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# Safety of Fermented Foods

## Assessing risks in fermented food processing practices and advice on how to mitigate them



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Additional fermented food guidance can be accessed at: http://www.bccdc.ca/health-professionals/professional-resources/fermented-foods

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# Section 1 | Introduction to fermented food safety

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## 1.1 Purpose

A national working group of health inspectors, food safety specialists, and industry fermentation experts formed in 2018 to discuss issues with fermented foods. Information shared in calls steered the decisions on how to approach defining fermented foods and what subjects to include in this document. Health inspectors, specialists and experts in the field wrote this guidance. This work intends to assist food safety staff (health inspectors) to evaluate the safety of fermented foods and fermentation processes encountered during inspections. Owners and operators of food processing facilities may also find this guidance helpful as it reviews critical control points and measures recommended to produce safe fermented foods. The information presented here lays out best practices for a variety of fermented foods, however, it does not replace or supersede federal and provincial guidance or regulatory requirements for fermented foods. Health inspectors, food safety staff, owner and operators of food processing facilities should follow federal and provincial food safety requirements. The best available evidence guided this work at the time of publication. The application and use of this document is the responsibility of the user.

This fermented food guidance defines fermentation processes, different types of fermentations, and focuses on risks associated with fermentation. It includes:

- Definitions for fermentation processes and terms,
- Risks associated with fermented food, risk mitigation measures and best practices,
- Examples of fermented foods provided include an overview summary for that food, followed by a description of how the food is prepared, important risks and food safety control measures, and a food flow chart diagram that illustrates the process steps, controls points, critical control points (CCPs), critical limits, and best practices.

Of importance, the advice in this guidance is targeted at small to medium scale fermentation operations such as: vendors selling at farmers' markets, chefs preparing fermented foods at restaurants and food premises, and small commercial operations. The underlying purpose of this guidance is to assist food safety and health inspectors in recognizing and controlling the food safety risk associated with fermented foods.

### Structure

This guidance is divided into three sections.

Section 1

- Reviews fermentation and options to define fermentation processes,
- Describes fermented foods by the microbial fermentation agent or starter culture (reviewing lactic acid bacteria, yeast and mould, alkaline fermentations, etc.),
- Lists examples of fermented foods known to be prepared in Canada.

Section 2

- Reviews spontaneous fermentation, backslopping methods and controls,
- Reviews commercial starter culture,
- Describes chemical and microbiological standards for fermented products, and
- Describes recommended testing for non-commercial starter cultures and foods.

Section 3

- Describes fermentation food processes for specific foods as shown highlighted in Table 1,
- Reviews recalls and outbreaks related to that food,
- Summarizes food safety control issues related to that fermented food, and
- Displays a food flow chart with illustrations of critical limits and critical control points.

**Table 1 | Alphabetical list of some of the fermented foods being served and prepared in Canada**

Foods reviewed in Section 3 of this guidance can be found in the document section number shown in the table

| | | | | |
|---|---|---|---|---|
| Amazake (3.9) | Idli (3.4) | Koji (3.10) | Pickles (3.1) | Soy Sauce (3.10) |
| Beet Kvass | Hakarl / Honjeo | Kombucha (3.11) | Pidan century egg (3.14) | Stinky Tofu |
| Cider | Hot sauces | Kvass | Plant-based cheese (3.7) | Tempeh (3.9) |
| Cu(o)rtido | Jun (3.11) | Lemons | Root Beer (non-alcoholic) | Tofu (fermented) |
| Doenjang | Kefirs (water and milk) (3.12) | Mead (honey beer) | Sauerkraut (3.2) | Torshi (veg) |
| Dosa (3.4) | Kenkey | Miso (3.10) | Sausage (3.13) | Vegetables (3.1) |
| Fesikh (3.5) | Kimchi (3.3) | Natto (3.8) | Seafoods | Vinegars |
| Ginger Beer | Kislaya Kapusta | Oyster Beer | Sourdough bread | Yogurt (3.6) |

## 1.2 Methods

Members of the working group reviewed content and chose fermented foods for inclusion in section 3 of this guidance. Members provided example fermented food recipes and their questions about the process to inform guidance content. Standards and recommendations for evaluation of fermented foods were searched from the literature (for e.g., using key-word searches of various library data-bases such as MEDLINE, Embase, and google scholar) and through experts' consultation. Citations to all information are provided through-out the guidance.

Recalls were identified by a search of the Canadian Food Inspection Agency recall database and similar databases in other countries as listed in Table 2.[1] Outbreaks were identified from the literature, internationally via a request to the Public Agency of Canada for review of the *Publically Available International Foodborne Outbreak Database (PAIFOD)*, and via a search of the National Outbreak Reporting System (NORS) of the Centers for Disease Control in the United States https://wwwn.cdc.gov/norsdashboard/.[2,3]

**Table 2 | Recall databases used in fermented food search**

| Country | URL |
|---|---|
| Australia | https://www.foodstandards.gov.au/industry/foodrecalls/recalls/Pages/default.aspx? |
| Canada | https://recalls-rappels.canada.ca/en/search/site |
| Europe | https://webgate.ec.europa.eu/rasff-window/screen/search |
| New Zealand | https://www.mpi.govt.nz/food-safety-home/food-recalls-and-complaints/recalled-food-products/ (only back to 2015) |
| United States Food and Drug Administration | https://www.fda.gov/safety/recalls-market-withdrawals-safety-alerts |
| United States Food Safety Inspection Services | https://www.fsis.usda.gov/recalls? (for meat products) |

Keyword searches of recall and outbreak databases, and literature sources for fermented foods included: “fermented vegetables”, “fermented”, “ferment”, “Kombucha”, “Kefir”, “sauerkraut”, “dosa”, “dosai”, “idli”, “pidan”, “century egg”, “yogurt”, “yogurt”, “nut cheese”, “cashew cheese”, “natto”, “miso”, “tempe”, “tempeh”, “koji”, “salt koji”, “kimchi”, “fermented food recall canada”, “sausage”, “salami” and “fesikh”.

## 1.3 An overview of the different types of fermentation

**What is fermentation?**

Fermentation is the process in which a substance breaks down into a simpler substance. Fermented foods are defined as “those foods that have been subjected to the action of microorganisms or enzymes so that desirable bio-chemical changes cause significant modification in the food.”[4] Or more simply, according to a panel of experts, “foods made through desired microbial growth and enzymatic conversions of food components”.[5] Fermentation transforms food by microbial action into a food with desirable quality and taste characteristics. Fermentation preserves foods that would otherwise spoil and increases the shelf life.
Fermentation occurs as a natural process of microbial metabolism. The desirable microorganisms, hereafter referred to as microbes, can be naturally occurring on the surface of food leading to a spontaneous (also described as wild) fermentation or can be deliberately added to the food for a cultured fermentation. Microbes will consume the available sugars and/or break down the complex carbohydrates of the food’s substrate to form simpler sugars, and use them to form acids, gas and other chemicals, such as ethanol. Traditionally fermented food can be attained through lactic acid, alcohol, acetic acid and alkaline fermentation.[6] If the process results in desirable food it is termed fermentation; when it results in decomposition, it will be called spoilage. A microbe used for fermentation may be the same microbe that results in food spoilage, depending on the specific situation. Microbes used in fermentations include bacteria and fungi (moulds and yeasts). Common fermentation bacteria, in order of abundance in fermented foods, include *Lactobacillus*, *Lactococcus*, *Enterococcus*, *Vibrio*, *Weissella*, *Pediococcus*, *Enterobacter*, *Salinivibrio*, *Acinetobacter*, *Macrococcus*, *Kluyvera* and *Clostridium*.[7] Other fermentative bacteria include *Bacillus subtilis* (used to make natto), fermentative moulds *Rhizopus* (used to make tempeh), and fermentative yeasts *Saccharomyces cerevisiae* (used in brewing).

**Different categories of fermented food and fermentation process**

Fermented foods may be categorised in different ways, for example:

(1) described by the microbial fermentation agent (starter culture), e.g., lactic acid bacteria (LAB)[8] would be the fermentation agent for all of the foods mentioned in Figure 1,

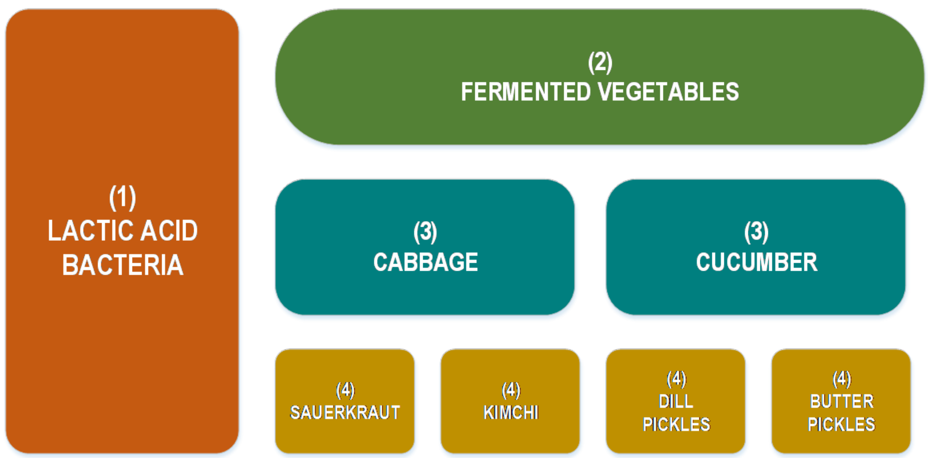
(2) described by food category as fermented vegetables;

(3) described by food substrate or food undergoing fermentation, e.g., cucumbers, cabbage; or

(4) described by the common name of the fermented food, e.g., dill pickles and butter pickles.

Each method has merit and one may find information about fermented foods described in these and other ways. In another example, if the food category was dairy, the food substrate as milk, then the common name of the food might be kefir or yogurt as both are fermented with LAB. This guidance will focus on microbial fermentation agents.

**Figure 1. Describing fermented foods using the example of fermented vegetables and the starter culture LAB**




The figure shows how fermented foods may be categorized, by (1) microbial starter culture, (2) food category, (3) food substrate, and by the (4) common name of food.

**Fermented foods described by their microbial fermentation agent (starter culture)**

Fermentation is a microbiological reaction. A variety of microorganisms can be involved in a fermentation process. Common categories of microorganisms involved in food fermentations are:

(1) Lactic acid bacteria
(2) Yeast
(3) Moulds (e.g., *Aspergillus* and *Rhizopus*)
(4) SCOBY based and combined fermentations (SCOBY=symbiotic culture of bacteria and yeast)
(5) Alkaline fermentations (e.g., *Bacillus* bacteria)

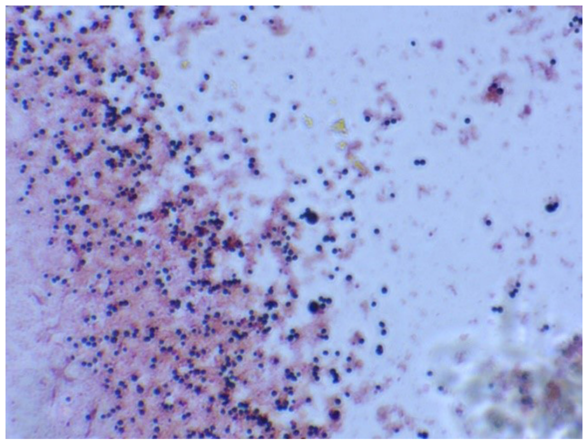
**Lactic acid bacteria**

Lactic acid bacteria (LAB) are a group of bacteria that microbiologists refer to as "gram positive, acidophilic, facultative anaerobes". This means these bacteria produce acids, in particular lactic acid and can grow with and without oxygen and are salt tolerant. They also stain purple when a particular stain is applied to them, differentiating them from gram negative bacteria. Note: in the food poisoning world, gram positive bacteria include *Clostridium botulinum*, *Staphylococcus aureus* and *Bacillus cereus*, while gram negative bacteria include *E. coli* O157, *Salmonella*, and *Campylobacter*, to name a few. LAB are commonly found in low numbers on many types of fresh produce, and grow rapidly with acid production when conditions are right. LAB produce lactic acid as the major end product during the fermentation of carbohydrates, reducing the pH of the end product to less than 4.6. LAB are made up of several families of bacteria, not just one type. Successful ferments using LAB may start with one type of LAB, such as *Leuconostoc* spp., before progressing to another type, such as *Lactobacillus* spp. and *Streptococcus* spp.

*Lactobacillus*, *Leuconostoc*, *Pediococcus* and *Streptococcus* are the four major genera of LAB.[9] Populations of LAB bacteria grow and outcompete each other during different stages of the fermentation period, producing lactic acid exclusively during a 'homo-fermentative period' or producing lactic acid with other fermentation products (e.g. acetic acid, ethanol, diacetyl, $CO_2$ during a 'heterofermentative period'. This is typical for LAB ferments, as the conditions during the fermentation become more acidic, populations of one type of LAB will die off, with other more acid loving LAB growing next in the succession. During growth, LAB can also produce antimicrobial compounds such as bacteriocins that will inhibit other microbial growth and this is important to the safety of the ferment.

**Figure 2. Fermented Sausage and LAB**

Dry fermented sausage



Gram stain 1000X gram positive cocci

Lactic acid fermentation is a common fermentation process producing yogurt, sausages, cheese, and vegetables such as pickles, kimchi and sauerkraut. Figure 2 shows dry cold fermented sausages with what appears to be surface mould. The predominant culture from surface scraping of the sausage was gram positive LAB.

**Yeasts**

Yeasts are single-celled microbes in the fungi kingdom. They are naturally occurring in the environment, found on fruits, vegetables, and grains. They are used widely in the baking and brewing industry to make breads, ciders, beers and wines. Yeasts are available for purchase at most grocery stores or craft brew supply houses, and are labelled as *Sacchoromyces cerevisiae* (bakers and brewers yeasts). Yeasts ferment sugars and carbohydrates into ethanol and carbon dioxide. Yeasts prefer to digest simple sugars over complex carbohydrates like starch. In many fermentations, including the fermentation of beer, yeast is used to convert sugars to alcohol at the end of several other processing steps. Kvass (rye bread), kenkey (cornmeal) and dosa (lentils) are ethnic yeast fermented foods. Figure 3 illustrates yeast activity before and two hours after rising of a sweet dough. Figure 4 shows bakers yeast in a solution of milk and sugar, bubbling and foaming indicates activated yeasts. The active yeast cells are multiplying and budding off, as shown in the photo to the right.

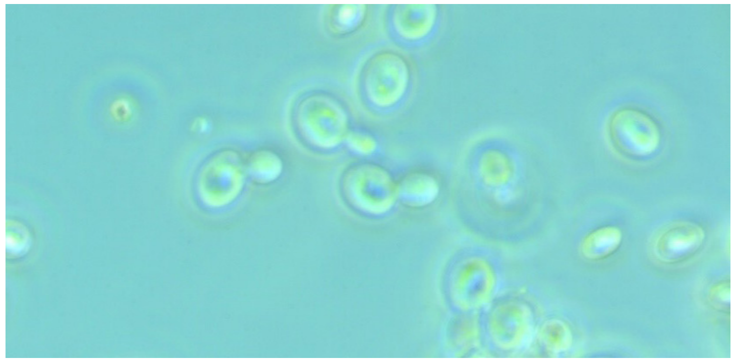
**Figure 3. Sweet dough before and after rising with yeast**

Before rising

After rising

**Figure 4. Activated yeast and budding yeast cells**

Activated yeast



Phase contrast, 1000X

**Box 1. Brewing grain into beer with yeast**

Grains are sprouted in a process called malting. The malt is ground and water added to make a mash. Enzymatic actions convert carbohydrates in the mash into fermentable sugars. This sweet liquid is boiled, and is called the wort. Yeast is added to the wort, different types of yeasts help to create different flavour profiles.

Similar to LAB, different populations of yeast will be present within a ferment container, and in the brewing industry may be described as “bottom fermenters” (e.g. for lagers) and “top fermenters” (e.g. for ales).

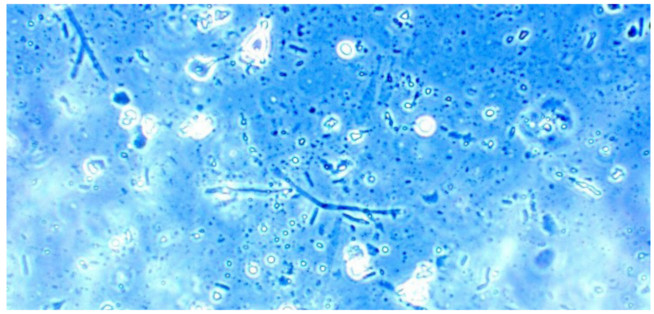
**Moulds**

Moulds are multi-celled and filamentous fungi. Moulds are used in production of soft cheeses, such as brie and camembert. Moulds are used to ferment soybeans into miso, tempeh, doenjang, amazake and koji.

Mould fermentations, from a food safety perspective, initially appear to be higher risk because as mould multiplies in the food substrate (e.g., soybean) the pH of the food increases. As the food becomes more alkaline, it is considered to be a low-acid food with a pH>4.6 which we traditionallly consider higher risk. Concern is amplified when the fermentation takes place at ambient temperatures. However, addition of adequate pure mould culture to a properly prepared food substrate will allow the mould culture to quickly grow and out-compete other spoilage and pathogenic microbes. For example, tempeh is made from boiled soy-beans inoculated with *Rhizopus* mould spores. Failure of the culture may occur if too few mould spores (less than 6 log spores per 100g of tempeh) are inoculated into the tempeh substrate. Spoilage organisms then have an opportunity to grow, instead of the *Rhizopus*.[10] Proper preparation of the substrate for these ferments usually involve soaking of soybeans in acidified or refrigerated water, along with appropriate cooking and cooling times and temperatures prior to addition of the starter mould culture. In figure 5, a mould-ripened cheese, brie, illustrates the outer protective rind. On the right is an image of the bacteria and moulds in the rind.

**Figure 5. Brie cheese rind microbial community**

Brie cheese



Phase contrast 400X

**SCOBY based and other combined fermentations**

***SCOBY*** or tea fungus (kombucha tea) is an example of a combined fermentation that is a symbiotic culture of bacteria and yeast (SCOBY). Although sometimes described as a mushroom, the SCOBY is actually a cellulose layer formed by the linking up of bacteria, primarily *Komogataeibacter xylinum*.[11] Acetic acid bacteria (AAB) or *Acetobacter* are the predominant group of bacteria within kombucha, one of which is *Gluconoacetobater* which makes up 85% of the bacteria in the liquid and cellulose portions.[11] LAB are also present in kombucha fermentations. Several varieties of yeast are also present in kombucha, including *Saccharomyces cerevisiae*. The numbers and varieties of bacteria and yeast in a typical kombucha ferment is complex, and can vary between different types of SCOBY regionally. A simplified overview of the chemistry in a kombucha tea ferment is that the sugars in the tea are converted into alcohol by yeasts, followed by AAB which convert the alcohols into acetic acids. In this type of fermentation "backslopping", also referred to as addition of the mother culture, to the next batch of brewed tea and sugar is normal practice. Operators may add portions of the actual floating SCOBY with or without liquid from earlier batches to start a new ferment. Standardized commercial SCOBY starter culture is not commonly or easily available for purchase. However, operators in some provinces may be required to purchase commercially sourced SCOBY when their business is starting up. Jun is the other fermented beverage that will also form a SCOBY during fermentation. Kefir, another fermented product using bacteria and yeast, has kefir grains or kefiran, submerged during fermentation. Kefir grains are not referred to as SCOBY, however, these types of fermentations, involving more than one type of culture, are referred to as 'combined fermentation'. Milk kefir grains look similar to small clumps of cauliflower florets with white to yellow colouration and contain a mixture of LAB, AAB, and yeasts that are immobilized on a polysaccharide and protein matrix.

**Figure 6. Kombucha SCOBY culture**

***Combined*** fermentation refers to fermentations that include more than one type of microbial fermenting agent (starter culture), such as kefir, kombucha and jun. Apple cider vinegar is another example, where the conversion of apples and sugar into cider occurs through the actions of yeasts followed by conversion of alcoholic apple cider into vinegar through the action of added AAB. The AAB may be spontaneously occurring if the fermentation vessel is left in the open (e.g., fruit flies can carry AAB) or AAB may be added through addition of a mother culture (backslopping).

There are many combined fermentations: chicha, a South American beverage made of corn contains LAB, AAB, moulds and yeasts; idli, an Indian spongy cake contains LAB and yeasts; meats and sausages contain moulds, yeasts and LAB; koji and misos from Japan also contain moulds, yeasts and LAB.

***Alkaline fermentations***

Alkaline fermentations are fermentations that occur above a pH of 7. Within this category, we also include alkaline processes that do not include fermentation, but are included here to show the differences in the process and outcome: high alkalinity food processing also called high alkalinity curing. All of these processes, fermentation, processing and curing are special food processing methods where pH of the food is increased to preserve food and achieve desired flavour and texture properties. Increase in pH is achieved through either microbial activity, chemical treatment or both.

**Alkaline fermentations** are most often dominated by species from the genus *Bacillus* of which *Bacillus subtilis* is the most frequently reported species. Other reported bacterial genera are *Staphylococcus*, *Enterococcus*, *Micrococcus*, *Propionibacterium*, as well as fungi like *Geotrichum candidum*.[12] *Bacillus subtilis* is a bacterial species that is known to possess strong proteolytic activity[13]; species from other bacterial genera and fungi were also identified as proteolytic in other food products.[14-16] Proteolysis initiates the degradation of proteins, producing ammonia, neutralizing the acids and increasing pH of food. Acids can also be removed by oxidative fungi (e.g., *Geotrichum candidum*); this is observed in the process of aging the bloomy rind cheese. Fish such as skate and shark, with high levels of urea in their tissues also release ammonia during spontaneous fermentations. There are variable fermentative bacterial genera present on the fish skin (e.g., *Photobacterium*, *Vibrio*, *Pseudomonas*, *Psychrobacter*).[17,18]
*Examples: Natto, Dawadawa, Ogri, Hongeo*

***High alkalinity processing*** uses (i) traditional natural compounds such as wood ashes, soda, lye and lime or (ii) more modern chemical additives such as calcium hydroxide, sodium hydroxide, potassium hydroxide, and sodium carbonate to increase the pH of a food and change the flavour and texture properties of the food.
*Examples: Pidan (Century Egg), Hominy (Nixtamal), Lutefisk (Lye fish)*

Although these products are made by chemical treatment, they are rarely sterile products. Studies on some of these products (i.e. Pidan and Lutofisk) showed that alkaline tolerant microbial population also contributes to the final characteristics of the products.[12,19] However, these microbes are not contributing to a traditional fermentation process, and are not considered a fermented food. We have included pidan as an example of high alkalinity processing. Pidan century egg is made from the chemical activity of sodium carbonate ($Na_2CO_3$), water ($H_2O$), and calcium oxide ($CaO$) to produce sodium hydroxide ($NaOH$) and the alkaline conditions that preserve the egg.

***Food safety risks associated with alkaline fermentations and processing:***

<u>Microbial risk</u>: Most of the known food pathogens can grow at pH 8.5, pathogens like *Salmonella*, *L. monocytogenes*, *S. aureus*, *B. cereus* can grow at pH of up to 9.5.[20] Foods produced with alkaline fermentation or alkaline processing may still require other intrinsic and extrinsic factors (i.e., water activity controls and refrigeration) to assure safety. Fully fermented foods with high alkaline pH (>9.5) would not be permissible for room temperature storage because some pathogens can survive and potentially grow at high alkaline pH. There is no upper pH limit that would allow alkaline fermented foods to be held at room temperature safely.

<u>Chemical risk</u>: Since most of the alkaline substances would be neutralized by stomach acid, the main concern is the corrosive injury to the esophagus during swallowing. Generally, substances with pH above 11 are considered to be of the greatest concern in regard to human exposure.[21] Most foods produced with alkaline fermentation or alkaline processing have sufficiently low pH thus, do not represent a risk. The main food products of concern that need to be verified for exact pH are products made with chemical processing; for example pH of lutefisk during processing can be as high as 12 which is the reason why the processing requires a final soaking in water to bring the final pH to below 11.[19]

**Table 3 | Examples of products made using alkaline fermentation or high alkalinity processing**

| Product | Origin | Basic ingredient | Microbial activity | Chemical treatment | Processing conditions | pH | Reference |
|---|---|---|---|---|---|---|---|
| Natto | Japan | Soybeans (Cooked) | *Bacillus subtilis* var. natto | NA | 40-42˚C, 85-90% RH, 18h | 6.8-7.0 | [22] |
| Dawadawa | Africa | Locust bean (Cooked) | *B. subtilis*, *B. licheniformis, Leuconostoc mesenteroides, Staphylococcus* spp.*, Micrococcus* spp. | NA | 35-40˚C, 51-71% RH, 36-48h | 7.9-8.9 | [12,23] |
| Ogiri | Africa | Melon seeds, Sesame seeds, Castor oil seeds (Cooked) | *B. subtilis, B. megaterium, B. firmus, Pediococcus* spp., Gram-negative bacteria, fungi (*Geotrichum candidum*) | NA | Room temperature, 5 days | 9.1 | [12] |
| Pidan (Century Egg) | Asia | Egg | NA. Incidental findings of *Bacillus* spp., *Staphylococcus* spp. | Wood ash, Soda, Lime, Salt, Alkaline solutions | Room temperature, 20-50 days | 9.00 | [12,24,25] |
| Hominy (Nixtamal) | Mexico | Corn | NA | Lye, Lime | Cooking in alkaline solution (minutes to hours), stepping (hours to days) | 6.79 | [26] |
| Lutefisk (Lye fish) | Nordic | Cod | *Aeromonas* spp., *Pseudomonas* spp., *Bacillus licheniformis*, *Staphylococcus* spp., *Carnobacterium* spp., | Lye | Dried fish is rehydrated and soaking in refrigerated alkaline solution (2 days). | 10.6-11.1 | [19] |
| Hongeo (Hongtak) | Korea | Skate | *B. subtilis, Leuconostoc, Photobacterium* spp., *Psychrobacter, Vibrio* spp. | NA | Room temperature, 7 days | 6.7-9.4 | [17,18,27] |

### Classification of the fermentation process

Fermentation can also be described by the type of process, for example spontaneous fermentation (naturally occurring or wild) or fermentation using added starter cultures. Other processes include broad terms such as lactic acid fermentation or fungal fermentation.[8] As described earlier, LAB include many types of bacterial families that produce acids. Spontaneous ferments occur from the activity of naturally occurring or normal microbes on the food substrate, for e.g., LABs on shredded cabbage that create a fermentation process during sauerkraut production. In comparison, microbes described as microbial starter agents are purchased from commercial suppliers, then deliberately added to the food substrates to create the fermentation process. Commercial starter culture will contain one or more purified microflora culture strains. For e.g., *Lactobacillus acidophilus* is a type of commercially available LAB used to make yogurt. Of note, a single food might be made with more than one of these methods. For e.g., sauerkraut can be produced by spontaneous fermentation of LAB in the presence of salt, by using commercial LAB starters or by backslopping.

### Spontaneous fermentation

Spontaneous (or wild) fermentations are often described as naturally occurring fermentations. Spontaneous refers to the actions of microbes already present on the food substrate, or on the equipment and utensils that contact the food substrate. Desired spontaneous fermentations often occur with the aid of added salt, for e.g., sauerkraut, kimchi (salted cabbage) and torshi, curtido (salted vegetables). They also occur spontaneously, for example, with fermented lemons. The microbial agent in the spontaneous ferment can vary. In the examples just provided, the cabbage and vegetables are fermented with naturally occurring lactic acid bacteria, while the lemons are fermented with naturally occurring yeasts.

In this guidance we differentiate spontaneous ferments from backslopping because during backslopping, the active microbial agents are already present in high numbers. Spontaneous ferments do have risk. When naturally occurring microbes needed for fermentation success are present in low numbers, or when conditions for the fermentation are poor, for example, the ambient temperature is too hot, the time for naturally occurring, wild microbes to grow into high numbers is prolonged. If the time is too long before acid development pathogens or spoilage present may multiply in the food. An evaluation of the time and conditions may be necessary in spontaneous fermentations, for example, operators may be required to evaluate if the pH drops within a set amount within a specific time period. This risk is less of an issue in backslopped ferments that begin with addition of a portion of the previous batch. Backslopping would also include ferments that begin with addition of “the mother”. “The mother” cultures refers to fermented substrate that is used to initiate fermentation in multiple other batches. Risks for backslopped culture include contaminants and spoilage agents that decrease microbial activity or shelf life.

### Fermentations using starter culture

Culturing refers to adding microbial starter to initiate fermentation. Some of the common microbial starters are: whey, SCOBYs, kefir grains and powdered starter cultures. “Backslopping” is when previous ferments are used to initiate the next fermentation.

Recommendations for food safety control of spontaneous fermentations, starter cultures, backslopped cultures and microbiological standards for starter cultures and fermented foods will be reviewed in depth in Section 2.

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Figure 2. Dry fermented sausage and gram stain. L. McIntyre, BC Centre for Disease Control

Figure 3. Sweet dough. L. McIntyre, BC Centre for Disease Control

Figure 4. Activated yeast and budding yeast cells. L. McIntyre, BC Centre for Disease Control

Figure 5. Brie cheese and microbial community. L. McIntyre. BC Centre for Disease Control

Figure 6. Kombucha SCOBY culture. Getty Images.