Can You Target Mycotoxin Sampling Using Historical Test Results?

Introduction

Mycotoxins are metabolites formed from certain moulds. Mould – and hence mycotoxins – can form on vulnerable foods in warm and humid conditions, either whilst crops are still growing or post-harvest during storage, drying and transport. Most mycotoxins have toxic effects in humans, and some of the better characterised mycotoxins have regulatory limits in food.

Certain foods are at particular risk. These include nuts and peanuts (primarily for aflatoxins) and raisins (primarily for ochratoxin A).

Within an individual food type it is harder to predict relative risk based upon seasonality or country of origin. Although mould growth is clearly climate-related, nut-producing countries tend to have similar climates. Minimising the risk of mould growth is highly dependent upon good agricultural, processing, storage and transport practices, and there is best practice and guidelines that apply to each type of crop. However, if you are a retailer or enforcement agency looking to carry out surveillance testing on the final product, you are unlikely to have sight of how the crops were harvested, dried or stored.

Testing for Mycotoxins

Mycotoxin-producing moulds can be highly localised within nuts or raisins, leading to hot-spots. Analytical testing is not an efficient way to control mycotoxins in traded goods; sub-sampling may miss them. But testing is used as a spot-check at multiple points in the supply chain, as well as at primary production to check that mitigation steps are effective. As well as sending sub-samples to a laboratory for a direct mycotoxin test, testing can include on-site checks for moulds, such as their distinctive glow under UV light, or testing bulk nut heaps for distinctive gas signatures.

Testing of Packaged Product: Targeted Surveillance Sampling

Despite the repeated testing throughout the supply chain, retailers, enforcement authorities and others still perform surveillance testing of retail packs and still regularly find mycotoxins. These are relatively rare spot-checks in the context of total trade volumes, and ideally should be targeted at products, production methods, countries of origin, or seasons with the highest risk.

Traditionally, people look to see which countries have a high historical number of detections in sources such as Fera's Horizonscan[i] database. But, as with any chemical contaminant, there is a well-known pitfall with this approach. There is no public record of the number of samples tested as negative; only of the positives. Therefore a high number of reported positives from one country of origin does not necessarily reflect a higher incidence rate and risk. It may just reflect a higher number of tests – either because trade volumes are higher from that country, therefore pro-rata test numbers are higher, or because the country has been targeted for testing due to a perceived higher risk. The latter can lead to a self-fulfilling prophecy cycle, with more testing leading to more positive results leading to more alerts leading to more testing.

Peanuts and nuts are an excellent example of this effect. Many industry and laboratory professionals would highlight Argentine peanuts, Chinese peanuts, and US pistachios as being at highest risk of aflatoxin contamination, and this seems supported by the number of historic incidents. But the reality is somewhat different. They only have high incidents because they are the largest exporters.

Data Normalisation

The ideal approach would be to normalise the number of positive results for the number of total tests for any given country of origin. In the case of most chemical contaminants this is very difficult to estimate, as there is no insight into how one country's produce has been targeted for sampling relative to another. Regulated mycotoxins in nuts and raisins, however, are an exception. This is as most import testing or industry Codes of Practice prescribe a fixed test frequency, or proportion of consignments to test, irrespective of country of origin. Compared to other chemical contaminants and other products, there has been relatively little country-specific targeting[ii]. Thus no normalisation should be needed for different testing frequencies; the only normalisation needed is for trade volumes (*i.e.* annual export tonnage). These figures are readily available, and have changed little (< 15%) over a 10-year period, meaning that an average annual export tonnage[iii] can be used to normalise mycotoxin alerts over an extended period of time in order to draw out trends.

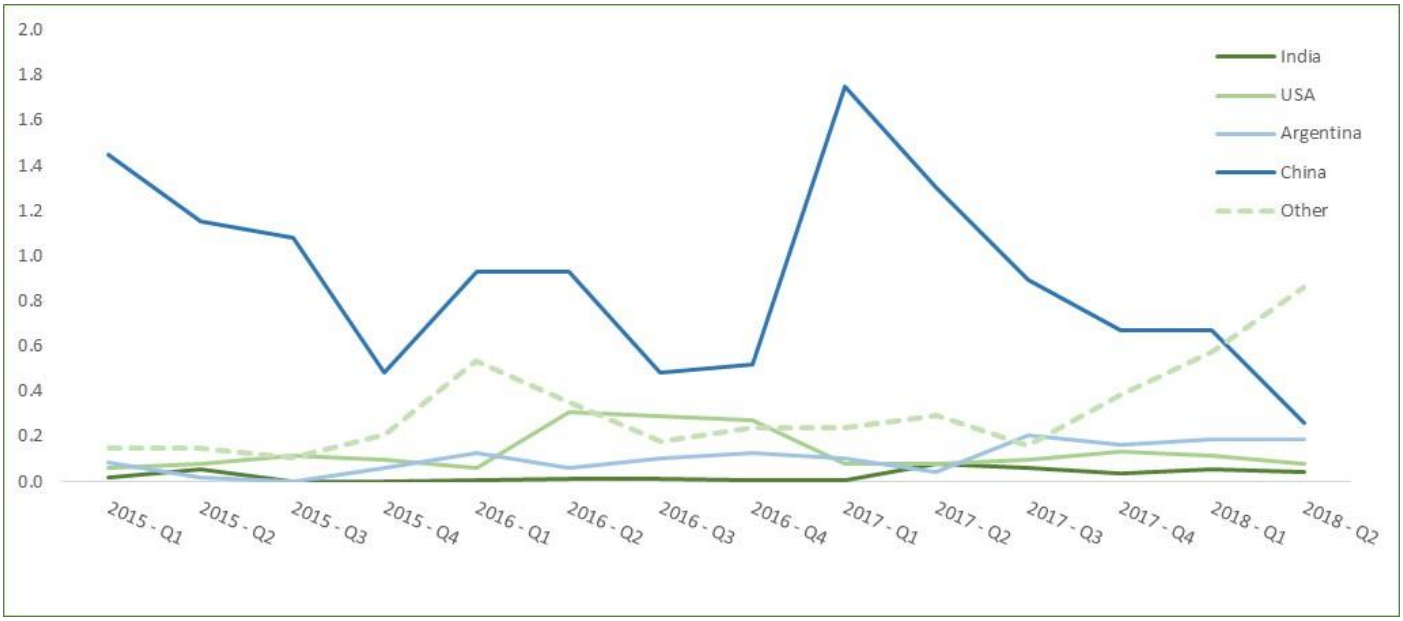
This approach only applies to products with standardised tests, frequently performed on a regular rotational basis, little targeting of specific countries of origin, stable trade volumes, and sufficient positive results reported to be able to draw out trends. The examples chosen here are:

- Peanuts – aflatoxins
- Pistachio nuts – aflatoxins
- Hazelnuts – aflatoxins
- Raisins – ochratoxin A

Peanuts - Aflatoxins

The major exporters, excluding transit countries, are India (39% of global export tonnage), USA (14%), Argentina (13%) and China (7%). Most Indian exports go to Vietnam, are likely to be subject to less testing than trade to the EU or US, and so incidence is likely to be underestimated in this analysis.

Figure 1: Reported Aflatoxin Incidents per 1,000 tonne exports, Peanuts, January 2015 – June 2018

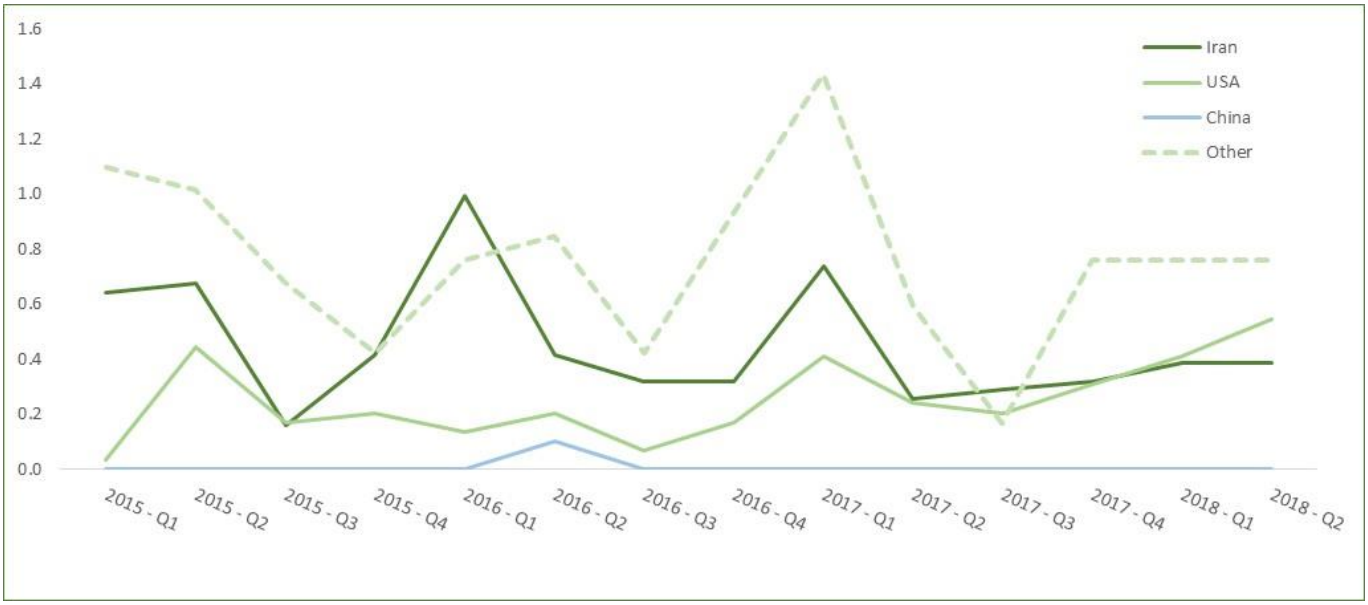


There is a notable difference in relative incidence between China (higher) and USA / Argentina (lower). Smaller producers (*e.g.* Egypt, Madagascar, Indonesia) have a higher incidence rate than either the USA or Argentina. The 2018 increase in incidence-rate from "other" countries is attributable mainly to Egypt and The Gambia. There is no evidence of seasonality.

Pistachios - Aflatoxins

The major exporters are Iran (38%), USA (36%) and China (12%).

Figure 2: Reported Aflatoxin Incidents per 1,000 tonne exports, Pistachios, January 2015 – June 2018

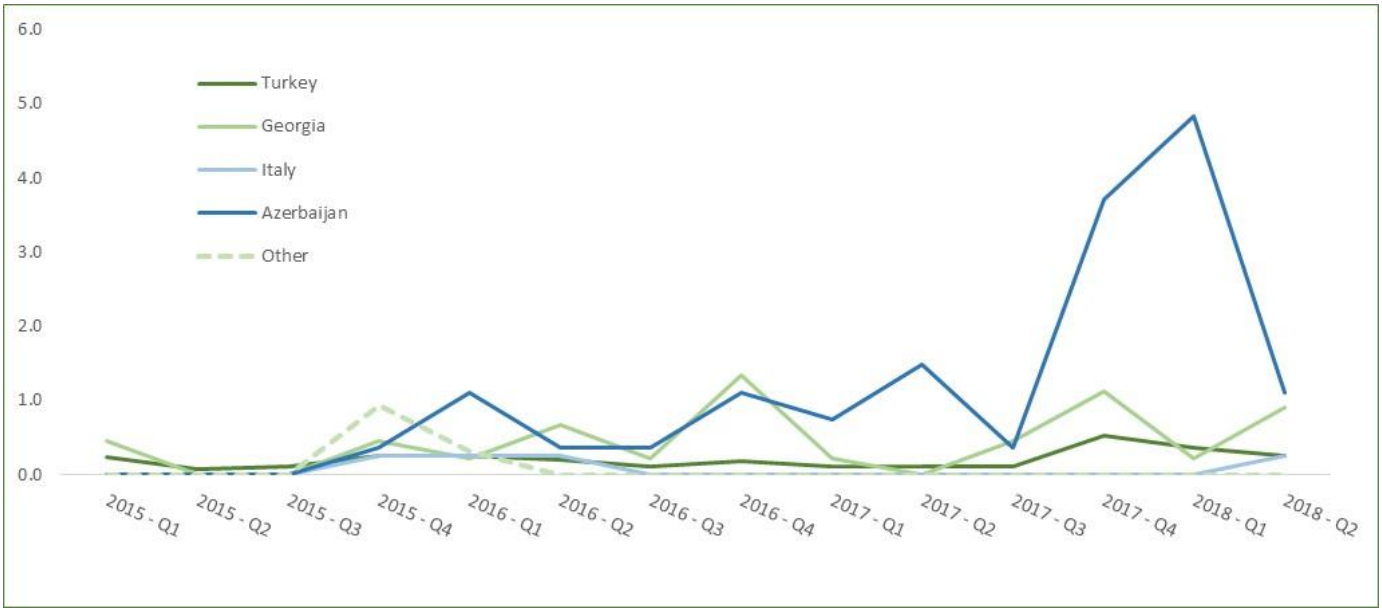


China is notable by the low relative incidence. Other than this, differences between countries are less marked than for peanuts. The historical gap between Iran (higher incidence) and USA (lower incidence) has now closed. As with peanuts, the smaller exporting countries (*e.g.* Turkey, Afghanistan, Lebanon) have a consistently higher incidence rate than the major exporters.

Hazelnuts - Aflatoxins

The export market is dominated by Turkey (71%), followed by Georgia (8%), Italy (7%) and Azerbaijan (5%).

Figure 3: Reported Aflatoxin Incidents per 1,000 tonne exports, Hazelnuts, January 2015 – June 2018

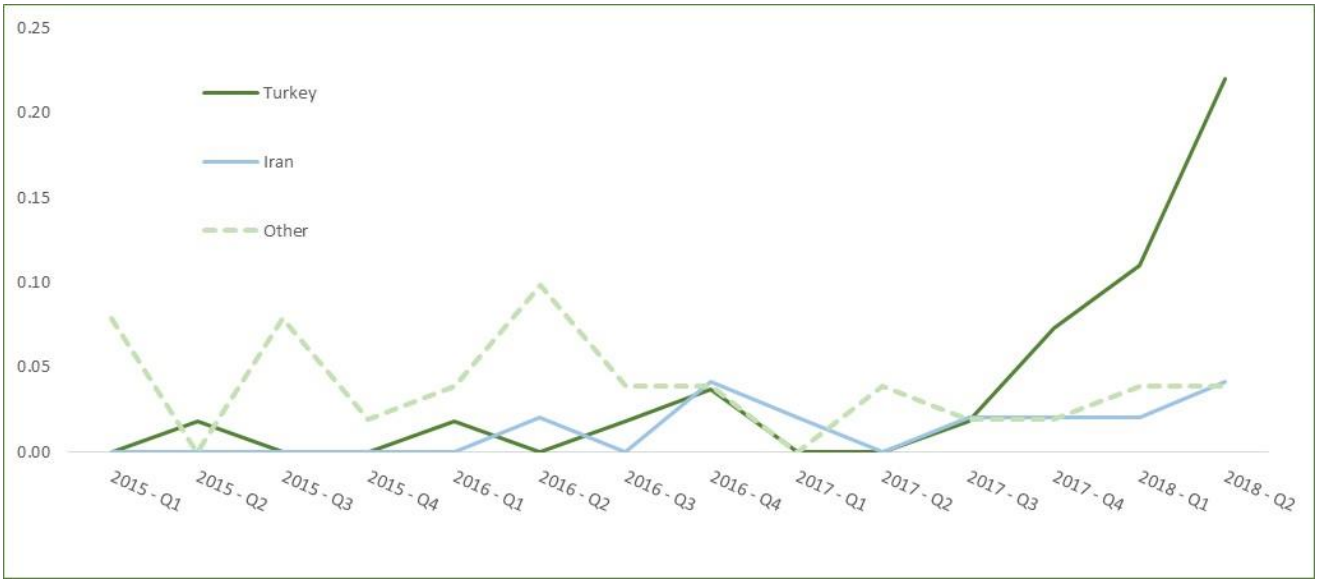


Georgia and Azerbaijan have a consistently higher relative incidence rate than Turkey or Italy. This was exacerbated by a spike in the incidence rate of aflatoxins in Azerbaijan hazelnuts in late 2017.

Raisins – Ochratoxin A

International Nut and Dried Fruit export statistics are categorised as "dried grapes" *i.e.* including both raisins and sultanas ("golden raisins"). The major exporters of dried grapes are Turkey (30%), USA (19%), Iran (14%) and Chile (9%). USA and Chile are excluded from this analysis, as much of their trade is in sultanas and flame-dried raisins. Sultanas are dried by a different method and are at minimal risk of ochratoxin-producing moulds; they are not comparable to raisins in this respect.

Figure 4: Reported Aflatoxin Incidents per 1,000 tonne exports, Dried Grapes, January 2015 – June 2018



There have been allegorical reports of Iranian raisins being re-badged as Turkish to circumvent trade sanctions against Iran, but little evidence. Trade statistics in this analysis are taken at face value.

Until the last 12-months, the relative incidence in raisins from smaller exporters (*e.g.* Uzbekistan, South Africa) has been higher than for the two major exporters of Turkey and Iran. Neither trade data nor reported incidents suggest a reason for the recent rise in the relative incidence from Turkey.

Conclusions

In limited cases, such as those of regulated mycotoxins in high risk products, it is possible to assume a uniform testing rate across most international trade and thus to normalise reported positive incidents by trade volumes alone. This can give valuable insight.

Contrary to widespread belief, both the USA and Argentina are at lower risk than other producers – particularly China – for aflatoxins in peanuts. Conversely, the risk of aflatoxins in Chinese pistachios is relatively low. There has been an unexplained steep increase in the relative incidence of ochratoxin A in Turkish raisins over the past year. There is no evidence of seasonality in risk from any of the major exporting countries.

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[i] https://horizon-scan.fera.co.uk/, subscription required

[ii] Commission Regulation 669/2009 (the "Intensified Checks" regulations) specifies frequencies of sampling only for aflatoxins in peanuts from Brazil and Sudan, with the frequency for Brazil being stepped down compared to historical levels.

[iii] 5-year export average, metric tonnes, from INC International Nut and Dried Fruit, Nuts & Dried Fruit Global Statistical Review 2015/16

Image from USDA National Peanut Research Laboratory https://www.ars.usda.gov/southeast-area/dawson-ga/national-peanut-research-laboratory/docs/mycotoxin-research/page-1/