Food safety issues and scientific advances related to animal-source foods in developing countries

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Food safety issues in developing countries

• Every year, at least 2 billion cases of diarrhea occur and 700,000 children under 5 years old die worldwide

• Animal-source foods provide nutrition, but are one of the main cause of food borne zoonoses (FBZs)

• FBZs include non-diarrheal disease such as tuberculosis and brucellosis
Food-borne zoonotic pathogens
(Common ones)

Diarrheal pathogens

- **Bacteria**
  - *Escherichia coli* (Intestine)
  - *Campylobacter* (Intestine)
  - *Salmonella* (Intestine)

- **Virus**
  - *Rota virus* (Water)

- **Parasites**
  - *Taenia spp.* (Meat)
  - *Giardia lamblia* (Mainly from water)

Non-diarrheal pathogens

- **Bacteria**
  - *Staphylococcus aureus* (Animal, human)
  - *Brucella* (Milk and meat)
  - *Mycobacterium bovis* (Milk, meat, contact)
  - *Bacillus anthracis* (Dead animal, skin)

- **Virus**
  - *Hepatitis virus E* (Meat)

- **Richettsia**
  - *Coxiella burnetii* (Cows, Q fever)

- **Cysticercosis**
  - (Pork-human feces)
Informal ≠ Illegal
Informal market

“Absence of structured sanitary inspection”
Informally-marketed foods dominate in developing countries

Targets of international cooperation so far
Training of public officers, infrastructure of public services

How much effective??
Value chain

A producer ↔ A consumer
Value chain

Producers  Middle men  Consumers
Value chain

Producers ➔ Middle men ➔ Consumers

Sanitation

Sanitation
Safe food, fair food (BMZ, ILRI)

Building capacity to improve the safety of animal-source foods and ensure continued market access for poor farmers in Sub-Saharan Africa
Risk is a probability of occurrence of a scenario and its size of impact (Vose, 2008)
Food safety risk analysis
in informal marketing system

Participatory methods

Risk Assessment
Risk Management
Risk Communication
What are participatory methods?

- Participants discuss problems
- Several formats:
  - Rapid rural appraisal
  - Participatory rural appraisal
  - Key-informants interview
 Codex Alimentarius Commission
Risk assessment framework \((\text{CAC/GL-30 (1999)})\)

- Hazard identification
- Hazard characterization
- Exposure assessment
- Risk characterization
Fault tree analysis in food safety

• How the illness can occur

Onset of illness  \(\rightarrow\) Infection  \(\rightarrow\) Ingestion  \(\rightarrow\) Purchase

Or

Preceded by

Direction of identification and diagraming
**Fault tree: understanding the logic of illness**

- **Initiating event**
  - Milk contains SA at production
  - Milk shed by SA Mastitis cow
  - Infected cow
  - Milk contaminated by a farmer
  - Human source
  - Milk contaminated with SA by traders/handlers

- **Illness due to Staphylococcal poisoning due to milk consumption**
  - A consumer is susceptible to SAET
  - SA multiply to reach enough cfu producing ET
  - Milk contains SA

**AND**

**OR**
Dairy value chain - RRA and interviews

Exposure assessment

Liquid raw milk sold to urban consumers

Dairy production in and around DZ by Ada Dairy Cooperatives farms

19258

Urban dairy production

2940

Restaurants Cafeterias

1960

Farm gate sales

1960

Home consumption

12398

Collection centers

4553

Peri-urban dairy production

Traditional processing sold to urban

Home consumption

75

Restaurants Cafeterias

400

Consumers

Ada milk processing plant

50

Cafeterias before processing

Processed milk

Addis Ababa

Other processing plant in Addis Ababa

Addis Ababa
Contamination rate - a survey

<table>
<thead>
<tr>
<th></th>
<th>Isolation of $S$ aureus</th>
<th>Boiling before sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk collection centre (n=25)</td>
<td>18 (70.4%)</td>
<td>0</td>
</tr>
<tr>
<td>Dairy farm (n=170)</td>
<td>74 (43.6%)</td>
<td>0</td>
</tr>
</tbody>
</table>

Risk mitigation by consumers - participatory and interviews

<table>
<thead>
<tr>
<th></th>
<th>Boil milk before consumption</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy farming households (n=170)</td>
<td>116</td>
<td>68.2</td>
</tr>
<tr>
<td>Consumers (n=25)</td>
<td>16</td>
<td>64.0</td>
</tr>
</tbody>
</table>
Hazard characterization

**Growth model:**

Fujikawa and Morozumi (2006) modified logistic model

Log of cfu/ml of *Staphylococcus aureus* in milk

- **Lag phase**
- **Exponential growth phase**
- **Stationary phase**
Hazard characterization

Risk mitigation by traditional milk fermentation - Modeling using reported data (Gonfa et al., 1999)

Bacteria growth stops at pH 4.9

\[
\frac{1}{\text{pH}} = 0.002 \times t \text{ (h)} + 1.187 \quad (\text{df}=3, \ r^2=0.90, \ p=0.009)
\]

Source: Makita et al., 2012 Int. J. Food Microbiol.
Hazard characterization

Stop of growth of *S. aureus* in milk by low pH

Log of cfu/ml of *S. aureus* at room temperature

Stop of bacterial growth due to milk fermentation
Risk characterization

- Each of them are uncertainty distributions
- The variety of uncertainty distributions shows variability
- Variability in this case is the growth speed of *S. aureus*
Risk characterization

- Training for hygienic milking
- Separation of cows with mastitis
- Temperature control

Sensitivity analysis

- Prob. SA has SE genes
- Prob. farmers boil
- Prob. consumers boil
- Store milk 3,4 days
- Contamination, farm
- Contamination, farm
- Consume on day 0
- Prob. centres boil
- Contamination, centre
- Store milk 1,2 days

Sensitivity Tornado

*It provides efficient control options

Mean of Incidence rate

-0.5 0 0.5 1 1.5 2 2.5
Advantage of participatory risk assessment identified

- Speed
- Affordability
- Flexibility in application
- Understanding of culture
- Best control option
- Potential to change behavior
Project partners conduct training of pig meat inspectors for safer harvesting in pig value chains in Uganda

Posted on 30 April 2014 by KRISTINA RÖSEL

The Safe Food, Fair Food (SFFF) project is promoting food safety in informal markets through the application of risk-based approaches. In Uganda, the project is aligned with work on developing smallholder pig value chains (SPVCD). Assessments conducted in 2012-13 by the International Research Institute (ILRI) and partners showed...
• More emphasis on risk management
• Egypt (fish), Uganda (pork), Tanzania (milk), Senegal, Ethiopia (small ruminants)
• Expanding in coordination with other projects...
Risk-based approach started in Asia - ACIAR (Australia)/ILRI project in Vietnam (2013-)

PROJECT UPDATES <aciar.gov.au>

PigRISK: empirical surveys in Hung Yen and Nghe An

Collecting data of possible actors in pig-pork value chains through production to distribution and consumption in study sites
PigRisk project in Vietnam

• Pork – most consumed animal source-food in Vietnam

• Salmonellosis, *Streprococcus suis*, and chemical hazards

• Integration of food safety risk assessment and value chain economic assessment (incentive research)

• Veterinary, public health, and economist teams- One Health
Case study

TASKFORCE OF RISK ASSESSMENT FOR FOOD SAFETY IN VIETNAM: LINKING SCIENCE TO POLICY TO INCREASE FOOD SAFETY
Food safety risk assessment training in Vietnam

Broad casted by ‘Voice of Vietnam’ on 2013 September 7

Dao tao danh gia nguy co an toan thuc pham tai cac chuyen

VOV.VN - Cac hoc vien tham gia khoa hoc nay duoc gioi thieu tong quan ve cac benh lien quan den thuc pham.

Lan dau tien mot khoa dao tao danh gia nguy co an toan thuc pham tai cac chuyen doc to chuc cho cac chuyen gia y te cong cong va thuy Viet Nam.

Khoa hoc dien ra tu 28/6 den 7/9 do Trung tam Nghieng cuu Y te Cong cong va he sinh thai (Truong Dai hoc Y te Cong cong Ha Noi) phoi hop voi Vien Chan nuoi Quoc te va Dai hoc Rakono Gakuen (Nhat Ban) to chuc tai Ha Noi.

Ban bat phu quan 5.000 dong va Sam Son bi phat 12.5 trieu dong

Cac hoc vien tham gia lop hoc (anh: Van Hai)

Cua so tinh yeu

Hoc cach hoa thuan voi me chong

Nguai 'tram cho' cho tinh yeu
Take home messages

• Food safety is a big issue in developing countries
• Targeting informal markets can make huge impacts on food safety and poverty alleviation
• Participatory risk analysis is useful and effective
• Integration of incentive-based economic study can show sustainable control options for food safety