Sensing food fraud from analytical chemistry and criminological perspectives

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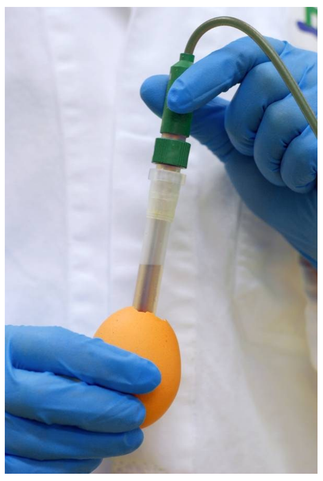
Background



Food authenticity and fraud in terms of genuine, reliable food composition has been on the agenda for at least 2000 years and has been typically a food quality issue. More recently a general interest in the sustainability of food productions, from both societal and environmental perspectives, developed and added a new dimension. Advanced analytical technology has emerged in the arena of food fraud detection. How are productions in terms of raw materials and processing mirrored in unique analytical characteristics? How to discern and measure these relevant characteristics? On the other hand, food fraud is always intentional and for economic gain. The human aspect of it raises questions with regard to the criminological perspective. What are the characteristics of organizations, sectors that are most vulnerable to food fraud? What is the nature, prevalence and causes of corporate involvement?

Sensing food fraud by analytical tools

Product authenticity and authentication are emerging topics within the food sector. It is a major concern not only for consumers, but also for producers and distributors. Regulatory authorities, food processors, retailers and consumer groups are all interested in ensuring that foods are correctly labeled. Food adulteration has been practiced for ages, 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. With the European harmonization of the agricultural policy and the emergence of the international markets, authentication of such food products receives more and more attention.

Ensuring high quality, safety, and authenticity of food requires powerful and reliable tools for food analysis, traceability, and control. In view of fair trade , consumer reassurance and enabling consumers to make informed choices, there is a need to identify foods with regard to:

- Ingredients (e.g. species, proteins, fats, water)
- Processing (e.g. freezing, heating, irradiation, storage)
- Geographical origin
- Production system (e.g. organic, halal, sustainable)
- Typicality (e.g. artisanal and specialty products)

Although single marker analysis works for simple authentication questions, for the above usually patterns of a range of compounds are needed. Therefore, food authentication requires the use of state-of-the-art analytical techniques such as mass spectrometry based techniques, such as GC(-MS), LC(-MS), PTR-MS, ICP-MS, IR-MS, and MALDI/SELDI-TOFMS. Furthermore, spectroscopy and other techniques are very useful, i.e. NMR, Raman spectroscopy, (Near) Infrared-technology, hyperspectral imaging, microscopy, and DNA-based methodology. With fingerprint technology, which allows a more forensic approach to authentication, chemometric evaluations have become of strategic importance.

Analytical authentication of organic eggs

An example of complex analytical verification is the development of a method for authentication of organic eggs. The analytical fingerprints of a range of carotenoids in egg yolks, the yellow pigments, were found to be able to discriminate between organic and conventional eggs in the Netherlands (Fig. 1). Chemometric models allowed the successful prediction of the identity of the eggs examined (organic/conventional). The method was subsequently successfully validated with eggs from other European countries.

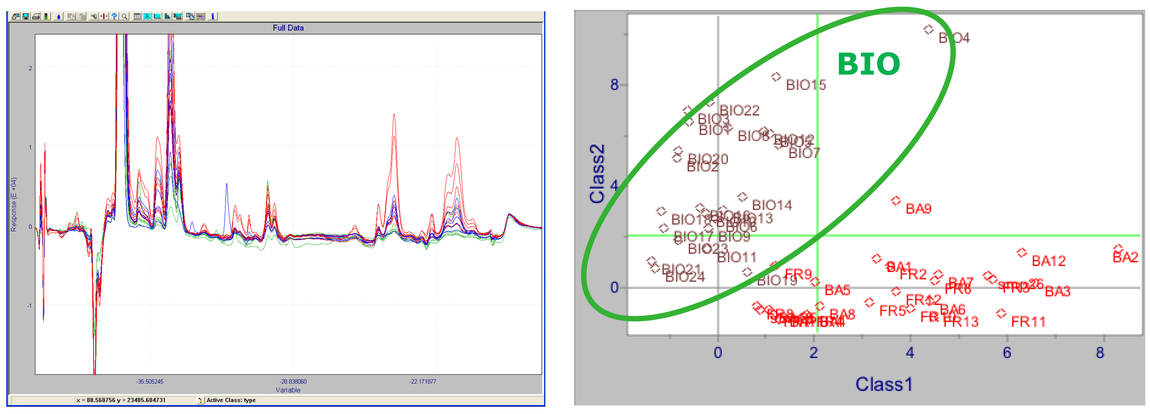


Figure 1. Fingerprint of carotenoids of organic and conventional eggs (left) and statistical comparison of the fingerprints (right).

Sensing food fraud from a criminological perspective

In most known instances of food fraud, food producing or food processing companies are the perpetrators. Criminological research on corporate crime has uncovered industry dynamics and organisational characteristics that are causally related to corporate law breaking, such as the level of competition, strained goal attainment and anomic corporate cultures. Further, criminological study has found criminogenic incentives and opportunity structures in markets. These findings have not yet been applied to food fraud. As food frauds such as adulteration and misrepresentation can be seen as purposive and as the outcome of a decision-making process, criminological opportunity-based theory offers a suitable framework for sensing food fraud. Situational Crime Prevention Theory identifies five characteristics of criminal opportunity, which need to be applied to food fraud for developing preventative tools for law enforcement as well as self-regulatory compliance management systems:

1. The effort required to carry out the offense;
2. The perceived risks of detection;
3. The rewards to be gained from the offense;
4. The situational conditions that may encourage criminal action;
5. The excuses and neutralizations of the offense.

Conclusions

The joint investigation of analytical opportunities for authentication and understanding the influece of peoples' motives and agri-food chain context characteristics on fraud, will provide input for a new approach towards fraud risks assessment for food industries and regulators.

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