Continuous High-Speed Determination of Aflatoxins in Pistachios and Other Crops

Methods and technology to continuously monitor and non-destructively detect the presence of aflatoxin in pistachios

Background

Agricultural crops (including nuts, grains, and legumes) are often contaminated with mycotoxins, such as aflatoxin. Aflatoxins are highly toxic, cancer-causing fungal metabolites that suppress immune-systems, retard growth, disease livers, and cause death in both humans and domestic animals when present on foods or animal feed. Because of the impacts on human and animal health, their presence in food supplies and animal feed is highly regulated.

The Problem

Over 120 countries have regulations for maximum allowable aflatoxin levels in foods. 25% of world food crops are affected. Aflatoxin testing of crops, food items, and animal feed is routinely performed in a destructive fashion, where a representative portion of the crop or product is chemically extracted and analyzed using liquid chromatography–mass spectrometry (LC-MS), high-performance liquid chromatography (HPLC), and enzyme-linked immunoassay (ELISA).

Although these destructive testing methods are well-established, the methods have several drawbacks:

- The sample that is tested is destroyed
- There is a possibility that aflatoxin may be missed when a representative sample is tested and may be found on re-testing elsewhere
- If a sample tests positive, the entire batch is destroyed
- For many crops, testing and approval occurs at the very end of the production line, after all value is added

Economic Losses from mycotoxin contamination in the U.S. are $932 million annually (2003) and losses from Regulatory Enforcement are $466 million annually.

Solution & Innovation

Methods and technology to non-destructively detect the presence of aflatoxin in real-time, enabling:

- Continuous monitoring of pistachios for aflatoxins during processing
- Alarms to alert when levels of aflatoxins are high
- Activation of flow diverters automatically to protect the bulk of pistachios

These capabilities protect the investment of growers and processors from losses of approximately $500,000 on each occasion when food safety regulations are violated.

Inventors and Departments

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Applications

A real-time, continuous detection and/or monitoring of aflatoxin in pistachios:

- At the start of processing
- Before storage in silos
- After storage

Huge markets beyond pistachios, including:

- Almonds and other tree nuts
- Corn, wheat, and peanuts (leading carriers of aflatoxin)
- Dairy products and eggs
- Dried fruits
- Certain spices (such as black pepper and chilis)

Need & Market Potential

Pistachios are a high value crop netting $2.9 Billion in 2021. The United States has 67% of value, with Iran having the next largest share at 17%.

Failure with a single batch (44,000 lb) costs a grower/producer approximately $500,000 per event, and the sample that is tested is destroyed.

Developing a method for continual monitoring and non-destructive testing of crop products would benefit growers, consumers, and the food industry. Establishing an instrument for continual and non-destructive testing will allow growers to know what products may have aflatoxin prior to regulatory testing and allow consumers to have an increased confidence in the safety of their food. The new approach should enable growers in New Mexico access to advanced chemical analysis for aflatoxins in their crops with high speed, high convenience, and comparatively low cost. The technology should be suitable for use by non-specialists in chemical measurements and provide early awareness of high levels of aflatoxins in crops.

Current Status

- Explored non-destructive and continual sampling technology for testing of crops
- Provisional patent 63/315,384
- Proven method/technology in lab studies
- Demonstrated in-field at a pistachio processing facility
- Utility Patent Application 18/116,076 and International Application PCT/US23/14261

Planned Next Steps

- Demonstrate a rugged and inexpensive instrument for continual aflatoxin detection that will be marketed to pistachio growers and producers
- Establish a commercial company in New Mexico to begin product development and manufacture of instruments for continual and non-destructive aflatoxin measurements from crops

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