Food Defence: Protection of the Food Supply Chain Against Criminal Manipulation and Terrorist Attack

Maria Jesus Alvarez, Ainara Alvarez, Ainhoa Oses, 
Tecnun (Universidad de Navarra)

Maria Carla De Maggio, Marcella Trombetta, Roberto Setola
University Campus Bio-Medico of Rome

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Summary

- The SecuFood project
- Overview on food defence
- Adopted Methodology
- Incident analysis
- Risk perception
- ORM analysis of the food supply chain
- Conclusions
**Aim of the project:**
to perform an overview of strategies adopted in EU to prevent terrorist attack against supply food chain

**Project launch:** April 7, 2009

**Duration:** 12 months

**Project website:**
http://secufood.unicampus.it

With the support of the Prevention, Preparedness and Consequence Management of Terrorism and other Security-related Risks Programme
European Commission - Directorate-General Justice, Freedom and Security
Food Safety and Food Security

**Food safety** refers to the extent to which food is safe to eat. It is related to the handling, preparation, and storage of food in ways to prevent illness, injury or death in the consumer.

**Food security** is generally referred to the availability of food and one's access to it.

**Food defence** is “the security of food and drink and their supply chains from all forms of malicious attack including ideologically motive attack leading to contamination or supply failure” [UK CPNI and British Standard Institute (BSI)]
Food Terrorism

“An act or threat of deliberate contamination of food for human consumption with chemical, biological or radionuclear agents for the purpose of causing injury or death to civilian populations and/or disrupting social, economic or political stability” (WHO 2002)

- Who could attack?
  “Food terrorism threats are categorized as internal and external, and attackers are grouped into five categories: criminals, protesters, terrorists, subversives and rogue or disgruntled insiders”

Food Terrorism (2)

- Why the attack?
  - To generate disease and death
  - To induce fear and anxiety

Indeed, also “symbolic” attacks are able to create
- Public health impact
- Economic losses or trade disruption
- Social and economic damages
Food safety vs Food Defence

**Motivation**
Fraud (e.g. illicit profit selling poor quality food) vs other reasons (terror, blackmail, etc.)

**Actor**
Performed by the food operator vs performed against food operators
SecuFood scope

Analyze, w.r.t. the food supply chain the:
- Possible threats
- Existing countermeasures
  - Technological
  - Operational
  - Legal framework
To indentify
- Best practice
And to perform
- Gap analysis
… to this end

- Survey of different legislations
- Study of the past incidents
- Analysis of the percept threats
- Estimation of the possible impact for the different threats
  - Decomposition of the food supply chain in its macro-steps
  - Identification of the threats
  - Estimation of possible impact (taking into account effectiveness of counter-measures)
The analysis has been focalized on 8 different types of food (milk, yogurt, fish, prepared salads, fruit juice, backed product, olive oil and baby food) selected to be a small set of largely adopted food and representative of different categories (fresh or prepared, animal or vegetal origin, liquid or solid, short and long duration).

<table>
<thead>
<tr>
<th>Category</th>
<th>Duration</th>
<th>Fresh</th>
<th>Half-Elaborated</th>
<th>Elaborated</th>
<th>Basic foodstuff</th>
<th>Other foodstuff</th>
<th>Products of animal origin</th>
<th>Products of vegetable origin</th>
<th>Liquid</th>
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</table>
SecuFood Scope (3)

It considered mainly five countries:

- Italy
- Spain
- United Kingdom
- Romania
- Denmark

Selected to be representative of Europe in terms of Mediterranean and continental countries, “new” and “old” EU countries, and with different food regimes
Survey of legislation framework

- All the analyzed countries have specific legislation and agencies devoted to Food Safety.
- All the EU countries are involved in early warning alert networks for food contamination.
- Italy (and partially Spain) has a specialized police corps to contrast Food adulteration
- Except partially for UK, there is no specific legislation about Food Defence
- There are several mandatory constraints on food operators to improve and guarantee Food Safety (e.g. HACCP), but no specific requirement about food defence
Incident analysis

Actually there are no evidence of terrorist attack against food supply chain (the only episode reported in literature is those appended in 1989 in Israel with contamination of grapefruits)

Even if, in the last years there were several “suspected” episodes many of them recognized as an attack against food supply chain (we collected data about 450 episodes from 1950 to 2008)
Incidents Analysis
Geographical occurrence
Incidents in the world

Source: Food Defence Incidents 1950-2008, G. R. Dalziel
Incidents Analysis
Geographical occurrence (2)

Incidents in Europe

- UK: 54%
- Other EU: 29%
- Italy: 11%
- Denmark: 1%
- Romania: 2%
- Spain: 3%
Time occurrence

Victims per year
Time occurrence

Incidents per year

![Graph showing time occurrence and incidents per year](image)

- X-axis: Year (1940 to 2020)
- Y-axis: Incidents per year (0 to 25)

The graph indicates a trend of increasing incidents per year over time, with peaks in the 1980s and 2000s.
Contamination type occurrence

Incidents per type of agent

- Unknown: 3
- Radiological: 7
- Biological: 10
- Physical contaminant: 8
- Chemical: 335
Supply chain level occurrence

- Large Retail and Food Services as weak point

Incidents in food supply chain (% of cases)
Risk perceived

- How is relevant for food operator and public authorities the terrorist/criminal threats?

To answer to this question we supply a specific questionnaires to about 40 food operators and 10 public authorities involved in food safety and performed 15 interviews.
Food operators consider very relevant the risk related to deliberate manipulation of food (while public authorities are more focalized on food safety issue)
While public authorities consider separately the risk related to criminals w.r.t. terrorist (largely due to the presence of separate competence and structures), food operator adopt assume that food defense strategies should have an “all hazard” approach.
Vulnerability – public authorities

Strong attention on IMPORTATION and primary production
Vulnerability – food operator

The large risk are assumed in the phase not directly controlled (i.e. Wholesale distribution and retailer)
Most relevant risk/issue

The management of ‘Hazardous agents’ is a critical point

“Controls” is the most important issue for public authorities
Public authorities pose great attention on traceability
Supply Chain workflow
1. Primary Production (these operations take place in the farm)
   - Premises preparation (preparing the soil for cultivations, cleaning building for animals, etc)
   - Application of inputs (fertilisers, animal feed, water, etc)
   - Establishment and production (feed animals, growing animals or plants)
   - Row material intake in primary production
   - Chemical treatment (pesticides, veterinary treatments)
   - Gathering and accumulation (milking, mechanical harvesting, catching fish, etc.)
   - Slaughter
   - Waste disposal (animal and vegetal wasted)

2. Storing and transporting raw commodities
   - Packing
   - Transfer products from farm
   - Storage materials
3. Processing and manufacturing raw commodities

- Trimming and cutting
- Washing-decontamination
- Row material intake
- Sorting and grading (selection on the bases of shape or size, etc)
- Cooling, chilling or freezing (cooling vegetables, chilling milk, icing fish)
- Physicochemical process (separation of milk fat, filtering of soft drinks etc.)
- Drying/conditioning
- Milling/crushing/extraction (Pressing of seed for oil, milling of cereals for flour extraction)
- Sprouting (germination of barley for malt, etc)
- Chemical treatment (salting fish, enzyme treatments, addition of additives, etc)
- Microbiological process (fermentation dairy products)
- Heat treatment (pasteurisation of milk, roasting coffee, cooking mass of bread, etc)
- Mixing and homogenising (mixing meat, homogenization of milk)
- Forming-assembly (rolling of cereal products, extrusion of snack products)
- Packing
- Wasted disposal
4. Storing and transporting processed and manufactured goods
   - Packing
   - Transfer products from food industry
   - Storage of manufactured products

5. Distributing goods to Wholesale and retail establishments
   - Display
   - Dispensing, serving
   - Storage in the sale point
   - Packing
Milk

- Milk collection
  - Selected Livestock
  - Automatic milking
  - Cold tank
  - Laboratory tanks

Raw milk
- Reception / download
- Sanitation skimming
- Sanitized milk storage
- Standardization of fat
- Adding ingredients
  - Storage standard milk
    - Thermal process
      - Homogenization
        - Aseptic packaging and encoding
          - Packaging
            - Storage / forwarding

Ingredients
- Reception and storage
  - Cream
    - Auxiliary materials (packing)
      - Reception / storage

- A glass of milk and a cow illustration
Yogurt
<table>
<thead>
<tr>
<th>Biological</th>
<th>Chemical</th>
<th>Bio-Chemical</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacillus anthracis</td>
<td>ammonia</td>
<td>Abrin</td>
<td>Bone fragment</td>
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<tr>
<td>Brucella spp.</td>
<td>Arsenic</td>
<td>Aconitine</td>
<td>Fizz bone</td>
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<tr>
<td>Burkholderia mallei (Glanders)</td>
<td>Arsine</td>
<td>Affidoxins</td>
<td>Glass</td>
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<tr>
<td>Burkholderia pseudomallei (Melicodiosis)</td>
<td>Benzene Ethylene glycol</td>
<td>Amantina</td>
<td>Plastic</td>
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<tr>
<td>Campylobacter jejuni</td>
<td>Cadmium</td>
<td>Clostridium botulinum toxins/organism</td>
<td>Small stones</td>
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<td>Coccioides Immitis</td>
<td>Cannabinoids</td>
<td>Ricin</td>
<td>Splinter</td>
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<td>Coxiella burnetti</td>
<td>Clostridium perfringens epsilon toxin</td>
<td>Sextoxin</td>
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<tr>
<td>Escherichia coli</td>
<td>Cyanide spp.</td>
<td>Staphylococcus aureus enterotoxin B</td>
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<td>Francisella tularensis</td>
<td>Chlorine</td>
<td>Tetrodotoxin</td>
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<td>Listeria monocytogenes</td>
<td>Chromium</td>
<td>Trichothecene mycotoxins</td>
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<td>Salmonella enteritidis</td>
<td>Diphenylycyanarsine</td>
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<td>Salmonella Typhi (Typhoid fever)</td>
<td>Diphenylychloroarsine</td>
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<td>Shigella spp.</td>
<td>Diphosgene Lewisite</td>
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<td>Vibrio cholera (Cholera)</td>
<td>Ethyldichloroarsine</td>
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<td>Vibrio vulnificus</td>
<td>Fenitrothion and other opioids</td>
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<td>Yersinia enterocolitica</td>
<td>LSD</td>
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<tr>
<td>Yersinia pestis</td>
<td>Methyldichloroarsine</td>
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<td>mustard spp.</td>
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<td>phenodichloroarsine</td>
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<td>Quinuclidinyl Benzilate</td>
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<td>Sarin spp.</td>
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<td>Zinc oxide</td>
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Risk assessment

On the base of the food supply chain workflow and considering the identified contaminating agents we developed an ORM approach to identify the most dangerous threats.
### ORM Matrix

#### Risk Assessment Matrix

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Insignificant</th>
<th>Minor</th>
<th>Moderate</th>
<th>Major</th>
<th>Catastrophic</th>
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<td>Almost Certain</td>
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</table>
Likelihood

- **Access probability:** is the probability that the terrorist could access to the substance, power, etc, that provoke damage. (The easier the access, the probability of using it for an attack is higher).

- **Vulnerability:** is the probability that the infrastructure is susceptible to attack.

Likelihood = \( P(\text{Access}) \times \text{Vulnerability} \)
## Likelihood Analysis

<table>
<thead>
<tr>
<th>Vulnerability</th>
<th>Rare</th>
<th>Unlikely</th>
<th>Possible</th>
<th>Likely</th>
<th>Almost Certain</th>
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<tr>
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<td>Possible</td>
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<td><strong>P</strong></td>
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<tr>
<td>Unlikely</td>
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<td><strong>U</strong></td>
<td><strong>P</strong></td>
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<tr>
<td>Rare</td>
<td><strong>R</strong></td>
<td><strong>R</strong></td>
<td><strong>U</strong></td>
<td><strong>U</strong></td>
<td><strong>P</strong></td>
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</tbody>
</table>

- **R**: Rare
- **U**: Unlikely
- **P**: Possible
- **L**: Likely
- **AC**: Almost Certain
Consequences

- **Effects**: the side effects that the attack can cause. This case study is going to measure both the physical and psychological consequences.

- **Persons affected**: number of people affected physically or psychologically or both at the same time.

Consequences = Effects x Persons Affected
**ORM Matrix**

**Risk Assessment Matrix**

<table>
<thead>
<tr>
<th></th>
<th>Insignificant</th>
<th>Minor</th>
<th>Moderate</th>
<th>Major</th>
<th>Catastrophic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Almost Certain</strong></td>
<td>M</td>
<td>H</td>
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<td><strong>Likely</strong></td>
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<tr>
<td><strong>Possible</strong></td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>H</td>
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<tr>
<td><strong>Unlikely</strong></td>
<td>T</td>
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<td>L</td>
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<tr>
<td><strong>Rare</strong></td>
<td>T</td>
<td>T</td>
<td>L</td>
<td>L</td>
<td>M</td>
</tr>
</tbody>
</table>

**Catastrophic:** 10% population death, system loss  
**Major:** death, severe injury, severe system damage  
**Moderate:** system damage, require medical attention  
**Minor:** minor system damage, no relevant illness  
**Insignificant:** possible minor injury
## Likelihood Analysis - Yoghurt production phase

<table>
<thead>
<tr>
<th>Probability</th>
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<th>Unlikely</th>
<th>Possible</th>
<th>Likely</th>
<th>Almost Certain</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
</tr>
<tr>
<td>Likely</td>
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<td>Thallium</td>
<td>Saxitoxin</td>
<td>Aflatoxin</td>
<td>Abrin</td>
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<td>Fentanyl</td>
<td>Cadmium</td>
<td>Mercury</td>
<td></td>
<td>Ricin</td>
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<tr>
<td>Possible</td>
<td>Nitrogen Mustard</td>
<td>Diphosgene</td>
<td>Safrol</td>
<td>Chromium VI</td>
<td>Phosphorus</td>
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<tr>
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<td>Lewisite</td>
<td>Zinc</td>
<td>Titanium</td>
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<td>Arsenic</td>
</tr>
<tr>
<td>Unlikely</td>
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<td></td>
<td>Tetrahydrocannabinoids</td>
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<td></td>
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<td>Nicotine</td>
</tr>
<tr>
<td>Rare</td>
<td>Coxiella Burnetii</td>
<td>Francisella</td>
<td>Tularensis</td>
<td>Bacillus Anthracis</td>
<td>Listeria</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Monocytogenes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E-Coli</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Salmonella</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Brucella</td>
</tr>
</tbody>
</table>
# Risk Assessment Matrix - Yoghurt Production phase

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Insignificant</th>
<th>Minor</th>
<th>Moderate</th>
<th>Major</th>
<th>Catastrophic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost Certain</td>
<td></td>
<td></td>
<td></td>
<td>Ricin</td>
<td>Abrin</td>
</tr>
<tr>
<td>Likely</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Possible</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unlikely</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rare</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Consequences**

- **Insignificant**
  - Titanium
  - Safrol
  - Tetrahydrocannabinoids
  - Nitrogen mustard
  - Diphosgene
  - Lewisite
- **Minor**
  - Aflatoxin
  - Cadmium
  - Thallium
  - E-Coli
  - Brucella
- **Moderate**
  - Ricin
  - Abrin
  - Arsenic
  - Mercury
  - Chromium VI
  - Saxitoxin
  - Nicotine
  - Phosphorus
- **Major**
  - Salmonella
  - Bacillus Anthracis
  - Listeria Monocytogenes
- **Catastrophic**
  - Coxiella Burnetii
  - Francisella Tularensis

**Legend**

- Extreme
- High
- Medium
- Low
- Tolerable
To produce a huge impact the most effective phase is immediately after the processing phase.

More the attacks is close to the consumer, less are the controls and hence it is high the probability of success.
Conclusions (1/3)

Many food operators think that their process is secure and their controls are adequate.

However, once asked where their productive process could be attacked by an enemy, they often say that it could be anywhere.

That means that they admit that there are vulnerabilities in their process.

Moreover, many food supply chain stakeholders are more aware about the “negative publicity” caused by the idea that their food can be malicious manipulated, rather than on effective possible attacks.
Conclusions (2/3)

- Currently the countermeasures for the *food safety* developed by the EC and by each MS provide a valid food defence for some of the supply chain.

There is the need to strengthen the weak ring of the chain in order to improve the security of the whole supply chain.
Conclusions (3/3)

However, they appear not satisfactory for that which concern manipulation of food:

- At consumer/retailers level
- In case of chemical agents

It is mandatory to create an adequate awareness

An other important source of risk is due to the illegal 
food import, that eluding food import safety controls make easier the spreading of pathogen agents
For more information about the project

http://secufood.unicampus.it

Final conference on Roma on 27 April 2010
Thank you for your attention!

r.setola@unicampus.it