Update on raw milk consumption and public health

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Rounds objectives

• Be able to situate the recent scientific literature on raw milk consumption and public health within the Ontario contexts (e.g., historical, regulatory, institutional).

• Become familiar with the methods and key findings of a review of recent evidence related to:
  o Contamination of raw milk,
  o Human illness following raw milk consumption, and
  o Selected possible benefits of raw milk consumption and/or harms of milk pasteurization.

• Consider the limitations of this literature review, as well as possible public health implications in Ontario.
Outline

• Introduction, report objectives, methods
• Background information
• Key findings
• Limitations and conclusions
• Discussion
INTRODUCTION, REPORT OBJECTIVES, METHODS
PHO Technical Report

• PHO Technical Report is now online
• Resource for Ontario public health professionals
• Developed by a group of PHO staff and experts, with input from OMAF experts
• Ontario Ministry of Agriculture and Food (OMAF), Ontario Ministry of Health and Long-Term Care (MOHLTC) and all 36 health units were invited to comment on the draft report
1. Provide background information relevant to the context of raw milk consumption and public health practice in Ontario.

2. Provide a review of the recent scientific literature to address questions related to:
   - Contamination of raw milk
   - Consumption of raw milk and human illness
   - Selected possible benefits of raw milk consumption and/or harms of milk pasteurization
   - Portable testing methods to identify raw milk
Scientific review methods

• Based on reviews published in the peer-reviewed and grey literature
  o Supplemented by a scan of recently published primary peer-reviewed and grey literature, as well as unpublished Ontario data from OMAF and iPHIS

• PHO staff, including experts in infectious diseases and environmental health, prepared a narrative summary of key findings for literature addressing each question
General search strategy

• Databases: BIOSIS Previews, Embase, Ovid MEDLINE

• Key words (including but not limited to):
  o raw* or unpasteur* or untreat* or pasteur* AND
  o milk or dairy products AND
  o pathogen or outbreak* or disease outbreaks or enteric or foodborne or transmission or “public health”

• Titles and abstracts screened, full-text articles of abstracts that met inclusion criteria reviewed and coded, key findings and study designs/limitations summarized.
## General search strategy inclusion criteria

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria for inclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language</td>
<td>English</td>
</tr>
<tr>
<td>Publication date</td>
<td>Articles published in the past five years (i.e., 2008 to July/August 2012) were included. Exceptionally, articles pre-dating this period were included.</td>
</tr>
<tr>
<td>Publication type</td>
<td>Peer-reviewed journal articles for which the full text was available to PHO and/or formal grey literature reviews by an academic institution.</td>
</tr>
<tr>
<td>Jurisdiction</td>
<td>Similar to Ontario.</td>
</tr>
<tr>
<td>Exposure</td>
<td>Raw (fluid) milk from cows, goats or sheep</td>
</tr>
<tr>
<td>Effect/Outcome</td>
<td>The effect/outcome described directly addressed the research question(s).</td>
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BACKGROUND INFORMATION
Potential pathways of raw milk contamination

- Multiple pathogens isolated from raw milk in the past
- Reservoirs include cows, goats, sheep
- 3 main sources of pre-processing contamination:
  - Inside the udder (e.g., mastitis)
  - Outside of the udder (e.g., soiling with animal feces)
  - On-farm milking equipment (e.g., inadequate cleaning)
Potential for chemical contamination of milk

• Antibiotic and other veterinary drug residues can enter milk through their use on dairy cattle.

• Other chemicals may enter milk through agricultural practices or industrial pollution.

• No major chemical contamination incidents involving the dairy milk supply have been reported in Ontario, but have occurred elsewhere.
Historical burden of disease linked to raw milk consumption in Ontario

Before widespread pasteurization:

- 1908: Toronto’s MOH attributed $\geq 25\%$ of TB in children to consumption of raw milk
- 1912-1939: milk consumption linked to multiple infectious disease epidemics each year
Expert advice and advocacy

• Health Canada and the U.S. Centers for Disease Control and Prevention (CDC) advise against consuming raw milk, citing infectious disease risks

• Some advocates view raw milk consumption as a source of health benefits, including the prevention or treatment of a range of diseases and conditions
Raw milk consumption in Ontario

• Data on the prevalence of raw milk consumption in the Ontario population is not routinely collected.
  o PHO estimated Jan.- Aug. 2011 prevalence of self-reported consumption of raw milk in Ontario was 1.84% (95% CI: 0.75 to 3.74%).
  o In a recent survey of >2,000 Canadian dairy farmers, 88.7% reported that they/their families consumed raw milk.
  o A recent Waterloo Region survey found that rural residents were more likely to report consuming raw milk.
Regulatory context: HPPA

**HPPA Section 18: Unpasteurized or unsterilized milk**

(1) No person shall sell, offer for sale, deliver or distribute milk or cream that has not been pasteurized or sterilized in a plant that is licensed under the *Milk Act* or in a plant outside Ontario that meets the standards for plants licensed under the *Milk Act*. R.S.O. 1990, c. H.7, s. 18 (1).

**HPPA Section 13: Order by M.O.H. or public health inspector re health hazard**

13. (1) A medical officer of health or a public health inspector, in the circumstances mentioned in subsection (2), by a written order may require a person to take or to refrain from taking any action that is specified in the order in respect of a health hazard. R.S.O. 1990, c. H.7, s. 13 (1).
Routine regulatory testing of unpasteurized milk in Ontario

- Regulation 761 of the *Milk Act* provides OMAF the authority for the collection, testing and enforcement of standards for cow and goat milk (other milking species such as sheep and water buffalo are not covered by the *Milk Act*).
- In the routine testing required by Reg. 761, samples of unpasteurized milk are collected at every farm pick-up from every licensed cow milk producer (approximately 4100) and registered goat milk producer (approximately 270).
- The samples are then tested at the University of Guelph’s Agriculture and Food Laboratory.
- Routine laboratory tests determine the microbiological quality (individual bacteria count), the herd udder health (somatic cell count) and any abnormalities in the freezing point of the milk. The results of this testing primarily assesses the quality of the unpasteurized milk – its suitability to make high quality pasteurized dairy products.

Routine regulatory testing of unpasteurized milk in Ontario

- High microbiological and somatic cell counts suggest that the best on-farm practices have not been followed.
- Pathogen testing is not routinely performed since unpasteurized milk from these licensed/registered producers must be pasteurized in a licensed plant.
- Samples from the regulated milk supply also undergo routine food safety testing for a wide range of antimicrobial substances (e.g., cleaning and sanitizing chemicals, veterinary drug residues).
- Milk being received at dairy processing plants is also screened for antimicrobial drug residues (a requirement in the Dairy Establishment Inspection Manual - the national dairy inspection standard).
- As part of its overall Food Safety program, OMAF & MRA also conducts periodic testing programs including baseline studies and surveys to determine the prevalence of pathogens, veterinary drug and environmental residues.
KEY FINDINGS: CONTAMINATION OF RAW MILK – RECENT OMAF STUDIES
Growing interest in cheeses made from unpasteurized milk

Safe cheese requires high quality unpasteurized milk with a very low prevalence of pathogens

Are current standards for raw milk quality sufficient to ensure the safety of cheese made from raw milk?

A gradient was observed between quality indicators and pathogen prevalence – the best quality unpasteurized milk had lower pathogen prevalence rates

However, pathogens were still found in milk from the best quality producers

The cheese making process will inhibit/destroy some pathogens
Prevalence of *Coxiella burnetii* in unpasteurized cow & goat milk

- *C. burnetii* causes Q fever in humans
- The Netherlands experienced a major outbreak in 2008/9
- Our study found high prevalence in both unpasteurized cow and goat milk samples
- Genetic typing of *C. burnetii* from both groups indicated that strains are unique to the host animal
- Also, the highly virulent strain causing the outbreak in the Netherlands was not found in any of the Ontario samples.
- Ontario’s pasteurization standards effectively destroy *C. burnetii*
Minor milking species – pathogen prevalence

- Unpasteurized goat milk study
  - done in 2003/4 found prevalence of pathogens similar to other published studies on cow milk

- Unpasteurized sheep study
  - production of sheep milk not regulated under the *Milk Act*
  - participation voluntary
  - results may not truly represent the entire population
  - *Listeria monocytogenes* prevalence similar to studies on cow milk
  - lower prevalence of *C. burnetti* than for cow or goat milk
Residue studies in the milk supply

- **Studies**
  - Environmental residues – metals, aflatoxins, pesticides, dioxins, PCBs
  - Veterinary drug residues – other antimicrobials, anticoccidials, anthelmintics, β-agonists, gestagens, nitrofurans, non-steroidal anti-inflammatory drugs, oxytocin, steroids
  - Good news story - very few issues identified
  - Very low levels of non-compliance even with antimicrobial drugs
Pasteurized fluid dairy products

- Approximately 2 billion servings per year in Ontario
- Large study (1900 samples) conducted 2002-4 indicated that pathogens are not a problem
- No pathogens found in pasteurized fresh product
KEY FINDINGS: CONTAMINATION OF RAW MILK – CONTINUED
Is there any recent evidence that raw milk is contaminated by human pathogens, in Ontario and similar North American jurisdictions?
Key findings

- Several recent Ontario bulk tank studies have identified the presence of multiple human pathogens in raw milk from Ontario cows, goats and sheep (see OMAF slides).
- Numerous recent U.S. bulk tank studies have identified the presence of human pathogens in raw milk. Pathogens have included *L. monocytogenes*, *Salmonella* spp., *C. jejuni*, *Y. enterocolitica* and *E. coli* O157:H7.
Is there any recent evidence that milk contains chemical contaminants, in jurisdictions similar to Ontario?

What chemical contaminants have been found in milk in Ontario and comparable jurisdictions?
Key findings

- Recent Ontario surveys (of pre-processed milk from licensed dairy farms) demonstrated few environmental contaminant residual levels above established limits (see OMAF slide).

- Raw milk from non-registered vendors is not monitored for environmental and other contaminants so similar survey data is not available.

- The literature suggests that pasteurization does not alter the presence of chemical contaminants in milk.
Is there any recent evidence linking consumption of raw milk or raw milk products to human illness, in Ontario and similar jurisdictions?
Key findings

- The recent scientific literature has demonstrated laboratory evidence of indistinguishable pulsed field gel electrophoresis (PFGE) patterns from human and raw milk specimens from product consumed before illness onset.

- Recent epidemiological studies have demonstrated statistically significant associations between consumption of raw milk and subsequent infectious disease occurrence.

- A systematic review concluded that the weight of evidence linking raw milk consumption to human illness is strongest for *E. coli*, *Campylobacter* spp. and *Salmonella* spp.
Key findings

- Surveillance data from the US, Australia and Ontario have linked reportable disease cases and outbreaks to consumption of raw milk or raw milk products prior to illness onset.

- Despite limitations (e.g., under-reporting), surveillance data from Ontario from Jan. 1 2005 to Sept. 30 2012 described 256 confirmed cases of reportable diseases with self-reported exposures to raw milk / products:
  - Campylobacteriosis, cryptosporidiosis, salmonellosis and verotoxin producing E. coli most frequently reported
  - 52% infants and children up to 14 years
  - 63% of cases from 5 health units
FINDINGS: POSSIBLE BENEFITS OF RAW MILK CONSUMPTION / HARMS OF PASTEURIZATION
Is there any evidence that consumption of raw milk offers protection against developing childhood atopy, rhino/conjunctivitis and asthma?
Key findings

- The review suggested a possible association between consumption of raw milk and decreased incidence of childhood atopy, hay fever and asthma. However, this may be due to:
  - potential confounders, or
  - bias related to the design of observational studies
- No mechanisms for the suggested potential protective effect of raw milk consumption were identified.
Is there any evidence linking the process of milk pasteurization to milk allergies?
Key findings

- Heat treatment processes such as pasteurization can alter the structure of certain milk proteins
  - the degree to which this causes clinical milk allergies in people is not clear
  - the mechanism by which heat treatment affects the allergenicity of milk proteins is not fully understood
Key findings

- The findings about the direction of the association between heat treatment and allergenicity of milk were inconsistent.
  - Heat treatment may decrease, rather than increase, the allergenicity of milk.

- The findings did not identify any reported cases of milk allergies attributed to altered milk proteins.
Is there any recent evidence that pasteurization affects vitamins in milk?
Key findings

- A 2011 systematic review and meta-analysis found some evidence that pasteurization:
  - decreased the concentrations of vitamins B12 and E,
  - increased vitamin A and
  - had no statistically significant different on vitamin B6 concentration in milk.

- However, the authors concluded that the effect of pasteurization on milk’s nutritive value was minimal because milk is not considered an important dietary source of these vitamins.
Is there any evidence to support portable methods to test for the presence of raw milk?
Key findings

- As of August, 2012, our review of peer-reviewed literature did not identify any described or evaluated portable tests that could be used to assess the adequacy of milk pasteurization (i.e., to detect the presence of raw milk) in the field without minimal laboratory resources.
LIMITATIONS AND CONCLUSIONS
Key limitations

• Limitations of scope, e.g.:
  o Did not seek to review all historical and international evidence, or evidence on all possible health benefits of consuming raw milk

• Limitations of data type and quality, e.g.:
  o Lack of data from unlicensed dairy producers
  o Lack of data on raw milk consumption in Ontario
  o iPHIS limitations (e.g., under- and incomplete reporting)
Key conclusions

• Multiple reviews and single studies relevant to the current Ontario context demonstrate **raw milk’s potential as a health hazard**, primarily via microbiological contamination.

• Recent evidence affirms the **association between consumption of raw milk and human illness** (e.g., due to *E. coli*, *Campylobacter* spp. and *Salmonella* spp.).

• Some observational studies suggest a **possible association between consumption of raw milk and decreased risk of childhood allergies and asthma**. However, findings may have been influenced by residual confounding and bias, and no mechanisms for a protective effect were identified.
ACKNOWLEDGEMENTS
Thank you:

• OMAF contributors and reviewers
• All OMAF, Ontario MOHLTC and Ontario health unit contributors of comments on the draft report
• PHO contributors and reviewers in Infectious Diseases, Communicable Disease Prevention and Control (including EZVBD and Surveillance Services), Environmental and Occupational Health, PHO Laboratories, Emergency Preparedness, Knowledge Services (including Library Services), Communications
REFERENCES
References

PHO Technical Report


Potential pathways of raw milk contamination


Potential for chemical contamination of milk

References

**Historical burden of disease linked to raw milk consumption in Ontario**


**Expert advice and advocacy**


References

Raw milk consumption in Ontario


Contamination of raw milk – recent OMAF studies


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Contamination of raw milk – recent OMAF studies, continued


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