SYMPOSIUM ON FOOD IDENTIFICATION AND AUTHENTICATION

Interesting tension between economics (fraud/adulteration) and safety?

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Food Fraud – a **Current Issue but an Old Problem**

Food beyond compare
Food beyond belief
Mix it in a mincer and pretend it's beef
Kidney of a horse
Liver of a cat
Filling up the sausages
with this and that.

(Master of the House, Les Miserables)

Food Fraud is Economically Significant (i.e. is “big business”)

Hundreds of millions of pounds each year in the UK alone.

"When we have done surveys on individual foods the level of fraud is often around 10 per cent ... The UK food sector alone is worth around £70 billion per year ...”

Food Standards Agency, UK

Advertisements:

Very blatant:

Why sell meat when you can sell water?

(Trade advertisement)

Synthetic L-malic acid

(DL-isomers etc, D-malic acid, L-malic became commercially available)

Economics

The economic advantage for an individual producer and the overall loss to the consumer of adding water to meat and cured meat is immense.

1 % of undeclared added water in bacon and ham alone would amount to the annual consumption in the UK of 4,662 tonnes of water in the mistaken belief that it is meat.”

The FSA’s authenticity programme has found that proteins from beef or pork are being used as water retaining agents in chicken.

Not a Recent Problem

Food additives were commonly used and in the 18th and early 19th centuries many of them were poisonous. Let alone the quality of water at that time.

To whiten bread bakers added alum and chalk to the flour and the weight of the finished loaves was increased with mashed potatoes, plaster of Paris (calcium sulphate), pipe clay and even sawdust.

Rye flour or dried powdered beans was used to replace wheat flour and the sour taste of stale flour was disguised with ammonium carbonate.

A treatise on adulterations of food, *and culinary poisons* exhibiting the fraudulent sophistications of bread, beer, wine, spiritous liquors, tea, coffee, cream, confectionery, vinegar, mustard, pepper, cheese, olive oil, pickles, and other articles employed in domestic economy

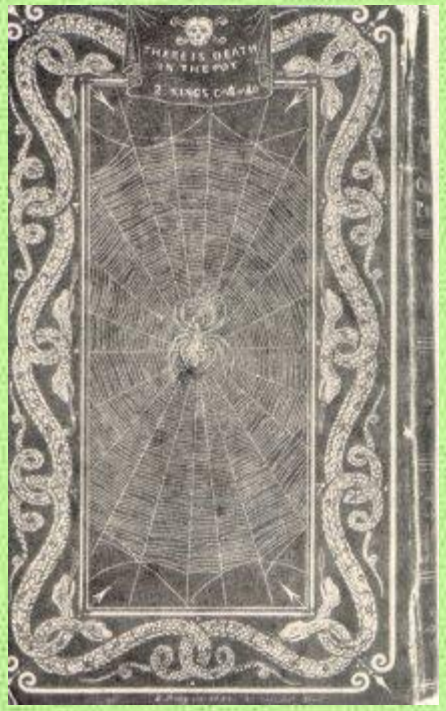
And methods of detecting them

***Fredrick Accum*,**

(Operative chemist, and member of the principal academies and societies of arts and sciences in Europe)

1820

(but still freely downloadable)


THERE IS DEATH
IN THE POT

Alcohol Drinks Adulteration

Brewers added mixtures of bitter substances, some containing poisons like strychnine, to ‘improve’ the taste of the beer and save on the cost of hops.

There was a widespread adulteration of beer. The major London brewers were producing beer of approximately 7.25% alcohol but by the time it was supplied to the publicans it had dropped to an average 4.5%.

And it was being treated with green vitriol, alum and salt to give it a good “cauliflower head” when it was poured and cocculus indicus, used by the dyeing and tanning trade, was added to enhance the bitter taste.

Old and faded cayenne pepper was laced with red lead, ground pepper was mixed with pepper dust (warehouse sweepings) and even ‘dust of pepper dust’.

Pickles were boiled in copper vessels and half-pence coins were added to produce “a lively green colour”.

Charles Dickens observed "green as it was, it seems that the customers were still greener“.

Tea and coffee drinking had become popular in the UK but both were expensive.

Exhausted tea leaves and coffee grounds could be bought for a few pence per pound from London hotels and coffee shops. The leaves were boiled with copperas (ferrous sulphate) and sheep's dung, then coloured with prussian blue (ferric ferrocyanide), verdigris (basic copper acetate), logwood, tannin or carbon black, before being resold.

Poisonous colourings were found in jellies and sweets, and in the wrappers. The bright colours used to attract children often contained lead, copper or mercury salts.

Recent UK Cases

Beer - the deception might be as simple as a simple lie.

On an industrial estate in Alperton, West London, traders were taking delivery of three tankers of ‘an Australian type’ lager (approximately 5000 gallon in each) every week, “racking” it (putting into kegs) then selling it on as Fosters and Carling Black Label.

Spirits (1) - alternatively, consumers might be deceived by in the misplaced faith in the label on the bottle.

Spirits substitution or 'tipping'' is the notorious practice of refilling a branded spirit bottle with another spirit, usually of an inferior quality. In November 1999 1 in 12 on-licensed outlets, or 8%, were substituting at least one spirit brand at any one time, a deception worth £43 million each year in the UK.

By 2006 the substitution rate had been reduced to 1 in 50 outlets or 2%, saving consumers over £30 million every year. The International Federation of Spirits Producers (UK IFSP) UK represents the major spirit brand owners and works closely with Trading Standards and Environmental Health Authorities that are responsible for consumer protection.

Spirits (2) - more alarmingly, consumers might be deceived by counterfeit and poisonous products, such as ‘vodka’.

Vodka is essentially a flavourless drink so it is relatively easy to counterfeit simply by diluting industrial alcohol with tap water- samples tested by the West Yorkshire Public Analyst in 2010 contained chloroform, iso-propanol, methyl ethyl ketone and dichloromethane - potentially carcinogenic, but not as harmful as those with high levels of methanol.

Fish - farmed salmon costs about £5/kilo, line-caught costs about £15/kilo. Food Standards Agency May 2007 snapshot survey into the labelling of fish on retail sale.

First - disclosure - whether the fish was caught or farmed and its geographical origin; 5% of retailers provided consumers with no information, or incorrect information. Smaller businesses, such as local fishmongers, scored worst.

Second - samples of fish described as ‘wild fish’ were tested one in ten fish sold as ‘wild sea bass’ and ‘wild sea bream’, and one in seven fish described as ‘wild salmon’, were farmed fish compared the samples, using the way that the different diets of wild and farmed fish alter the composition of the fatty acids within them, and their carbon, oxygen and nitrogen isotopic signatures.

Beef - food fraud involving beef takes at least two forms: gender and origin. Beef from male animals is commercially more valuable than beef from female animals. Can now detect the gender of boned, packaged and chilled, ready for sale beef. The principle of the technique is the same as used for sexing pre-implanted cattle embryos. As to origin fraud - Brazilian sirloin beef costs about £4.50/kilo. British costs £8.50. Once the meat is unbagged and unbadged it is difficult to tell them apart. Working on a form of 'fingerprinting' technique whereby the chemical elements of grass, nutrients and especially water can be identified. Thus beef that was grown in Brazil can be identified apart from that grown elsewhere by analysing the effects left by the water it drank and the water content of the grass it ate.

Rice

‘Basmati’ rice costs more than twice the price of other ‘more ordinary’ varieties. It currently accounts for about 37% of the UK dry rice market by value, with a value of £50m per year. It is known as the ‘Prince of Rice’. The word Basmati refers to its aroma – literally ‘the fragrant one’. There are 11 varieties from India and 5 from Pakistan that can use this appellation. Anything else is fraud, and fraud is common. The Food Standards Agency 2004 surveyed samples of the rice sold in the UK as Basmati and found that more than one sample in six contained high levels of other non-Basmati varieties.

FSA calculated that the fraud cheated consumers out of over £5 million that year.

‘Organic’ Foods

World organic food sales jumped from £14.4 billion in 2002 to £32.6 billion in 2008. The sales of organic food in the UK fell in 2009 from a record high of £2.1bn in 2008 to £1 .84bn but this is still three times higher than in 1999 and more than 50% higher than in 2004. But – an assertion that food and drink is organic is an imprecise claim. In the UK ‘organic’ produce must display a certification symbol or number. The Soil Association organic symbol is the UK's main certification mark, appearing on approximately 70% of organic food produced in the UK avoids the use of artificial fertilizers and pesticides, and the use of crop husbandry to maintain soil fertility and control weeds, pests and diseases. Controls on organic arable systems cover soil fertility, crop rotation, crop protection, organic seed and organic crop storage and in terms of livestock: feeding, housing, health management and the use of manures. Consumers’ increasing demand for organic produce is outstripping the industry's ability to supply. Therefore producers are masquerading as organic suppliers and produce is being imported from sources where its provenance is uncertain. There is no foolproof way to check whether a particular food on a supermarket shelf has been produced organically because there are so many different criteria and most are hard to verify scientifically.

Problems in the EU Food Sector:

Have tended to be not predicable – most discovered by accident!

Major EU Authenticity Crises

1975 Addition of synthetic alcohol in port (Portugal)

1986 Methanol in wine (Italy)

1995 Diethylene glycol in wine (Austria)

1990 Orange juice adulteration (UK)

2003 Illegal Dyes, mainly Sudan dyes (India)

2007 Melamine (China)

Major EU Safety Crises

1978 Mercury in oranges (Israel)

1981 Olive oil adulteration (Spain)

1984 Bovine Spongiform Encephalopathy (UK)

1999 Dioxins and PCBs (Belgium)

2003 Illegal Dyes, mainly Sudan dyes (India)

2007 Melamine (China)

2008 Dioxins and PCBs in pork products(Ireland)

2011 Dioxins and PCBs (Germany)

SUDAN DYES and Other ILLEGAL DYES

Recent example of adulteration leading into a safety issue.

Have had many problems with illegal dyes in the EU (Sudans etc etc).

UK took the EU Analytical Network - methods information disseminated and control samples prepared.

Large economic cost to producers/retailers.

FSA commissioned analytical development work.

Warned by industry that there was likely to have a problem with cryoisidine in some spices (cassia bark and star anise). Used for inks and wood polish and colouring maggots

Many assumed that existing methods would be satisfactory.

Found not to be the case (extraction difficulties – false negatives?)

Good example of cooperation – except RASFF issued too early.

CRITERIA FOR METHODS OF ANALYSIS USED IN CHECKING OF THE LEVELS OF ILLEGAL FOOD DYES IN FOODSTUFFS

Precautions and general considerations

The basic requirement is to obtain a representative and homogeneous laboratory sample without introducing secondary contamination.

Specific requirements

Laboratories may select any validated method provided the selected method meets the performance criteria indicated below.

Parameter	Value/Comment
Analytes	Illegal food dyes, and in particular: Sudans I - IV, Para Red, Rhodamine B Orange II Sudan Red 7B Sudan Orange G Red B [may also be prefixed by "Sudan"] Butter Yellow (dimethyl yellow - p-dimethylamino azobenzene).

Parameter *contd*	**Value/Comment**
Applicability	Foodstuffs
Detection limit	No more than 15 μg/kg for: Sudans I - IV, Rhodamine B Orange II Sudan Red 7B Sudan Orange G Red B [may also be prefixed by "Sudan"] Butter Yellow No more than 50 μg/kg for: Para Red

Parameter *contd*	**Value/Comment**
Limit of quantification	No more than 30 μg/kg for: Sudans I – IV, Rhodamine B Orange II Sudan Red 7B Sudan Orange G Red B [may also be prefixed by “Sudan”] Butter Yellow No more than 100 μg/kg for: Para Red

Parameter *contd*	**Value/Comment**
Reporting Limit	No more than 30 μg/kg for: Sudans I – IV, Rhodamine B Orange II Sudan Red 7B Sudan Orange G Red B [may also be prefixed by “Sudan”] Butter Yellow No more than 100 μg/kg for: Para Red

Parameter *contd*	**Value/Comment**
Precision	Not available through interlaboratory exercises, but see section of Measurement Uncertainty
Recovery	70% - 110%, unless the method of standard additions is used. Results shall be reported corrected for recovery.
Specificity	Free from matrix or spectral interferences. This is best confirmed by the use of the method of standard additions. It should be noted that many of these analytes are prone to interferences.

Parameter *contd*	**Value/Comment**
Additional identity criteria	Additional criteria that apply to confirmation of analyte identity using LC-MS/MS are as follows; Confirmation may be based on 2 ions, but 3 or more is preferable. These will be made up of at least one precursor and one daughter ions. The signal to noise for each diagnostic ion should be >/= 3:1. The maximum permitted tolerances for relative ion intensities should be +/- 20% for a relative intensity (% of base peak) of >50%. This tolerance may be increased as the relative intensity decreases as below. >20% to 50% +/- 25% >10% to 20% +/- 30% <10% +/- 50%

Parameter *contd*	**Value/Comment**
Measurement uncertainty of the reported result	The maximum expanded measurement uncertainty of a reported result shall be 40% of the result.

Internal quality control

Laboratories should be able to demonstrate that they have internal quality control procedures in place. Examples of these are the 'ISO/AOAC/IUPAC Guidelines on Internal Quality Control in Analytical Chemistry Laboratories'.[1]

[1] ISO/AOAC/IUPAC International Harmonised Guidelines for Internal Quality Control in Analytical Chemistry Laboratories, Edited by M Thompson and R Wood, Pure Appl. Chem., 1995, **67**, 649 - 666.

Analytical/Sampling Advice

Control by analysis:

HPLC or LC-MS/MS to be the defining procedure?

Wrong way of proceeding?

Toxicologists not overly helpful.

Conclusions

Adulteration is widespread often with large economic consequences.

Analytical procedures required now very sophisticated, but so is the adulteration.

For many countries these are beyond their financial abilities.

Economic considerations are driving forces for those who adulterate foods – safety concerns are normally secondary.