

Spotlight

FOOD FRAUD IN CANADA

Understanding the Risks
and Exploring Opportunities
for Leadership

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ABOUT ARRELL FOOD INSTITUTE

The University of Guelph is a world leader in food and agricultural innovation. Arrell Food Institute at the University of Guelph harnesses multidisciplinary expertise, convenes dialogues, and publishes papers on timely and relevant topics.

Food is intrinsic to human, economic, and planetary health; yet, it rarely comes first in conversations about how to meet today's challenges. Arrell Food Institute at the University of Guelph exists to elevate food to improve life. We bring people together to conduct research, train the next generation of food leaders, and shape social, industrial, and governmental decisions, always ensuring food is the central priority.

More information about the Arrell Food Institute can be found at:
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OUR MISSION: ELEVATE FOOD TO IMPROVE LIFE.

EXECUTIVE SUMMARY



Transparency and trust in global food chains have emerged as growing concerns for regulators, consumers, and food businesses alike due to recurring incidents of food fraud. In 2013, a scandal unfolded across Europe where products labelled as “beef” were found to contain up to 100% horse meat. This fraudulent labelling is a reminder that effective regulatory-based deterrents, modern science-based identification methods, and food fraud prosecution are required to maintain integrity and trust in national food control systems.^{1,2} A 2019 survey of Canadian food business operators highlighted that fifty-six percent of respondents were confident they could address food fraud vulnerabilities, but only thirty-three percent indicated their business was safe from food fraud.³ Another survey of UK-based food and beverage firms reported that price reduction pressures contributed to an increase in demand for lower cost and lower quality ingredients.^{3,4} Despite prior recommendations, 32% of firms could not verify the authenticity of the ingredients they purchased.²

On a global scale, the United Nations Food and Agriculture Organization (UNFAO) commissioned a report to understand the extent of global fish fraud.⁵ The report noted: “the scale of mislabelling and species substitution in the global fish marketing chain is a cause for concern and occurs in many countries.” It highlighted 200 published studies from 55 countries, and found that on average, 20% of fish is mislabelled. Subsequently, the UNFAO called for the strengthening of national food control systems and regulatory programs, and the development of science-based traceability and identification methods. Most recently, the COVID-19 pandemic disrupted global food supply chains, leading to an inevitable rise in food fraud according to food authenticity experts.^{6,7}

The illicit nature of food fraud and the scarcity of scholarly publications quantifying the problem complicates the accurate assessment of its global economic burden.⁸ Despite this, a 2010 report by the U.S. Grocery Manufacturing Association (GMA) suggested the cost of food fraud is in the range of \$10–15 billion USD.⁹ However, a more recent estimate by global consulting firm PwC suggests it could be as high as \$65 billion USD annually.¹⁰ The globalized nature and opacity in food supply chains, combined with a low probability of being detected, creates a perfect storm for food fraud to exist and thrive in Canada. For instance, the UNFAO-commissioned report on fish fraud highlights research from Oceana which alleges almost 50% of the samples tested in Canadian grocery stores and restaurants were mislabelled.^{5,11}

Food fraud is often perceived as an economically motivated and victimless deception. However, such reports of significant food fraud in our domestic market can damage “Brand Canada.” Moreover, it can negatively impact the reputation and economic interests of legitimate Canadian businesses and pose a significant risk to public health and safety. Many countries have established specialized food fraud units comprising experienced police officers, customs agents, and other specialists to strengthen national food control systems, professionalize their investigative capabilities, and enhance their enforcement and prosecution capabilities.^{2, 5}

Globalization, urbanization, and other factors—including consumer purchasing trends for foods that align with social beliefs, lifestyle, faith, and ethical values—may provide some insights as to why food fraud is growing. Specific consumer segments are willing to pay a premium for a growing range of credence claims such as antibiotic-free, grass- or grain-fed, cage-free, organic, halal, kosher, or certified humane.¹² On the one hand, credence claims can be very beneficial to differentiate a brand, but costly for the producer to implement and independently certify. On the other hand, if the credence claim sends a strong trust signal to consumers and achieves market acceptance with premium pricing, a fraud opportunity quickly opens. More broadly, globalization creates longer food supply chains to meet the growing demands of urban populations. Global food chains include food that passes through many hands, including disparate cultures and languages and strong and weak regulatory systems. Economic motivations will continue to drive the involvement of organized crime activity since opacity and anonymity are often characteristics of these global food supply chains.⁵

While food safety has always been a top concern for the food industry, food fraud is more difficult to identify. This is due, in part, to the lack of specific data detailing the scope of the issue and the different rules and regulations between countries. Food fraud presents certain risks to the Canadian agri-food sector at the consumer and industry levels. A proactive, comprehensive, and collaborative approach to identifying solutions through deterrence, identification, and prosecution (DIP) will contribute to Canada’s voice and role as a global leader in safe and trusted food supply systems.

This discussion paper details the importance of identifying food fraud incidents in order to protect and further elevate Canadian brands domestically and globally.

DIP Food Fraud

To our knowledge, this is the first document to contextualize the topic of food fraud across Canada's agri-food system and to present a novel intervention framework to *Deter, Identify and Prosecute* (DIP) food fraud. In this context, *deter* refers to the strengthening of regulatory and legal deterrents. *Identify* refers to the scientific methods to identify food fraud and *prosecute* refers to the ability to use the scientific evidence as a basis to prosecute bad actors. We believe that this novel framework captures and integrates the key components which are essential to reducing the risk of food fraud in Canada.

IN THIS PAPER, WE REVIEW:

- Characteristics of food fraud
- Scope of the issue
- How food fraud is currently addressed through science, regulations, and penalties
- Impacts of food fraud on different groups
- The challenges and barriers to detecting and preventing food fraud incidents
- Opportunities to collaborate and develop solutions to combat food fraud in Canada

////////// **Definitions**

For purposes of clarity, the following definitions are used for this paper:

Food fraud

is the deliberate and intentional substitution, addition, tampering, or misrepresentation of food, food ingredients, or food packaging for economic gain.¹³ The types of fraud include: substitution, adulteration or dilution, mis-labelling, and making false claims or misleading statements.¹⁴

Food value chain

refers to the chain of stakeholders who participate in the production and “value-added” activities required to produce food products.¹⁵

Direct food fraud risk

occurs when there is an immediate or imminent risk to the consumer, such as the inclusion of an acutely toxic or lethal contaminant.

Indirect food fraud risk

occurs when the consumer is put at risk through long-term exposure, such as the build-up in the body of a chronically toxic contaminant through its ingestion in low doses. Indirect risk also includes the omission of beneficial ingredients, such as preservatives or vitamins.

Technical food fraud risk

is non-material in nature. For example, food documentation fraud occurs when product content or country-of-origin information is deliberately misrepresented.

CURRENT CONTEXT

What is Food Fraud? The Scope of the Issue and Global Responses

Research shows that food fraud is not a new problem, and it is happening in Canada and throughout the world. In a world where news travels faster than ever before, media coverage and social media amplification have led to an increasing public awareness of the problem. Recent statistics and tracking support the suspicion that food fraud is on the rise. For example, using DNA barcoding, the Canadian Food Inspection Agency (CFIA) found a seafood mislabelling rate of 14.8% between 2013 and 2016, compared to only 6% in 2013–2014.¹⁶ However, an independent research report by Oceana indicated that almost 50% of Canadian fish samples from grocery and food service were mislabelled.¹¹

Consumers report being concerned about food safety. Specifically, 59% of Canadians are concerned about the safety of imported foods and 55% are concerned about the safety of all foods, whether local, domestic, or imported.¹⁷ However, quantifying the economic and public health impact of food fraud remains difficult, mainly because the full extent of the problem remains poorly understood. Most available information is anecdotal, but numerous incidents and case studies indicate that food fraud is a growing trend.¹⁶

In Canada specifically, the statistics and reliable information are lacking. The CFIA has not identified how widespread the problem is nationally, and to our knowledge, no one is specifically investigating the scope of food fraud. Individual cases provide an incomplete picture. The 74 cases of non-compliance with labelling laws from the past year published on the CFIA website—a number the agency says has held steady over the past five years—present only a portion of incidents where the agency has specifically found and caught companies breaking the rules.¹¹ This knowledge gap represents an opportunity to enable the system to evolve into one that can DIP food fraud effectively.

DOCUMENTING

A report published by the UK National Audit Office found that in 2012, English local authorities registered around 1380 cases of fraud, up two-thirds since 2009.¹⁸

Other overseas data also reveal a similar scenario: The U.S. Pharmacopeial Convention, which set up a global database of independently documented examples of food fraud, added almost 800 new records, based on information published in scholarly journals and the media in 2011 and 2012.¹⁹

An increase of food fraud cases was also revealed in a report published in 2017 by a joint Interpol-Europol initiative, called Operation OPSON VI, which led to the seizure of over 13,000 tonnes of fake or substandard food and nearly 26 million litres of counterfeit drinks.²⁰

Although large-scale fraud has been well covered in the scientific literature, documentation of small-scale incidents has been inadequate.²¹ Furthermore, food fraud may go undetected in poorly regulated markets and, with respect to seafood, in countries with weaker governance of fisheries imports.^{22, 23, 24}

It is difficult to fight a problem we do not know much about; however, our methods and technologies are becoming increasingly advanced, leading to better detection methods to identify food fraud. This includes world class, state of the art technologies and services developed by researchers at the University of Guelph.^{25 26, 27, 28}

Commonly Adulterated Foods

Seafood is one of the largest food categories subject to fraud.^{24,29-34} Complex supply chains that span the globe—including processing activities that take place during transport—have made traceability difficult.^{24, 33, 35} In a recent study, 44% of Canadian samples were found to have been mislabeled. Snapper, yellowtail, and butterfish were mislabelled 100% of the time.³⁶

Meat adulteration typically occurs when species are mixed and/or substituted and cuts are improperly labelled as higher value. In a recent case, a study revealed that 20% of Canadian sausages sampled were mislabeled.¹⁷ Almost all published studies using DNA barcoding have found a significant incidence of undeclared products in processed meat samples.³⁷⁻⁴⁴

Honey is another commonly adulterated food product; changing the country of origin is often part of the fraud to reduce the risk of detection. Honey products are often diluted with high fructose corn syrup and other cheap sweeteners. In fact, it is estimated that adulterated honey is such a widespread problem that it has affected prices in the international market.^{125, 57}

Grains and oilseeds—two of Canada’s largest agricultural exports—are important to protect from food fraud risk. Some potential incidents could include misrepresented dockage levels (the percentage of unwanted material, such as stems or leaves, in the final product) or mislabelled organic products, as seen in Italy in 2011 when more than 700,000 tonnes of non-organic grains were sold as organic.⁴⁵

Alcoholic beverages are subject to fraud by being diluted and under-poured in food establishments. Other instances can include the substitution of higher value wines for wines of lower value. In one instance, a California man sold over \$150 million in fraudulent wine.⁴⁶ In Canada wine fraud has not been reported; since it is highly regulated and considered traceable, this is of relatively low concern.

Produce has been subject to labelling and origin fraud. Canada’s organic labelling laws have been subject to scrutiny over their vulnerability to food fraud.¹²⁵ The most widely known produce fraud incident involved a three-year period over which greenhouse tomatoes were labelled and sold as Canadian, when in fact they were grown in Mexico.

To effectively address Canadian interests, we recommend identifying and addressing the risks of different avenues of food fraud, including: 1) products produced and consumed domestically; 2) products produced domestically, but exported—thereby creating a risk of co-mingling with non-Canadian products and increasing the risk of counterfeit packaging, branding, and substitution with sub-standard products; 3) products produced domestically, exported for processing, and then re-imported—thereby creating the risk of substitution, comingling, and contamination; and 4) imported products, whose risks depend on the commodity and source and are at a higher risk for food fraud in documentation, ingredient declaration, authenticity of certification, pesticide use, and chemical or drug maximum residue limits (MRLs).

Regarding exports, Australian beef producers struggle with mislabelled (fake) Australian beef in global markets. The cost to Australian producers could be as high as \$2 billion AUD.¹⁰ One producer noted, “We estimate it is a kilogram for kilogram. So, for every kilogram of meat being sold in countries like China, at least another kilogram is being sold labelled as Australian, but it is not.”⁴⁷ Further, fake Australian wine is abundant in the Chinese market and genuine exports of wine have fallen.^{8, 48} Caroline Francis, a researcher at the University of Melbourne studied the perceived trust among Chinese consumers on the security elements applied to Australian meat imported into China. She noted, “A lot of Australian products are just so easy to copy. We have to think smart.”⁴⁹



OPERATION
OPSON VI ²⁰

#OPSON

Tackling Counterfeit and Substandard Food and Drink

- Began in 2011 with 10 EU member states
- Now includes 65 countries from all continents and 20 industry partners

Since its inception:

- 50,000 checks
 - Seizure of 45 tonnes of fish from processing plants in Italy and Spain that was being sold as fresh, when it was previously frozen. The fish was being chemically treated to disguise the fact that it was rotting
- 13 million units/items seized
 - Dismantling an organized crime network in Columbia producing, distributing, and selling fake whisky and Aguardiente
- €230 million worth of fake food and beverages prevented from entering the marketplace

Understanding the Crime and Punishment Aspects Within the Canadian Context

Other economies are already seriously pursuing food fraud. The Europol-Interpol Food Fraud Task Force or, *Operation OPSON*, is one example.^{20, 50} The task force consists of partnerships between 65 countries and industry members including the USA, Netherlands, Thailand, UK, Rwanda, and Unilever, Nestlé, and Mars to name a few. The task force is the first group of its kind dedicated to seizing fraudulent food. Its industry membership was targeted to include companies that supply highly regulated or commonly counterfeited products. To date, Canada has not participated in OPSON and, unlike countries such as the UK, Canada does not have a dedicated food crimes unit through either the RCMP or CFIA.

The United States Food Safety Modernization Act (FSMA) in section 418 (Preventative Controls Rule) requires food establishments to have a written Hazard Analysis and Risk-based Preventative Control plan (HARPC) to address economically motivated adulteration.⁵¹ This is the first legislation of its kind to address intentional adulteration and food defense. Under the FSMA, both domestic and foreign companies required to register with the FDA are subject to the rule. The rule is designed to target larger companies with greater consumer reach, and many smaller companies are exempt. Currently, it covers roughly 3,400 companies representing 9,800 food facilities.⁵² A key characteristic of the legislation is that mitigation strategies contain actionable steps, strategies, and procedures for monitoring, corrective actions, and verification.

A Scientific Leader, a Regulatory Laggard

Arguably, food adulteration calls for legal solutions beyond those that currently exist in Canada. While this paper recognizes that increased regulation of food is not always the answer, given the current political landscape, there is opportunity to modify regulations and better deter and enforce existing mandates for the benefit of consumers in a smart, efficient manner by setting priorities and collaborating with experts and the food industry.

In order to protect consumers and law-abiding actors in the industry, legal recourse requires practical solutions that recognize the sophistication and systemic nature of cheating. In Canada, producers can be given a hefty fine for deceiving consumers through misleading labelling.⁵³ For example, one Ontario company was heavily fined for forging kosher certificates for food that was not kosher.⁵⁴ In the case of a 2016 investigation into the misrepresentation of organic poultry products by a large poultry operation, the Canadian Food Inspection Agency pursued criminal charges of fraud, among others, in recourse.⁵⁵ While there is speculation that food fraud has recently garnered the serious attention

of national agencies, legal action to-date has varied and has been a reactive strategy to combatting food fraud. However, the Food Policy for Canada, released in 2019, is intended to provide a roadmap for a healthier and more sustainable food system. Of the \$134.4M earmarked for this initiative, \$24.4M will go towards helping the CFIA crack down on food fraud.⁵⁶

In EU countries, border officials have the authority to seize and destroy goods they believe are counterfeit. In Canada, customs officials can detain a product, but it is then incumbent on the complainant to undertake court action and to pay for the goods to remain in detention until the case is heard—which can cost in the tens of thousands of dollars.

Further, much of the action on the issue in Canada has been industry-led. Large retailers like Loblaw or Costco have programs to safeguard against adulterations, requiring suppliers to subscribe to standardized food safety programs and undergo annual audits. Of note, as a result of the horsemeat scandal in Europe, many UK retailers have adopted unannounced supplier audits as a fine-tuning of best practices.

Canada's legislation is lagging not only behind its trading partners, but also in respect to industry action and available technology. There is an opportunity to elevate Brand Canada by helping consumers understand risk, and leverage initiatives to combat food fraud that are already in place domestically.

SAFE FOOD FOR CANADIANS REGULATIONS

Food fraud will continue as long as the potential for profit outweighs the odds of getting caught.

—Everstine, Spink and Kennedy (2013)²¹

The Safe Food for Canadians Regulations (SFCR) is a new set of rules and regulations for food inspection, standards, and licensing that was adopted under the Safe Food for Canadians Act (SFCA), in January 2019. Certain requirements, however, are being phased in over a 12- to 30- month period. The regulations do not replace the Food and Drugs Act and the Food and Drug Regulations which will continue to apply to all food sold in Canada. The SFCR is meant to align Canada's regulations with prevention-focussed international standards. It seeks to reduce the administrative burden on businesses by replacing 14 different sets of regulations with just one. The new regulations aim to help Canada maintain and grow its global market access.

What's included?

Food businesses that import or prepare food for export or to be sent across provincial/territorial borders will require licenses and preventative controls that outline steps to address potential food safety risks. Businesses will be required to trace their products back to their supplier, as well as forward to their purchasers. Ultimately, the SFCR will reduce the time it takes to remove food safety risks from the marketplace.

What about food fraud?

The SFCR does not directly address food fraud; however, Division 2, Part 4 of the regulations, Preventative Controls, deals with biological, chemical and physical hazards of food, and Division 6, Preventative Control Plan, provides an approach for managing risks.⁵⁷ Industry, particularly larger companies, have been implementing risk and vulnerability assessments and are increasingly requiring compliance with benchmarked schemes set by the Global Food Safety Initiative (GFSI), an organization composed of the world's leading food safety experts that develops industry standards. This is especially important to gain and maintain market access to countries, like the U.S., who have mobilized the call-to-action on food fraud. The Canadian government could improve control over food fraud by implementing a country-wide vulnerability assessment to identify the most detrimental types of food fraud and then develop a country-wide prevention strategy.⁵⁸

THE COST OF SEAFOOD MISLABELLING

Seafood is thought to be the largest food category subject to food fraud:

- 900 + different species are sold in Canada and 44% of Canadian samples have been found to be mislabeled.³⁶
- Canadians have paid up to 244% more for mislabeled fish.³⁶
- A recent study by Oceana revealed that 60% of substituted fish samples could have potential health consequences.¹¹

With complex supply chains that intersect borders and oceans, disparate cultures and languages, and strong and weak regulatory systems, it has historically been difficult to implement “boat-to-plate” traceability for seafood. For example, it is not uncommon for fish to be caught in Canada, sent to China to be gutted, to the United States to be breaded, and then back to the Canadian marketplace, where it is labelled and sold as an American product. Fish mislabelling incidents have been found to occur most frequently at food service establishments, followed by distributor or retail sale. The goal of mislabelling is to increase profits for some actors along the supply chain—typically, this does not include those responsible for harvesting.²¹

Collaboration Between Governments

A 2011 report from the U.S. Government Accountability Office found problems with collaboration among three federal agencies responsible for seafood fraud identification and prevention.⁵⁹ Two large problems included an absence of standardized testing capabilities and the fact that agencies were not sharing results with one another. Similarly, in Canada there are two main agencies whose mandates include seafood safety: the Canadian Food Inspection Agency (CFIA)—responsible for food safety—and the Department of Fisheries and Oceans—charged with developing policies that support healthy and productive ecosystems and ensure sustainable fisheries and aquaculture. While the issue of food safety, and subsequently food fraud, is the responsibility of the CFIA, collaboration between the two federal departments is important to reducing seafood fraud risk in Canada.

Among the three major seafood importing States (Japan, U.S., and the European Union), a recent report has identified areas of convergence and also gaps in supply chain traceability systems and import controls of seafood products. These systems need to be harmonised in order to successfully combat illegal, unreported and unregulated (IUU) fishing.²⁴

Examples of common substitutions		
What you bought		What you got
Butterfish		Escolar
Cod		Haddock, Pollock
Halibut		Haddock, Flounder, Turbot
Wild-caught Salmon		Farmed Atlantic Salmon
Sea Bass		Asian Catfish
Snapper		Rockfish, Tilapia
Sole		Asian Catfish
White Tuna		Escolar
Yellow Tale		Japanese Amberjack

CBC NEWS SOURCE: OCEANA CANADA

Tools and Systems for Mitigation

The University of Guelph has the world’s largest database of seafood DNA sequences that use barcodes (i.e., DNA sequences that can uniquely identify a species) to simplify authenticity and improve testing accuracy.²⁵ The University of Guelph-based Animal and Plant Health Lab, using this database, offers services to determine fraudulent seafood by comparing acceptable names for market fish and the DNA of the fish packaged.

While DNA barcoding is a made-in-Canada technology, we currently do not use it as

a regulatory tool to mitigate seafood fraud. However, Canadian seafood suppliers and producers are already implementing traceability systems to satisfy export requirements that are more stringent than domestic regulations.¹¹ With imports, a group of NGOs recommends that states gather specific information (so-called “key data elements” such as catch area, unloading ports, catching method etc) that are essential for effective import control.²⁴ On the scale of global trade, seafood traceability could be greatly improved through use of Latin species names rather than the vague, generic names commonly used in trade records.³⁵

GAPS AND OPPORTUNITIES

Opportunities

Combatting Food Fraud with Science

A range of types of food fraud exist, including: 1) substitution of one product with another of a different character or quality, 2) adulteration or dilution of a product with other substances that are not declared on the label 3) labelling a product as something it is not (e.g., false declaration of net quantity), and 4) falsification and misleading labelling (e.g., labelling that claims a product is preservative-free when in reality it contains preservatives).¹⁴

Some of these types of fraud are easier to detect than others, and a wide range of methods have been developed for food fraud detection, including physical, chemical, biochemical, immunological, and molecular techniques. A brief summary of some major detection methods and examples of their use is found in [Table 1](#).

A 2012 meta-analysis of 137 unique food fraud incidents in the U.S. since 1980 determined the commonalities between cases to help evaluate and reduce the risk of economically motivated fraud.²¹ The study described specific, effective, analytical methods as key components in combatting fraud. Non-specific testing methods were determined to be a risk factor for fraud. For example, the testing method for general protein content in Chinese-made infant formula concealed the true protein content through the widespread use of melamine, resulting in six reported deaths and about 300,000 sick infants and young children.⁶⁰

TABLE 1

Selected food fraud detection methods and examples of their application.¹⁰⁸

Detection Method	Application Examples
Microscopy (including light, IR, electron fluorescence, and others)	<ul style="list-style-type: none"> • Identification of starch types¹⁰⁹ • Detection of fish-meal additives¹¹⁰
Spectroscopy (including UV, visible light, infrared fluorescence emission, nuclear magnetic resonance (NMR), and many others)	<ul style="list-style-type: none"> • Classification of teas¹¹¹ • Purity and botanical origin of honey¹¹²
Mass Spectrometry (including GC-MS, ICP-MS, LC-MS, Raman, IR, ambient, and many others)	<ul style="list-style-type: none"> • Detection of melamine in milk¹¹³ • Dilution of olive oil with hazelnut oil¹¹⁴
Electronic Noses and Tongues	<ul style="list-style-type: none"> • Authenticity of protected designation of origin (PDO) cheeses¹¹⁵
Isotope Analysis	<ul style="list-style-type: none"> • Purity of vanilla extract¹¹⁶ • Geographical origin of fruits¹¹⁷
Chromatography (including GC, HPLC)	<ul style="list-style-type: none"> • Addition of syrups to honey¹¹⁸ • Dilution of pomegranate juice with grape juice¹¹⁹
Differential Scanning Calorimetry	<ul style="list-style-type: none"> • Purity of coconut oil¹²⁰ • Contamination of sunflower oil¹²¹
Immunoassay and other protein-based tools (i.e. ELISA, electrophoresis)	<ul style="list-style-type: none"> • Detection of meat species¹²² • Detection of cow's milk in sheep and goat milk¹²³
Molecular Tools (including DNA barcoding, species-specific PCR, next generation sequencing, biosensors)	<ul style="list-style-type: none"> • Mislabelling of game meat⁶² • Seafood substitution¹²⁴

Abbreviations: ELISA enzyme-linked immunosorbent assay; GC gas chromatography; HPLC high performance liquid chromatography; ICP inductively coupled plasma; LC liquid chromatography; IR infrared; MS mass spectrometry; PCR polymerase chain reaction; UV ultraviolet

APPLICATION OF MOLECULAR TOOLS IN FOOD AUTHENTICITY INVESTIGATIONS*

*Based on work by U.S. and Canadian researchers.^{29, 28, 61-76}

It can tell you what you're eating...

44% of fish samples studied were mislabelled in a 2018 study of 382 seafood samples from 177 supermarkets and restaurants across Canada. In many cases, fish were labelled as high value species, but had been substituted with low value fish species. For example, samples that were labelled as cod were actually haddock or Alaska Pollock.³⁶

...and where it's from.

The geographic origin of fish samples was determined by extracting and analyzing the DNA present in the microbes on the fish. Biomarkers for the composition of the microbial community were used to identify the geographic origin of the fish samples.⁷⁷

DNA barcoding has cultural applications too.

DNA barcoding and other molecular tools have been developed for the identification of halal and non-halal meats and their derivatives, including the use of gelatin for binding, glazing, and shaping food, cosmetic, and pharmaceutical products.^{78, 79}

Interesting specific analytical methods include the emerging suite of molecular tools for detecting food fraud by analyzing nucleic acids (i.e., DNA) and comparing these DNA profiles to known reference materials via barcoding, polymerase chain reaction (PCR), fragment lengths, sequencing, and other materials. These molecular tools are highly specific and can be used to investigate both targeted and non-targeted queries about the origin and authenticity of food products. For example, molecular tools can be used to determine if a target species is present in a food product (e.g., "Is there horsemeat in this sample of ground beef?"), but these tools can also be used to query for unknown species (e.g., "What are all of the species present in this sample of ground beef?").^{36, 77, 78, 79}

DNA testing, however, cannot always be used in certain food products that have either scarce amounts of DNA or altered levels/stability of DNA as a result of processing.⁸⁰ Some DNA-based techniques are also not suitable for mixtures of multiple species. DNA is not traditionally used in food science to indicate percentage mass. That is, if you could separate plant matter from the meat in a chicken strip that contained 50% bird DNA to 50% soy DNA, the two halves would not balance a scale. This was further demonstrated in the Subway chicken

breast controversy. The CBC's television show *Marketplace* reported that Subway chicken analyzed by a DNA testing laboratory contained significant amounts of non-chicken DNA. Subway retaliated by commissioning two laboratories for its own study, the results of which refuted *Marketplace*'s findings. This case demonstrates that DNA testing results are not always conclusive, and depend on the particular testing methods, experimental controls, and reporting methods used.⁸¹

Nuclear Magnetic Resonance Spectroscopy

Another increasingly important technology that can be used for targeted or non-targeted food authenticity analysis is nuclear magnetic resonance (NMR) spectroscopy, which has the advantages of analysing complex mixtures with little, and sometimes no, sample preparation. NMR scanning techniques can create a fingerprint of chemical species in the liquid, semi-solid, or solid states, which can identify undeclared components or fraudulent quality claims (e.g., geography, variety). Currently, NMR is not as widely used as it could be, likely because of the high equipment cost and the requirement for expert operating personnel. Industry collaborations with public sector laboratories should be explored as a valuable tool to expand the use of NMR and the development of high-throughput and rapid protocols.

Non-traditional Data

The suite of techniques available to detect and prevent food fraud is advancing rapidly with new technologies and increased sensitivity available to support the practical implementation of food safety and security systems. In addition, incorporating the use of non-traditional data for detection is a relatively inexpensive strategy to add to assessment and prevention methods (e.g., tax records, sudden changes in suppliers, below market pricing, no change in supply following a natural disaster or severe weather event). One practical example of this was the discovery of international wine fraud when a tax inspector noticed deductions taken by one winery for diethylene glycol, which serves no purpose in winemaking.⁸²

Gaps

Understanding the risks associated with food fraud

In 2007, pufferfish was mislabeled and sold as monkfish. Consumers became ill with symptoms consistent with *tetrodotoxin* poisoning (a toxin found in pufferfish).

We argue that food fraud and food safety are “two sides of the same problem.” In fact, food fraud can have serious public health consequences.^{21, 83-89} Food fraud, food safety, and food defense incidents are interconnected, all presenting public health threats. Economically motivated food fraud incidents are arguably more risky than unintentional food safety incidents, since contaminants are often unconventional, and fraudsters are not concerned with the quality of their product.⁴⁵ Globally, current systems are not looking for these contaminants, and the current public health risks are unknown. Understanding risk is required to transition from a reactive to a proactive approach to combatting food fraud. In the case of the horsemeat scandal, the Food Standards Agency of Ireland (FSAI) was the only EU-based regulator who tested regularly for the presence of horsemeat.

In order to formulate a risk-based approach, we must first understand the risks to consumers, industry, and government. Importantly, responsibility and accountability are required from industry and government to combat food fraud.

Consumer Risks and Perspective

The common factor in many cases of food fraud is that the adulterant is neither a food safety hazard nor is it readily identified (as this would defeat the aim of the fraudster). Common adulterants in products such as fruit juices, for example, include water and sugar, or ingredients that may be legitimately used and declared, but whose improper use constitutes fraud. Fish fraud can include over-glazing (peeled shrimp or scallops) or over-breading and undeclared use of water-binding agents to increase weight by up to 50%. Some processors use undeclared carbon monoxide treatments to enhance and maintain the colour of frozen fish (e.g., tuna).⁵ Food fraud deceives the vulnerable consumer by providing lower quality ingredients without their knowledge and against their will.⁹⁰

One example highlighting the importance of consumer education and verification of global seafood products is the recent regulation from China, which allows rainbow trout to be labelled as salmon. Consumers can educate themselves by looking for the blue checkmark logo of the Marine Stewardship Council — a program that tracks seafood supply chains, and which producers can voluntarily join. However, fraud of credence claims is also a common occurrence. A credence claim is a claim (e.g., halal, kosher, organic, sustainably sourced) that, due to their lack of technical knowledge and expertise, the consumer cannot easily verify

before or after purchasing. For example, the USDA Organic logo is meant to send a strong trust signal to consumers; however, the label is fraudulently used, and the agency maintains and publishes a list of products misusing its organic label. Further, in 2015, U.S.-based research examined 245 eco-claims and indicated that 56% of American consumers did not trust credence claims such as eco-friendly or sustainability.⁹¹

Recent food fraud scandals have shown the detrimental impact that food fraud can have on consumer confidence regarding food safety, public trust, and the reputation of food businesses.² Food fraud intentionally cheats consumers and violates the consumer's right to make informed choices about their food. Consumers expect to receive trustworthy and correct information from product packaging; they are entitled to receive the product they agreed to buy for the price they agreed to pay. As price reflects the quality of the product, among other things, consumers expect a certain degree of confidence in the quality and safety of their food purchase. There is a well-documented demand and growing global movement towards sustainably produced, nutritious, and local foods.⁹² In fact, the growing demand for foods that are verified to be sustainably produced is a testament to the importance of authentic verification and traceability. Consumers are expecting and demanding better traceability of their food from producer to plate. As such, there is an opportunity to inform consumers and engage a positive market response by favouring and rewarding authenticity.

In addition to public trust, food fraud can also have impacts on public health, including direct, indirect, and technical risks. Mislabelled food products can have severe consequences on consumer health through unidentified allergens and/or risk of toxins or contaminants.^{85, 86, 89} In addition to economic fraud and potential health impacts for consumers, fraudulent activities also damage consumer trust in the food supply chain. Particularly when consumers adhere to strict dietary restrictions (e.g., faith-based, health-related, lifestyle choices), the undeclared substitution of species can compromise trust and can lead to potential health threats. The food-related public health risks could be more risky than traditional food safety threats because the contaminants are unconventional.⁴⁵ Current research does not adequately capture the public health risks associated with food fraud. Ding et al.⁹³ explain that when food safety risk events are successfully managed, consumer confidence improves, and subsequent events are perceived as manageable. Importantly, risk management should consider the cumulative effects of more than one risk event on consumer trust.

Industry Risks and Perspective

From an industry perspective, mislabelling can create unfair competition for honest businesses. Players among the food supply chain have to compete with lower-priced, fraudulent products. When they cannot compete with the prices, they can be pushed out of business. There is also relatively little data on where along the supply chain food fraud occurs and what sectors in Canada are most vulnerable.⁶⁵ The Canadian industry must create checkpoints or monitoring systems to better track and account for food fraud incidents.



Guntzburger et al. (2020) surveyed almost 400 Canadian food business operators (i.e., producers, processors, and distributors) on their perceptions and experiences related to food fraud, including potential vulnerabilities.³ They found that food fraud was well understood by food business operators and that operators would likely act against suspected food fraud, either upstream or downstream of their business, if they could afford it.

Some vulnerabilities identified in the study included 34–40% of respondents reporting poor knowledge of federal and/or provincial regulations, 33% evaluating their knowledge of preventative measures as insufficient, and 62% of respondents stating that they never use detection methods for food fraud management.

To help mitigate industry risk, The Global Food Safety Initiative (GFSI) supports an industry Food Fraud “Think Tank.”⁹⁴ The think tank has provided two recommendations on how industry should address food fraud: 1) carry out a food fraud vulnerability assessment, and 2) put in place appropriate control measures to reduce the risks from these vulnerabilities.

Other mitigation measures can be incorporated into everyday business practices, including: raw material specifications, analytical surveillance, improved and highly trusted supplier relationships, and supplier audits.⁹⁵ Ultimately, industry can continue to pursue and tackle food fraud by “embracing the norm of authenticity and establishing self-governance rules as it has done so with sustainability” (p. 4).⁹⁶ In doing so, industry themselves can create a social climate where food authenticity is diligently sought, measured, and validated.

Government Implications, Risks, and Perspective

Canadian food is perceived as an internationally trusted brand, recognized for its preventative focus on food safety issues and an accurately traceable food system.^{45, 97} In order to maintain this high standard, food fraud must also be a priority. This has traditionally not been the case. Failing to protect and prove our food system is safe from fraud risks diminishing the value of ‘Brand Canada’ to international partners. Indeed, others, such as the European Commission, Chinese Food Safety Authorities, and the United States Food Modernization Act, emphasize food fraud as a key issue—the GFSI has indicated food fraud as a “top 5 issue.”⁹⁴ Making food fraud a priority has led the European Union to implement stringent traceability and comprehensive labelling requirements for seafood products. Their dedication to tackling the issue of food fraud resulted in a decrease in seafood mislabelling rates across several European countries.⁹⁵

More recently, a 2020 report offers recommendations on tackling illegal, unreported and unregulated (IUU) through various measures that include: using comprehensive import control documents to determine product legality and maximize traceability, implementing operational best practices, and harmonizing import control systems among importing states.²⁴

Fortunately, existing initiatives abroad and even domestically (within industry) provide an opportunity for Canada to align itself.²⁴ There is an opportunity to contribute to global harmonization of standards, regulations, and testing methods and to keep pace with international standards. The risk of avoiding this responsibility means opening doors for trade restrictions and/or implications with misalignment of international standards. For example, throughout the Chinese milk product/melamine scandal, a total of 68 countries banned or recalled all suspected products.⁹⁶ Ultimately, the demand for foreign-trusted brands sky-rocketed such that the Chinese market was flooded with some 100 foreign products.⁹⁷

HEALTH PRODUCT OR HEALTH FRAUD?

The Natural Health Product (NHP) sector, which includes teas and herbal supplements, is a common area for adulteration and food fraud. What makes this sector more complicated and fraught with regulatory and government confusion is the fact that NHPs are not subject to the same regulations as food in Canada. NHP regulations also vary substantially by country. Since the boom in the NHP industry, the regulations have been changing and evolving as our government develops ways to properly control this sector and keep Canadians safe.

NATURAL HEALTH PRODUCTS STATISTICS

- 73% of Canadians consume a NHP⁹⁸
- The NHP sector earns more than US \$60B per year⁹⁹
- 59% of NHPs were found to contain fillers not listed on the product label or have substituted ingredients¹⁰⁰

The issue of food fraud in this sector was first brought to light in 2011, when a study found that nearly one-third of herbal teas generated DNA identifications not listed as ingredients on the product labels.⁷¹ Work conducted at the University of Guelph found similar results with 59% of products containing fillers, like wheat or rice, that were not listed on the label.¹⁰⁰ Some products were also found to

be contaminated with other plant species. In this work, conducted by Dr. Steven Newmaster, approximately one-third of the products tested were instances of product substitution. In fact, only two of the twelve companies sampled had products with no substitution, contamination, or fillers.

Consumer Health Impacts

The contamination and substitution of ingredients that are not listed on the product labels can result in considerable indirect and direct health risks for consumers. Many of the ingredients that are found in these products could cause toxicity or allergic reactions, or could interact negatively with other herbs, supplements, and medications. This was exactly the case in the Chicago area, when a dietary supplement was confirmed as containing high, near-toxicity, levels of lead after a series of adverse health events were reported. The investigation revealed that one of the distributors apparently substituted a plant-based ingredient imported from China for an industrial version used in paint thinners, which created the high levels of lead.

A Call for Research and Investigation

As the NHP sector and market continues to grow, along with continued international trade of ingredients and products, there is increased concern about the widespread adulteration and substitution of raw ingredients. The adverse consequences of such adulteration on the health and safety of consumers have only recently begun to be recognised and documented. More research is needed to investigate the food fraud in this sector and the potential public health impacts.

Socio-economic Risks of Food Fraud

Although the socio-economic impacts of food fraud are currently not fully understood, there are some issues that warrant consideration. Since adulterating a food product is often times economically motivated, the outcome can be that traditionally low-cost food products are sold at a higher cost. Given that lower income households spend a higher proportion of their income on food, the socio-economic consequences of food fraud could be disproportionately impacting consumers who are already at a disadvantage.

Other incidents, such as the horsemeat scandal in Europe, demonstrate that food fraud does not just concern well-off shoppers looking to indulge in red snapper.¹⁰¹ For example, during the horsemeat scandal, the first product to be recalled was an “Everyday Value” beef burger that was found to contain 29% horsemeat.¹⁰² In another more recent example, it was discovered that 20% of sausages sold in grocery stores across Canada contained off-label ingredients.⁴² Vulnerable socio-economic populations—particularly women, immigrants, and those with poor health—tend to have less access to healthcare. As such, health risks associated with food fraud could disproportionately affect vulnerable populations.¹⁰³

Further, vulnerable populations—especially those who are food insecure—may be more at risk for consuming fraudulent foods. Canadian consumers who are forced to obtain their foods from non-commercial sources such as food banks, may be put in jeopardy from a health and safety perspective. Low cost foods, such as those frequently donated to food banks, often correlate with higher rates of mislabelling. Nearly 3% of Canadians visit a food bank on a monthly basis.¹⁰⁴ This means that nearly 1.1 million Canadians may be unwittingly consuming fraudulent foods—foods that may not comply with their faith-, health-, and lifestyle-based needs. As such, food banks must be safeguarded from unsafe, mislabelled, and otherwise fraudulent foods.

Mislabelling of food products allows businesses to get around bans. In fisheries, this may allow illegally caught fish—including endangered species and fish caught with destructive methods—to reach consumer plates. A recent study conducted by Oceana in collaboration with University of Guelph researchers found that 30% of mislabelled fish samples were threatened, vulnerable, or endangered species.³⁶ As well, they found that 40% of mislabelled fish samples belonged to a species whose population size was not sufficiently understood to ascertain whether harvesting would be sustainable. These unethical behaviours can have consequences on the sustainability of our food system and negatively impact fisheries and other economic sectors.

GROUND MEAT — AFFORDABLE AND HONEST?

Meat, as a premium protein source, is commonly a target of fraudulent activities⁸⁴, 46—including the substitution of high value meat species with lower value meat species, the addition of additives and fillers, such as water, plant proteins, or other non-disclosed types of animal tissue, and the mislabelling of the geographical origin, animal diet (e.g., grass-fed), meat processing methods (e.g., fresh versus frozen), or quantity of meat ingredients.

GROUND MEATS ENTERED THE “FOOD FRAUD SPOTLIGHT” IN 2013

- Millions of products were recalled¹⁰⁵
- Up to 20% of Canadian sausage samples were found to be mislabelled³¹
- There have been lasting impacts on consumers and mistrust in the food value chain

The EU-wide Scandal

Ground meats entered the food fraud spotlight in 2013, when the Food Safety Authority of Ireland found that 37% of frozen beef hamburgers in Ireland contained horse DNA. A subsequent EU study found that nearly 5% of ground beef products in the EU contained horse meat. This resulted in the recall of tens of millions of processed food products across the EU and a significant shift in consumer perception of their food supply. Consumers were surprised at the complexity of the food chain and demanded increased transparency

across the value chain, from farm-to-fork.¹⁰⁵ Purchase habits changed immediately following the horsemeat scandal and while these economic effects largely subsided over time, there have been lasting impacts on how food processors and retailers source, inspect, and market food. The situation also highlighted gaps in awareness and responsibility for the investigation and prosecution of food fraud in the EU. Ultimately, two people were jailed for their role in substituting horsemeat for beef and mislabelling ground meat products.¹⁰⁶

Following this scandal, the CFIA funded research at the University of Guelph to take a closer look at the level of food fraud in Canadian retail ground meat products. Dr. Hanner’s lab sampled 100 raw meat sausages from across Canada that were labelled as containing a single species of meat. His lab analyzed the samples for the presence of beef, pork, turkey, chicken and horse meat.

The overall mislabelling rate in the sausages was 20%, including five samples of turkey sausage that actually contained no turkey DNA and one pork sausage sample that contained horse meat. In addition, 6% of beef sausages also contained pork, 20% of chicken sausages contained turkey, while 5% of chicken sausages and 5% of pork sausages contained beef.⁴²

Opportunities for Canada

Despite the publicity of the horse meat scandal, the food industry continues to have fraudulent activity. There is the opportunity to learn from other countries and sectors on how to properly mitigate and prevent food fraud in Canada.

KNOWLEDGE SHARING AND POLICY FOR IMPACT

Where Can We Go from Here?

To develop an informed understanding of potential punitive measures, one can look to the field of criminology for answers. Criminology tries to better understand why people offend and is a useful platform for examining food fraud incidents.⁴⁵ Historically, focusing on the opportunity structures that make crime possible and employing opportunity-reducing techniques (such as increasing the risk or effort of crime) have been effective in lowering crime across a number of differing communities. The DIP concept we present here offers a framework for integrating knowledge from criminology as a means of reducing food fraud.

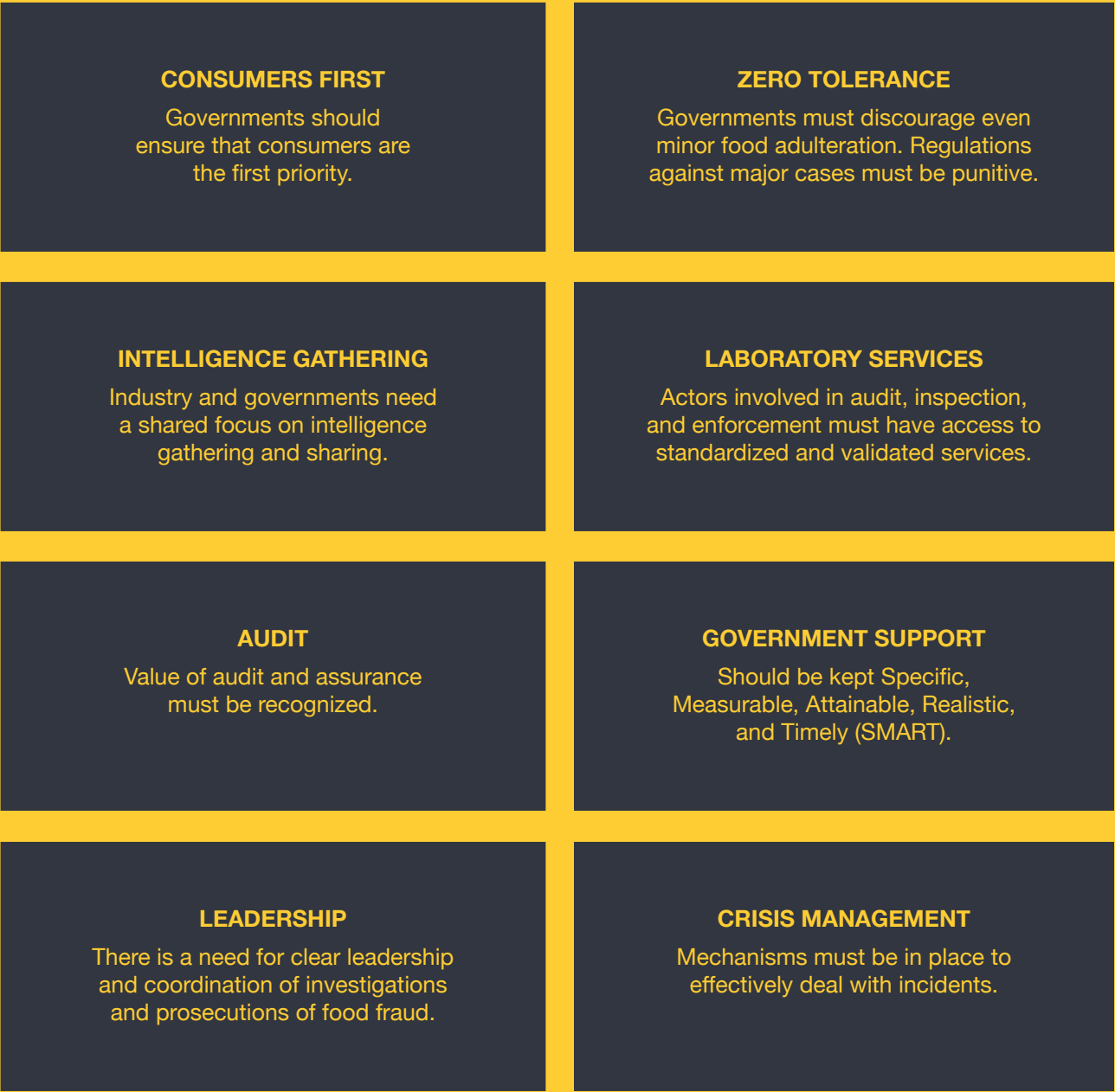
The UK government commissioned Professor Chris Elliott, of Queens University Belfast, to assess the horsemeat scandal and make recommendations. The subsequent “Elliott Review” made eight recommendations for eradicating food fraud by setting enforcement priorities and encouraging collaboration with science experts and industry.² These recommendations include: 1) Consumers First, 2) Zero Tolerance, 3) Intelligence Gathering, 4) Laboratory Services, 5) Audit, 6) Government Support, 7) Leadership, and 8) Crisis Management. [Figure 1](#) describes these legal and policy strategies for government, food industries, and consumer litigation to consider.

Of these strategies, Canada falls behind in most. While “consumer safety” is first, there is room for improvement in almost all other recommendations. “Laboratory services,” for example, are available but are not standardized or recognized as legitimate regulatory tools.

Reducing food fraud requires a clear strategy to deter, identify, and prosecute. This will require collaboration between governments, law enforcement, and industry. By employing a risk-based approach and leveraging existing technologies and traceability systems, Canada has the opportunity to reach its goal of becoming the world’s trusted supplier of safe and sustainable food for the 21st century.¹⁰⁷

FIGURE 1

Recommendations for forming the basis of a national food crime prevention framework (modified from Elliott, 2014).



Science and Collaboration— Finding Solutions for a Global Issue

This discussion paper is intended to inform industry leaders, government, and consumer advocacy groups of the threats and opportunities that exist to collaboratively reduce food fraud. In particular, it recognizes that the Canadian food industry is well poised to continue to innovate and drive quality assurance practices that help grow the Canadian economy for safe, affordable, nutritious, and sustainable food. It is evident that there are gaps related to knowing the true scope of food fraud, the mechanisms in which it occurs, and the risks associated with food fraud to various groups and populations. Further, the recent emergence of COVID-19 highlights the call for information and resources to tackle major disruptions to the global food supply chain such as the pandemic.^{6,7} Within Canada, there is a need to not only have a better and more appropriate, integrated response to food fraud, but also a clearer focus on deterring food fraud in the first place.

With the experience of other sectors and countries who have successfully managed and deterred the reoccurrence of major food fraud incidents, Canada is in a prime position to collaboratively address food fraud with an interdisciplinary approach. It is natural that mitigating the risks will require a multi-disciplinary approach, including the entire value chain, various stakeholder groups, and research experts such as criminologists and supply chain managers, among others. It will also be necessary to fully understand the risks to all groups; proper risk analysis, vulnerability assessments, applying criminology and behavioral sciences theory, prioritization, and risk mitigation planning will facilitate a strategy that is proactive and can prevent food fraud before it occurs.

We recommend the initiation of a novel food fraud intervention called “DIP Food Fraud.” As a starting point, Canadian laws and regulations must be sufficient to *deter* food fraud from occurring. Further, proactive analytical testing, combined with market surveillance and intelligence sharing, will help to *identify* food fraud. When food fraud is identified, engaging with the appropriate regulatory agency and/or law enforcement agency who has the relevant skills, knowledge, and legal frameworks to investigate and *prosecute* bad actors is crucial. Importantly, Canada must have a mature process to ensure the integrity of scientific evidence toward food fraud is irrefutable in court. We believe that this novel framework captures and integrates the key components which are essential to ensuring the risk of food fraud in Canada is reduced.

TAKING ACTION FOR FOOD FRAUD IN CANADA

Each stakeholder, and audience of this discussion paper, is encouraged to play a role in this collaborative approach.

What Can Government Do?

- Ensure collaboration between government departments and ministries to deter food fraud.
- Modify and update existing regulations to meet international and industry standards.
- Contribute to the global harmonization of standards, regulations, and testing methods.
- Enforce criminalization of food fraud—it is not enough for food fraud to be viewed only as a problem if it compromises safety.
- Engage with law enforcement agencies to ensure awareness and integration of enforcement actions including evidence gathering, covert investigations, etc.

What Can Industry Do?

- Continue improving and using traceability systems.
- Implement and carry out food fraud vulnerability assessments.
- Actualise appropriate control measures (check points) to reduce risks from vulnerabilities.
- Further promote the use of technology to identify food fraud incidents.

What Can Consumer Groups Do?

- Continue to demand supply chain transparency, product traceability and accountability.
- Support honest companies or those who are accountable to their actions and appropriately handle food fraud incidents, if they do occur.
- Become educated on food fraud and its risks.

What Can Non-Governmental and Non-Profit Organizations Do?

- Provide funding and other support for research.
- Conduct in-depth analyses and offer recommendations.
- Become educated on food fraud and its risks.
- Take on an activist role to bring attention to food fraud.

How Can Academia Respond?

- Enforce post-market compliance and regulation (through testing).
- Develop indicators to predict and anticipate food fraud problems (social, environmental, and economic).
- Promote science, social science, and regulatory compliance education on food fraud.
- Continue researching and supporting the advancement of technologies.
- Conduct socio-economic research related to the impacts of food fraud.
- Discuss “jurisdictional fragmentation” and note that establishing a comprehensive working group with all stakeholders should be a priority.

The University of Guelph is uniquely positioned to help answer the call-to-action on food fraud in Canada. The strong interdisciplinary research base is well-poised to help fill the knowledge gap. Addressing food fraud will require an interdisciplinary and holistic approach to develop preventative measures.

This can include a policy, criminology, food science, public health, and supply chain management lens, to name a few.⁴⁵ University of Guelph is in the position to take a lead role on the issue of food fraud—it is a “one-stop” shop for food safety research, collaborations, and solutions, including:

- State-of-the-art laboratory facilities and testing equipment;
- Highly qualified faculty with world-renowned expertise in food safety;
- Unique partnerships: NHP Research Alliance, Canadian Centre for Food Integrity, Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), and others; and unique commercial enterprises putting the science to practice.

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Workshop Summary

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Participants

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