Cheese and Fromage; Common Cultures

Health Benefits of Cheese; what’s new in Cheese (Raw milk cheese track)

Montreal 2011
Thursday, August 4
France: a thousand cheeses

How do we cope with attacks on (1000) cheeses? Build on data and assets
Raw milk cheeses production in France

<table>
<thead>
<tr>
<th>Production</th>
<th>2009 (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow’s raw milk Soft cheeses</td>
<td>22 220</td>
</tr>
<tr>
<td>Cow’s raw milk Hard cheeses</td>
<td>77 684</td>
</tr>
<tr>
<td>Cow’s raw milk Semi hard cheeses</td>
<td>43 547</td>
</tr>
<tr>
<td>Cow’s raw milk Blue cheeses</td>
<td>1 069</td>
</tr>
<tr>
<td>Goats raw milk cheeses</td>
<td>7 408</td>
</tr>
<tr>
<td>Ewe’s milk cheeses</td>
<td>21 358</td>
</tr>
<tr>
<td>Others</td>
<td>187</td>
</tr>
<tr>
<td>Total</td>
<td>173 473</td>
</tr>
</tbody>
</table>

78% of raw milk cheeses are AOC/IGP
AOC are 10% of cheese produced in France and amount for 17% of value
Cheeses and raw milk cheeses; main issues

1. Food safety
2. Health and nutrition
1. Food Safety of raw milk cheese

⇒ The major foodborne diseases (USA- CDC 2011 estimates)

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Illnesses</th>
<th>USA</th>
<th>Hospit.</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacter</td>
<td>845,000</td>
<td>8463</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Salmonella</td>
<td>1,027,000</td>
<td>19336</td>
<td>378</td>
<td></td>
</tr>
<tr>
<td>STEC E coli</td>
<td></td>
<td>2138</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Listeria</td>
<td>2,500</td>
<td></td>
<td>255</td>
<td></td>
</tr>
<tr>
<td>Staphylococcus</td>
<td>241,000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

⇒ Focus on Listeria monocytogenes, the main “bug” when raw milk products’ consumption is evoked

“...milk and products made from milk (including certain cheeses, ice cream, and yogurt) are foods that, when consumed raw, can pose severe health risks” (CDC 2011)
1. Food Safety of raw milk cheese

The major collective cases of foodborne diseases (INVS, France 2010)

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Illnesses</th>
<th>Hospit.</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacter (all)</td>
<td>118 (15000)</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>Salmonella (all)</td>
<td>1254 (17000)</td>
<td>186</td>
<td>1</td>
</tr>
<tr>
<td>STEC E coli</td>
<td>130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Listeria monocytogenes (all)</td>
<td>(312)</td>
<td></td>
<td>(63)</td>
</tr>
<tr>
<td>Staphylococcus</td>
<td>1723</td>
<td>208</td>
<td>3</td>
</tr>
</tbody>
</table>

50 out of 1255 collective cases are linked to milk and milk products (less than 4%) → not that important

Less foodborne diseases in France proportionally to USA, even though less pasteurized products
1. Food Safety of raw milk cheese

- **Facts on Listeriosis**
  - Most of the reports regarding the epidemiology of listeriosis in Europe in the past 15 years have shown that listeriosis had the same prevalence in those countries where raw milk product consumption was forbidden (such as Norway) and those countries where it was not (such as France)\(^1\), \(^2\)
  - Highest contamination rates with *Listeria monocytogenes* are currently from fish and seafood, and especially ready-to-eat smoked salmon preserved or hot-treated meat products, and ready-to-eat salads with meat or seafood ingredients\(^3\), \(^4\)
  - Secondary contamination of pasteurised milk products is at the origin of the majority of listeriosis cases when milk products are the suspected food, and pasteurised milk products may contain significant amounts of *Listeria*.

Raw milk Cheese is self-protected against major pathogens and is less exposed to re-contamination by major pathogens. The studies referenced hereunder started with the observation that some types of raw milks and some type of cheese technologies resisted L. monocytogenes contamination better than others.

- **Strong inhibition of Hafnia alvei on Escherichia coli O26: H11 in presence of model cheese microbial consortium**

- **Strong inhibition of Listeria monocytogenes**
  The inhibition is due to a complex antilisterial consortium of lactic acid bacteria, gram positive catalase positive bacteria, gram negative bacteria and yeasts. The growth of L.m. is highest in cheese prepared with pasteurized milk and Streptococcus thermophilus.

- **Inhibition of enterotoxicogenesis (Staphylococcus aureus)**

1. Postollec F. et al. IAFP European Symposium, Ede (nl), 18-20 May 2011
1. Food Safety of raw milk cheese

How can such a high standard of food safety in raw milk cheese production be achieved?

1. Good practices and good control
2. QMRA: Quantitative risk assessment: enables to substantiate that there are other ways to achieve food safety than pasteurization
Good Practices and good Control
1 example of Management of raw milk cheeses production

Charter of good practices
- Producers
  - Herd qualification/Producers selection
  - Milk Collection
  - Milk analysis/cheese making vat
  - Moulding
  - Cheese analysis before leaving plant
  - Studies on Aging (AFNOR norm)

HACCP in plant
- Data analysis (milk payment 2x/month) + pathogens (2x/month)
  - 1 sample/day/producer
  - Milk truck: Detection of S.aureus, E.coli, L.m, salmonelles (2-4x/month)
    - If positive: analysis of all producers
    - If producer is positive → rejection (accepted only when 3 analysis are OK + audit of dairy technician)

  - Cheese making vat: Detection of S.aureus, E.coli, L.m, salmonella (if mixture of many milk collections)
    - J+24h: S.Aureus (enterotoxines); E.coli S.aureus, E.coli; Lm; salmonella
QMRA: Quantitative Microbial Risk Assessment

From the Farm to the Fork

Contaminated raw materiel

Secondary contaminations (environnement, people, etc)

FARM MANAGEMENT
Statistical procedures for microbiological data analysis

CHEESE PROCESS MANAGEMENT (AQR)
QMRA models using predictive microbiology and cheese process parameters (pH, T°, aw, etc)
Bulk tank milk for one batch of cheese

Cheese process

Acidification, Salting, Ripening

Packaging, Transport

Retail

Conservation and consumption at consumer’s home

1. Raw milk Contamination scenarios

2. Process parameters at each step (pH, T°, aw, lactates... and variability

3. Microbiological data of products from farm to fork

4. Predictive microbiological models (growth, destruction, survival)
Simulating growth in dynamic conditions

\[ (X_{T1}, L_{T1}) \]

\[ \frac{T'}{L_{T1}} \times \varepsilon_{T1} - \int_{T_{T1}}^{T'} \varepsilon(t) dt = 0 \]

\[ \varepsilon_{T1} = \varepsilon_{opt} \cdot f(T^o(t), pH(t), aw(t)) \]

\[ X_{T2} = \int_{T'}^{T_{T2}} \varepsilon(t) X(t) \left(1 - \frac{X(t)}{X_{max}}\right) dt \]

\[ L_{T2} = \frac{L_{T1} \times \varepsilon_{T1} \int_{T_{T1}}^{T_{T2}} \varepsilon(t) dt}{\varepsilon_{T2}} \]

\[ (X_{T2}, 0) \]

\[ (X_{T1}, 0) \]

\[ (X_{T1}, L_{T2}) \]
QMRA: what for?

- **QMRA modelling approach**
  - Know the (Raw) Cheese better, be able to protect it and protect the consumer
    - Clients
    - Legislation and authorities
    - Objective, transparent, scientific basis
  - Simulate new options and decide, simulate the most cost effective process
    - New product formulation
    - New management options
  - Meet regulatory requirements
  - Communicate
Example of QMRA on Listeria in raw milk Camembert and Brie Cheese

QMRA Study: Risk Assessment of Listeriosis Linked to the Consumption of Two Soft Cheeses Made from Raw Milk: Camembert of Normandy and Brie of Meaux

Main results:
- Measure of progress of Good practices: 2002 versus 1992; Lm concentration in selected raw milk divided by $10^4$
- 88% of servings are Lm free
- Estimated median number of cases of Listeriosis in France due to Camembert raw milk cheese (480 million servings): less than $2.5 \times 10^{-3}$

→ This convinced FDA there was no higher risk of Listeriosis with raw milk camembert cheese than with pasteurized Camembert (as opposed to a previous study of FDA with unappropriate set of data)

1 Sanaa M et al. Risk Analysis, 2004: 24 (2), 389-399
2 Whiting RC. FDA/FSIS. Quantitative assessment of the relative risk to public health from foodborne Listeria monocytogenes among selected categories of ready-to-eat foods. 2003
2. Health and nutrition benefits of cheese

- Raw milk cheeses combine the benefits of:
  - Native milk
    - Nutrient rich
    - Cognitive reservoir
  - Living micro-organisms
  - The interaction of both

- But this is difficult to promote when some dogma and myths have been created.
- According to NIH, SFA’s are empty calories...
2. Health and nutrition benefits of cheese - Dogma

- **Milk and milk products are rich in Saturated fatty acids. Yes so what!**
  - Saturated fatty acids is a chemical classification
  - We do not eat fatty acids but fats or lipids
  - All saturated fatty acids should not be considered as a single group (see P Legrand: complex and important cellular and metabolic functions of saturated fatty acids)\(^1\)
  - The problem lies more in the commodities (palm oil, soy oil, corn oil)
  - The association between saturated fatty acids, serum cholesterol and coronary heart disease has been over emphasized \(^2\)

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1. Legrand et al. Lipids, 2010: 45(10) 941-946
2. Health and nutrition benefits of cheese - Dogma

Omega 3

- Not that much a problem of good PUFA versus bad SFA but problem of imbalance between ω6 versus ω3 caused by commodities like soy, corn. Public health is plagued by this imbalance rather than by SFA.
- Ratio ω6/ω3 should be 5; it’s > 35 with soy oil. Guess where the reference ratio comes from? Milk.
- Which food category provides most of ω3 to the consumer in France (46%): milk and milk products.

- Part of French paradox?
- How much by cheese: 29%
- In a very bio-available form

The improvement of the ω6/ω3 ratio in USA population or elsewhere can be contributed to by dairy products and cheese.

Needs appropriate breeding

1 Combe et al. Oléagineux, Corps gras, Lipides 2001: 8 (2) 118-121
2 Legrand P.et al., 2010. The Consumption of Food Products from Linseed-Fed Animals Maintains Erythrocyte Omega-3 Fatty Acids in Obese Humans. Lipids, 45, 11-19
2. Health and nutrition benefits of cheese – Health benefits of native structures in Raw Milk

- Nutrient Density or richness (Milk and Milk products)
  - Milk is nutrient rich but rather than a sum of nutrients (endless list of bioactive molecules), it is a balance of nutrients designed by nature since more than 100 million years: cognitive reservoir for food and nutrition & health industry. No molecule is simple; proteins are glycosylated, acylated
  - Milk is highly complex; native structures such as fat globules and casein micella; nutri-functional properties aren’t unraveled yet

  « ... milk is present as highly complex globules with structural properties distinct from other biological sources of fats.. »

- Genomic tools to unfold this complexity
  «...The evolutionary success of milk has afforded compelling examples of a food material designed by selective pressure to provide optimal health to healthy mammalian offspring. Milk contains components that are more than assembled essential amino acids and that provide biological activities that improve the competitive success of offspring who consume them.”

1 German B. Science des Aliments 2008: 28 176-186
2 Ward R. & German B. J. Nutr. 2004: 134(4) 962s-967s
2. Health and nutrition benefits of cheese – Health benefits of native structures in Raw Milk

- **Future of cheese making industry as far as health is concerned** is to elaborate mild technologies that respect the wealth of health-protective molecules and native structures that the raw milk contains!!
- **Many of the industrial processing techniques have been destructive**
- **The structure and the dispersion state of milk fat is important for its metabolic fate**¹

2. Health and nutrition benefits of cheese – Health benefits of living micro-organisms

- Extensive scientific references exist on effects of « probiotics »; less is known about the whole set of micro-organisms in raw milk cheese.

- Benefits include:
  - antimutagenic effects,
  - anticarcinogenic properties,
  - improvement in lactose metabolism,
  - reduction in serum cholesterol,
  - and immune system stimulation

- Allergy

- Extremely complex to study

1 Shah NP. International Dairy Journal, 2007 :17(11) 1262-1277
Allergic diseases; a huge health concern

- Allergic diseases: atopic dermatitis, asthma, Inflammatory Bowel Disease, rhinitis

Team of E. von Mutius

- Author of Hygiene hypothesis
- 260 publications in major peer reviewed journals tracking since 20 years the evidence of the effects of early exposure to micro-organisms on reducing allergic reactions
- Conclusion of works; more and more pointing at the fact that the protective factors are in raw milk (and cheeses)
- Recent review article: “Can farm milk prevent allergic disease” ?

Medical guidance strongly discourages consumption of raw milk because of the known health risk associated with pathogenic bacteria present in unpasteurized milk. Despite these risks there is a growing body of epidemiological evidence suggesting that consumption of unprocessed cow's milk does not increase but rather decreases the risk of asthma, hay fever and atopic sensitisation

2. Health and nutrition benefits of cheese – Health benefits of living micro-organisms interacting with nutrients of milk

- In (raw milk) cheese, micro-organisms interact with nutrients and native structures of the raw milk
- New world of molecules, and structures, and living micro-organisms. Dead micro-organisms (cell membranes) can also have health impacts.
- Extremely complex to study
  - Studies
    - on model cheeses
    - On model micro-flora
    - On epithelial cell models
    - On limited functions (inflammatory function)
- Difficulties in interpreting
- Still a long way to go
Take home messages

1 Safety of raw milk cheeses
  ➤ Good practices from stable to table make this production safe;
  ➤ Better « self protection » of raw milk cheese because of rich ecosystem
  ➤ New tools help monitoring (QMRA)
  ➤ Mind STEC

2 Health benefits of raw milk cheeses
  ➤ Global sake issues to cope with dogma
    ➤ Fats in milk: distinct properties
    ➤ Omega 3; dairy products provide most of them, can be improved with new breeding and feeding techniques
    ➤ Raw Milk; nutritional reference
  ➤ Specificities of raw milk cheese
    ➤ Better preservation of native bioactive molecules and structures
    ➤ Higher richness in flora and secondary metabolites; health benefits still difficult to prove scientifically