Organic food authentication: potential and limitations

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Souls for sale?

- What’s in it 4U?
- Food product adulteration and counterfeiting is a thriving multi-billion euro global industry. It is highly profitable and the risks of significant legal consequences are low.
The food supply network

- Retail demands shape global food market
- Price is the main governing feature
- Food and ingredients are sourced world-wide
- Extensive, fragile, vulnerable food supply chain
The world’s food trade grows faster than the food production

Food fraud

- Food fraud differs from most food safety issues in that fraudsters intentionally aim at deceiving targets by food adulteration or counterfeiting for their own economic gain.
The crime triangle

- Environmental Criminology
- Guardians/Hurdles
- Victim
- Fraudsters

The Fraud Opportunity

Traditional Criminology
Food authenticity and safety

- Control systems are nowadays primarily aiming at food safety and defense
- Food authenticity and integrity has received less attention in the last decade
- Development of fraud risk assessment:
- Temptation ACCP: People factor, critical points, how to optimize detection
Detection

- Laboratory-based: checks of occasional samples
  - Single markers
  - Patterns

- Supply-chain: pro-active, red/green light, 100% check
Comparison of mineral concentrations in commercially grown organic and conventional crops – Tomatoes (*Lycopersicon esculentum*) and lettuces (*Lactuca sativa*)

Simon D. Kelly *, Alison S. Bateman

School of Environmental Sciences, University of East Anglia, Norwich NR4 7JJ, UK

Concentrations of phytanic acid and pristanic acid are higher in organic than in conventional dairy products from the German market

Walter Vetter *, Markus Schröder

University of Hohenheim, Institute of Food Chemistry (1708), Gerbenstrasse 28, D-70599 Stuttgart, Germany
Sensory quality in retailed organic, free range and corn-fed chicken breast

Kishowar Jahan, Alistair Paterson *, John R. Piggott

Centre for Food Quality, Department of Bioscience, University of Strathclyde, 204 George Street, Glasgow G1 1XW, Scotland, UK

Received 22 July 2004; accepted 24 September 2004
Multiple markers: looking for patterns
Multi marker fingerprints?

Fingerprints of target product group versus counterparts (e.g. genuine and adulterated products).
Method developments and confirmation

- Laboratory-based: finding the relevant markers:
- Combining analytical chemistry and chemometrics
AuthenticFood EU project
## Tomato samples (n=24)

<table>
<thead>
<tr>
<th>Region of origin in Italy</th>
<th>Botanical origin</th>
<th>Production method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basilicata</td>
<td>2</td>
<td>Organic, Conventional</td>
</tr>
<tr>
<td>Emilia</td>
<td>2</td>
<td>Organic, Conventional</td>
</tr>
</tbody>
</table>

- Sample design was a full factorial 2x2x2 design
- Triplicate samples batches
- Duplicate analysis
Italian tomatoes

- PTR-MS
- Sensory analysis
Sensory profiling of the tomatoes

- Only 9 of the 12 samples from Emilia were assessed by sensory profiling due to early deterioration.

- Sensory analysis was performed by 13 expert assessors from the Flavour Research Team of Caroline Labrie and Petra Dorstijn at Wageningen UR Greenhouse Horticulture.

- A total of 17 sensory attributes comprised of aroma, taste and texture were used to evaluate the samples.
Method developments and confirmation

- Laboratory-based: finding the relevant markers AND (international) validation
The egg study continued

- Farming Method
  0 = Organic
  1 = Free Range
  2 = Barn
  3 = Cage

- Country of Origin
e.g: IE = Ireland

- Farm and County ID
  A specific letter denoting county of production and a two digit number denoting actual farm where your eggs were produced e.g. A12

- Best Before Date
e.g: 06/DEC

**Organic**

**Cage**

**Barn**

**Free range**
Instrumental method based on yellow pigments: carotenoids
Carotenoids in egg yolk

- Natural carotenoids
  - Lutein
  - Zeaxanthin

- Feed additives
  - Canthaxanthin
  - Apocarotenoic ester
  - Citranaxanthin
~750 eggs
~200 pooled samples
~250 samples to be analysed
Chromatographic analysis of the yellow pigments
## Lots of data

### Raw results

| Sample | Region of analysis | Class | Reg/non-reg | Sample | Unknown 1 | Unknown 2 | Unknown 3 | Unknown 4 | Unknown 5 | β-apo-carotenal | Unknown 6 | Unknown 7 | Unknown 8 | B-Carotene | Known at RT 1 | S | FR3W 4 4 1 2 29C | 769.9 47.6 30.6 0.00 0.00 0.00 0.00 13.34 8.17 0.00 0.0 212.8 1082.4 |
|--------|-------------------|-------|-------------|--------|-----------|-----------|-----------|-----------|-----------|---------------|-----------|-----------|-----------|-------------|----------------|-----|------------|
Statistical analysis
Scientific validation

- Cross-validation with training set: all organic and 24 out of 26 non-organic egg samples were correctly classified.
- Validation with new eggs from 12 organic and 12 conventional farms from:
  - The Netherlands
  - New Zealand
Validation with new eggs

![Validation diagram with new eggs]

- Class 1
- Class 2
- Origin unknown
- BA-unknown
- FR-unknown
- BIO
Organic egg classification based on model for Dutch eggs
Eggsp ectation: organic egg authentication method challenged with produce from ten different countries
Application

- For certifiers
- For farmers/trade
- For NGO’s
- For research
- For the press

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Supply-chain: pro-active, red/green light, 100% check

- In industry
- 100% check
- Anomaly testing (red/green light)
- Rapid, low-cost, in-/at-line detection
Analytical Methods

Mid infrared spectroscopy and multivariate analysis: A tool to discriminate between organic and non-organic wines grown in Australia

Daniel Cozzolino*, Matt Holdstock, Robert G. Dambergs, Wies U. Cynkar, Paul A. Smith

The Australian Wine Research Institute, P.O. Box 197, Adelaide, Glen Osmond, SA 5064, Australia
Meat testing

- Hyperspectral measurements
Principles hyperspectral imaging
Principles hyperspectral imaging 2
Comparison organic/conventional beef
Potentials and limitations

- Interdisciplinary developments: social sciences/food science/chemistry/physics/statistics/economics/financial world
- Technology allowing more detailed evaluations

- Limitations: one can only find differences if they are present (consistently)....
Outlook food authentication

- Interaction with social sciences required to understand what would be perceived as a fraud opportunity which will allow eventually science-based determination of critical temptation points
- Developments in authentication in confirmatory laboratory testing, especially with regard to fingerprinting
- New opportunities to measure in industrial environment
Thanks
The Future

NEXT EXIT