Sub-theme:

Industry Role in Implementation of Successful Phytosanitary Systems

Title:

The role of regulatory institutions in safeguarding consumers against aflatoxin exposure: a case of KEPHIS

Presented by:

Edmond Momanyi

Introduction

- Aflatoxins are a group of structurally related toxic metabolites produced by *Aspergillus flavus* and *Aspergillus parasiticus*. Among aflatoxins, aflatoxin B1 is the most frequent metabolite present in contaminated foods and is classified as a human carcinogen. Generally, aflatoxin B_2, aflatoxin G_1 and aflatoxin G_2 are reported in the absence of aflatoxin B_1 and are classified as possible carcinogens to humans. Epidemiological studies have also suggested that aflatoxins might be associated with human cancer and acute hepatitis.

- Because of potential health hazards to humans, regulatory levels have been recently documented. Recently, the Codex Alimentarius Commission, Joint FAO/WHO Food Standards Program adopted a limit of 15 µg $kg^{-}1$ for total aflatoxins (Codex standard 193-1995). In Kenya, a maximum limit of 5 µg kg^{-1} aflatoxin B_1 and 10 µgkg^{-1} total aflatoxin for foodstuffs has been established since 1989.

Introduction cont'

- A review of monitoring studies on the aflatoxins occurrence in maize and ground nuts products has demonstrated that aflatoxins are still being found frequently in these food commodities at levels that are of significant concern for consumer protection. Recently, a study on aflatoxin contamination in Kenya revealed that 30% of the maize samples and 40% of the groundnut samples tested had high levels of aflatoxins of above 5 µg kg^{-1} aflatoxin B_1 and 10 µg kg^{-1} total aflatoxin. This exceeds the maximum limits for both aflatoxin B_1 and total aflatoxin in maize and ground nuts as per the codex and Kenyan standards. Aflatoxin B_1 was the most prevalent in all the samples tested during the period of the survey.
- High performance liquid chromatography analysis is convenient and accurate for simultaneous determination of contaminants and suitable for separation and quantification of aflatoxin contaminants in a wide range of matrices.

Problem Statement

- Aflatoxins are secondary metabolites produced by *Aspergillus flavus* and *Aspergillus parasiticus* fungi. They occur naturally in food and can cause severe sickness or death and can cause large economic losses. Aflatoxin contamination in maize and groundnuts is still a major problem in Kenya due to poor post-harvest handling.
- Prevention of aflatoxin contamination is a complex process; it requires large capital investments and a multidisciplinary approach to safeguard consumers from exposure.

Justification

- The effect of mycotoxin especially aflatoxins to humans as well as the environment has become a major concern, affecting trade in food due to the adverse effects of mycotoxins.
- With the growing concern on food safety (human health and environmental exposure) the monitoring program is an important tool for assessing mycotoxin levels in cereals and therefore enhancing food security in the country, facilitating trade and sustainable development.
- Therefore, there is need to enhance and support aflatoxin surveillance focusing on commodities which are of economic importance to the country for local consumption.

Objectives

General objective

The survey was designed to obtain representative samples for aflatoxin analysis, as a measure to check the compliance levels of aflatoxin (Total Aflatoxin and Aflatoxin B1) in maize and groundnuts.

Specific objective

To determine the levels of compliance of maize and groundnuts to codex Maximum Levels for aflatoxin contaminants.

To establish regions and commodities with higher risk of aflatoxin contamination.

To provide recommendations for future work.

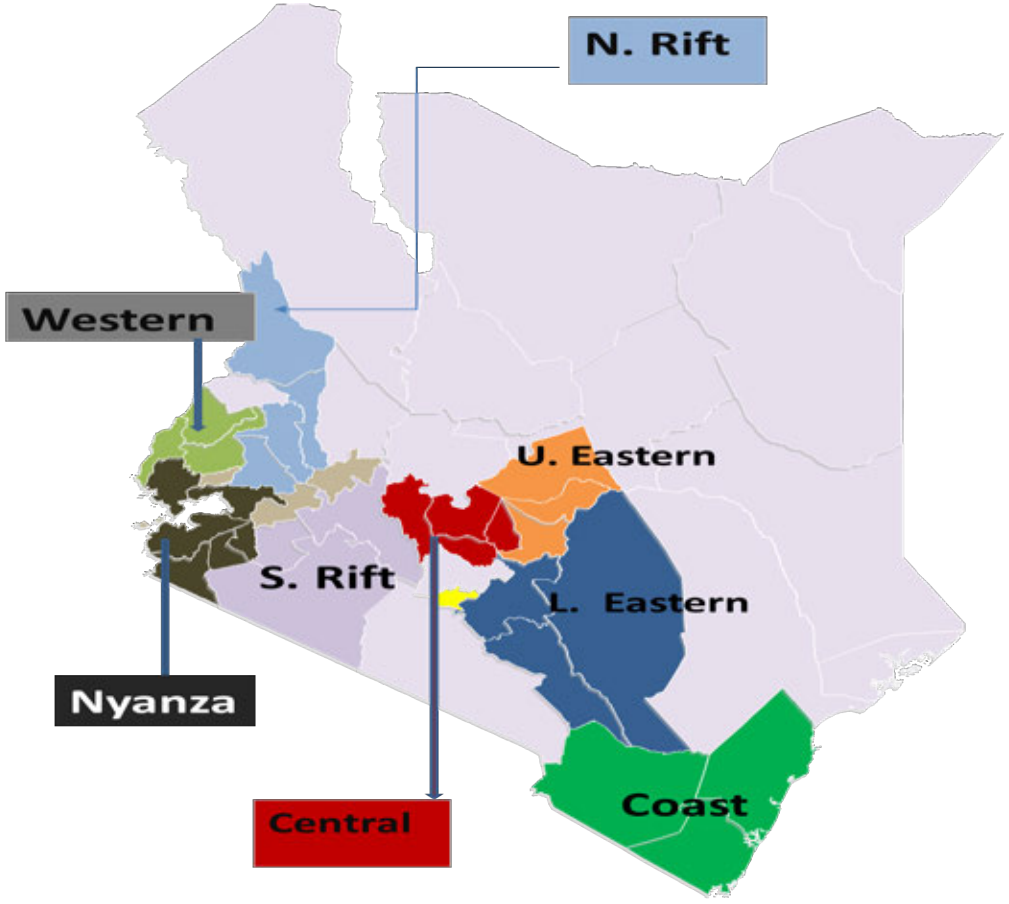
Methodology

- To obtain representative samples and ensure unbiased during data Collection, random sampling methods will used to carry out the survey.
- Clustering of the counties was based on production areas of cereal crops and data on previously reported aflatoxin contamination on cereals particularly maize. The regions of lower and upper eastern has been allocated a larger volume for sampling since it is identified as a high risk area for aflatoxin contamination.

Methodology cont'

- The KEPHIS analytical chemistry laboratory has established aflatoxin testing laboratory using organic solvents for extraction and liquid chromatography for analytical testing. From 2018 to 2020, KEPHIS has initiated risk-based aflatoxin market surveillance programs for cereals and groundnuts in 30 counties in Kenya as well as sampling of Cereals and groundnuts imports at border points for aflatoxin testing.
- The sampling design was referenced from the guidelines of European commission regulation on sampling and analysis of aflatoxins in food products EC No 401/2006.

Methodology cont'



Thirty counties were targeted:

Makueni, kitui, Machakos, Tharaka-Nithi, Meru, Embu, Nyeri, Kirinyaga, Nyandrua, Muranga,

Elgeyo-Marakwet, Uasin gishu, Trans-nzoia,West pokot, Kericho, Nakuru, Narok,

Bungoma, Kakamega, Busia, Siaya,Kisumu,Homabay,Migori,Kisii,Nyamira,

Taita taveta, Mombasa, Kwale and Kilifi Counties

Methodology cont'

Materials

- Methanol and Acetonitrile used was HPLC grade supplied from fisher scientific chemicals while the HPLC-grade water was prepared in the laboratory by double distilling followed by deionization.
- The Aflatoxin standards were purchased from Sigma Aldrich. Stock standard solutions of aflatoxin B1, B2, G1 and G2 with concentrations 1 mg/kg of were prepared in acetonitrile and stored in dark brown bottles to prevent gradual break down of aflatoxins under UV light and kept under protected conditions at -20^0C. All other inorganic chemicals and organic solvents were of analytical grade.

Methodology cont'

Aflatoxin Analysis

- For HPLC analysis of aflatoxin B_1, the cereal powder samples were extracted as follows: a 10 g sample was extracted with 40 ml of 84% acetonitrile for 45 min with vertical shaking. After extraction, the sample was filtered with filter paper (Whatman No. 1).
- For ground nuts samples, a 5 g sample was extracted with 10 ml of 100 % acetonitrile, 10mls of HPLC grade water and 6.5g QuEChERS extraction salts followed by shaking on a Geno grinder for 1 min. After extraction, the sample was centrifuged at 4,000 rpm for 5 min and 5 ml of the supernatant was transfer to 15ml centrifuge tube containing 1g of QuEChERS cleanup salt followed by shaking on a Geno grinder for 1 min then centrifuged at 4,000 rpm for 5 min.
- An aliquot of sample was diluted with HPLC water with 1% acetic acid and analyzed for aflatoxin B1, B2, G1 & G2.

Methodology cont'

- Aflatoxins in the samples were quantified by HPLC subsequent to partitioning, and photo chemical derivatization based on the AOAC method 991.31 (2000) with minor modifications.
- HPLC analysis was carried out by using a Shimadzu HPLC system equipped with a prominence fluorescence detector. The chromatographic separation was performed on a zorbax C_{18} column (50mm x4.1 IDx3.5µm) using a gradient system of water : acetonitrile : methanol mobile phase at a flow rate of 0.9 ml/min.
- Detection of aflatoxin was carried out using 365nm and 460 nm as wavelengths for excitation and emission, respectively. In method of HPLC, the recoveries of aflatoxin B1, aflatoxin B2, aflatoxin G1, aflatoxin G2 on spiked samples were 70 – 130%.The estimated LOQ of aflatoxin B1, aflatoxin B2, aflatoxin G1 &aflatoxin G2 was 2 µg/kg

Results

Natural occurrence of aflatoxin

- For the three year period the surveillance was conducted the levels of aflatoxin detected in maize and groundnuts was as shown in the next table. The contamination levels varied from **LOQ (2 µg kg-1) to 510.62 µg kg-1 in maize and LOQ (2 µg kg^{-1}) to 411.31 µg kg^{-1} in groundnuts**
- Total aflatoxin levels in **341 maize** samples and **103 groundnuts** samples were higher than the permitted level (10 µg kg-1 total aflatoxin) established in Kenya as per the Kenyan standard on aflatoxin.
- Measurable levels of aflatoxins found in maize and groundnuts sampled from counties and border points are indicated in the next table.

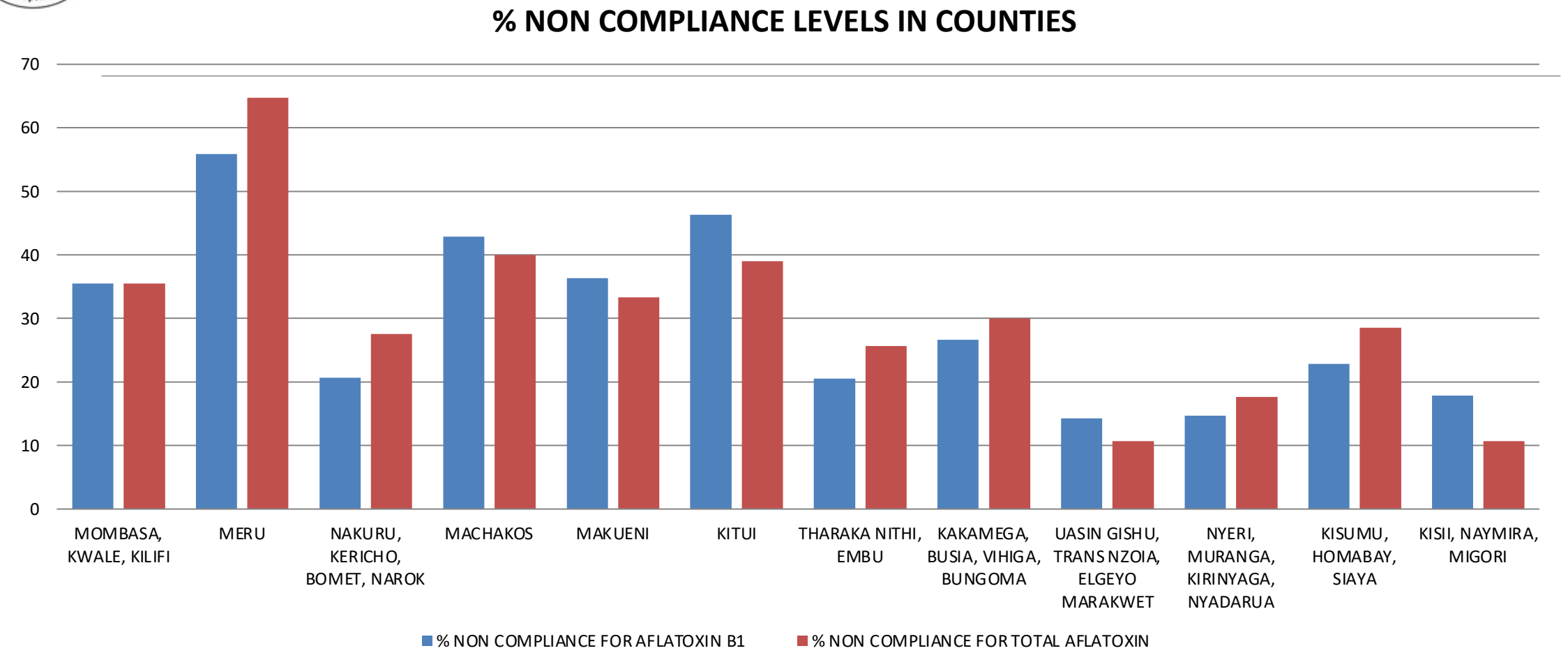
Results cont'

Samples from Local markets					Samples from Borders		
Year	**Commodity**	**No of samples**	**Non-compliance level**	**Occurrence range for total Aflatoxin (µg/kg)**	**No of samples**	**Non-compliance level**	**Occurrence range for total Aflatoxin (µg/kg)**
2018	**Maize**	400	20.51%	2 to 57.96	NA		
	Groundnuts	25	39.39%	2 to 102.32	NA		
2019	**Maize**	241	38.43%	3 to 510.62	251	19.44%	3 to 50.57
	Groundnuts	96	41.20%	3 to 236.02	19	35.29%	3 to 410.89
2020	**Maize**	221	32.73%	2 to 182.96	111	41.74%	3 to 262.31
	Groundnuts	98	40.81%	2 to 810.23	17	35.26%	3 to 411.35

Results cont'

- The survey established that maize and groundnuts were the most common commodities contaminated with aflatoxin thus giving an indication of possible high consumer exposure to aflatoxin since maize and groundnuts have a high consumption level in Kenya.
- The number of incidences and levels of aflatoxin in samples collected from counties in **lower and upper eastern, coast and some parts of Nyanza** were higher than in other counties.
- Aflatoxin contamination was prevalent in regions with adverse climatic conditions with high temperature and humidity. This are the favorable conditions for the growth of aflatoxin producing fungus *(Aspergillus flavus* and *Aspergillus parasiticus)*.

Results cont'



Results cont'

Aflatoxin contamination in maize and groundnuts sampled at border entry points was detected and the number of incidences and non-compliance levels of aflatoxin were as shown in the table below.

Border entry point	Total No of Samples analysed	% non-compliance for Aflatoxin B1	% non-compliance for Total Aflatoxin
Busia	111	49.21	46.03
Malaba	62	39.58	33.33
Loitoktok	16	33.33	22.22
Namanga	41	0	14.28
Taveta	40	27.27	27.27
Lungalunga	71	8.00	12.00

Conclusion

- The survey has established that there were incidences of high aflatoxin contamination in maize and groundnut samples collected in counties from **Nyanza, coast, lower and upper eastern** region where there is adverse climatic conditions of high temperatures and humidity that promote the growth of the aflatoxin producing fungus.
- The high noncompliance is majorly attributed to poor post-harvest handling and poor storage conditions by farmers and traders of maize and ground nuts.
- Aflatoxin contamination in maize and groundnuts locally produced and imported from neighboring countries is a food safety concern for the country.

Recommendations

- There is need to continuously engage farmers and traders on improved methods of post harvest handling of maize and groundnuts.
- Enhance the capacity of regulatory agencies such as **KEPHIS, KEBS** and **AFFA** to carry out inspections and aflatoxin rapid testing at border entry points.
- Multi-sectoral collaboration with other regulatory agencies and county governments in aflatoxin information dissemination and create awareness on aflatoxin management, hence safeguarding the health of the citizens and promoting safe trade.
- Facilitate implementation of risk-based monitoring as well as enhanced monitoring in areas that are found to be more susceptible to aflatoxin contamination to access the impact of awareness campaigns done on aflatoxin management.

Acknowledgements

Theme: *"Enhancing Phytosanitary Systems for Healthy Plants, Safe & Sustainable Trade"*
www.africa-cope.org

For more information, please contact:

www.africa-cope.org
www.kephis.org
Facebook.com/3rd phytosanitary Conference 2020
Twitter: @3rdphytoconf

Theme: *Enhancing Phytosanitary Systems for Healthy Plants, Safe & Sustainable Trade"*
www.africa-cope.org