Aflatoxin testing kit

Protects human health; helps meet international market standards

ICRISAT

INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

Science with a human face

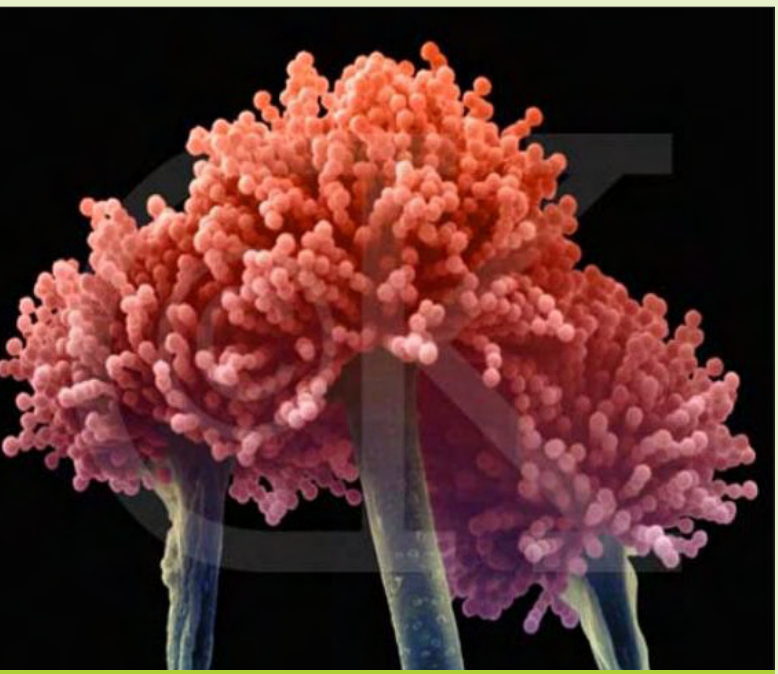
Introduction

Agricultural products are often invaded by fungi that can produce poisonous substances called Mycotoxins. Among mycotoxins, aflatoxins, produced by *Aspergillus flavus* and *A. parasiticus*, occur globally. Groundnut, maize, sorghum, pearl millet, chilies, pistachios, cassava and other food products are contaminated by aflatoxin each year. They affect human and livestock health, affect the marketability of food products, and hence are of great economic importance.

More than five billion people in developing countries are constantly exposed to aflatoxins by unknowingly consuming contaminated foods. A World Bank study estimates that the EU's standards for allowable aflatoxin in imported grains and nuts (4 parts per billion) costs Africa alone US$750 million every year. The Food and Agriculture Organization attributes a quarter of food spoilage due to mycotoxins, with losses of up to US$26 million recorded in the USA from groundnut aflatoxin contamination alone.

Many countries reject imports of agricultural products that exceed certain levels of aflatoxin, costing farmers millions of dollars each year in lost sales.

Acute intoxication of aflatoxin can result in death. The aflatoxicosis epidemics in Kenya, which occurred three times since 1981, resulted from ingestion of contaminated maize. During 2004, the outbreak of acute hepatotoxicity with 317 cases



The fungi Aspergillus flavus *that produces aflatoxin.*

Aflatoxin contaminated groundnuts.

and 125 deaths was one of the largest and most severe outbreaks documented worldwide.

Contamination can occur at any stage from pre-harvest to storage. Studies have shown that the fungi causing this poisoning are present in air and soil, affecting between 20 and 80% of crops at different levels in warm humid environments.

Pre-harvest infection is significant in the semi-arid tropics, especially when end-of-season drought occurs. Poor post-harvest conditions in warm humid areas, and bad harvesting and storage practices lead to rapid development of the fungi and higher levels of toxins. Storage of grains and nuts before they are properly dry, or in damp conditions, also creates opportunities for contamination. This is especially true in developing countries where preventive measures are frequently ignored.

Consumption of aflatoxins by human beings can lead to liver cancer. A person's chances of contracting cancer are compounded significantly if he/she carries the hepatitis B virus, as do an estimated 20 million people in India. Aflatoxins do their damage by suppressing the immune response. They affect poultry and, when present in cattle fodder (groundnut cake and haulms), the yield and quality of milk.

Children exposed to aflatoxin suffer from poor growth and immune suppression, making them susceptible to HIV and malaria.

Detection

Since the aflatoxin contamination is invisible in commodities, the key is detection. In developed countries, farmers routinely use detection technologies to manage outbreaks. Methods such as high performance liquid chromatograph (HPLC), high performance thin layer chromatograph (HPTLC), thin layer chromatograph (TLC) and antibody-based ones are available for routine

ELISA kit for aflatoxin detection and food products that are susceptible to infection.

quantitative estimation of aflatoxin. But in developing countries, the tests have been too expensive and too difficult for most farmers to implement. These tests are laborious, time consuming and require extensive sample cleanup.

High testing costs were also constraining the development of new resistant varieties and integrated management technologies.

cELISA kits for aflatoxin detection

It is in the face of such challenges that scientists at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) devised a fast, simple and affordable test kit for detection of aflatoxin. The test uses a competitive enzyme-linked immunosorbent assay (cELISA) to rapidly detect the presence of aflatoxin. The new detection kit has cut the cost of testing crops from US$25 to $1 per sample.

The results obtained using cELISA are comparable with that of highly sensitive HPLC results. This assay is simple to perform, requires minimum laboratory facilities and most of the chemicals are available locally in developing countries. This small kit can be used for even the most remote rural farms to monitor grains and nuts and improve storage techniques to avoid serious contamination.

This cELISA test provided a unique opportunity for ICRISAT and its partners to conduct field studies to select breeding populations, to develop pre- and post-harvest management technologies and to discover dietary sources of aflatoxin, thereby stimulating interventions that enhance safety of food and human health, trade, and ultimately farmers' income. The end result is safer products for consumers and higher returns for farmers.

Impacts

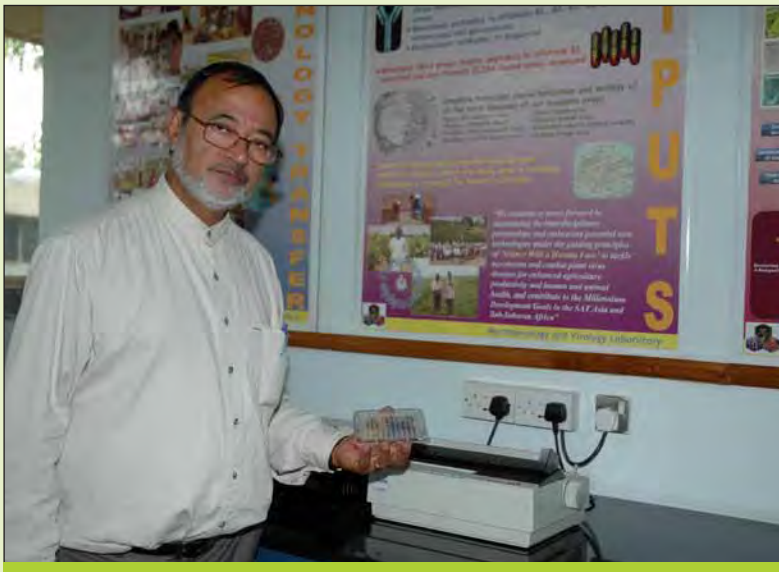
Responding to the increasing demand for more testing facilities, ICRISAT helped in setting up aflatoxin-monitoring laboratories in India, Mozambique, Kenya, Malawi and Mali where our cELISA technology is used. Local personnel were trained to manage the facility. The diagnostic reagents are widely distributed to partners in Asia and sub-Saharan Africa (SSA). These laboratories contribute to the quality certification of the farmers produce and enhance the competitiveness of the produce in domestic and international markets.

In Malawi, which saw its status in the 1970s as a major groundnut exporter eroded by aflatoxin outbreaks, the National Small Farmer Association of Malawi (NASFAM) has successfully used the new aflatoxin detection kit as part of a broader effort to regain and re-establish itself with its once-lucrative European export markets.

The low-cost kits are also being used in around 20 laboratories across the world to detect aflatoxin content. In India, several commercial seed companies use these kits with great success.

Future Thrusts

- Institutional participation in decisions to induce awareness among producers, traders, and consumers of the economic significance of aflatoxin contamination. These include risks to health and premium price for quality products.
- Develop cost-effective pre-harvest agronomic practices and post-harvest processing technologies
- Select low cost biocontrol agents and develop appropriate integrated management technologies



ICRISAT scientist displaying aflatoxin quantification using the ELISA reader.

- Identify genotypes, though conventional and non-conventional breeding (transgenics and interspecific derivatives), which can resist contamination at farm level
- Promote the technologies among marginal farmers as well as commercial holdings to result in production of quality nuts
- Monitor human exposure to aflatoxins, assessment of hepatic-toxic relationships and examine quality of household diets, the impact of household incomes on dietary choices and evaluate the effects of aflatoxins on HIV/AIDS.

Vimala Seeds, the second largest poultry manufacturer in Andhra Pradesh, benefits from use of the ELISA kits.

ICRISAT is planning to further upscale high yielding groundnut tolerant varieties and aflatoxin testing facilities to strengthen the local capacity for aflatoxin monitoring in SSA and Asia. Measures like these will yield favorable results to farmers, contribute to the production of aflatoxin-free food and enhance regional and international trade opportunities.

ICRISAT is developing resistant groundnut cultivars through breeding and biotechnological methods. Trials on an integrated management approach using bio-control agents, application of calcium and farmyard manure, showed a 99% reduction in aflatoxin.

The Consultative Group on International Agricultural Research (CGIAR) Centers have also established strong linkages with several universities and advanced research institutions in several countries to bring a long term solution to combat aflatoxins.

About ICRISAT

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The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 644 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

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