Research theme 7- Food authenticity and traceability

Introduction
Food authenticity and integrity refers to the genuineness and intactness of food products. The series of food fraud incidents – melamine, horse meat, organic eggs, cardboard stuffed dumplings – is demonstrating that the vulnerability of food fraud incidents reaches to every dinner table in the world nowadays. Food fraud is a major concern not only for consumers, but also for producers and distributors. Food adulteration has been practiced forever, but has become more sophisticated in the recent past. These illicit activities result in considerable monetary losses worldwide and eroded consumer confidence. Foods or ingredients most likely to be targets for adulteration include those which are of high-value and which undergo a number of processing steps before they appear on the market. To understand why fraud possibilities are seen as opportunities fraud risk assessments are required. Since the perceived risk of detection is one of the factors, and food adulteration is advancing more and more, novel analytical methodology are pivotal to uncover food fraud.

Objectives
The main objectives are to elucidate economic/criminological risk factors contributing to food fraud vulnerability, and to discern markers which substantiate the identity of food products. Both information on vulnerability and detection options will help to set up food fraud management systems.

Detailed objectives are:

- To explore food fraud risk factors from product and business perspectives
- To develop analytical methodology to ascertain the authenticity of food product constituents
- To advance detection techniques to substantiate the history of food products, i.e. the production system (e.g. organic, halal), provenance (geographical origin), and processing.
Project 7.1 Chocolate: linking sustainability to flavour composition and release

**Target:** MFT

**Supervisors**
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Novel analytical techniques are able to measure naturally occurring compositional characteristics of chocolate which in turn may demarcate the place and way of production/processing of sustainable chocolate and chocolate ingredients. This will ultimately improve the traceability of sustainable chocolate.

In this student project you will examine the release of volatiles from chocolates during consumption, in order to examine differences due to origin and production system (e.g. organic, sustainable). Volatile release will be measured by Proton Transfer Reaction Mass Spectrometry in the nose of volunteers while they are consuming the chocolates. You will set up a method to measure adequately in the nose of people. Subsequently, a representative set of chocolates will be analysed. Data will be subjected to statistical analysis in order to examine the different patterns observed and to link origin/production of chocolate to their flavour (volatile) characteristics.
Herbs and spices are costly commodities, vulnerable to adulterations. An example of food adulteration is the blending of the spices with lower value ingredients to increase own economic benefit. In this case, other parties in the chain and consumers are deceived. Saffron is a spice derived from the flower of *Crocus sativus*. Prices of saffron may be go up to €7,500 per kg, which makes the spice susceptible to adulteration. Typical adulterations include mixing in extraneous substances like beets, pomegranate fibers, red-dyed silk fibers, or the saffron crocus's tasteless and odorless yellow stamens. To support saffron production and genuine trade, measures against deliberate adulterations are required. The general project aims at improvement of non-targeted analytical fingerprint methods which could be used for screening for anomalies.

In this student project you will develop methodology to analyse different grades and adulterations of saffron. A fingerprint type method based on mass spectrometry will be used and adapted for saffron. The method will be compared with the colorimetric ISO method for grading saffron which is based on spectroscopy. Eventually, retail samples will be collected and tested with the newly developed method.
**Project 7.3 Meat fraud control**

**Target:** MFT

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Food ingredients are sourced globally nowadays, with price being the main governing feature. The food supply chain network has become very extensive, which increased its susceptibility to fraud. Food fraud covers issues with composition, processing, shelf-life, geographical origin as well as production practice (e.g. organic). Recently, cases of meat fraud received considerable media attention (e.g. horse-meat scandal). Fraud may relate to the species of meat and the meat content in a product, but also processing (injection of water; defrosted meat sold for fresh), the geographical origin, and production practice (organic). Rather than looking at specific incidents, a system analysis approach is preferred in order to prevent fraud in the future. The overall objective of the study is to get insight in technological and social (people) factors increasing the risk on fraud in meat supply networks by development of an analytical research framework (for system analysis) based on in-depth theory analysis and expert interviews. In this student project, the possibilities for fraud with beef will be inventoried, the beef meat chain mapped and analysed, people factors in fraud studied, as well as market economics providing fraud opportunities. The study is a collaboration project between FQD and RIKILT.
Project 7.4 Development of DNA-based screening and identification methods for (food) authentication

Target: MFT

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Currently, food/feed authentication is one of the upcoming topics around the world. Processed food/feed products are more vulnerable to adulterations and ensuring its authenticity is really challenging. DNA-based screening and identification methods is one approach to identify the raw materials used to obtain the processed/complex product, but the applicability of advanced DNA methods has so far not been fully investigated. DNA-based screening methods can be based on identifying known or unknown genomic sequences. Identifying the endangered species in complex mixtures could be achieved by using DNA-based screening approaches for the known sequence that is specific for this endangered species. Overall, more than 33,000 species of flora and fauna are categorised as endangered species. Although international trade agreements are being implemented, illegal trading and the use of (parts of) endangered species are still common practice. Usually, visual inspection (microscopy, etc.) is the initial approach to identify the endangered species in the customs offices. If the product is more complex or processed, visual inspection will not be sufficient. In those cases, DNA-based methods may be more appropriate to detect and identify the endangered species that may be present in the sample.

To identify genetically modified organisms (GMOs), including unauthorised genetically modified organisms (UGMOs) a similar DNA-based approach can be used to characterise the unknown genomic sequence, adjacent to known GMO sequences. GMOs need to be assessed for their food/feed and environmental safety prior to market introduction. In recent years, the number of incidents related to the presence of UGMOs and (UGM) derived products (food and feed) have globally increased. DNA-based enrichment strategies are applied to identify the unknown adjacent sequence of the known GMO elements to positively identify also unknown UGMOs that have not (yet) been assessed for their safety.

This project is aimed to understand how advanced DNA-based methods can be applied for food/feed authenticity issues related to the potential presence of endangered species and UGMOs. The PhD project aims to evaluate advanced DNA methodologies (including Next Generation Sequencing (NGS)) in terms of applicability and sensitivity for authenticity purposes. To this end simple reference materials will be used, as well as well-characterised complex mixtures and real-life samples that may contain endangered species and UGMOs, respectively.
Project 7.5 Understanding intrinsic characteristics and origin of organic milk

Target: MFT

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Organic food brings more benefits to environment and humans. However, the organic products are retailed at a higher price, which makes them susceptible to fraud. Taking organic milk as an example, since the organic dairy system is very complex and restrict, some people utilise the difficulty of authenticity detection to make the adulteration. Organic milk is the production of the organic system, including organic farming and organic rearing. All the feed for cows should meet the requirement of organic farming discipline, which means the chemical fertilizer and pesticide are not allowed, no matter for the silage or fresh grass. To ensure the authenticity of organic milk and regular the organic milk market, the internal relationship between organic feed and organic milk and identification methods need to be studied.

In this project, we need to study the factors which can affect the quality of organic milk, find the difference between organic milk and conventional milk and develop the detection method based on results. Finally, the traceable characteristics and the detection method can be applied for the organic milk authentication in the retail market.