Made in Parma?

Is it pure wine?

How much sheep's milk is in it?

Was it cold pressed?

KEY TOPIC: AUTHENTICITY

Tracking down the food fraudsters

Laced, cut, adulterated – food fraud is a global problem. The BfR is examining how methods for establishing the authenticity of foods can be harmonised. To do so, the researchers at the BfR slip into the role of the food fraudsters too.

Does it come from the Allgäu region?

A monitor, a PC, an infrared spectroscope and lots of little sample vessels filled with fat extracted from hard cheese – Allgäuer Emmentaler. A lab assistant draws a sample of fat the size of a pin head and takes it to an analysis device. Seconds later, a wavy line made up of 1,800 data points appears on the screen: the spectrum of the cheese fat sample. A second laboratory, another analysis: test tube by test tube, a gripper arm picks up Allgäuer Emmentaler samples and inserts them into the strong magnetic field of a nuclear magnetic resonance spectroscope. The measurement produces up to 130,000 data points that are characteristic for each cheese sample. A third laboratory, a third test method, in which isotope ratio mass spectrometry is used to determine the origin of the hard cheese samples. A total of 150 to 200 samples are to be procured and analysed. "All of the data are processed and fed into evaluation software which calculates a characteristic data spectrum for each method – the authentic fingerprint of Allgäuer Emmentaler," explains Dr. Susanne Esslinger who coordinates the tests to establish the authenticity of Allgäuer Emmentaler.

The search for the fingerprint

In the BfR laboratories, scientists are working hard to find the typical, unmistakable fingerprints of various foods and feeds, including wines, spirits, herbs and spices, hard cheeses, vegetable oils and corn. Their goal is to be able to verify the authenticity of these products or deviations which indicate falsification. If this is successful, it will make faking foods more difficult. The awarding of the EU quality mark "Protected Designation of Origin" guarantees that for the specific product designation "Allgäuer Emmentaler", the cheese must actually have been produced, processed and manufactured in the Allgäu region. What is the use of the quality mark though if there is no method to distinguish the original from the fake. For this reason, the BfR has set up the trainee group "Authenticity along the supply chain" to strengthen research and interdisciplinary networking for the standardisation of data collection to verify authenticity.

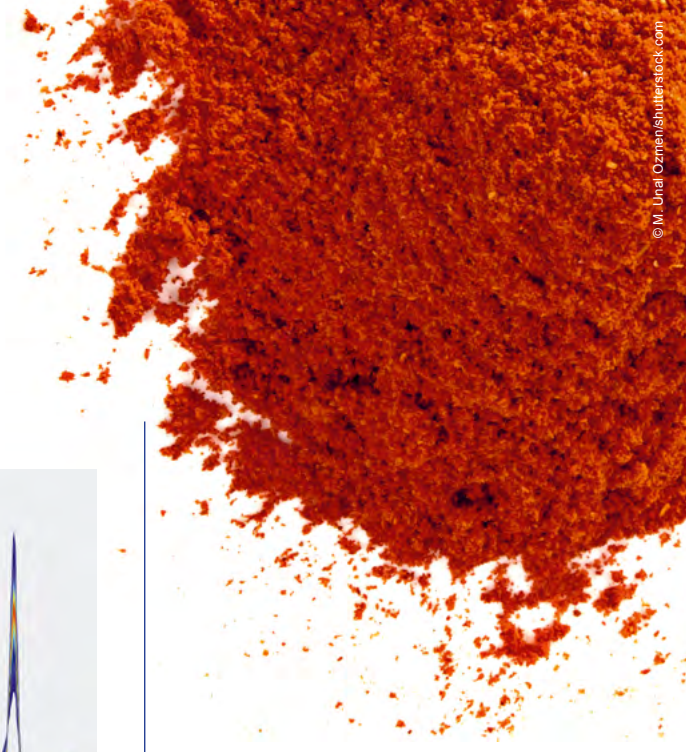
The BfR participates in several national and international joint projects to develop new approaches and strategies to detect food and feed fraud with which practices of this kind can be better discovered all over the world. The main focus of the BfR's research in this field is on the designation of origin and identification of unknown additives by means of targeted and non-targeted analytics in combination with statistical methods and issues concerning data processing and interpretation.

> **The data points that lie outside the normal range or bandwidth can be very clearly recognised. A food that falls through this grid is suspect.**

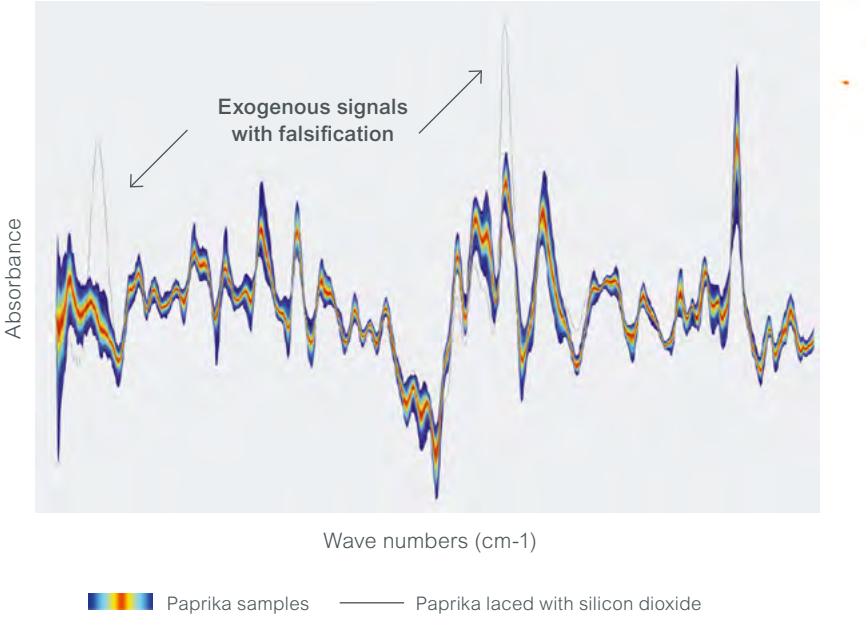
Non-targeted analytics

A challenge in the search for the analytical characteristic of foods is the natural variation of ingredients. "That's why a large number of unadulterated samples have to be drawn first, in order to find characteristic features in the data sets," explains Dr. Carsten Fauhl-Hassek, who heads various research projects on the authenticity testing of foods and feeds at the BfR. "Our results show that the idea of the unmistakable fingerprint of foods works". The BfR has already recorded the physico-chemical

The preparation of the cheese samples for testing involves homogenisation with liquid nitrogen.



The principle of "non-targeted methods"



Relevant aspects during testing

Authenticity tests can confirm official product descriptions or prove statements to be false. Relevant aspects here are substitution with cheaper but similar additives, lacing with foreign substances (e.g. water, starch) or the use of unlisted or unauthorised methods such as radiation or extraction, confirmation of geographical origin, botanical or zoological species or of the manufacturing process, such as organic, conventional or genetically modified, as well as the declaration and statements on traceability (product labelling, process stages, batch identification).

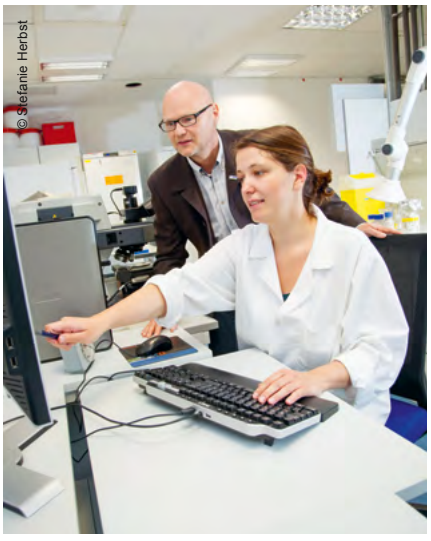
fingerprint of various wines, edible oils and most recently herbs and spices by means of infrared and nuclear magnetic resonance spectroscopy. In doing so, the BfR laboratory was turned into a fraudster's den: herbs and spices are mixed with various ingredients before processed samples of them are measured with the help of analysis equipment. "The data points that lie outside the normal range or bandwidth can be very clearly recognised. A food that falls through this grid is suspect", says Dr. Fauhl-Hassek. In this way, the spectra of oregano mixed with olive leaves, for example, or paprika powder laced with Sudan Red – a substance suspected of being a genotoxic carcinogen – look unmistakably different.

Accordingly, the new analytical methods that use the characteristic fingerprint of a food constitute a flexible and quick form of authenticity testing. Instead of looking specifically for falsified products, the focus here is on proving authenticity. This new approach is also known as non-targeted analysis.

Fingerprint cloud

For the perspective, routine application of non-targeted analysis for food safety, however, joint utilisation of the databanks for reference food fingerprints of all actors involved in the field of food safety must first be enabled and it must also be ensured that the data collection and subsequent analysis of all users produce comparable results.

The BfR is conducting joint research on a simplified scenario for the future in which certified official and private laboratories make their food fingerprints available via a data cloud, with manufacturers, processing and refining businesses contributing the related product information. When monitoring authorities, wholesalers or retailers want to check food samples for authenticity, they compare the fingerprint of their own sample with those in the fingerprint cloud. If there are significant deviations, the food is initially classed as conspicuous and is earmarked for further examination. There are still many technical and organisational obstacles to be overcome.



A cheese fat sample the size of a pin head is put into the analysis device. To find characteristic features in the data sets, Dr. Carsten Fauhl-Hassek (picture right above) and his team must analyse a large number of samples of this kind.

The search for fingerprints

So-called non-targeted methods are used to build up standardised reference databases. In doing so, the physi-co-chemical fingerprints of foods are collected on the basis of spectrometric and/or spectroscopic data. These then serve as a comparative standard with which the data of unknown food samples are compared. This makes it easier to recognise deviations so that monitoring authorities no longer have to search specifically for particular undesired substances which are often unknown.

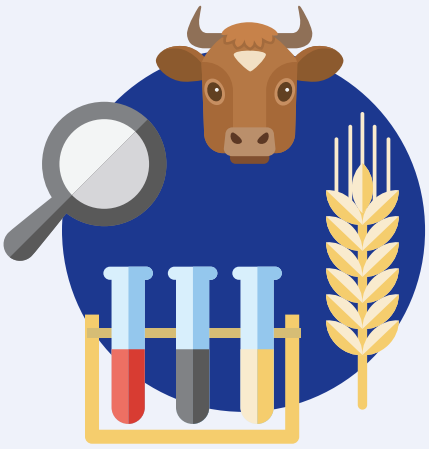
"First of all, uniform data standards, separately operating system solutions and organisational system approaches which guarantee the integrity and quality of data have to be developed if this vision in the field of food safety is to be realised," explains Matthias Filter who coordinates tasks focusing on "Global Supply Chains" at the BfR.

Networked reference databases

To bring this future scenario a bit closer, scientists at the BfR are conducting research to develop mathematical and statistical models for data evaluation and the harmonisation of data exchange formats, as well as harmonised sampling. These are essential prerequisites for the build-up and routine use of collaborative reference databases which can be made available via the cloud. "At the moment, for example, all manufacturers of spectrometers use their own data formats so that the data have to be deciphered first before they can be used by everyone involved," says Filter.

Until reference databases of this kind containing the typical chemical-analytical profiles of foods can be built up and made fit for widespread use in a network comprising monitoring authorities, laboratories, manufacturers and dealers will take at least another 10 to 15 years, in the opinion of the experts. All the more reason to lay the foundations now. ◘

More Information:
www.bfr.bund.de/en > A-Z-Index: authenticity



Original or fake –

working together against food fraud

The BfR is involved in third party-funded projects to provide manufacturers and monitoring authorities with methods with which the authenticity of a food can be recognised quickly, reliably and cost effectively. A few of them are presented here.

Food Integrity

EU consortium against faked foods

The EU consortium made up of 38 project partners aims to establish the structural and methodical prerequisites to recognise fakes uniformly and in a timely manner. To do so, a network involving authorities, industry and research is to be built up among other things, test processes are to be harmonised and knowledge databases created. The project is set to run until the end of 2018.

FoodAuthent

Collaborative reference databases for chemical fingerprinting

The fundamentals for the routine use of fingerprinting analysis methods in the food sector and official monitoring are being created in this three-year project. In a project scheduled to end in April 2019, the BfR and its partners are developing joint fingerprinting databases and interfaces to privately operated product information systems. This is being done for hard cheeses, cooking oils and spirits, for example. The data is to be freely accessible to all parties involved in the food sector.

Animal-ID

Proof of origin of animal proteins in feeds and foods

The project partners combine mass spectrometry with protein enrichment methods in order to develop analysis methods for the tissue-specific determination of the origin of feeds, as well as rapid tests on the basis of protein-based ELISA/dipstick tests for the most important animal species used for meat production, such as cattle, pigs, horses and chickens. The BfR is coordinating the four-year project (2016 to 2019).

FoodRisk-Lab

Software solutions to support the assessment of risks

The BfR is developing freely available software solutions and web services for the assessment tasks of official institutions, as well as for science and research purposes. FoodChain Lab, for example, supports the traceability of feeds and foods along the supply chain and enables the interactive analysis of outbreak incidents. Other programs serve the mathematical modelling of hazards in the field of feed and food safety.

SPICED

Safeguarding Europe's spice and herb supply chains

Spices and herbs are added to a great many foods. The results of this research project contribute towards the protection of Europe's spice and herb supply chains from natural, unintentional and intentional biological and chemical contamination. The project involving 11 partners from seven EU countries was promoted from 2013 to 2016 within the scope of the 7th EU framework programme and coordinated by the BfR.

"We want to clamp down on fakes"

Professor Wittkowski, which foods are usually falsified?
Fraud takes place wherever an economic advantage can be gained. That's why product piracy is practiced above all with high-quality, expensive branded products, such as olive oil, sheep's milk cheese, wine and spirits. A common trick is to sell inferior ingredients as high-quality produce, such as shrimps as prawns. Or, it is attempted to dissemble the origin of products with quality characteristics based on the geographical origin, such as Parma or Serrano ham, Irish whiskey or champagne.

Can consumers trust food safety despite this?
Credibility, trust and safety are closely linked to one another. People want to shop, cook, eat and drink, stay healthy and enjoy the taste. They don't want to know how the wine was filtered or at what temperature the coffee was roasted, but they want to be able to trust that the information given is correct and that these technologies produce safe foods. This is only possible because standards exist for the food industry and monitoring authorities check for compliance.

Just because Parma ham doesn't come from Parma doesn't mean that it poses a health risk. Isn't it much more about the economic interests of the manufacturers?
Scientists can recognise norm deviations but not what motivates falsifiers. It goes without saying that a risk assessment is conducted as soon as findings of this kind are made. After making further checks and tracing products back along the supply chain, it can then be decided whether it was a deliberate falsification or not.

Can you give an example?
A few years ago horse meat was found in lasagne instead of beef. This case of fraud didn't appear to pose a health risk at first, because horse meat is a high-quality food, but no one knew where the meat came from and whether it was contaminated with banned and/or health-damaging drugs. After this had been checked, the meat was declared safe. Then there were the pistachios from Iran which had increased mycotoxin levels for a while due to the traditional cultivation method and which were therefore subject to strict sanctions when they were imported into Europe. False declarations of origin then cropped up to get around these sanctions and Iranian pistachios were marketed as Californian produce.

So it's always primarily about consumer protection and not about protecting against deceit or fraud?
In my view, yes. Some falsifiers simply accept that people can be harmed – through alcohol laced with methanol or milk powder thinned with melamine, for example. The falsifiers aren't toxicologists after all, so the question centres around the methods that authorities can provide to maintain trust in the safety of food.

That sounds like a race: research against forgery. Is there always a right method?
The good thing about analysis is that if you use the right method, you will find what you are looking for. We don't always know though what new deceitful ideas falsifiers will come up with next. That's why we participate in international research projects to develop reference databases with the typical fingerprints of foods. Known as fingerprint analysis, it provides the opportunity of identifying not only foods as falsified through their deviation from the norm but also of discovering previously unknown adulterations and manipulations which could pose a health risk before the goods hit the shelf.

> **Our unique feature is that we conduct risk assessment and research.**

Measures on this are bound to exist already in actual practice?
Private analysis firms have already specialised in the fingerprint method for certain products and established large databases, but there is a problem here, because they all work with their own data. The firms' results don't stand up in court either, because the data basis is not public. State institutions, on the other hand, work with transparent and comparable data so that complaints do stand up in court. That's why the measurements of the various labs have to be validated and the databases harmonised for the fingerprint methods to be successful.

What does the BfR contribute to the verification of the authenticity of foods?
We have been involved for quite some time in all of the decisive EU research projects on authenticity testing. Our unique feature is that we conduct risk assessment and research. Unlike other assessment authorities, the BfR has its own laboratories, which is why we cast a very strict eye on assessment methods and ask how reliable and meaningful the data is. The core business of the BfR's 17 reference laboratories is the

BfR Vice-President Professor Dr. Reiner Wittkowski aims to ensure that research to find new methods for the authentication of foods is carried out at the BfR. As a young food chemist at the BfR's predecessor institution, the Federal Health Office, he already developed and established methods for verifying the authenticity of wine and began to build up a fingerprinting database.

validation of methods. On a national level, the BfR already works closely with the official food monitoring authorities of the federal states.

What specific approach does the BfR use?

We combine analytics and data modelling. The institute has a long history when it comes to verifying the authenticity of foods, because research on this was already done in our predecessor institutions. One of the first databases for validating the authenticity of wine was built up in the 1990s. Nuclear resonance spectroscopic methods were used in food analysis for the first time. We then transferred the expertise acquired with wine to other food matrices. In addition to analytics, statistics is our second impetus. The BfR has gathered a lot of experience in the field of data analysis for upstream and downstream traceability along supply chains. Complex data modelling is possible with the FoodChainLab software that we developed in the course of the EHEC crisis.

What are the next steps?

We have already established a national competence network between federal authorities, state investigations offices, universities and research institutions and we are driving ahead with the topic all over the world. The BfR organised a symposium in November 2016 at which around 100 experts from Germany, Europe, North America, Africa, Asia and New Zealand discussed the challenges of standardisation. In my view, a European reference laboratory must be set up at all costs – the EU Commission is already considering this – in order to establish a harmonised system of the applied methods and data collection for the authenticity testing of foods in Europe. Only this will help us to achieve our goal of clamping down on fraud! ◘