

# Dashboard for Interactive Analysis of Mycotoxin Occurrence in Human Foods Data: Streamlining Annual Report Generation and Data-Sharing



Tabitha J. Miller<sup>1</sup>, Anthony Adeuya<sup>1</sup>, Ernest Kwegyir-Afful<sup>2</sup>, Lauren Posnick Robin<sup>1</sup>

1. US Food and Drug Administration, Center for Food Safety and Applied Nutrition, Office of Food Safety 2. US Food and Drug Administration, Center for Food Safety and Applied Nutrition, Office of Food Additive Safety

## Abstract

Fungal growth on agricultural commodities not only decreases the value of the product, but also presents a health concern. These fungi produce mycotoxins, a toxic metabolite produced by certain species of fungi. The FDA has generated a large amount of data through the Compliance Program for Mycotoxins in Domestic and Imported Human Foods regarding the occurrence of mycotoxins in foods. Each fiscal year, an internal annual report is generated summarizing the data collected via the compliance program, but no external-facing report has been generated to summarize and discuss the data. In order to create an overview of the data, find trends, and facilitate report development, we created a data dashboard using Amazon Web Services Quicksight. The new dashboard has increased our ability to review and summarize mycotoxin data as well as respond to questions more rapidly.

## Introduction

Mycotoxins are toxic metabolites produced by specific fungi that can infect and grow on various agricultural commodities. Aflatoxins, fumonisins, deoxynivalenol, patulin and ochratoxin A are the main mycotoxins of concern for humans. Foods commonly contaminated with mycotoxins are those derived from cereal grains (wheat, corn, etc.), peanuts and tree nuts, legumes, and certain fruits. Mycotoxin occurrence is influenced by environmental factors such as temperature, humidity, and rainfall during growth and harvest stages. Deleterious health effects due to mycotoxins range from gastrointestinal upset to long-term consequences including cancer. Because mycotoxin occurrence is not entirely avoidable, small amounts may be legally permitted in foods. Therefore, to protect consumers, FDA has issued action levels and guidance levels for certain mycotoxins. FDA staff review mycotoxin findings on a case-by-case basis, considering the action/guidance levels and other factors, to identify adulterated samples. About 2000 samples of susceptible human food products (domestic and imports) are collected and tested yearly for one or more mycotoxins each year. The CFSAN Office of Food Safety develops an internal report each year summarizing the findings, but an external-facing report would provide added value for stakeholders. In addition, there is also a need to support FDA work on international standard setting in Codex Alimentarius. The dashboard was developed to address these needs.

## Methods

To prepare data for the dashboard, it was first downloaded from the Office of Regulatory Affairs' (ORA) FACTS database. Manual cleanup steps were conducted, including ensuring correct product codes, consistency in the units used for data reporting, and removing any non-human foods data. The data was then uploaded to Quicksight through a direct query data connection upload portal developed by collaborators in OFAS. Once the data was on Quicksight, additional data fields were generated to facilitate categorization, calculations, and visualizations.

**Table 1.** Mycotoxins included in the FDA Compliance Program.

Mycotoxin	Foods Commonly Contaminated	Current FDA Regulatory Level
Aflatoxins (B <sub>1</sub> , B <sub>2</sub> , G <sub>1</sub> , G <sub>2</sub> )	Peanuts, corn, tree nuts, other grains (e.g. rice)	20 ppb (all foods, total aflatoxins)
Deoxynivalenol	Wheat, corn, oats, barley	1 ppm (finished wheat products)
Fumonisin (B <sub>1</sub> and B <sub>2</sub> )	Corn and other grains	2 – 4 ppm (various corn commodities)
Ochratoxin A	Wheat, rye, oat, barley, coffee	No action level set
Patulin	Fruit (particularly apples), grains, and cheese	50 ppb (apple juice and apple juice products)

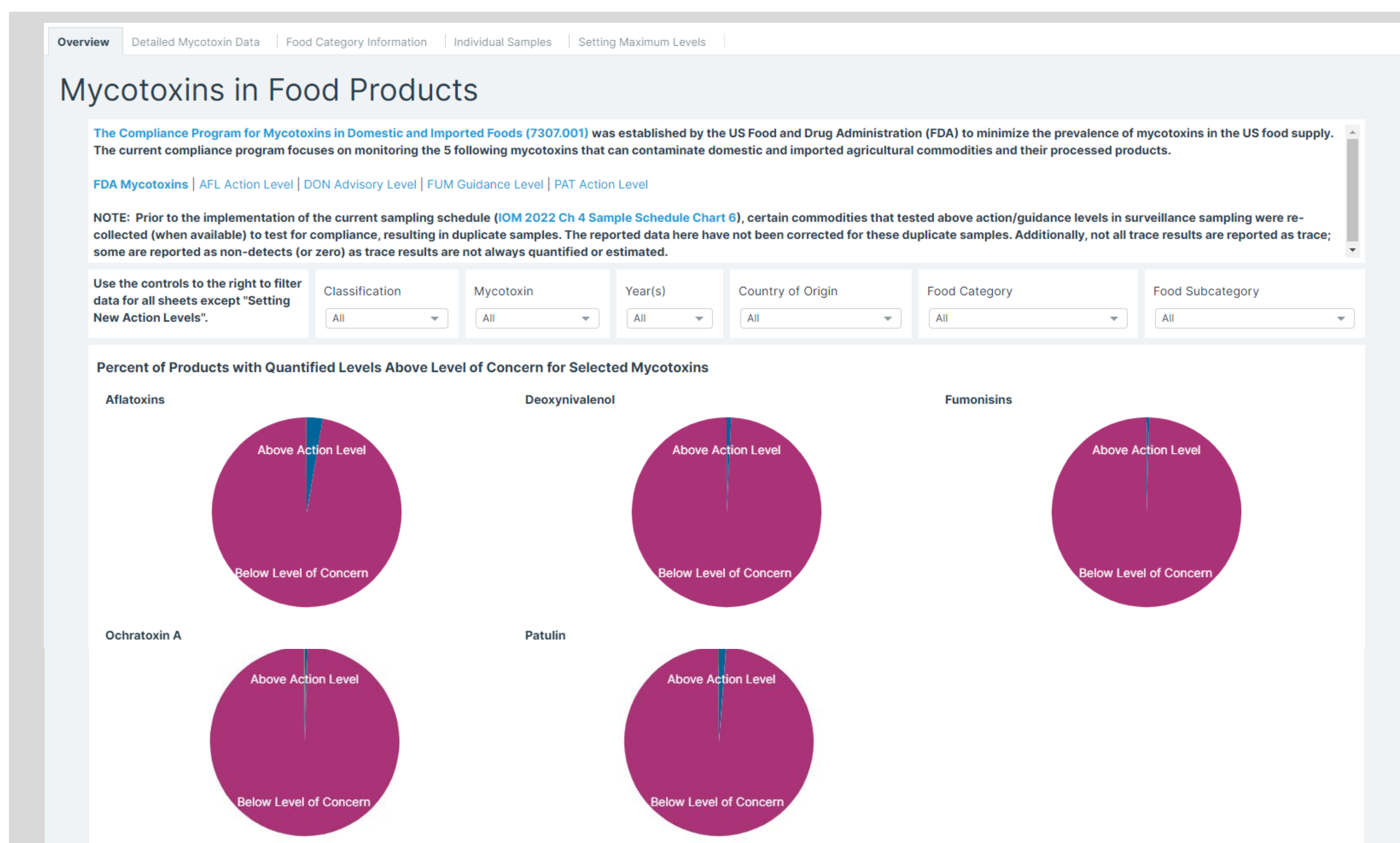
**Table 2.** Examples of data fields created on Quicksight for use in visualizations.

New Data Field	Purpose
IsomerOrTotal	Categorize datapoint as corresponding to a total mycotoxin measurement or individual isomer measurement
Positive_trace_nd	Classifies datapoint as 1 of 6 types: Adulterated, Positive (Non-Adulterated), Trace, Non-Detect, Unclassified, or No Analysis Completed
Adulteration_count	Assigns value of 1 if adulterated, otherwise 0; helps perform calculations and counts in visualizations
AvgQuantLevel	Calculates a running average for datapoints characterized as either adulterated or positive (non-adulterated)
maxDetect	Returns the maximum value of mycotoxin detected

## Results and Discussion

The resulting dashboard allows for quick data tabulation and display of statistical measures of mycotoxin findings. Subcategories (specific years, mycotoxins, types of foods, etc.) can be highlighted to tease out factors that might affect mycotoxin adulteration, such as region of production. The functionality of a dashboard also provided an opportunity to design pages with specific work functions.

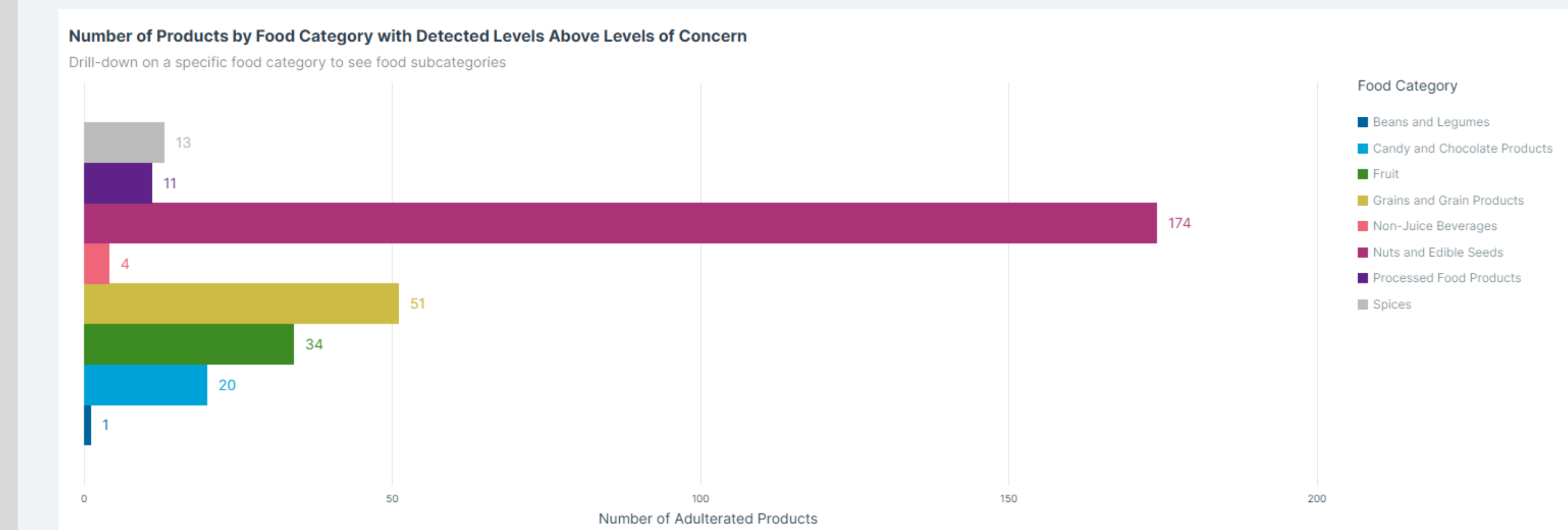
The first page gives a big picture outlook on the occurrence of mycotoxins in foods. Adulteration rates by mycotoxin are displayed, and statistical data about the number of samples tested overall for each mycotoxin are displayed. Additionally, we added a geospatial display for quickly displaying a heat map of adulteration rates by country of origin. This page also contains the controls that allow the user to focus in on specific subsets of data (e.g., a specific country of origin or specific food category).



**Figure 1.** The dashboard has various pages. Shown here is the overview page and some of the visualizations contained within.

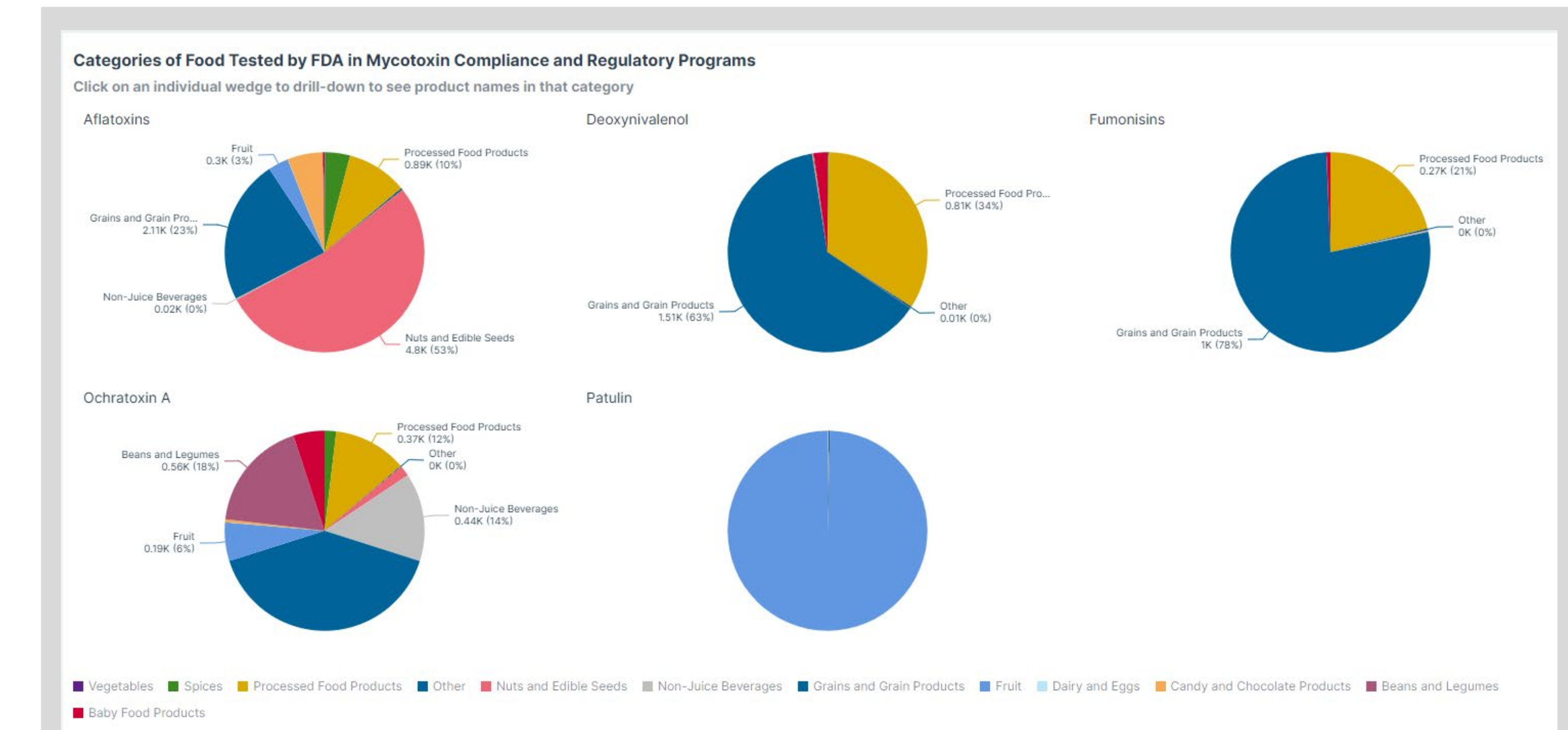
A second page gives more detailed annual data for each mycotoxin, showing the trends in average quantified levels in foods and isomer ratios for those mycotoxins with multiple isomers (aflatoxins and fumonisins). More in-depth statistical analysis for each mycotoxin is also displayed and can be further broken down into domestic vs. imported foods.

**Detailed Information Regarding Specific Food Categories Tested**



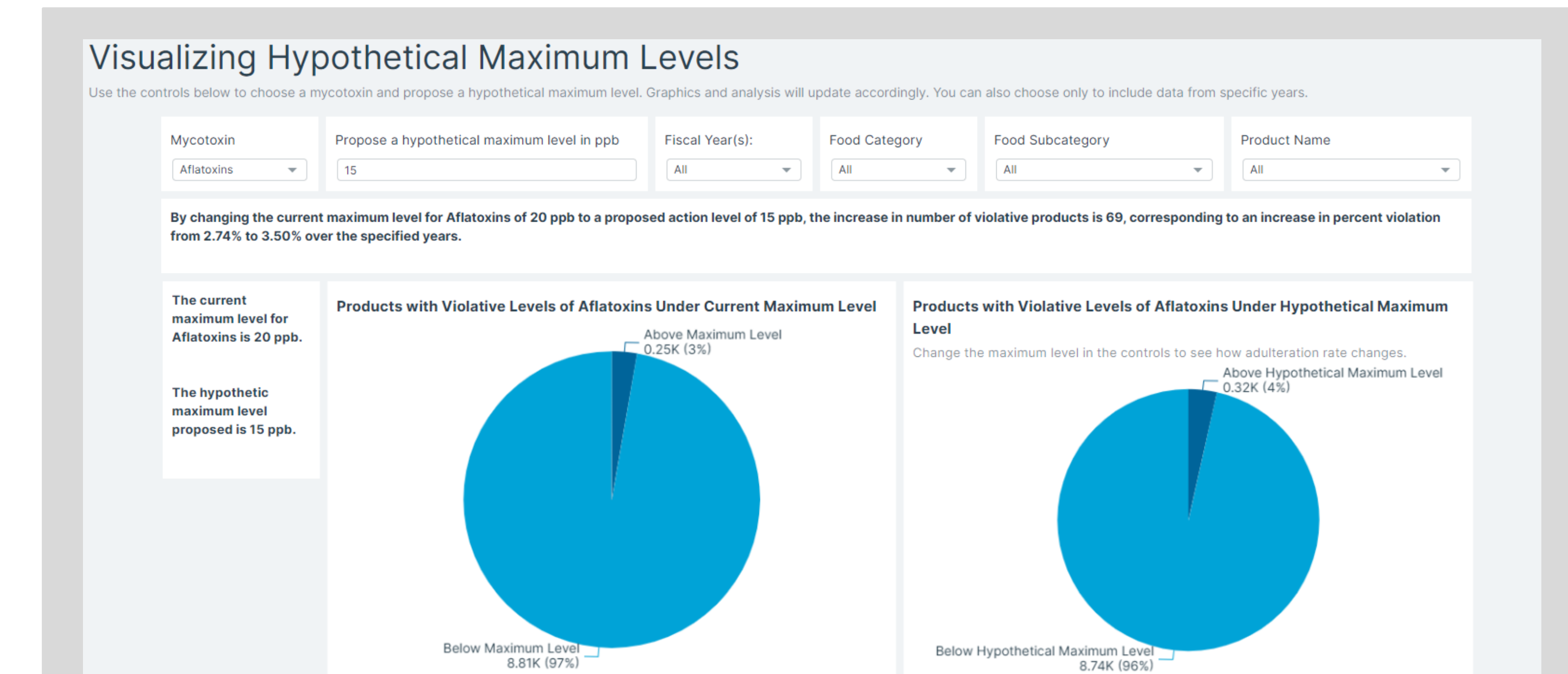
**Figure 2.** Dashboard visualization showing which food categories have products testing above levels of concern.

The third- and fourth-pages breakdown the data even further, looking at the data by food category and food subcategories, as well as individual samples. These two pages serve to help quickly identify foods which should be looked at more carefully due to higher positive rates, as well as to assist in the generation of annual reports.



**Figure 3.** Dashboard visualizations showing the breakdown of food categories tested by mycotoxin.

The last page on the dashboard allows a user to test the effects of hypothetical maximum levels on violation rates. As the level is changed, graphics show how the maximum level affects the violation rate and the food supply. This page was specifically designed to support future work in Codex Alimentarius on setting new maximum levels of mycotoxins in foods.



**Figure 4.** One of the pages of the dashboard allows the user to set new action/guidance levels for a particular mycotoxin. The visualizations on the page will reset to illustrate what effect the new level will have on various analytical parameters.

## Conclusion

Our Mycotoxins Analytics Dashboard provides a mechanism to quickly obtain and analyze information on mycotoxin occurrence in various foods. The dashboard will be useful in responding to stakeholder inquiries and generating information for international Codex work. Furthermore, we envision using the work products of this dashboard to prepare annual reports that can be published externally for public awareness of FDA mycotoxin work. We plan to make this dashboard accessible to all mycotoxin stakeholders and interested parties within the agency by either granting access to the published dashboard via an access website, or by pulling information/generating graphics to share.