Fermented Food Safety Guidance for Canadian Public Health Inspectors

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Saskatchewan

Outline:

- Background
- An Overview of Fermentation
- National Fermentation Working Group
  - Who we are?
  - What are we doing?

Background

The group was formed in the fall of 2017 through the National Collaborating Centre for Environmental Health. In 2018, the group moved under the FPT Food Safety Committee.

Fermented foods pose unique food safety challenges. The review of fermented food safety is a shared challenge for many public health practitioners across Canada. While many of these foods are generally safe, unfamiliar ethnic foods and emerging fermentation trends do have risk.

It was agreed upon that guidance for food safety assessment approaches to these foods would benefit public health inspectors, food safety specialists, and the general public.

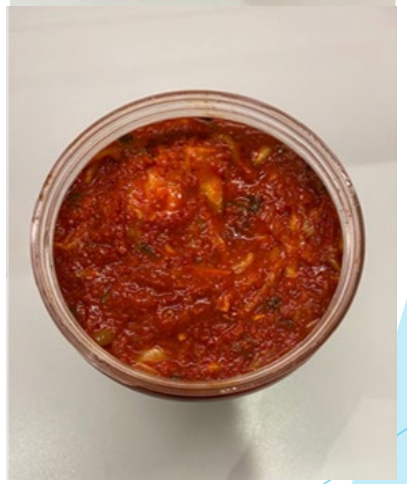
Fermentation

What is Fermentation

- “Ferments are the creative space between fresh and rotten food, where most of human culture’s most prized delicacies and culinary achievements exist”. (Katz. S, The art of fermentation: 2012)
- A metabolic process where microorganisms’ organisms convert carbohydrates, such as starch or sugars, into alcohol acids and other by-products.
- Preserves foods that would otherwise spoil and increases the shelf-life.
- Fermentation can be:
  - Wild fermentation (a natural process where microorganisms can be naturally occurring on the surface of food) or
  - Cultured fermentation (microorganisms deliberately added to the food)

Wild Fermentation

- Naturally occurring fermentations.
- The result of microorganisms already present on the food substrate, or on the equipment and utensils that contact the food substrate.
- Commonly occur with the aid of added salt (e.g. kimchi) or can also occur spontaneously (e.g. Fermented lemons)
- Food safety concern with wild fermentation:
  - There are low number of wild microorganisms present for fermentation
  - Poor conditions for the fermentation, e.g., (temperature is too high or too low, pH is not lowered fast enough to prevent growth of pathogenic organisms)



Fermentations using starter culture

- Desirable microbial agents are added to initiate fermentation.
- Using starter culture can shorten the fermentation time and may lead to reduction in the likelihood of growth of pathogenic microorganisms and mold.
- Example of microbial agents added:
  - Lactic Acid Bacteria (LAB)
  - Yeast (e.g. *Sacchoromyces cerevisiae)*
  - SCOBY
  - Kefir grains
- Backslopping (addition of a small amount of a previously fermented batch is added to the raw food e.g. sourdough bread), is another example of culture-dependent ferments.

Different fermentation processes

1. Acidic fermentation
   - Lactic acid fermentation: Lactobacilli bacteria → sugar→ lactic acid
   - Acetic acid fermentation: Acetobacter bacteria → alcohol → acetic acid
2. Alkaline fermentation
   - Bacillus or Fungi (e.g. Geotrichum)→ Protein → ammonia
3. Ethanol fermentation/alcohol fermentation
   - Yeast→ sugar and carbohydrates→ alcohol + carbon dioxide
4. Symbiotic culture of bacteria and yeast/SCOBY based and combined fermentations (more than one type of starter microorganisms are use)
   - symbiotic culture (e.g. bacteria and yeast)→ sugar→ alcohol→ acetic acid

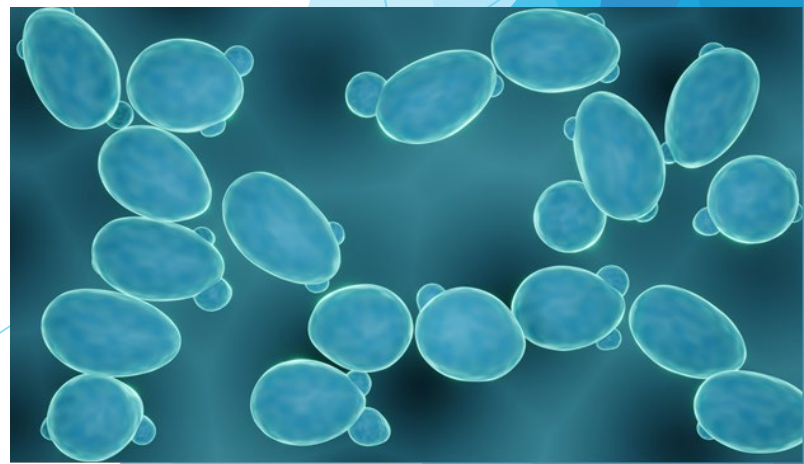
Common Features of LAB Fermentation

- Low pH (pH < 4.6)
- Involve lactic acid bacteria; produce lactic acid, some produce other acids (acetic, malic, etc.)
- Need source of sugar
- Some produce CO_2
- Don't need oxygen
- Sensitive to temperatures (e.g. optimal LAB fermentation temperature is 20°C to 25°C)

Combination of low pH and competitive microflora contributes to the safety of the LAB fermented food.

Common Features of Alkaline Fermentation

- Also referred to as high alkalinity curing.
- Results in a product with high pH (above 7).
- Starter culture most often includes *Bacillus* spp. and/or fungi (e.g. *Geotrichum candidum*).
- Processing can include a soaking step (food safety actions requires acidification of water or soaking under refrigeration).
- Foods produced with alkaline fermentation or alkaline processing may still require other intrinsic and extrinsic factors (i.e., water activity and refrigeration) to assure safety.



Food Safety Concerns

- The Main concern with fermentation is from raw materials and fermentation failure
- Fermentation does not replace general food safety principles (i.e., food hygiene)
- Other areas of concern are:
  - Delayed/stunted fermentation
  - Insufficient salt
  - Poor sanitation and post ferment handling and process
  - Contamination by spoilage microorganisms (yeast and moulds, polysaccharide producers)

Pathogens/by-products of concern

- Biogenic amines
- Moulds (mycotoxins)
- *Listeria monocytogenes*
- Salmonella
- *E. coli* O157:H7
- *Staphylococcus aureus*
- *Clostridium botulinum*

The National Fermented Foods Working Group

Purpose

- To identify risk in fermented foods, create fact sheets, guidelines, and educational training materials for fermented foods.
- To enable communications between health agencies and fermented food experts and stakeholders.

Working Group Members

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Deliverables

- Develop a Fermented Food Safety Guideline that will include:
  - Assessment of risk in fermented food practices,
  - Include guidance to mitigate fermented food risk, and
  - Include critical limits, CCPs and food flow charts that would inform operators and health practitioners
- General Information and food specific chapters

Complexity	Foods	Fermenting agent	Section
high ↑ low	Sausage	Added LAB[1], wild molds & yeasts	3.13
	Kefir, Kombucha	SCOBY[2] based: *Acetobacter*, yeast & mold	3.11-3.12
	Koji, Miso	*Aspergillus,* wild or added yeast & LAB	3.10
	Tempeh	*Rhizopus*	3.9
	Natto	*Bacillus*	3.8
	Yogurt, Nut Cheeses	Added LAB	3.6-3.7
	Dosa, Idli, Fesikh	Wild LAB and Yeast	3.4-3.5
	Vegetables, Sauerkraut, Kimchi	Wild or added LAB	3.1-3.3

[1] – LAB-lactic acid bacteria; [2] – SCOBY-symbiotic culture of bacteria and yeast

A non-fermented, high alkalinity processed food is also included in this guideline: pidan century egg

Guideline Example:
Chapter 3.2 Kimchi

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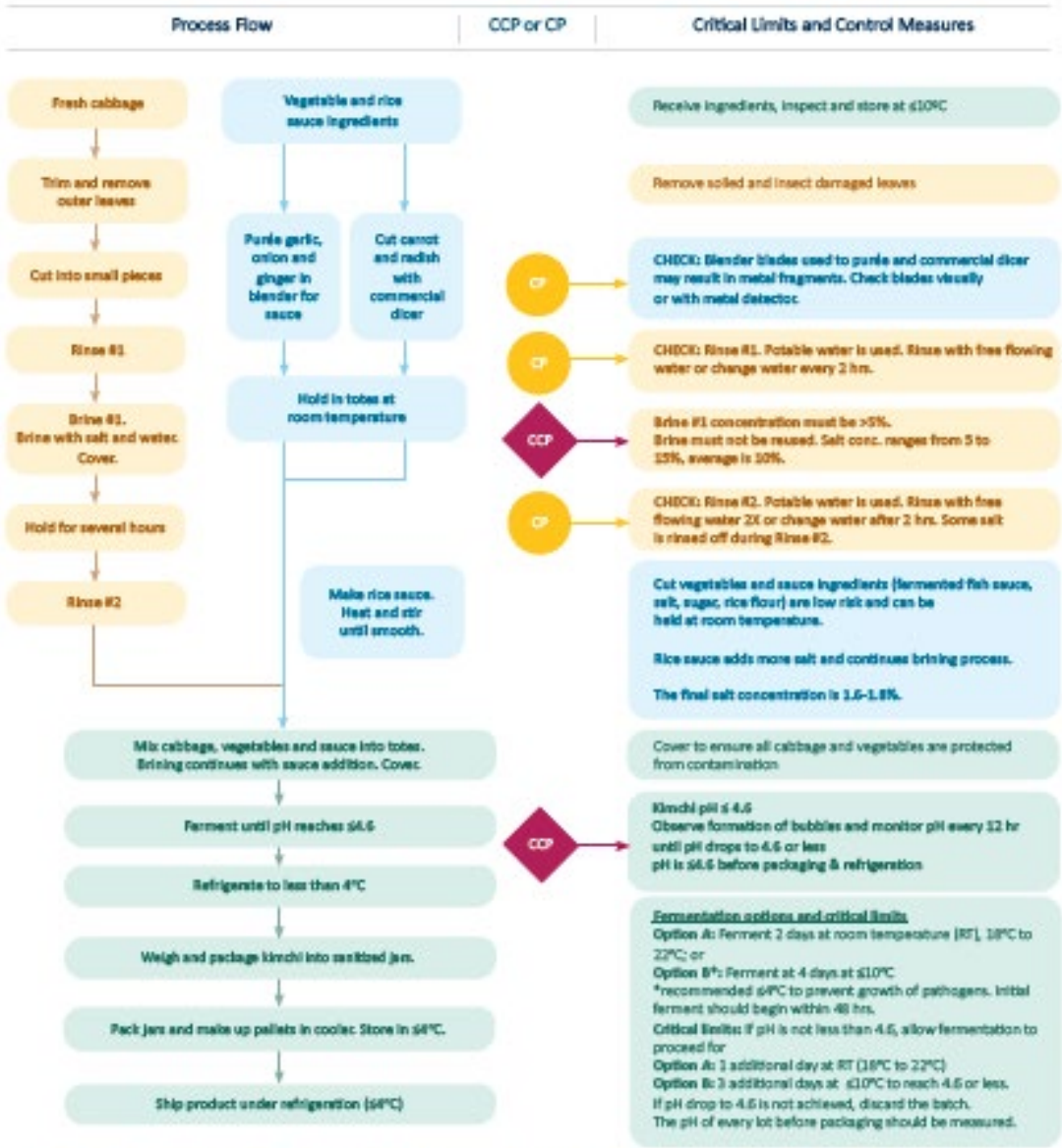
3.2 | Kimchi

Authors: Sung Sik Jang, Lorraine McIntyre | BC Centre for Disease Control

Overview

Description	Cabbage and other vegetables are salted and fermented with other ingredients such as red pepper powder, garlic, ginger etc. 
Starter culture	Wild fermentation of lactic acid bacteria (LAB) is normal for smaller companies. Large commercial companies use proprietary starter culture not available for purchase (in South Korea, companies make their own). Backslopping is not a practice in this industry.
Key features	Depending on the process chosen • Cabbage is typically salted for several hours, the salt is rinsed off, then other ingredients are added, including salt, and the mixture is fermented. • Fresh kimchi, i.e. kimchi prepared for immediate consumption requires continuous refrigeration as pH may be >4.6 allowing pathogens to grow. Fresh kimchi should be used within 3 days. • Fermented kimchi, i.e. kimchi fermented for longer periods, is held refrigerated until pH of <4.6 or lower is achieved (max 7 days), or may be fermented at ambient conditions until a pH of <4.6 or lower is achieved (max 3 days). If pH of 4.6 or less is not achieved within specified time the batch has failed and should be discarded. • Adequately fermented kimchi is held and stored under refrigerated conditions.
Hazards of concern	• *E. coli*, *S. aureus*, and *Salmonella* spp. • Norovirus • Parasites (worms: roundworm, hookworm and others) • Biogenic amine formation
Important control points	• Washing ingredients to remove soil and contamination • Fermentation is recommended at refrigeration temperatures to prevent the growth of acid tolerant pathogens • Brining to prevent the growth of pathogenic bacteria • Fermentation at lower temperature with pH drop to 4.6 or below to remove pathogens and parasites, and a holding time of two weeks prior to distribution.

Kimchi food flow chart | Process flow and controls



Based on BioTech kimchi process flow diagram[40] and Ministry of Food and Drug Safety guideline (South Korea).[41] NB: Diagram colours under process flow and controls are matched (green=cabbage process; blue=vegetable process; yellow=both process).

Highlighting of Potential Food Safety Issues

Potential issues with kimchi food preparation

Issue	Description
Pathogenic microorganisms (in source ingredients and cross-contamination during processing)	Biological hazards include pathogenic microorganisms *S. aureus*, *Salmonella*, *E. coli*, norovirus, and parasites. These can be removed by washing ingredients using potable water during the preparation of raw ingredients and by rapid pH decrease, with final pH ≤ 4.6, during fermentation. Salt in the brine inhibits the growth of non-halophilic, putrefactive, and pathogenic bacteria and supports halophilic (2-3%) lactic acid bacteria. Organic acids produced by fermentation and antimicrobial substances such as bacteriocins and carbon dioxide inhibit pathogenic and aerobic bacteria.[2] Parasites originated in vegetable ingredients can be recovered or inactivated by washing and adequate fermentation process. [2,15] Parasites eggs were detected in kimchi imported from China: *Ascaris lumbricoides* (roundworm), *Ancylostoma duodenale* (hookworm), *Trichostrongylus orientalis*, and *Isospora belli*.[15]
Pesticide	Pesticides occur if they are overused to ingredients or ingredients are harvested too early before pesticide residues dissipate. Washing, salting, and fermentation can remove or reduce pesticides on raw ingredients. Washing four times could remove up to 43% of the pesticide, and the average half-life of pesticides (Chlorpyrifos) in kimchi was 1.8 weeks.[41] Higher fermentation temperature could remove more pesticide, and over 69.4% of the pesticide disappeared after storing kimchi for 24 days at 4°C.[42]
Biogenic amines	Biogenic amines can be produced during kimchi fermentation and are harmful if ingested in high concentrations. It occurs primarily from metabolic activity by microorganisms during fermentation in Jeotgal (fermented seafood) and Aekjeot (fermented fish sauce) products that are commonly used for kimchi production. Jeotgal and Aekjetot were found in one study to contribute to the production of histamine and tyramine in kimchi.[43]
Foreign material (Metal)	Metal fragments can occur when blades and utensils chop raw vegetables and other seasonings. Metal detectors should be used to detect iron and stainless steel fragments before packaging.[15]

Other inclusions in Each Guideline

- Background on food including cultural and ethnic context
- Outbreaks and Recalls of the food
- Description of food preparation and variations
- Food Safety control points
- Inspection Checklist
- Frequently Asked Questions
- References

In Summary

- Historically, fermentation is performed as a method of food preservation, where if done correctly, microorganisms break down sugars and starches into alcohols and acids, preserving food so people can store it for longer periods of time without it spoiling.
- Main food safety concerns with fermentation are:
  - Contaminated raw materials and
  - Fermentation failure/delayed or stunted fermentation
- A food safety plan can assist with safe production of fermented products.
- Fermented Foods Guidelines will be released as they are finished and available.

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