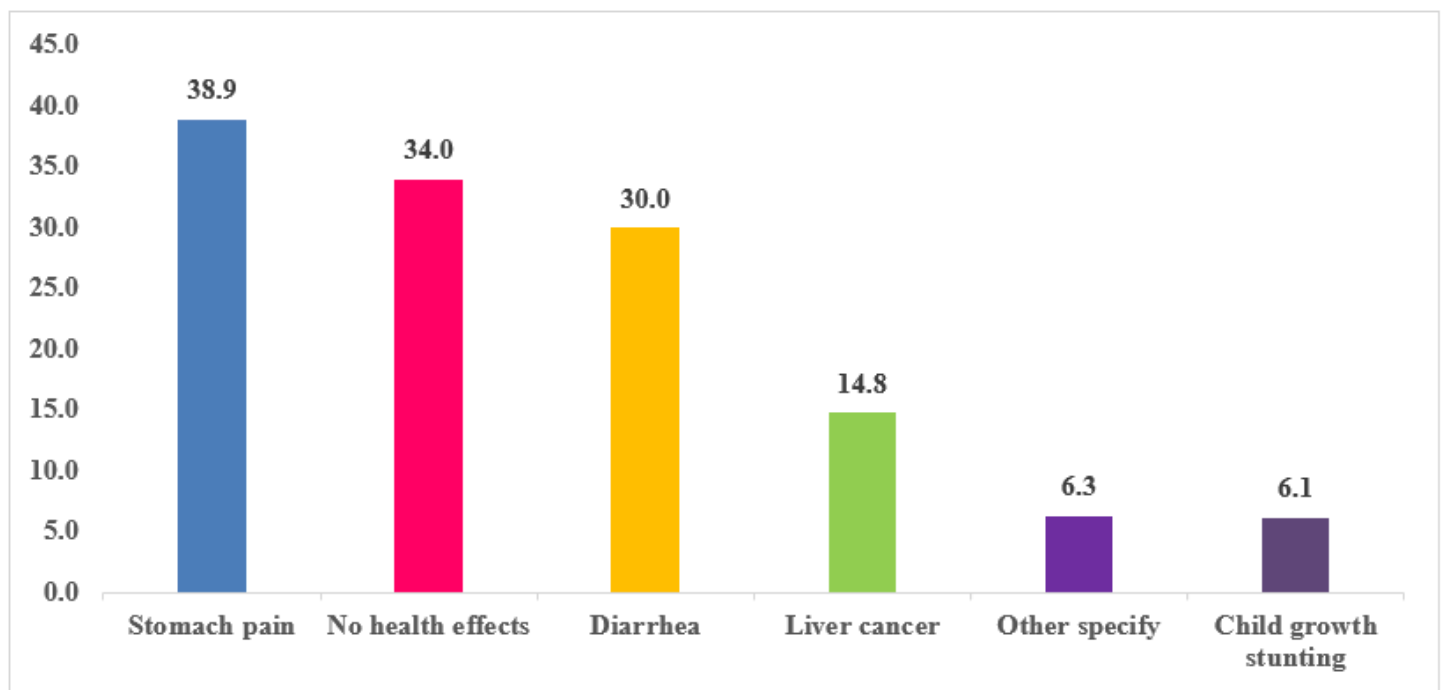


Figure 3

Nature health problems associated with mouldy food

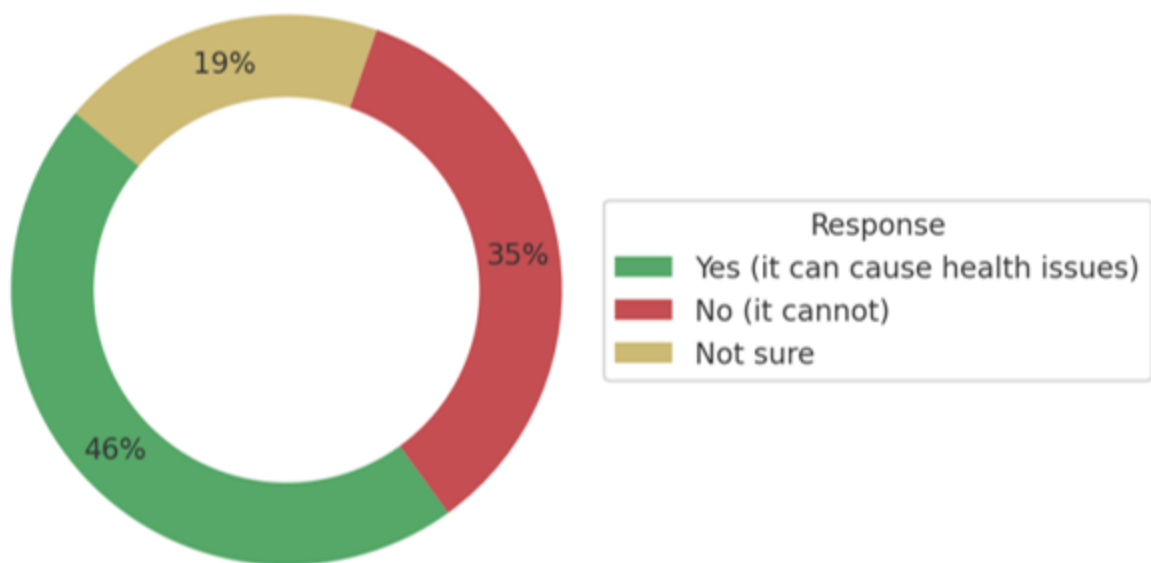


Figure 4

Belief that eating mouldy food causes health problems