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# **Chemical Contaminants in Food: Current and Future Challenges.**

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# Contaminants in food

## ◆ From production practices:

- Pesticides
- Veterinary drugs

## ◆ Inadvertent Contaminants:

- From natural & environmental sources.

## ◆ Others:

- Manufacturing, storage, packaging, transport.

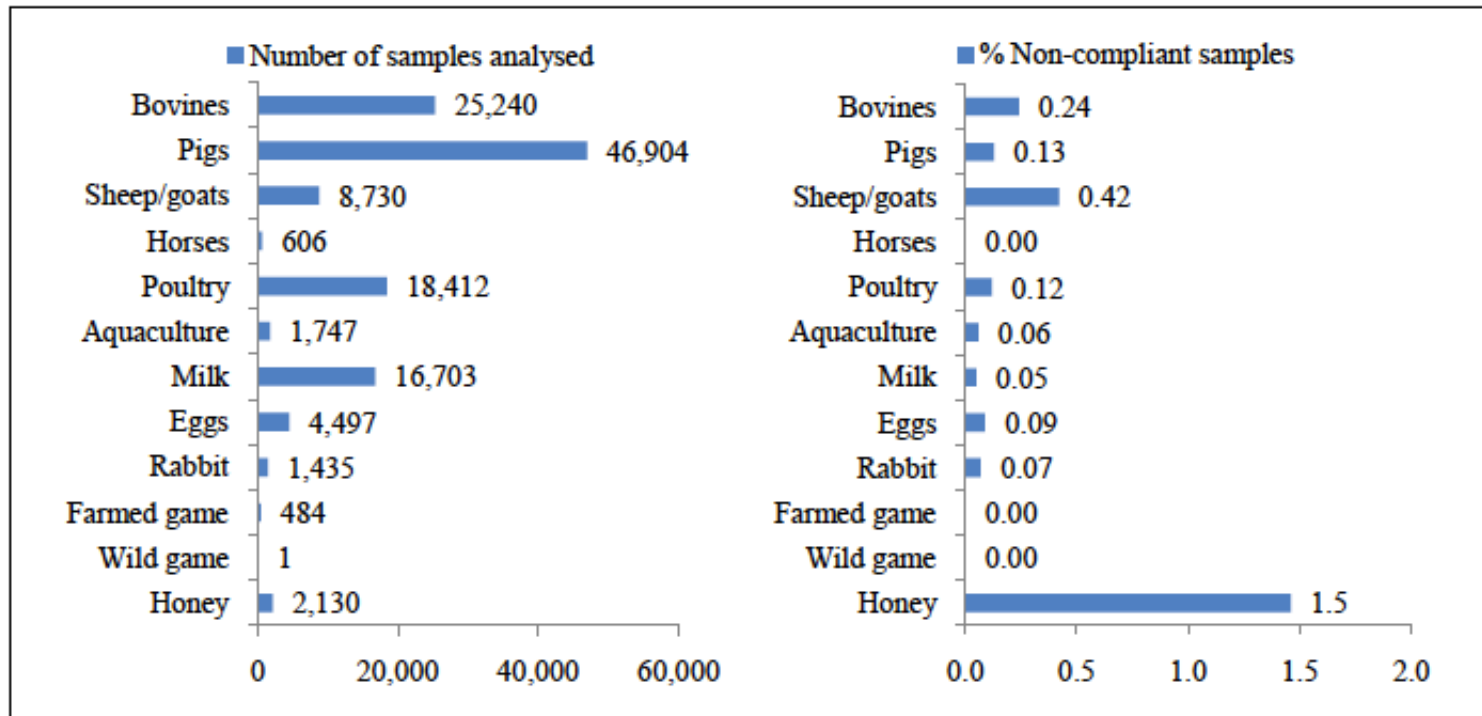
## ◆ Deliberate: FRAUD (melamine, horse meat).

# Contaminants in food

## ◆ Developed countries:

- Stringent regulatory frame work has led to very low levels of contamination.
- In the EU of the total **427,193** targeted samples analysed in 2012 only **1,071** samples (0.25 %) were non-compliant.

# EU Results for 2012



- For antibacterials 0.18 % were non-compliant.
- The highest frequency of non-compliance for antibacterials was in honey (1.5 %).

EFSA supporting publication 2014:EN-540

# Control of veterinary residues in the EU.

## ◆ Effort over some years:

- **Directive 86/469/EC** (September 1986) required member states to implement a plan based on random sampling for the detection of groups of residues or substances, according to the type of animal.
- Revision **Directive 96/23/EC** specified both random and targeted sampling criteria.
- Real effort started in 1989 with antimicrobials in kidney samples collected at slaughter houses.

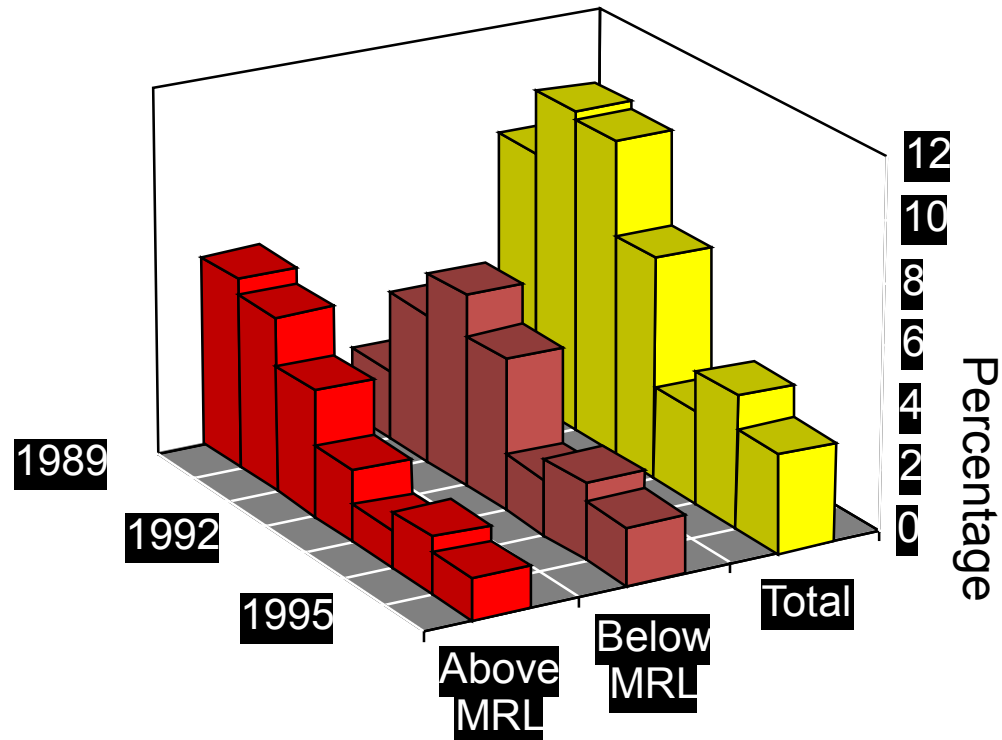
# NSS : Residues of Sulphadimidine in Kidney

## 1989 - 1995

1989: 7% over MRL

1995: 2% over MRL

**2013: less then 0.1%  
over MRL**



MRL = 0.1mg Kg<sup>-1</sup>

2014-11-13

# Developing Countries

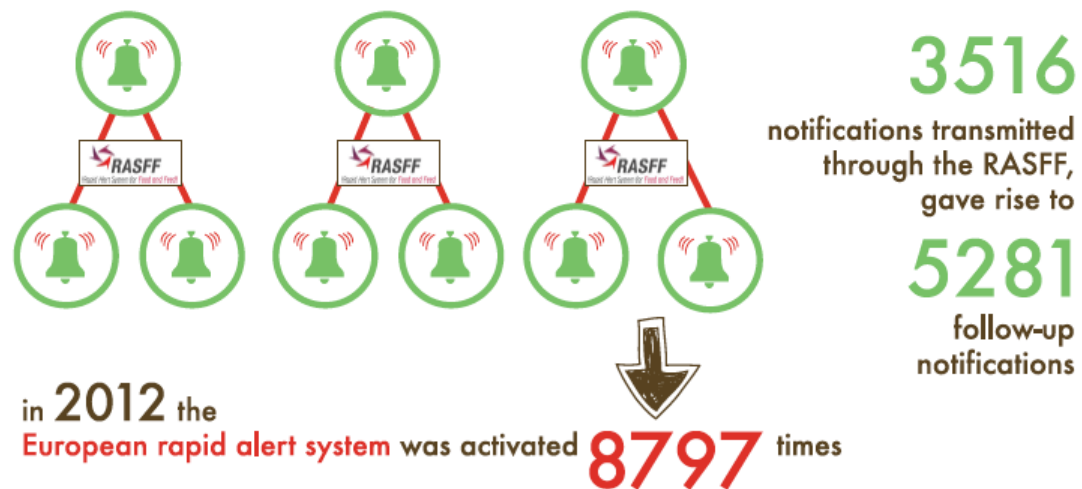
- Lack of robust regulatory framework.
- Lack of Good Practices (education?).
  - Extension officers with “side-businesses” to sell agricultural inputs (pesticides, veterinary medicines, etc.). Conflict of interest??
- Segregated production chains for exports.
  - No food safety for domestic market?
- Lack of skills and laboratory capacity.
- No surveillance data published.

## 2013 EU RESULTS: PRODUCTS IMPORTED

Group	Samples Analysed	Non-compliant	Contaminant
Bovines	511	2	Chloramphenicol, Ivermectin
Pigs	171	5	Chloramphenicol
Sheep/Goats	157	3	Chloramphenicol, AOZ (3-amino-2-oxazolidone)
Horses	80	0	
Poultry	766	29	Doxycycline, Chlopidol, Cyromazine
Aquaculture	1951	11	AOZ (3-amino-2-oxazolidone), Oxytetracycline, Arsenic, Cadmium, Mercury
Milk	20	0	
Eggs	37	0	
Rabbit	15	0	
Farmed Game	47	1	Chloramphenicol
Wild Game	54	0	
Honey	355	1	Sulphathiazole
	4164	52	
	Percentage	1.25%	



# RASFF (2012)



# RASFF (2012)



## PRODUCTS CONTAINED:

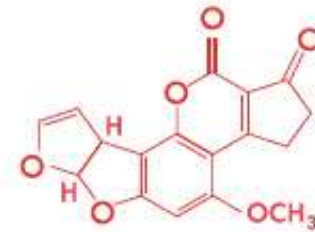
### PESTICIDES



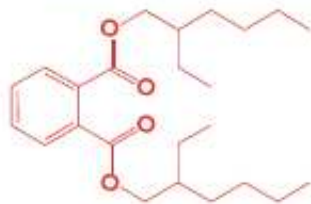
### HEAVY METALS



### AFLATOXINS



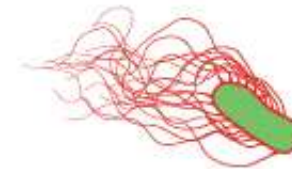
### PLASTICIZERS



### DIOXINS



### MICROBIOLOGICAL CONTAMINANTS



# RAPID ALERT SYSTEM – EU

## Annual Reports

Table 15 – 2009–2011 notifications by country of origin

country	2009	2010	2011
China	345	449	558
India	154	251	337
Turkey	278	255	318

India: mycotoxins, microbial contamination,  
pesticides and veterinary drug residues

[http://ec.europa.eu/food/food/rapidalert/docs/rasff\\_annual\\_report\\_2011\\_en.pdf](http://ec.europa.eu/food/food/rapidalert/docs/rasff_annual_report_2011_en.pdf)

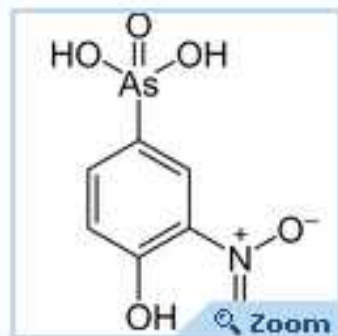
# India: antibiotics and other pharmacologically active substances banned for use in aquaculture

Sl. No	Name of the antibiotic/chemical
1.0	Chloramphenicol
2.0	Nitrofurans including: Furaltadone, Furazolidone, Furylfuramide, Nifuratel, Nifuroxime, Nifurprazine, Nitrofurantoin, Nitrofurazone
3.0	Neomycin
4.0	Nalidixic acid
5.0	Sulphamethoxazole
6.0	Aristolochia spp. and preparations thereof
7.0	Chloroform
8.0	Chlorpromaxine
9.0	Colchicine
10.0	Dapsone
11.0	Dimetridazole
12.0	Metronidazole
13.0	Ronidazole
14.0	Ipronidazole
15.0	Other nitroimidazoles
16.0	Clenbuterol
17.0	Diethylstilbesterol
18.0	Sulphonamide drugs (except approved Sulphadimethoxine, sulphabromomethazine and sulfaethoxypyridazine)
19.0	Fluoroquinolones
20.0	Glycopeptides

CAP →

NITROFURANS →

# Easy availability of veterinary medicines.



## Roxarsone 20 Percent

✓ **Aadinath Chemical Industries, Mumbai**

We process roxarsone 20 percent, which is an additive chemical. This is used by the poultry industry to increase weight. This is highly appreciated for killing stomach parasites. These are available at industry leading prices.

Address: Flat No. 5, Nirmal Sagar, Kestuba Cross Road No. 1,

Borivali East


Phone: +(91)

Website: <http://www.indiamart.com/aadinathchemical/>

**Send Enquiry**

# Easy availability of veterinary medicines: even prohibited substances!!

*“powerful gut acting and non toxic growth promoter to assure better health”*



Zoom

### Furazolidone


✓ **Bluecross Animal Healthcare Pvt Ltd,**  
**Gandhinagar**

Bluefuzon-200  
Active ingredients:  
Furazolidone 20% each 1 kg.  
Benifits:  
powerful gut acting and non toxic,  
growth promoter  
to assure better health  
Dosage:  
200gm per ton of feed. [more...](#)

Address: Plot No. 612, G.I.D.C., B.N. Road, Dahisar,  
Gandhinagar  
Phone: +91 79 2745 2001  
Website: <http://www.indiamart.com/bahpl/>

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# Availability of veterinary medicines.

August 2014: examples from a rural veterinary pharmacy in SE Asia.



2014-11-13

15

A cocktail! Includes chloramphenicol, enrofloxacin and neomycin.





## Beta-agonists (e.g. clenbuterol).



- Was a problem in Europe but largely eliminated.
- Currently an issue in other countries e.g. China and Mexico.

# Not just animals!

**SPORT FOOTBALL**

Home | Football | Formula 1 | Cricket | Rugby U | Rugby L | Tennis | Golf | Olympics

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10 June 2011  
Last updated at 07:00

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## Five Mexico players test positive for banned substance

Five Mexico internationals have tested positive for the banned substance Clenbuterol.

The players named are goalkeeper Guillermo Ochoa, defenders Francisco Rodriguez and Edgar Duenas and midfielders Antonio Naelson 'Sinha' and Christian Bermudez.

Mexico are taking part in Concacaf Gold Cup in the United States.

Despite the controversy, Mexico booked their place in the quarter-finals on Thursday with a 5-0 victory over Cuba.

"We will wait for the final result [of the investigation]," said Mexico coach Jose Manuel De La Torre after the game.

# Clenbuterol in Mexico: Footballers



The screenshot shows the top portion of a news article on The Telegraph website. The masthead 'The Telegraph' is in a blue serif font. Below it is a navigation bar with 'HOME', 'NEWS', 'SPORT' (highlighted), 'FINANCE', 'COMMENT', 'BLOGS', 'CULTURE', 'TRAVEL', 'LIFESTYLE', and 'FASHION'. Under 'SPORT', there are links for 'Olympics', 'Football' (highlighted), 'Six Nations', 'Cricket', 'Tennis', 'F1', 'Boxing', 'Golf', 'R Union', 'R League', and 'Cyc'. Further down are links for 'Live Scores', 'Blog', 'Teams', 'Fixtures', 'Results', 'Tables', 'Statistics', 'Transfers', 'Galleries', and 'Video'. The breadcrumb trail reads 'HOME » SPORT » FOOTBALL » FOOTBALL NEWS'. The headline is 'Over 100 players test positive for banned drug clenbuterol at Fifa Under-17 World Cup in Mexico this summer'. The sub-headline states: 'More than 100 players at the FIFA Under-17 World Cup in Mexico this summer tested positive for banned drug clenbuterol due to contaminated meat, the world governing body has revealed.' The byline is 'By Telegraph staff and agencies' and the date is '7:12AM BST 18 Oct 2011'. The first paragraph of the article reads: 'Fifa's chief medical officer Jiri Dvorak revealed last night that players from 19 of the 24 squads involved, in roughly equal numbers, had shown traces of the substance after analysis of urine samples.' On the right side, there are social media sharing options: 'Share:' with icons for email and print, a 'Recommend' button with a count of 21, a 'Tweet' button with a count of 5, and a 'Share' button with a count of 0.

**The Telegraph**

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## Over 100 players test positive for banned drug clenbuterol at Fifa Under-17 World Cup in Mexico this summer

More than 100 players at the FIFA Under-17 World Cup in Mexico this summer tested positive for banned drug clenbuterol due to contaminated meat, the world governing body has revealed.

**By Telegraph staff and agencies**  
7:12AM BST 18 Oct 2011

Fifa's chief medical officer Jiri Dvorak revealed last night that players from 19 of the 24 squads involved, in roughly equal numbers, had shown traces of the substance after analysis of urine samples.

Share:  

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# Increasing public awareness: International Food!!



Good News?? Obesity is an increasing problem!

# Public Awareness of contaminants.



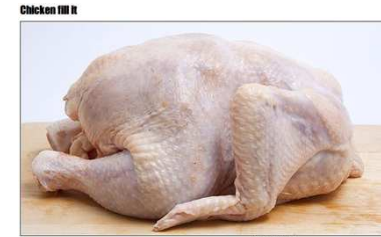
# FOOD AUTHETNTICITY and TRACEABILITY:

## Examples

- Wrong Descriptions:
  - Using cheaper fish
  - Labelling cheaper varieties of potatoes as “King Edward”
  - Adding undeclared beef to lamb kebabs
- Presence of undeclared ingredients:
  - Mechanically Recovered Meat processed products.
  - “Chicken Powder” .



## “CHICKEN POWDER”



### Chicken injected with beef waste sold in UK

Muslims and Jews conned into eating meat bulked out with cow and pig products

BY MARTIN HICKMAN, CONSUMER AFFAIRS CORRESPONDENT | THURSDAY 04 JUNE 2009



**THOUSANDS of Brits are being served chicken bulked up with beef and pork when they go out for a meal, a report revealed yesterday.**

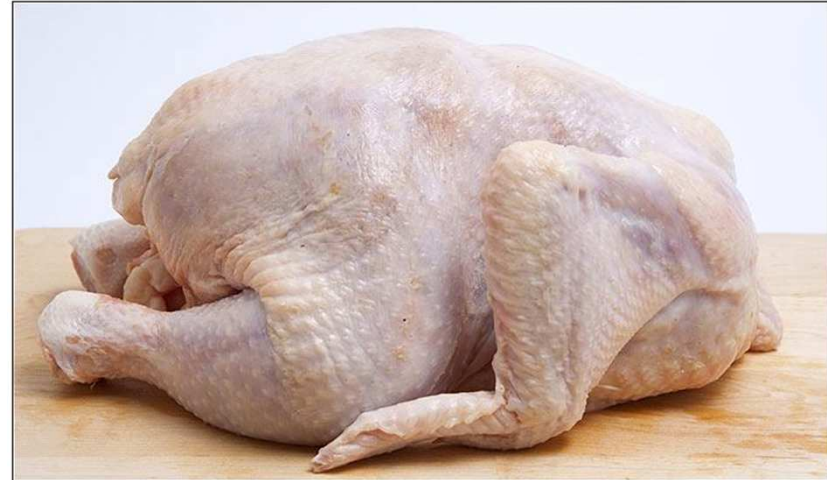
Restaurants and cafes unwittingly buy chicken containing other animals from wholesalers and dish it up for customers.



# Chicken Powder!!



Chicken fill it



Studied ... chicken

**THOUSANDS of Brits are being served chicken bulked up with beef and pork when they go out for a meal, a report revealed yesterday.**

Restaurants and cafes unwittingly buy chicken containing other animals from wholesalers and dish it up for customers.

The meat is bulked up by producers in Germany and Spain.

The Food Standards Agency traced the beef and pork proteins only after using new scientific techniques.

The proteins are in a powder mix that is injected with water into birds to make them look "meatier".

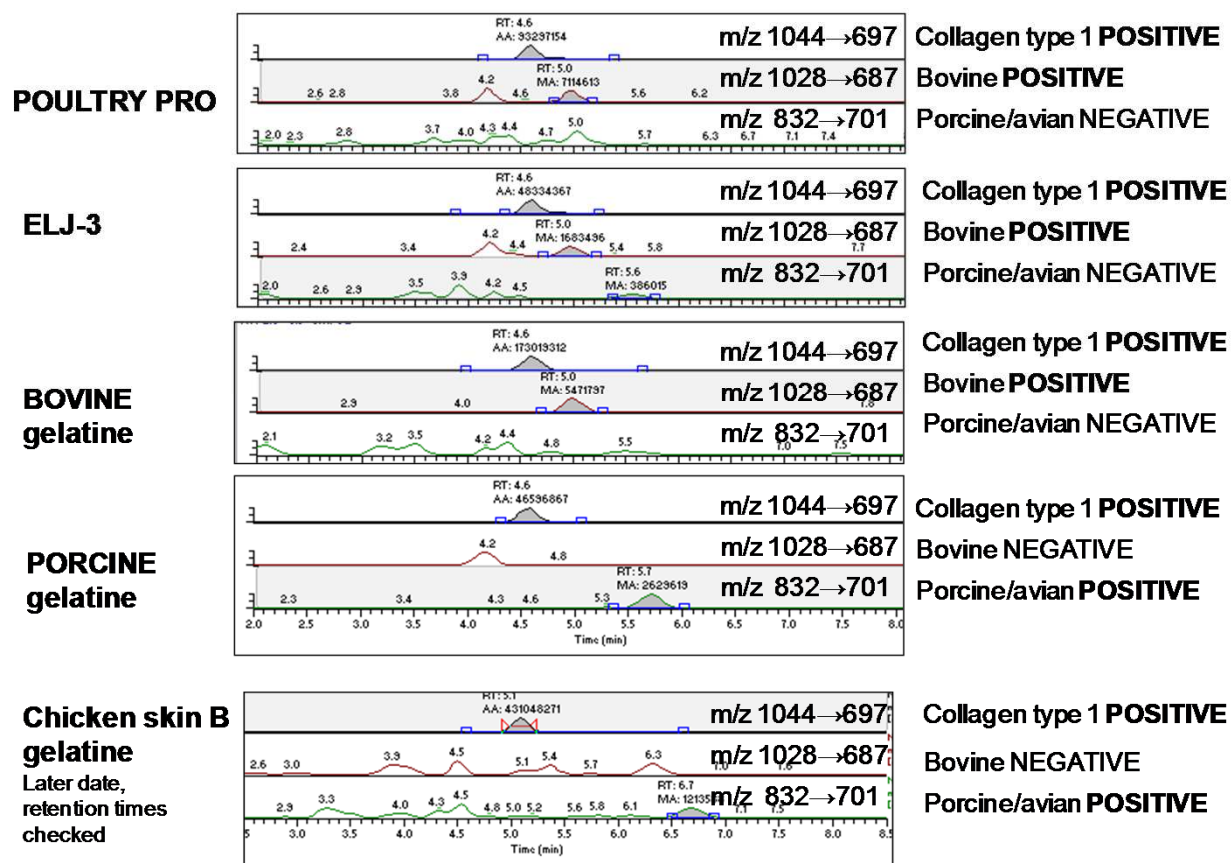


Gulp! Shoppers pay £1.50 (15CNY) a kilo for water in chicken

- CUSTOMERS are paying more than £1.50 a kilogram for water that is used to bulk up the meat.
- Some popular brands are more than 15% added water.
- The meat is pounded with water and additives in machines similar to cement mixers, in a process known as “tumbling”.
- The chicken is labelled “with added water”, which manufacturers say improves the succulence of the meat.
- The Food Standards Agency (FSA) has, however, begun an investigation into whether manufacturers are breaching food regulations.

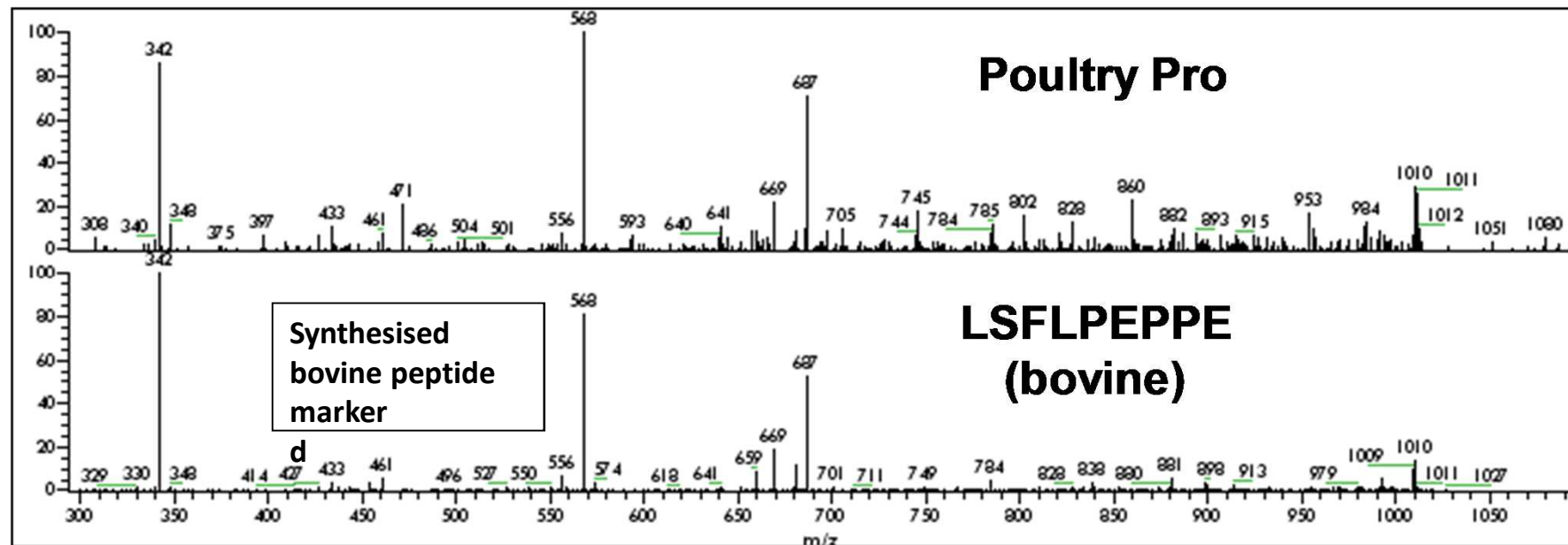
# AN INVESTIGATION INTO INJECTION POWDERS USED IN FROZEN CHICKEN BREAST PRODUCTS

## Peptide-specific chromatograms



# Proteomics

## Species specific peptide fragments



# Metabolomic Approach to the identification of Mechanically Recovered Meat (MRM) in Food Products.

MRM is defined as “product removed by mechanical means from flesh bearing bones after deboning or from poultry carcasses, resulting in the loss or modification of the muscle fiber structure”.

# What is Mechanically Recovered Meat (MRM)

MRM is obtained by removing residual raw meat from bones, typically using a high pressure machine.



MRM is a cheap ingredient for the food industry.



Chicken Nuggets



Clear and separate labeling of MRM in products is required.

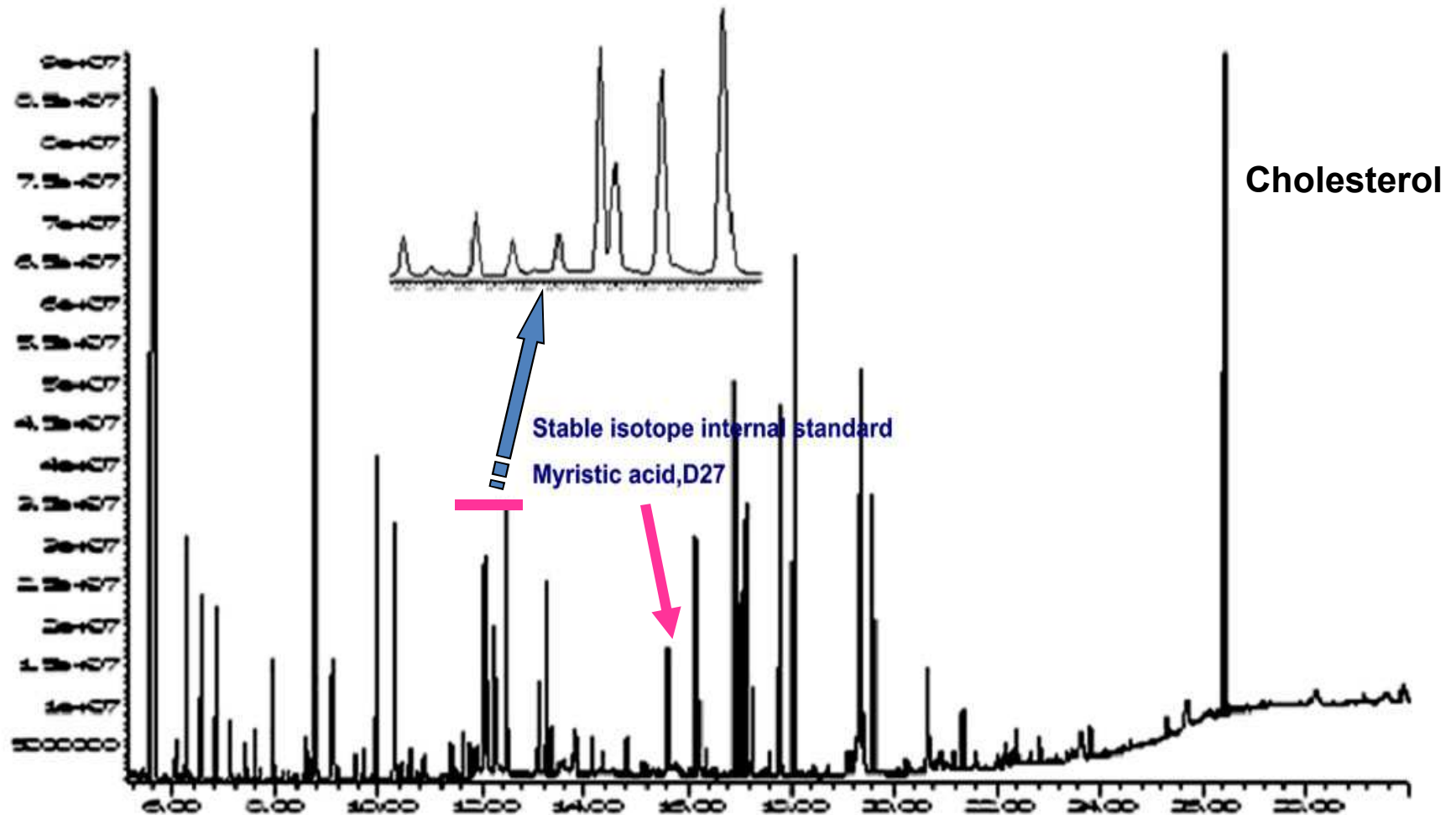
- Analytical procedures are needed to differentiate MRM from hand-deboned meat (HDM) and from recovered under lower pressures, desinewed meat.
- Microscopy to look at muscle fibre.
- Metabolite profiling to detect the presence of MRM

## METHODS

- Sample extraction: methanol/water (9:1), dried extracts derivatized and then analyzed using GC-MS.
- Eighty manually chosen peaks were used for the creation of the chemometric model.
- The data matrix table constructed from peak areas for each of the samples and use multivariate analysis and data modeling using SIMICA-P 11 software.



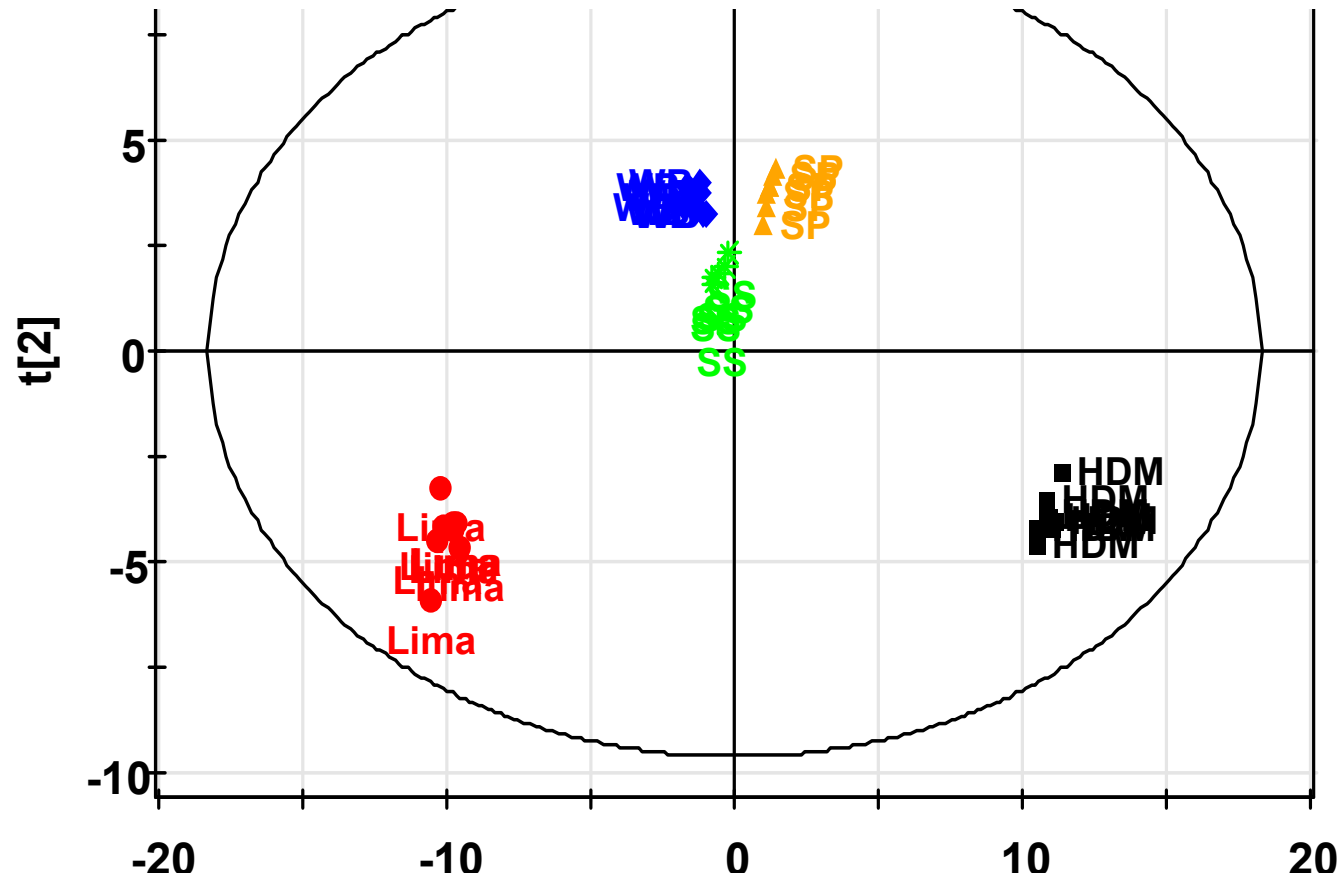
# GC/MS profile of MRM/MSM



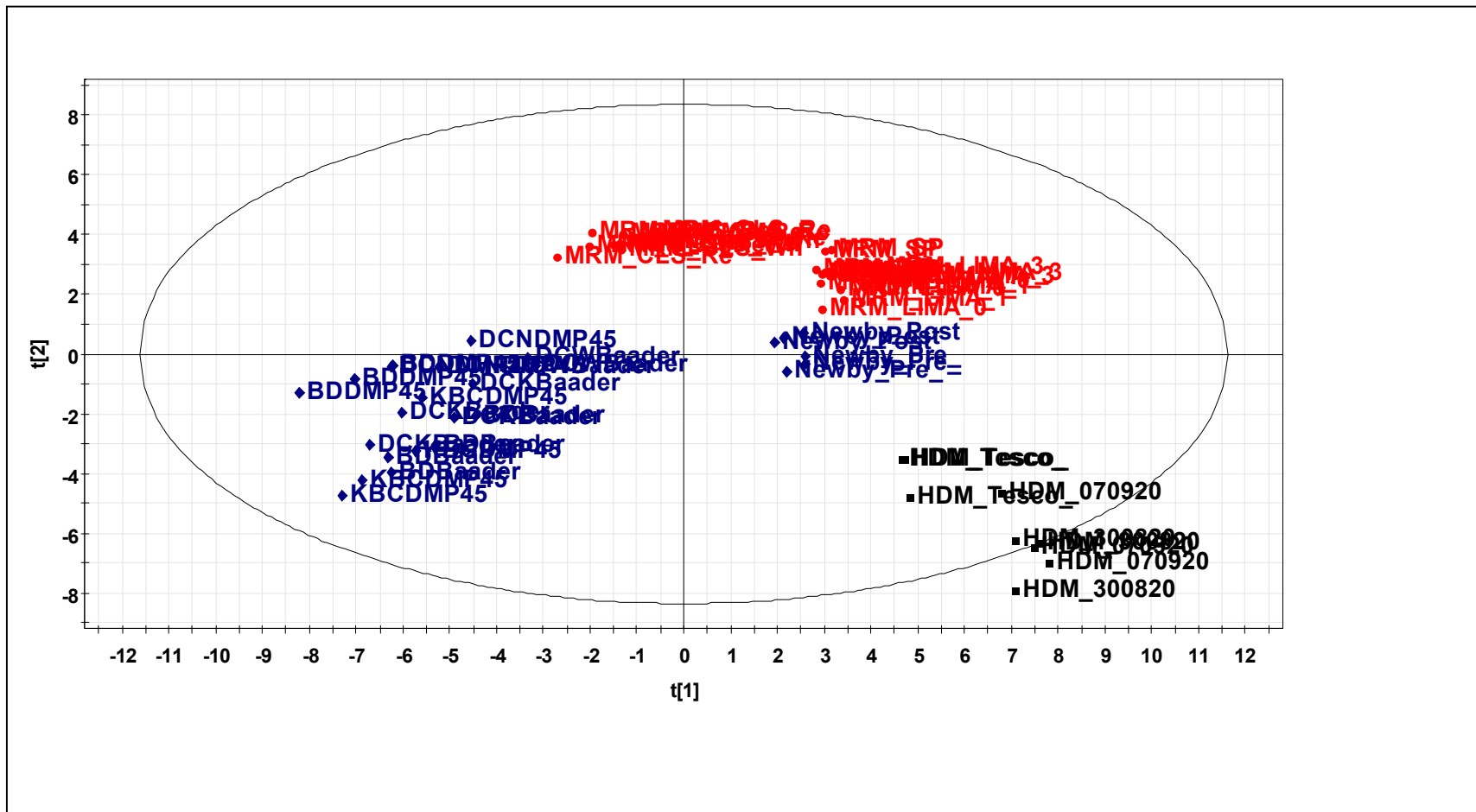
DB5 capillary column( 30m×0.25 mm, 0.25 um), temperature ramping from 70 to 310°C at rate of 10 C /min, flow rate:0.9ml/min, mass scan range:10-800 m/z.

# GC/MS analysis of pork meat products

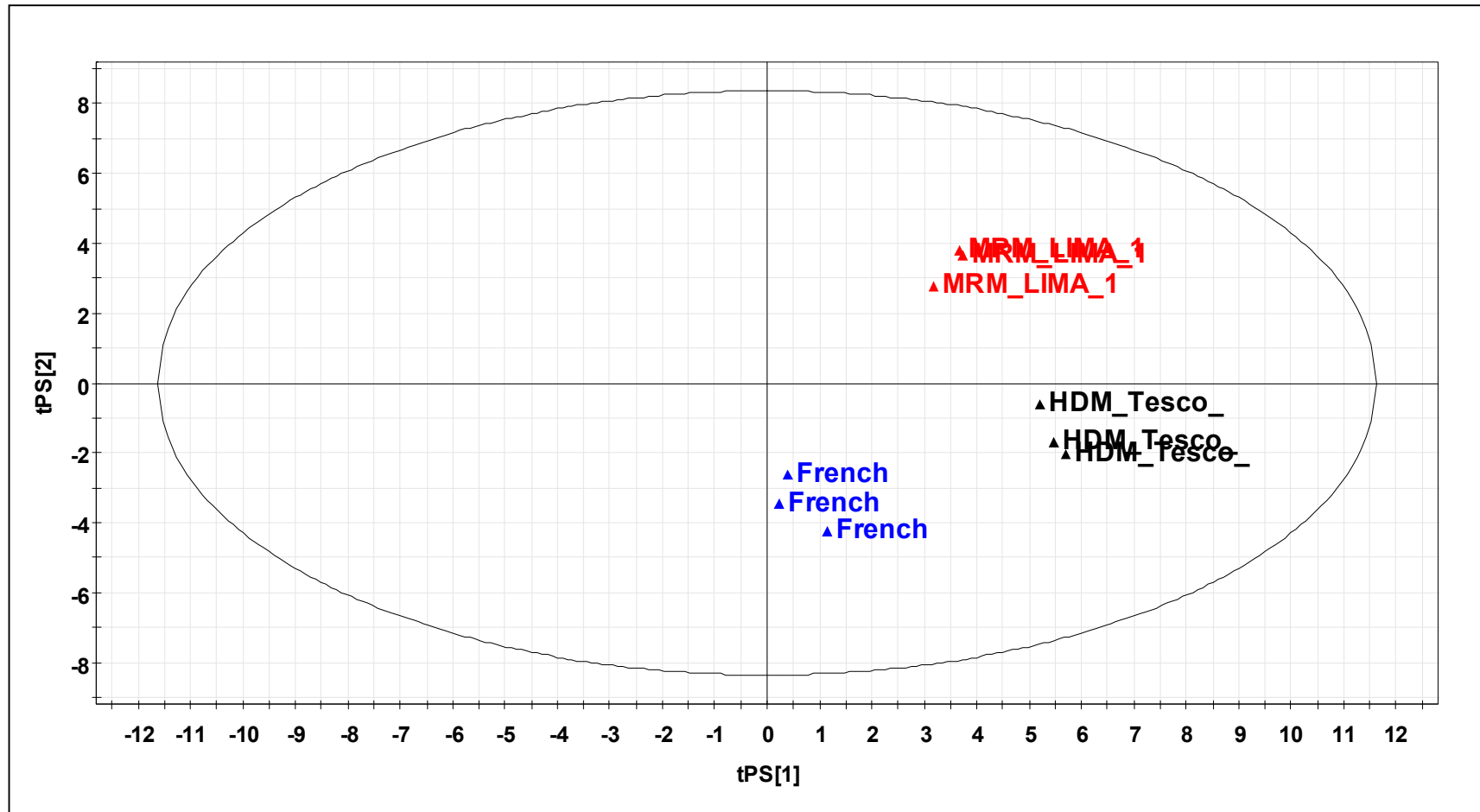
## Score plot of pork MRM and HDM



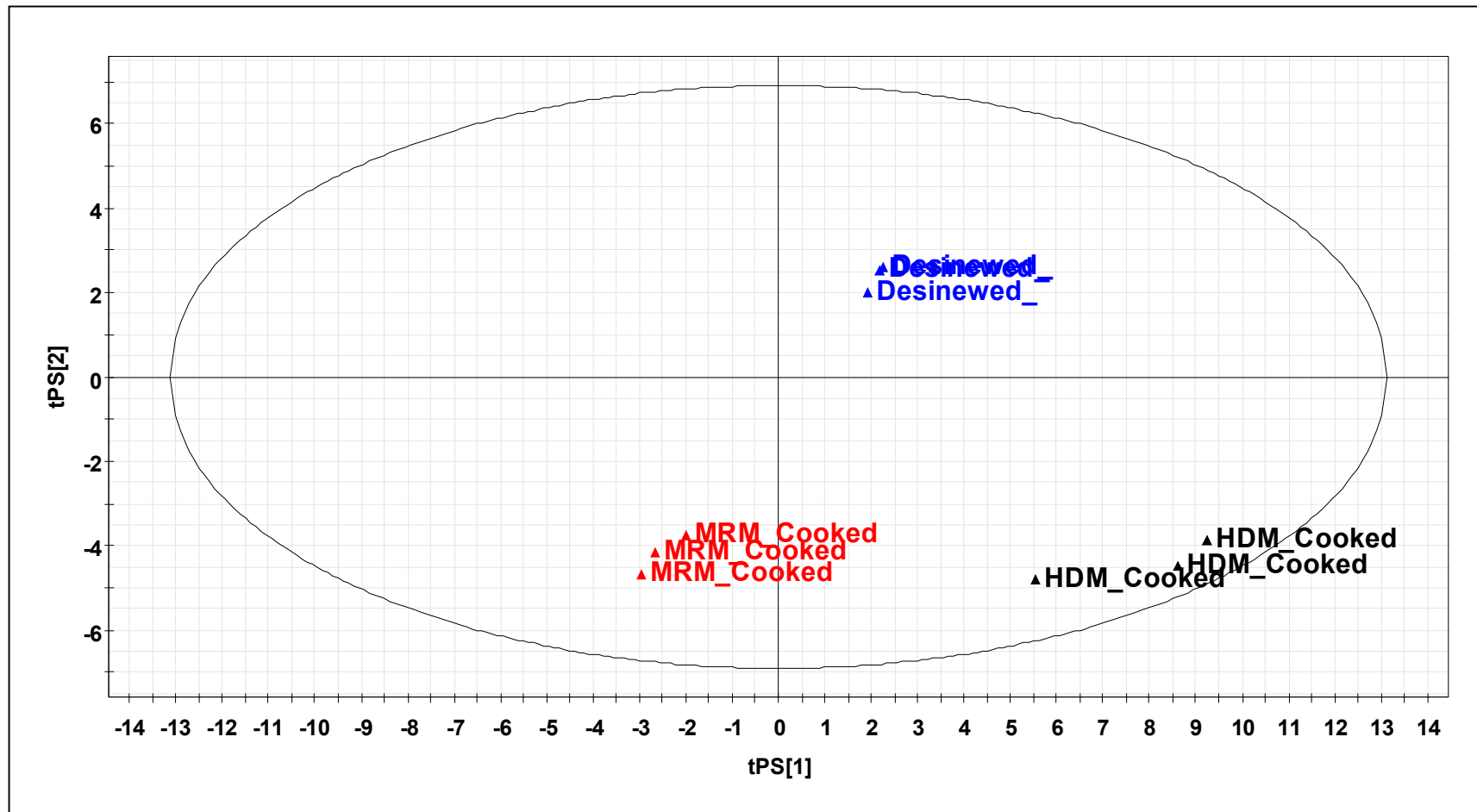
# Validation Samples.



# Real samples from FSA



# Even cooked meat

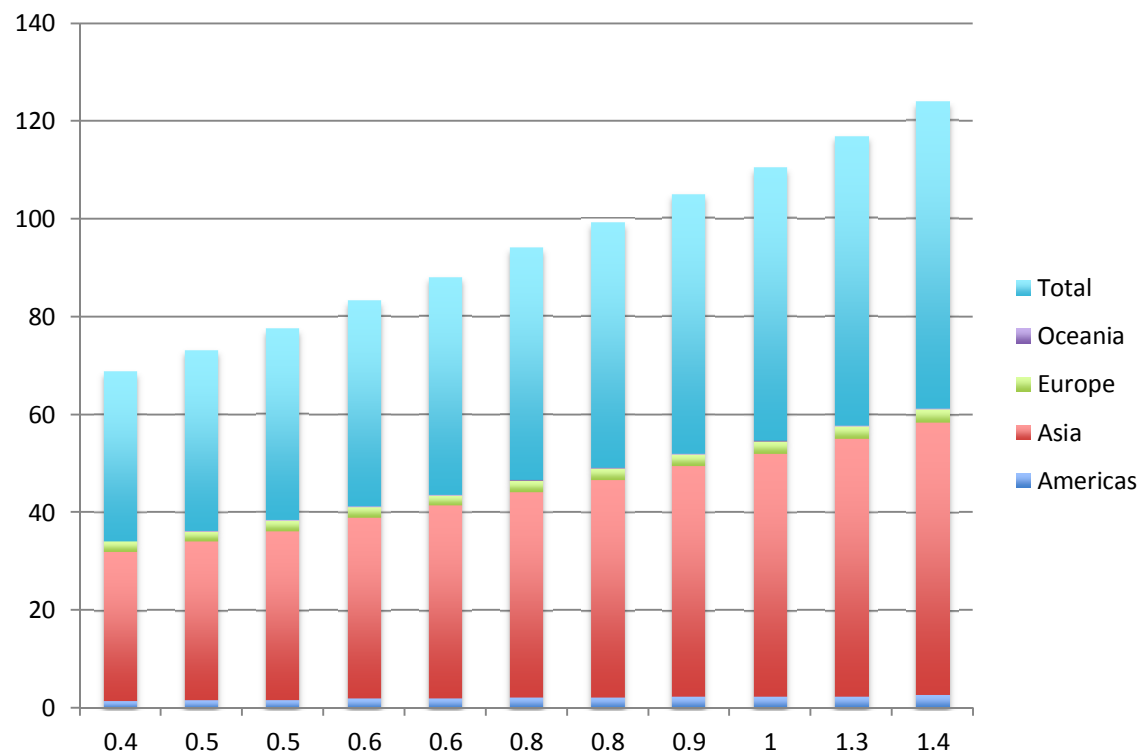


## Metabolomics approach: conclusions

- Proposed methodology based on single step extraction method followed by derivatization and GC-MS analysis provided the basis for further method development and validation for metabolite profiling of methanolic extracts derived from meat samples.
- Chemometric model once established and validated could be used for classification of the samples coming to the routine laboratory in different time intervals.

# Emerging Issues in Aquaculture

# World aquaculture production of food fish\* by continent (million tons)



\* Food fish = fishes, crustaceans, molluscs, amphibians, reptiles (excluding crocodiles) and other aquatic animals (such as sea cucumber, sea urchin, etc.) for human consumption



# Feed

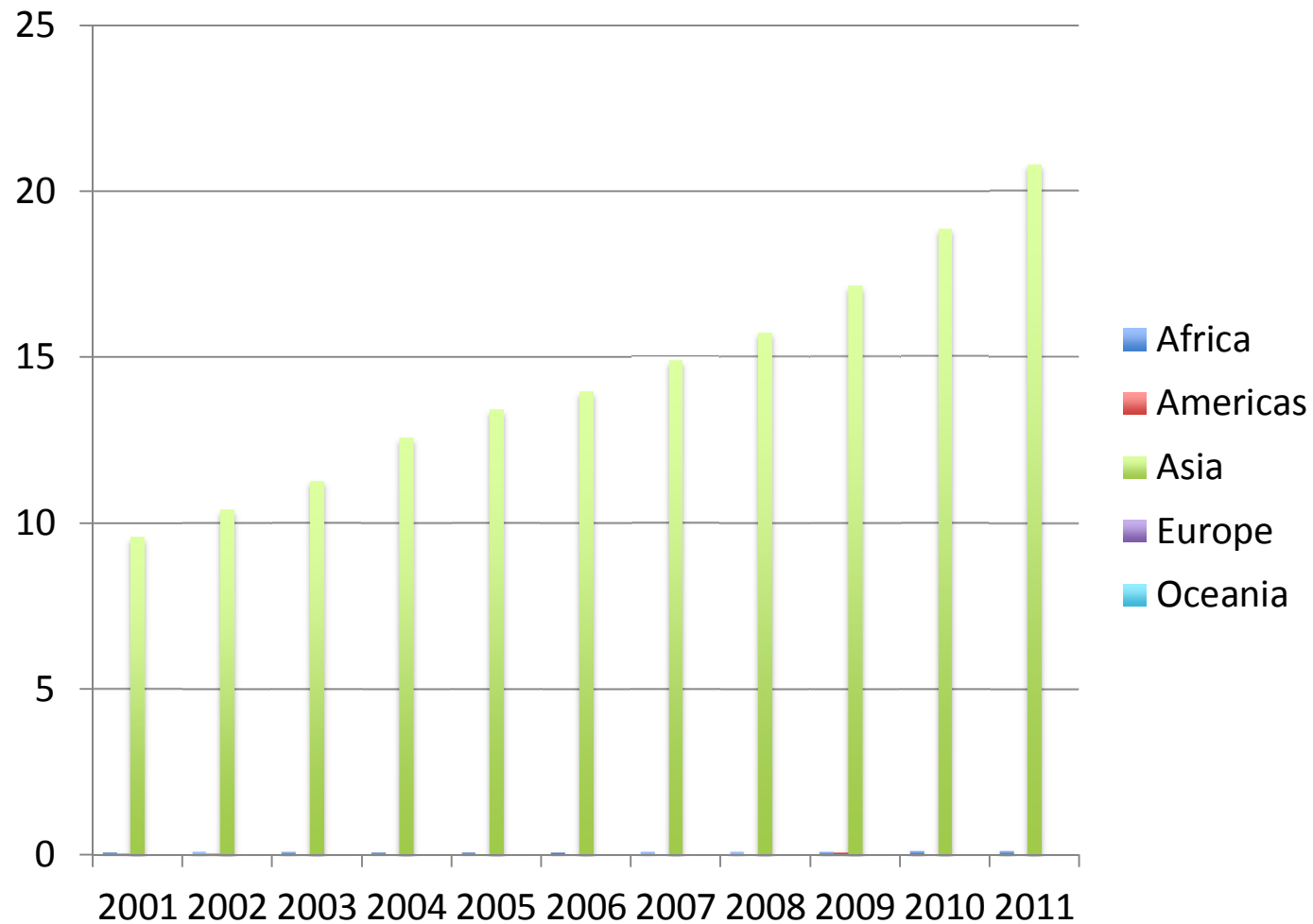
Costs can be as high as 40 to 50% of total operating costs.

The use of alternative feed such as [algae](#) or [insect protein](#) to reduce dependency on soya and fishmeal.

## Other Advantages of Algae

1. Taste quality: more “natural”.
2. Improving public health: fish fed from algae based food present a better ratio of Omega 3/Omega 6 oils in its flesh.
3. Disease Control

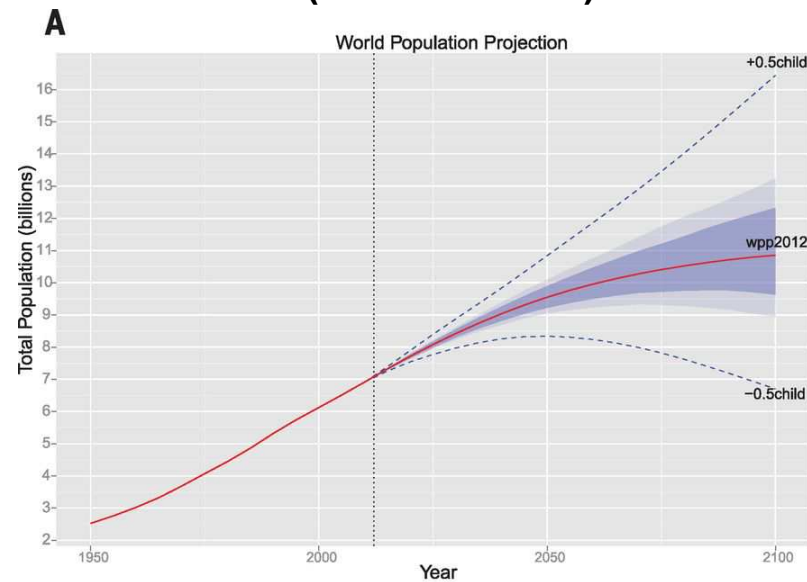
# World aquaculture production of aquatic algae by continent (million tons)



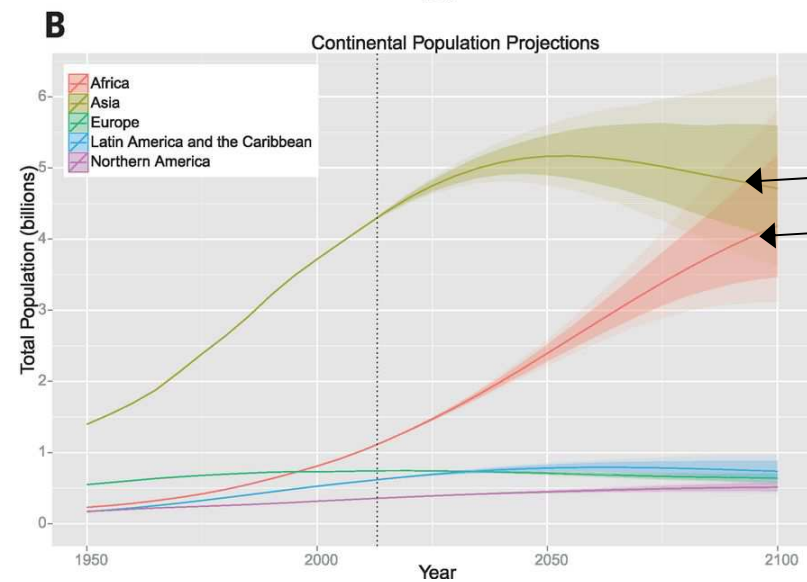
# Horizon Scan

- Marine & fresh water environments are filled with bacteria and viruses that can attack fish and shellfish, and can devastate aquaculture farms.
- Bacteria and viruses can also attack microalgae, so these microorganisms have developed biochemical mechanisms for self-defence; such mechanisms involve production of compounds that inhibit bacterial growth or viral attachment. For instance, extracts of *Scenedesmus costatum* exhibit anti-bacterial activity, these compounds have not yet been characterised.
- Are some of these antibacterial compounds of concern from a human health perspective?

## World and continental population projections.(A) UN 2012 world population projection (solid red line).



The vertical dashed line denotes 2012



P Gerland et al. Science  
2014;346:234-237

2014-11-13

## Increased population in urban areas: mega-cities

- Much of what we have heard this week focused on “formal” high-end” supply chains.
- What about the majority of the world population relying on “informal” supply chains?

# Urban retail supply in developing countries





# Urban retail supply in developing countries



# Future

- Increasing urban populations.
- Increasing production of aquaculture
- Climate change
- Need for low cost and rapid testing:
  - Mobile laboratories?
- Solutions will lie in a multi-disciplinary approach with engineers playing a bigger role.



**THANK YOU**