DRIVERS OF POST-HARVEST AFLATOXIN CONTAMINATION: EVIDENCE GATHERED FROM KNOWLEDGE DISPARITIES AND FIELD SURVEYS OF MAIZE FARMERS IN THE RIFT-VALLEY REGION OF KENYA
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ABSTRACT

Maize-dependent populations in sub-Saharan Africa are continually exposed to aflatoxin poisoning owing to their regular consumption of this dietetic cereal. Being a staple in Kenyan households, consumption of maize-based meals is done almost daily, thereby exposing consumers to aflatoxicoses. This study assessed awareness levels, knowledge disparities and perceptions regarding aflatoxin contamination at the post-harvest phase among farmers in the Rift-valley region of Kenya. Households were randomly selected using a Geographical Positioning System (GPS) overlay of the agro-ecological zones within Uasin Gishu and Elgeyo Marakwet counties. Face-to-face interviews were conducted in 212 smallholder and large-scale farms. The study documented the demographic profiles of farmers, knowledge, awareness, and perceptions of aflatoxin contamination using a pre-designed structured questionnaire. Most farmers were familiar with aflatoxins and the adverse effects they present to health (61.32%). Almost all the farmers (94.37%) were aware of storage molds and food spoilage fungi. However, few farmers adopted good post-harvest practices (PHPs) such as avoiding premature harvests (49.8%), using well-ventilated storage spaces (44.6%), grain sorting (30.5%), proper drying of maize (17.8%) and using hermetic bags for storage (30.5%). Conclusively, intensified farmer education is required to train farmers on good PHPs to protect their maize from aflatoxigenic fungi and aflatoxin accumulation.

INTRODUCTION

Tropical food systems increasingly remain predisposed to frequent mycotoxin outbreaks thatcripple all possibilities of them being self-sustaining. In Kenya, massive attention is aways diverted towards the localities where fatal mycotoxicoses tend to occur, while other regions, though being equally at risk, tend to be neglected. A classic example are the lethal aflatoxicosis outbreaks that have transpired in Eastern Kenya spanning over several years. All of them have received overwhelming attention (Lanyasunya et al. 2005; Azziz-Baumgartner et al. 2005; Daniel et al. 2011; Okoth et al. 2012; Kang'ethe et al. 2017), whilst agricultural zones in the western regions remain unexplored. The Rift Valley region of Kenya is one such location where little research on mycotoxin and aflatoxin contamination has been conducted although it is the country's food basket, particularly when it comes to maize cultivation and production. The aforementioned geographical location produces approximately 80% of maize countrywide (Reynolds et al. 2015).

Consumers across Kenya rely on this maize for their self-reliance, a factor that denotes the importance of assessing the aflatoxin situation in this region. Zero aflatoxin or mycotoxin outbreaks have been reported in the Rift Valley, and the lack of surveillance programs could be solely responsible for this observation. In a singular study, Mutegi (2010) reported high prevalence of aflatoxin contamination in peanuts (*Arachis hypogaea* L.), but since its

consumption is not as widely popular as maize, the revelation did not receive much attention. Being a tropical country, Kenya primarily cultivates its maize under agro-climatic conditions that are known to accelerate fungal colonization and subsequent mycotoxin multiplication (Mutiga et al. 2015; Okoth et al. 2018).

Most people practicing maize cultivation are resource-poor farmers whose pre- and post-harvest practices easily subject the cereal to increased mycotoxin contamination. The objectives of this study were to assess the magnitude of aflatoxin contamination in two major maize cultivation regions where minimal research on mycotoxin prevalence has been conducted, namely Uasin Gishu and Elgeyo Marakwet counties located in the Rift Valley Region of Kenya. The study further sought to investigate the main drivers of post-harvest aflatoxin contamination by assessing knowledge disparities by conducting field surveys among both large-scale and small-scale maize farmers.

MATERIALS AND METHODS

Study regions

Regional site surveys were conducted in Uasin Gishu (Fig. S1) and Elgeyo Marakwet (Fig. S2) counties between June and November 2021. Both counties fall within the Rift Valley, an administrative region popularly known for large-scale cereal cultivation and production, including maize, millet, sorghum, and wheat. By far, maize accounts for the widely cultivated cereal, with nearly most farmers growing the crop in either small or large scale. The corresponding agro-ecological zones (AEZ) for both counties were categorized into either of the following: (1) upper highlands (UH); (2) upper midlands (UM); (3) lower midlands (LM); (4) highlands; (5) lowlands; and (6) escarpment. Within each county, sub-counties or smaller administrative districts were selected as preferential field survey hubs. In each sub-county, villages were purposively selected and a total of 213 farmers interviewed subject to their consent to take part in the study.

Questionnaire design, development, administration, and data collection

Structured questionnaires designed using KoboCollect Toolkit open-source Software (KoBoCollect v2021 1.3.4, Harvard University, Cambridge, MA, USA) were administered to maize farmers for purposes of obtaining quantitative data on post-harvest practices.

The questionnaires were organized according to the following sub-sections: (1) sociodemographic information; (2) maize cultivation practices; (3) major post-harvest pests and diseases; and most importantly, (4) participant knowledge and awareness of mycotoxins.

RESULTS AND DISCUSSION

Farmers across Uasin Gishu and Elgeyo Marakwet practice both small- and large-scale farming depending on available land acreage. Maize varieties commonly grown in the Rift Region are the hybrid series, with Hybrid-614 (H614) being the most popular among farmers at 41.53%, followed closely by H6213 at 39.87%. Some farmers opted for indigenous maize varieties such as *Ndume, Pannar, and Duma* due to their large cob size, disease tolerance, high yielding abilities and kernel type. When the chi-square test was applied in testing the fit of association between knowledge of aflatoxin and the variables of gender and level of education, the former showed a significant difference ($p < 0.05$), indicating that gender plays a pivotal role in aflatoxin awareness and management in the study region. The variables of age, county of residence, income-generating activity, and level of education were not significantly associated with knowledge of aflatoxins, as their p-values were all greater than the level of significance ($p > 0.05$).

The present study sought to investigate the knowledge disparities, perceptions, and awareness levels of aflatoxin contamination among maize farmers residing in the Rift Valley Region of Kenya. Recurrent outbreaks of acute aflatoxin poisoning and fatal aflatoxicosis in Kenya associated with consumption of contaminated maize are often reported in the Eastern Region (Machakos, Makueni, and Kitui). Hardly do these reports highlight any outbreaks in the Western or Rift Valley Regions, which could equally be possible risk-alert areas. It remains unsubstantiated whether mycotoxins are a periodic, sporadic, or chronic problem in the aforementioned areas where these fatalities have not yet been reported. Deemed the breadbasket of Kenya, the Rift Valley produces the bulk of Kenyan maize and is primarily where the cultivation and production of this important cereal is done majorly in large scale. With agriculture generating revenue and income for more than half of the households residing in Uasin Gishu and Elgeyo Marakwet Counties, the importance of farming in this area cannot be overemphasized. In the current study, we endeavored to extend the understanding of the aflatoxin situation in the Rift Valley, Kenya's highest maize-producing region, through increased interviewing of farmers whilst undertaking farm assessments across multiple locations.

The regional survey specifically targeted the post-harvest level, particularly storage, while Mutegi (2010) compared the findings to pre-harvest parameters such as climatic patterns, cropping systems (mono-cropping versus mixed cropping), harvesting techniques, and other important farm-management practices. Approximately 78% of people residing in Uasin Gishu and Elgeyo Marakwet Counties earn their living primarily through engagement in crop farming and livestock husbandry (MoALF 2017). Nonetheless, despite these regions being the trailblazers in maize farming, scarce comprehensive mycotoxin surveys have been conducted in the region to ascertain whether there is any prevalence of aflatoxins. Our study revealed that even though a fraction of the farmers were well-versed with aflatoxin contamination at post-harvest, most of them still required intensive training to be taught about the importance of adhering to good post-harvest practices and how these would protect their maize from aflatoxin accumulation.

Aflatoxin surveillance and mycotoxin monitoring is evidently paramount not only in the known hot-spot regions but also in the breadbaskets of Kenya, where there is high maize production.

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