

Institution: Queen's University Belfast		
Unit of Assessment: UoA6		
Title of case study: Uncovering the causes of a Major Crisis in the World Food Programme		
Period when the underpinning research was undertaken: 2010-present		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Professor Chris Elliott	Professor of Food Safety	2006-present.
Dr Simon Haughey	Senior Research Fellow	2008-present.
Dr Olivier Chevallier	Senior Research Fellow	2009-2020
Period when the claimed impact occurred: From 2014 – 2020		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the impact		
<p>Societal/industrial Impact: The UN World Food Programme (WFP; largest humanitarian food-aid provider) tasked the QUB team to investigate food-poisoning incidents in Uganda, which caused the death of five people and hospitalised hundreds. The cause was identified as highly-toxic tropane alkaloids found within WFP Super Cereal, leading to USD15,000,000 of cereal being withheld due to fears of widespread contamination. Following tracing by the QUB team, confirmed non-contaminated cereal were re- distributed, circumventing a humanitarian disaster.</p> <p>Economic Impact: The WFP is funded entirely by voluntary donations (USD8,000,000,000 in 2019). Being linked to deaths attributable to widespread cereal-contamination could have had an enormous detrimental impact on donations and availability of humanitarian food aid.</p>		
2. Underpinning research		
<p>Professor Elliott, Drs Haughey and Chevallier and team have investigated the chemical contamination of foodstuffs using many different analytical techniques for over 20 years [3.1-3.5]. For example, molecular spectroscopy coupled with chemometrics to determine contamination and adulteration was developed by Professor Elliott, Drs Haughey and Chevallier and team over the last 10 years, providing a rapid screening [3.1, 3.2]. In addition, the chemometric profiling of spectroscopic data can be used to look at the composition of foods and determine how and where they were produced [3.2]. More recently in this REF cycle, the team have also developed advanced non-targeted high-resolution mass spectrometry (Q-ToF-MS) to 'fingerprint' foodstuffs to determine accidental contamination or deliberate fraud incidents [3.3, 3.4]. The advantage of this approach is that all compounds that are present within a foodstuff can be profiled and compared against chemical databases to identify potential contaminants contained in the</p>		

samples. This highly sensitive technique can detect contaminants down to parts-per-billion, however it requires expensive instrumentation and highly skilled operators.

Professor Elliott, Drs Haughey and Chevallier and team applied these underpinning enabling technologies [3.1-3.4] to investigate the cause of a major food-poisoning outbreak in Uganda in 2019. By applying these innovative methodologies, the team concluded that the cause of the food poisoning was due to the presence of the Tropane alkaloids (TA), atropine and scopolamine, in the Super Cereal distributed by the leading food-providing humanitarian UN World Food Programme (WFP) [3.5]. In addition, the data generated showed all outbreaks were caused by a single batch of the Super Cereal, which meant that this batch was destroyed but the remaining US\$15 million of Super Cereal could now be despatched globally to the countries requiring aid. Furthermore, a review on the history, development, occurrences, exposures and human legislative and health benchmarks for TAs was carried out in 2019 [3.6]. Included were control strategies for reducing TA contamination of agricultural commodities and resultant health implications following consumption of TA contaminated foodstuffs. If controls are adequately implemented from the start of cereal cultivation, through to the final stages of manufacturing of food products, then there would be a marked reduction in the presence of toxic plants, including *Datura stramonium*, appearing in cereal fields.

3. References to the research

- 3.1. Haughey SA, Galvin-King P, Ho Y-C, Bell SEJ, Elliott CT. 2014. The feasibility of using near infrared and Raman spectroscopic techniques to detect fraudulent adulteration of chili powders with Sudan dye. *Food Control*, 48, 75-83.
- 3.2. Haughey SA, Galvin-King P, Malechaux A, Elliott CT. 2015. The use of handheld near-infrared reflectance spectroscopy (NIRS) for the proximate analysis of poultry feed and to detect melamine adulteration of soya bean meal. *Analytical Methods*, 7 (1), pp. 181-186.
- 3.3. Black C, Chevallier OP, Haughey SA, Balog J, Stead S, Pringle SD, Riina MV, Martucci F, Acutis PL, Morris M, Nikolopoulos DS, Takats Z, Elliott CT. 2017. A real time metabolomic profiling approach to detecting fish fraud using rapid evaporative ionisation mass spectrometry. *Metabolomics*, 13, 153.
- 3.4. Chatterjee NS, Chevallier OP, Wielogorska E, Black C, Elliott CT. 2019. Simultaneous authentication of species identity and geographical origin of shrimps: Untargeted metabolomics to recurrent biomarker ions. *Journal of Chromatography A*, 1599, 75-84.
- 3.5. Haughey SA, Chevallier OP, McVey C, Elliott CT. 2019. Laboratory investigations into the cause of multiple serious and fatal food poisoning incidents in Uganda during 2019. *Food Control*, 2021, 107648.
- 3.6. Abia WA, Montgomery H, Nugent AP, Elliott CT. 2019. Tropane alkaloid contamination of agricultural commodities and food products in relation to consumer health: Learnings from

the 2019 Uganda food aid outbreak. *Comprehensive Reviews in Food Science and Food Safety*, 20, 501-525.

4. Details of the impact

Societal and industrial impact

The WFP Assists close to 90,000,000 people in over 80 countries each year [5.1]. It is the leading humanitarian organisation that saves and changes lives by delivering food assistance in emergencies and working with communities to improve nutrition and build resilience. WFP directs its efforts on the poorest and the most vulnerable people around the world who have high nutrient needs, such as young children, adolescent girls, pregnant women and nursing mothers. The foods distributed vary from common commodities disseminated among the population in general, to Specialised Nutritious Foods (SNF) given to target beneficiaries for the specific purpose of prevention and treatment of malnutrition. One of the SNF products is Super Cereal, which consists of pre-cooked corn, soybean and micronutrients. In the region of 130,000 MT Super Cereal is distributed to close to 5,000,000 people every year.

Reports of multiple cases of serious food poisoning in Uganda became apparent in April 2019 [5.1; 5.2]. Many hundreds of hospitalizations and 5 fatalities, including 3 young children, had occurred and all in regions where Super Cereal was supplied. The WFP immediately suspended all supplies of Super Cereal into these regions and this escalated to suspension of Super Cereal into 25 countries around the world [5.3; 5.4]. Professor Elliott was contacted by the WFP to provide scientific support in the investigation and he agreed to act as an independent scientific expert to the WFP [5.5; 5.6]. Working closely with WFP and the Food and Drug Administration in the United States, Professor Elliott, Drs Haughey and Chevallier and team uncovered the cause of the illness. Using untargeted mass spectrometry (underpinning research) identified the presence of the plant toxins atropine and scopolamine in samples recovered from households where illnesses had occurred. Levels in the order of parts per million were found and if consumed toxicity could be expected [3.4]. The identification of DNA from *Datura stramonium* (jimsonweed, a plant in the deadly nightshade family) in tropane alkaloid containing samples provided further evidence of the cause as the seeds of this plant were found to contain high levels of the tropane alkaloids [3.5].

Professor Elliott, Drs Haughey and Chevallier and team then supported a WFP investigation into the source of the alkaloid toxins by tracking the supply chain of the contaminated batch. Strong evidence was produced to implicate soya that was grown in Turkey and Serbia and processed by a Turkish company [3.5]. The possible causes for the contamination were investigated by the QUB team and these have been detailed in a report commissioned by the WFP [3.6]. A complex

combination of factors ranging from poor agriculture and manufacturing practise and climate change were identified and a range of mitigation strategies were outlined [3.6].

There was a belief that the crisis had been contained until on the 26th August more reports of illness linked to Super Cereal in a completely different region of Uganda became apparent [5.7]. In the Palabek refugee camp in the West Nile region of north-western Uganda 33 cases of serious illness occurred. The symptoms from this episode matched closely those of the previous one. Samples were again dispatched to Professor Elliott's laboratory and the same tropane alkaloids were detected in high concentrations. This caused a further crisis in the WFP as the Super Cereal supply chains for this refugee camp were totally different than the first incident i.e Belgium/France. The result was all Super Cereal supplies from WFP worldwide were suspended leaving many tens of thousands of recipients, mainly young children without adequate food. Not only was there massive welfare issues but also the potential that many millions of dollars of vital food aid would have to be destroyed. Professor Elliott, Drs Haughey and Chevallier and team used their analytical capabilities and undertook complex analysis of the samples from the second outbreak. Using forms of untargeted spectroscopic analysis they were able to provide robust evidence that the contaminated food samples from both incidents were closely linked and that the second incident was caused by Super Cereal which originated from the Turkish supply chain [3.5]. On the 20th September, the WFP informed Professor Elliott that, on the basis of their findings, the supply of Super Cereal worldwide was to recommence. The final joint WHO – WFP report on the incident was due for publication in 2020 but due to the global pandemic has been delayed (see Covid-19 impact statement). The draft report which was close to finalisation details the incident and the follow up investigations [5.8].

Economic Impact

The WFP is funded entirely by voluntary donations and raised a record-breaking USD8,000,000,000 in 2019. Being linked to a scandal that caused deaths could have had an enormous detrimental impact on the level of donations received. This was evidenced by accusations of negligence and the filing of a lawsuit against the WFP by the Anti-Counterfeit Network, a Ugandan coalition of civil society groups [5.2]. Furthermore, more than USD15,000,000 million of Super Cereal was withheld from supply into Africa and other global regions due to fears it was contaminated. The potential for this food to be destroyed was very high until the QUB team were able to deem it safe for distribution.

The contribution of Professor Elliott and team to ensuring Food security and integrity globally has also resulted in the designation of IGFS as an United Nations International Atomic Energy Agency (IAEA) collaborating centre [5.9; 5.10].

5. Sources to corroborate the impact

5.1 <http://www.fao.org/3/ca8736en/ca8736en.pdf>

(PDF)

5.2 <https://www.thenewhumanitarian.org/news/2019/06/19/wfp-uganda-food-aid-deaths-accused-negligence> (PDF)

5.3

<https://www.wfp.org/news/government%20WFP%20investigate%20link%20Karamoja%20illness>

5.4 <https://www.wfp.org/news/wfp-halts-distribution-super-cereal-while-tests-continue> (PDF)

5.5 WFP contract letter to work with Prof Elliott on the investigation (PDF).

5.6 Terms of reference of the contract with WFP (PDF).

5.7 <https://www.monitor.co.ug/uganda/news/national/wfp-suspends-food-aid-after-33-are-taken-ill-1845826> (PDF)

5.8 WHO – WFP draft report (PDF).

5.9 United Nations International Atomic Energy Agency (IAEA) collaborating centre letter (PDF).

5.10 United Nations International Atomic Energy Agency (IAEA) collaborating centre contract (PDF).