
CASE STUDY:
CHOCOLATE
PRODUCTS

Lessons learned from global food safety and fraud data and the guidance it can provide to the food industry.

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CASE STUDY: CHOCOLATE PRODUCTS

FOREWORD

The chocolate industry, according to a recent study by the International Cocoa Organization [1], is the top performing sector of the confectionery industries. Cocoa and chocolate products rely on high-quality ingredients and raw materials, strict supplier partnership schemes and conformity to clearly defined quality and safety standards.

Over the course of the past 10 years there have been a significant number of food safety incidents associated with chocolate products. The presence of *Salmonella enterica*, *Listeria monocytogenes*, allergens and foreign materials in cocoa/chocolate products have been reported on a global scale.

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Today, information on food safety incidents and potential risks is quickly and widely available by way of the internet. However, because the pertinent data is frequently siloed, food safety professionals are unable to take full advantage of it.

The combination of contemporary consumer concerns and awareness, the global distribution of cocoa/chocolate products, the complexity of multi-continental food supply chains, and the highly diverse product lines within food industries, creates an environment where food safety challenges and threats to the integrity of brands are continuously increasing.

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A. CHOCOLATE PRODUCTS: HAZARDS AND FRAUD

There are many sources on the web that publish information on food safety and fraud incidents.

Examples of such sources are the Rapid Alert System for Food and Feed (RASFF) database of the European Commission, regulatory and statutory authorities such as the United States Food and Drug Administration (USFDA), the Japanese Ministry of Health, Food Standards Australia New Zealand (FSANZ), as well as various professional portals like the "Food Safety News" and "Food Safety Tech".

Such information can be used to identify critical food protection trends, including food safety and authenticity, for different food products.

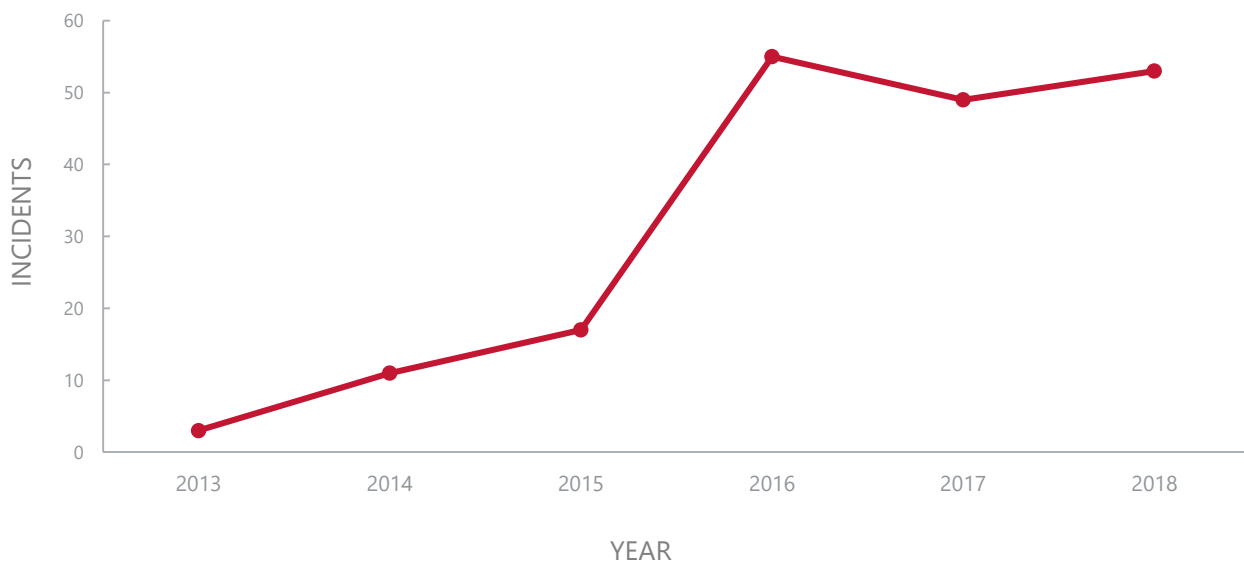
A review of this publicly available information, clearly shows a considerable increase in food safety incidents for cocoa/ chocolate products during the last five years.

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CHOCOLATE PRODUCTS: HAZARDS AND FRAUD

TRENDS OF INCIDENTS IN CHOCOLATE PRODUCTS (2013-2018)

The available data from official sources (European Union RASFF, Australian Competition and Consumer Commission, UK Food Standards Agency) provides useful insight on the top emerging hazards for chocolate products and the associated raw materials for the period 2013 - 2018.

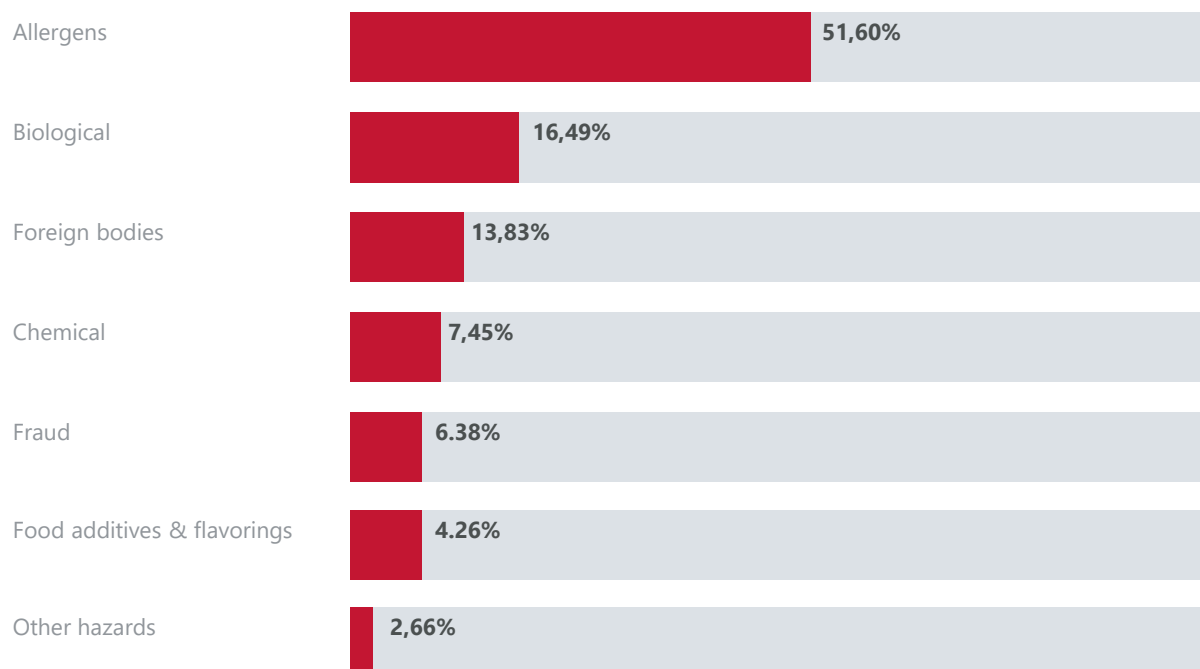


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CHOCOLATE PRODUCTS: HAZARDS AND FRAUD

TOP EMERGING HAZARDS IN CHOCOLATE PRODUCTS (2013-2018)

For chocolate products, the publicly available data shows that allergens, foreign bodies, fraud, food additives and chemical contaminants should be taken into account when designing a supplier risk assessment workflow as part of internal food safety procedures. This would also apply to meeting the requirements of a FSVP Plan (Foreign Supplier Verification Program) and a GFSI certification program.



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B. FOOD PROTECTION TRENDS: MONITORING INCOMING RAW MATERIALS

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Assessment and identification of potential food protection issues, including food safety and fraud, at the stage of incoming raw materials is of vital importance for food manufacturers. Knowledge of the associated risks and vulnerabilities allows for timely actions and appropriate measures that may ultimately, prevent an incident from occurring.

Specifically, the efficient utilization of global food safety and fraud information should allow for:

- A** identification of prevalent, increasing and/or emerging risks and vulnerabilities associated with raw materials;
- B** comparative evaluation of the risk profile for different raw materials' origins; and
- C** critical evaluation and risk-based selection of raw materials' suppliers.

COCOA and HAZELNUTS have been identified as “high risk” raw material categories based on data from border rejections, food recalls and food safety alerts, as provided by international food safety authorities. These raw material categories, their origins and suppliers should be carefully examined as part of the risk assessment process.

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FOOD PROTECTION TRENDS: MONITORING INCOMING RAW MATERIALS

Both of these product categories are acknowledged as important raw materials in chocolate production. Their high-quantity global distribution and their notable association with specific food safety hazards (i.e. pesticides and aflatoxins) as reported by regulatory authorities worldwide, places them in a “high risk and high vulnerability” classification.

”

Cocoa (nibs, butter, ground cocoa beans) and tree nuts (e.g. hazelnuts) and other raw materials, are implicated in the majority of chemical contamination issues in the chocolate manufacturing process.

Proper identification of the main sources of origin for the raw materials, Cocoa and Hazelnuts, calls for the analytical efforts to be focused on the key regions for cocoa supply globally and the global leader in hazelnut production (i.e. Turkey).

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C. INSIGHTS FOR COCOA

In order to evaluate cocoa suppliers and create a supplier risk profile, a data driven approach needs to be adopted. An analysis must be performed to determine the key prevalent hazards in cocoa derived ingredients



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INSIGHTS FOR COCOA

TRENDS OF INCIDENTS FOR COCOA

In order to evaluate cocoa suppliers and create a supplier risk profile, a data driven approach needs to be adopted. An analysis must be performed to determine the key prevalent hazards in cocoa derived ingredients



This analysis was performed by analyzing almost 400 unique food safety incidents around the globe from 40 official authority sources (including RASFF, FDA and the Japanese Ministry of Welfare and Health).

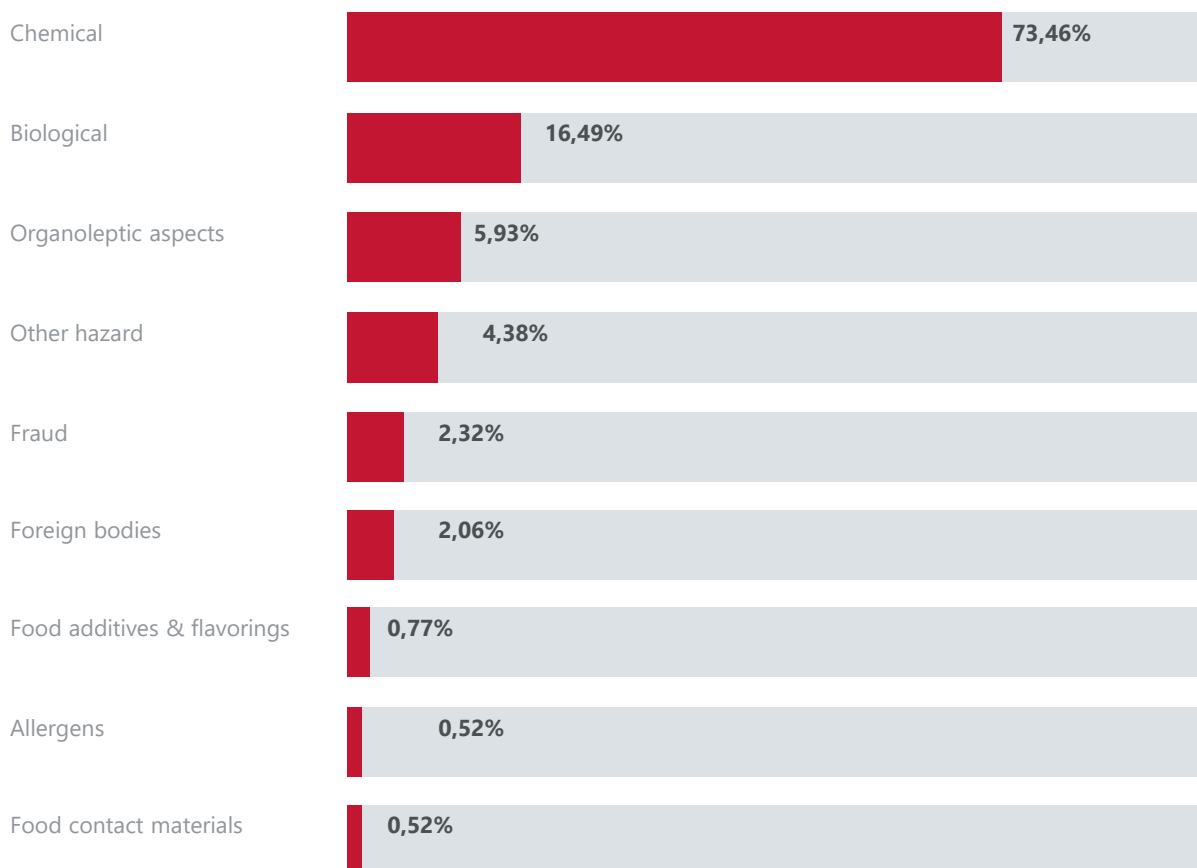
The trend of incidents reported between 2002 and 2018 is illustrated in the diagram above. It can be observed that after a significant rise between 2009 and 2010, the number of incidents approximately doubled and remained at that level for the rest of the evaluated period (i.e. from 2010 to 2018), compared to the period from 2002 to 2005.

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INSIGHTS FOR COCOA

HAZARDS FOR COCOA

A hazard analysis of cocoa demonstrates that chemical hazards constitute the major hazard category for this commodity.



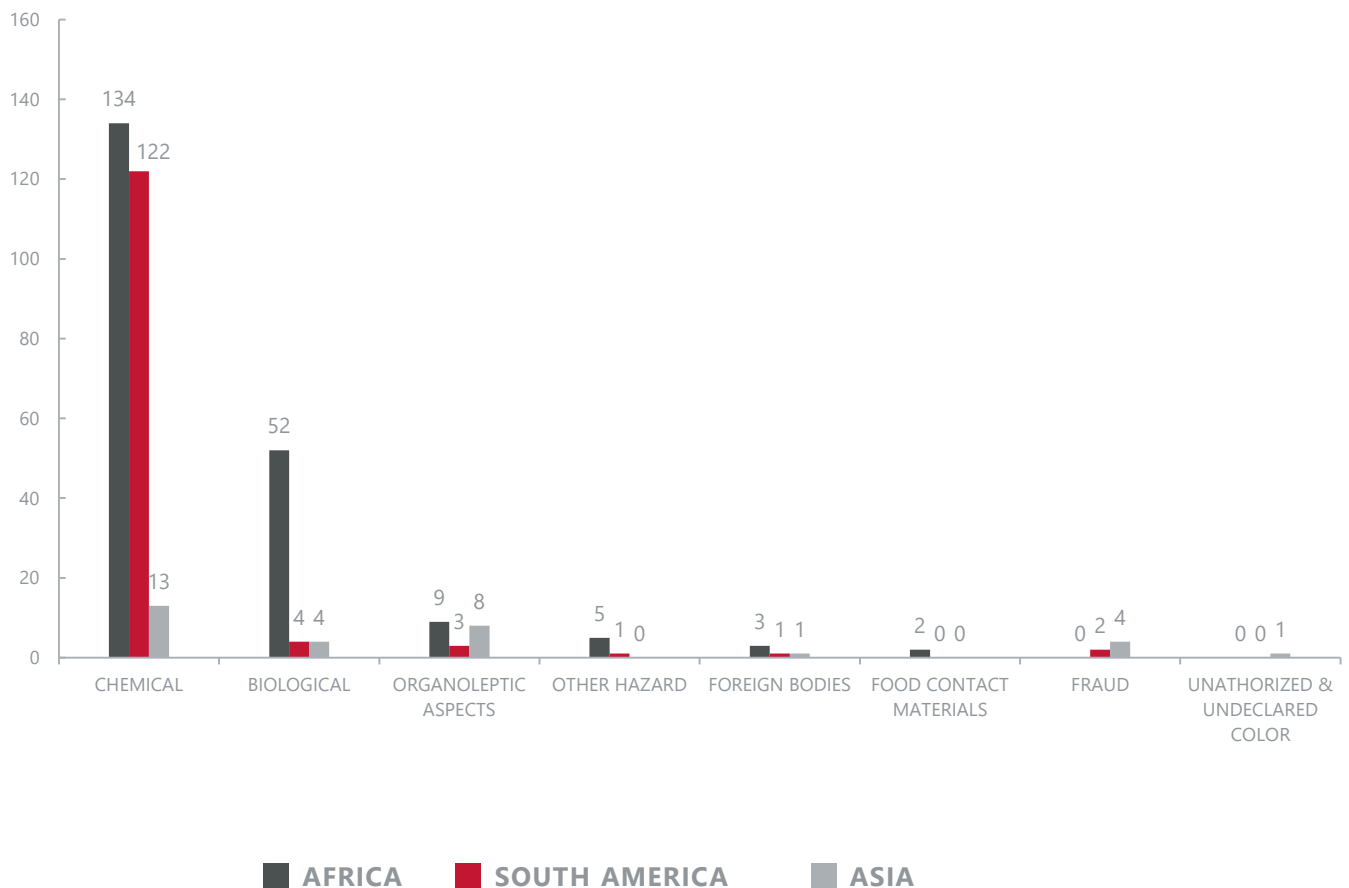
Suppliers from different regions such as Africa, Asia and South America, which are the main regions of origin for cocoa globally, were evaluated, using global data stemming from recalls and border rejections.

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INSIGHTS FOR COCOA

TOP HAZARDS FOR COCOA BY REGION

Based on the frequency of pertinent incidents, the top hazards for cocoa, by region, can be accurately identified.

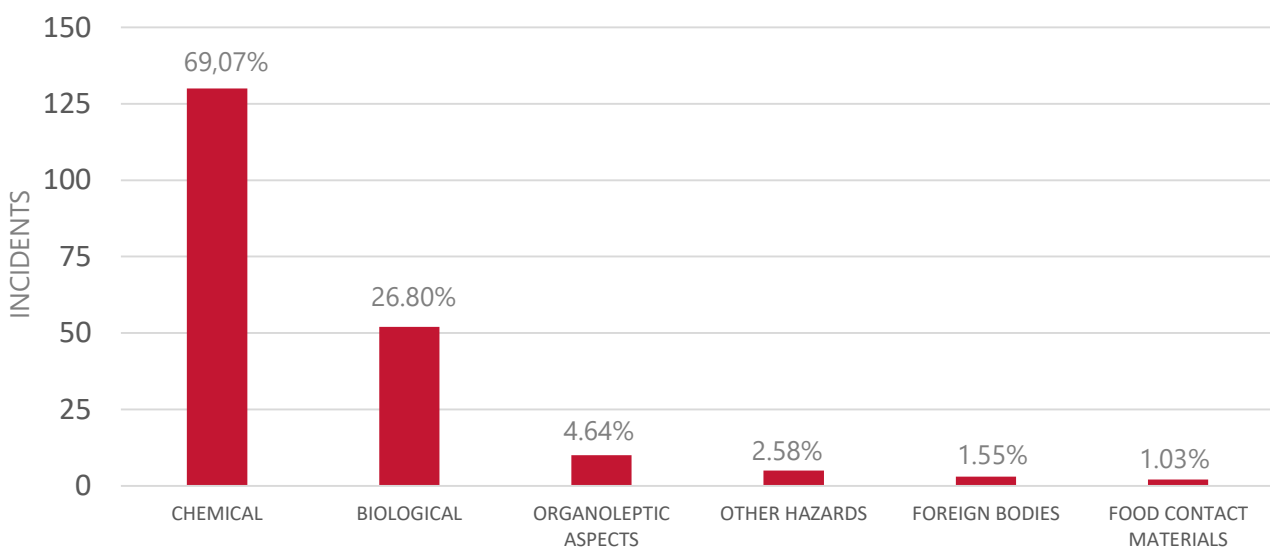


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INSIGHTS FOR COCOA

AFRICA'S TOP HAZARDS

The most prevalent hazard types for African cocoa are presented in the following diagram:



The top five specific hazards for cocoa from Africa are:

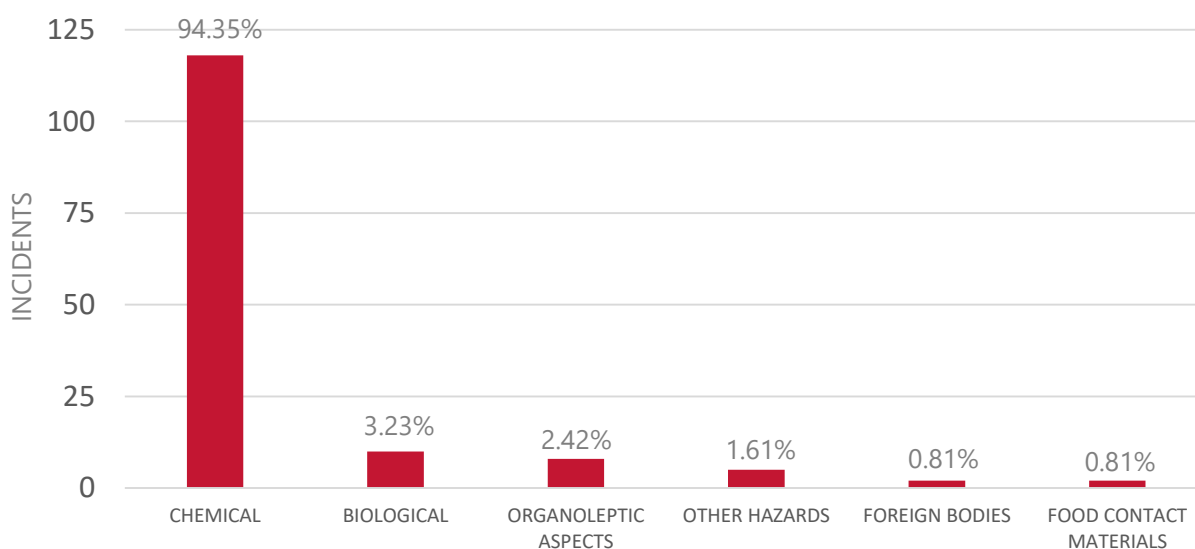
- 01 Organophosphate
- 02 Moulds
- 03 Neonicotinoid
- 04 Pyrethroid
- 05 Organochlorine

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INSIGHTS FOR COCOA

SOUTH AMERICA'S TOP HAZARDS

The hazard types for South American cocoa are presented in the following diagram:



The top five specific hazards for cocoa from South America are:

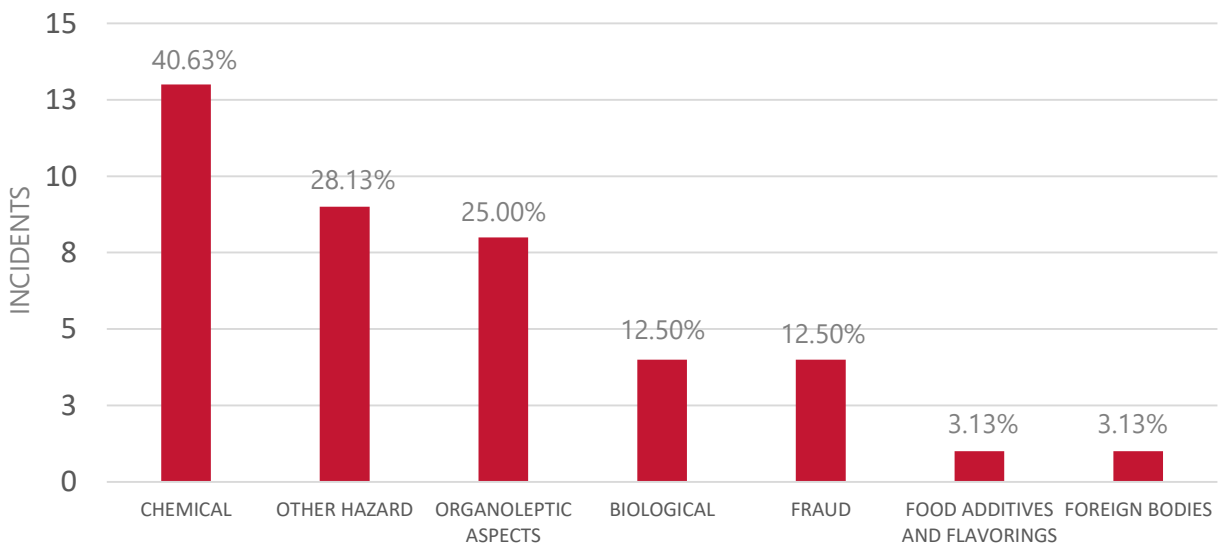
- 01 2,4-dinitrophenol (dnp)
- 02 Pyrethroid
- 03 Aflatoxin
- 04 Cadmium
- 05 Anilinopyrimidine

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INSIGHTS FOR COCOA

ASIA'S TOP HAZARDS

The hazard types for Asian cocoa are presented in the following diagram:



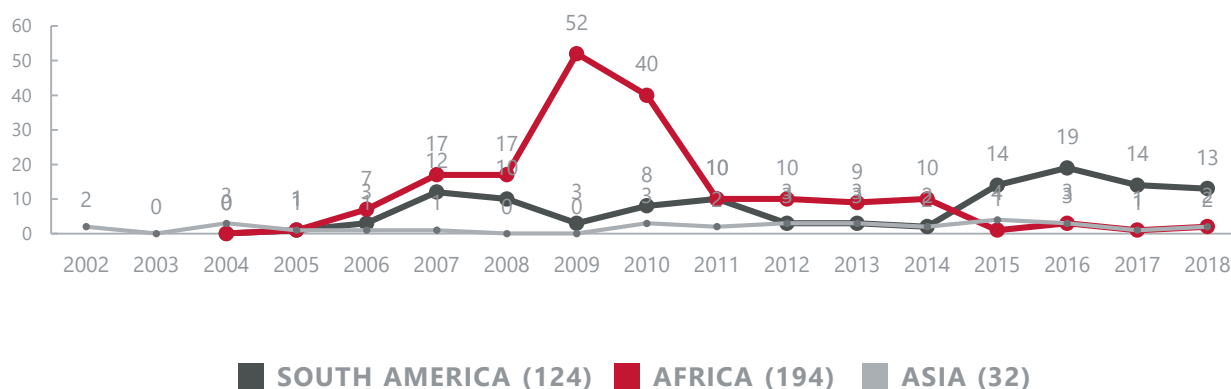
The top five specific hazards for cocoa from Asia are:

- 01 2,4-dinitrophenol (DNP)
- 02 Poor or insufficient controls
- 03 Aflatoxin
- 04 Spoilage
- 05 Salmonella

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INSIGHTS FOR COCOA

COMPARATIVE RISK PROFILES FOR SOUTH AMERICA, AFRICA AND ASIA



A notable increase in cocoa recalls occurred between 2009 and 2010 in Africa, however, a total of only 15 recalls or other food safety-related incidents were reported during the last three years (2016-2018). On the other hand, cocoa from South America has been, on average, associated with 15 such incidents on an annual basis during these last three years.

The prevalence of chemical contamination, as either industrial contaminants or pesticides, has been a commonly observed pattern for all three of the above-mentioned regions (i.e. Africa, South America and Asia).

Beyond the general hazard category level, there are also different trends with regard to specific hazards for the three different regions; one such example is the increased presence of mould in cocoa beans coming from Africa.

Cocoa claimed to be organic, fair trade or sustainably sourced is most vulnerable for fraud. In addition, cocoa can easily be mixed with low-cost materials like carob flour and soybean flour contributing to its high level of vulnerability to food fraud [3, 4].

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D. INSIGHTS FOR HAZELNUTS

Hazelnuts are one of the most used ingredients in chocolate and cocoa products. Turkey, the global leader in hazelnut production, is the major supply source for the chocolate and confectionary industries.



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INSIGHTS FOR HAZELNUTS

TRENDS OF INCIDENTS FOR HAZELNUTS



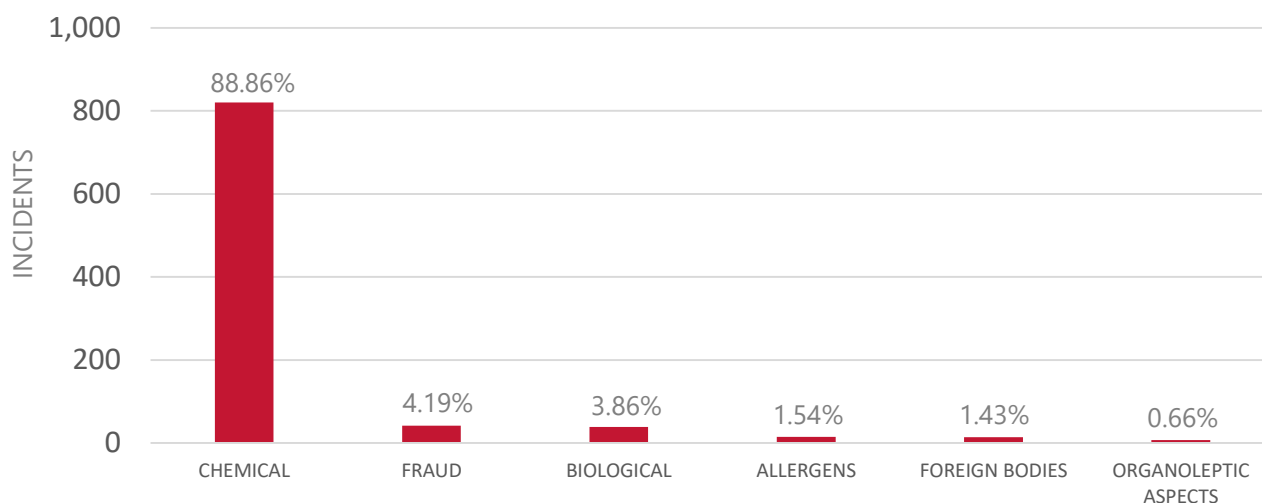
Based on data reporting food recalls and border rejections, there has been an increasing trend of food protection incidents related to hazelnuts during the five last years (2014-2018).

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INSIGHTS FOR HAZELNUTS

TRENDS OF INCIDENTS FOR HAZELNUTS

The top five types of hazards that have occurred during the past five years are chemical contamination, fraud, biological issues, allergens and foreign bodies.



The top five specific hazards for hazelnuts from Turkey are:

- 01 2,4-dinitrophenol (dnp)
- 02 Poor or insufficient controls
- 03 Aflatoxin
- 04 Spoilage
- 05 Salmonella

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INSIGHTS FOR HAZELNUTS

DRILL-DOWN OF THE DATA, REVEALS TRENDS FOR AFLATOXIN IN TURKEY

From 2016 to 2018, the number of food safety incidents presented a drastic increase, almost triple the total number of incidents and alerts. The vast majority of these incidents were related to chemical hazards, and especially aflatoxin.

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Despite the fact that aflatoxins constitute a major hazard for tree nuts like hazelnuts, it is important not to neglect the other categories of hazards and fraud issues that are also trending upward.

As demonstrated by data derived from recall and/or border rejection incidents during the last three years (2016-2018), there were several **fraud** incidents that were related to health certificate issues and improper analytical reports.

In addition to this, Interpol's Operation Opson VI (Dec 2016 - Mar 2017) found hazelnut paste and roasted chopped hazelnuts in Germany to be adulterated by up to 45% with peanuts, cashews and almonds [4]. Furthermore, biological hazards such as Salmonella enterica were also reported by RASFF and FDA in hazelnut paste.

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INSIGHTS FOR HAZELNUTS

INSIGHTS GAINED FROM AFLATOXINS DATA FOR HAZELNUTS

The Black Sea region of Turkey, which has the top producing provinces, accounts for the largest proportion of the food safety-related incidents associated with aflatoxins. A comparison of the weather data for three key hazelnut producing provinces of Turkey in the Black Sea shows that during the humid years of 2006-2008, the occurrence of aflatoxins was expected to be high. [5]

An analysis of the data of 50 national and international authorities, shows that the amount of hazelnut recalls due to aflatoxins skyrocketed from 2006 to 2008.

According to meteorological data from the Turkish State Meteorological Service, weather in the Black Sea Region shows high humidity levels. According to recent studies, the high percentage of relative humidity (RH) increases the risk of aflatoxins contamination during the harvest and drying processes of hazelnuts. [6], [7]

In addition, improper handling and storage conditions after hazelnut dehulling, increase the risk of Aflatoxin contamination.

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Monitoring Aflatoxin levels is critical, during the suppliers' assessment processes in the chocolate industry. The accurate assessment of aflatoxins risk is essential to minimizing food safety concerns and reducing economic losses.

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INSIGHTS FOR HAZELNUTS

CAN WE PREDICT AFLATOXINS OCCURRENCE ?

Across the supply chain there are different ways to ensure raw material conformance. Starting from the farm, the utilization of smart sensors enables monitoring of critical parameters that are key to aflatoxin contamination. Especially during harvest, temperature and relative humidity play an important role in increasing the risk of aflatoxin contamination.

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Continuous monitoring of the critical risk parameters for aflatoxin contamination, allows for instant data collection from the different production and supply chain stages.

Additionally, by applying smart sensors during the processing stage, quality analysts can collect valuable data on correlating critical control indications (e.g. processing) with the quality and safety of the end product.

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E. THE IMPORTANCE & ROLE OF GLOBAL FOOD SAFETY AND FRAUD DATA ON AN ONGOING BASIS

HOW GLOBAL FOOD SAFETY DATA CAN CONTRIBUTE TO THE ESTABLISHMENT OF AN ADAPTIVE FOOD SAFETY/ QA PROCESS:

Based on the continuous analysis of food recalls and rejections, from key national and international food authorities, a FS/QA Manager could set up an adaptive Supplier Verification process by utilizing the knowledge provided by such data.

In that way, QA, Procurement, Food Safety, Regulatory and Quality departments can be empowered with critical supplier data that will inform the internal procedures for incoming materials and ingredients (e.g. raw materials, packaging materials) and allow for adaptive laboratory testing routines and compliance protocols.

Moreover, Food Safety systems become adaptive, enabling quality assurance and safety professionals to quickly update points of critical control when needed, and intervene in important stages of the chocolate manufacturing process.

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F. FOODAKAI'S 5 + 5 STEPS PROCESS FOR RAW MATERIAL RISK ASSESSMENT

CHECKLIST FOR MAPPING POTENTIAL RISKS AND VULNERABILITIES PER PRODUCT GROUP AND INGREDIENT

- ✓ Did you take into consideration the product category's specific legal demands?
- ✓ Do you have available laboratory test results for (at least) two batches of this product/ raw material from each of your suppliers?
- ✓ Do you have available test results from the sensory evaluation of this product/ raw material?
- ✓ Do you have the global trends in recalls for this product category/ specific raw material for the next 5 to 10 years?
- ✓ Have you identified the top hazards and vulnerabilities for this product category for the last 10 years?

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FOODAKAI'S 5 + 5 STEPS PROCESS FOR RAW MATERIAL RISK ASSESSMENT

THE SUPPLIERS' RISK ASSESSMENT CHECKLIST

1. GEOPOLITICAL CONSIDERATIONS

- ✓ Is the supplier based in a country with a history of frequent of food recalls for this type of raw material during the last 5 years?
- ✓ Is the food safety regulatory system in the country of origin based on Codex principles or considered to be a "similar" system to the US?
- ✓ Is the supplier based in a country with a high corruption index?
- ✓ Is the supplier based in a country with a high-risk index, according to OECD?
- ✓ Is the supplier based in a country that has experienced significant fluctuations in crop production during the past 5 years?

2. SUPPLY CHAIN DUE DILIGENCE

- ✓ Does the supplier provide verified information on raw material transparency?
- ✓ Does the supplier provide verified information on raw material traceability?
- ✓ Does the supplier provide verified information on raw material certification compliance?

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FOODAKAI'S 5 + 5 STEPS PROCESS FOR RAW MATERIAL RISK ASSESSMENT

THE SUPPLIERS' RISK ASSESSMENT CHECKLIST

3. CERTIFICATION STATUS

- ✓ Does the supplier possess a valid certificate certificate of compliance to a global standard of food safety such as GFSI?
- ✓ What is the status of the certificate?
- ✓ Does the supplier possess more than one food safety certification?

4. HISTORY OF FOOD RECALLS, FOOD SAFETY INCIDENTS OR FOOD FRAUD INCIDENTS

- ✓ Has the supplier been involved in food recalls, food safety or food fraud incidents during the last 5 years?
- ✓ Has the supplier been involved in food recalls , food safety or food fraud incidents during the last 2 years?

5. HISTORY OF BORDER REJECTIONS, IMPORT DETENTIONS, COMPLAINTS OR WARNING LETTERS

- ✓ Does the supplier have any records of border rejections, import detentions, complaints or warning letters in the last 5 years?
- ✓ Does the supplier have any records of border rejections, import detentions, complaints or warning letters in the last 2 years?

WITH DATA PROVIDED FROM

- RASFF
- Ministry of Health Labour and Welfare Japan
- Australian Department of Agriculture
- Imported Food Reports
- FDA Import Refusals
- FDA Import Alerts
- Czech Agriculture and Food Inspection Authority
- Hellenic Food Authority
- Food Standards Australia New Zealand
- Australian Competition and Consumer Commission
- Canadian Food Inspection Agency
- Food Safety and Standards Authority of India
- German Federal Office of Consumer Protection and Food Safety
- Republic of China Import Refusals
- FDA
- Federal Agency for the Safety of the Food Chain of Belgium
- Ministry of Environment and Food of Denmark
- UK Food Standards Agency

All data in this report stemming from the above-mentioned sources were aggregated, harmonized and enriched through FOODAKAI.

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<https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1745-4557.1988.tb00914.x>
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[https://www.mgm.gov.tr/veridegerlendirme/fenolojik-normal-haritalari.aspx?b=findik#sfB\[A1\]](https://www.mgm.gov.tr/veridegerlendirme/fenolojik-normal-haritalari.aspx?b=findik#sfB[A1])
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<https://doi.org/10.1080/19393210.2012.656146>
- [7] Weather data from Turkish Meteorological Agency <https://www.mgm.gov.tr>

The regulatory environment the food industry must operate in has never been more intense. The threats to an organization's brand have never been greater. This is not going to change. What must change is the way in which food companies confront these challenges.

EXPLORE HOW YOUR INTERNAL FSQA PROCESS CAN BE TRANSFORMED THROUGH THE EFFICIENT USE OF GLOBAL FOOD SAFETY DATA

CREATE A CUSTOMISED REPORT FOR YOUR ORGANIZATION, NOW

FOODAKAI is an intelligent online system that minimizes the food safety risks and helps to mitigate the vulnerabilities in your supply chain by delivering insights about hazards (food safety and food fraud) in raw materials and products.

FOODAKAI strategically gathers, processes and delivers live food safety data and risk estimation for ingredients, products and suppliers in a fast and easy way.



CONTACT US VIA MAIL:

info@foodakai.com

US PARTNER:



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