

# Safety of Fermented Foods

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

## Glossary of Terms and Acronyms



## Fermented Foods Guideline Glossary and Acronyms

**Acetic Acid Bacteria (AAB):** Are a group of Gram-negative bacteria including *Acetobacter*, that oxidise ethanol to produce acetic acid. They are widespread in the environment and are used to ferment many foods, such as vinegar and kombucha.

**Aerobic Plate Count (APC) or Aerobic Colony Count (ACC) or Standard Plate Count (SPC):** ACC, APC and SPC can be used interchangeably, and they refer to an enumeration of viable aerobic bacteria on microbiological culture media. Aerobic bacteria refer to bacteria able to grow in an oxygenated or aerobic environment.<sup>1</sup>

**Aerobe:** An organism that requires the presence of air or free oxygen to live and multiply.

**Aflatoxin:** A family of toxins produced by certain moulds, for example, *Aspergillus flavus* and *Aspergillus parasiticus*, often found on poorly stored grains and nuts. Consumption of foods contaminated with aflatoxin is a risk factor for primary liver cancer.<sup>2</sup>

**Alcohol:** alcohol, also known as ethanol, or ethyl alcohol, is produced from fermentation of sugars and carbohydrates by yeasts and bacteria. It is a colorless liquid with intoxicating properties.

**Alcohol, unintentional:** natural formation of alcohol may occur in small amounts during fermentation. Multi-step fermentations may include breakdown of alcohol into acetic acid and carbon dioxide as part of the process, for example, kombucha or kefir. When this stage of fermentation is incomplete and residual alcohol occurs in foods or beverages in amounts higher than regulatory levels, this is referred to as unintentional alcohol.

**Alkaline fermentation:** see fermentation.

**Allergen:** is a substance that causes immunological response in susceptible, exposed individuals. Food allergens include eggs, milk, mustard, peanuts, crustaceans and molluscs, fish, sesame seeds, soy, sulphites, tree nuts, wheat and triticale.<sup>3</sup>

**Ambient temperature:** refers to temperature of immediate surroundings, in food processing this refers to the temperature inside a room or building. When fermented food guidance describes room or ambient temperature this is described as temperatures between 18°C and 22°C.

**Anaerobe:** An anaerobic organism lives in the absence of air or free oxygen.<sup>1</sup>

**Available water or water activity ( $a_w$ ):** See water activity.

**Backslopping:** is the practice of using a portion of the previous ferment to inoculate the next batch of substrate, for example, a portion of the fermentation liquid or piece of the finished food is used as the starter culture for the next batch of food.

**Bacteriocins:** are proteins or peptides released by bacteria that may have a negative effect on growth of other bacteria (bacteriostatic) or may be used to as a communication or signal for bacteria. In fermentations, bacteriocin activity are considered beneficial because they can reduce growth of

biogenic amine producing bacteria and can inhibit pathogenic bacteria. Some bacteriocins are approved for food preservation, for example, nisin.

**Best-before dates (BBD):** is a measure of freshness and nutritional value of a food product. It tells you how long a properly stored unopened food product will keep its qualities claimed by the producer.

**Biogenic amines:** are produced by bacteria during fermentation or food spoilage. These are nitrogenous-containing compounds (derived from ammonia) and may cause illness. Common biogenic amines include histamine, tyramine,  $\beta$ -phenylethylamine, putrescine, cadaverine and spermidine.

**Blanching:** is a cooking term used to describe immersion of a food substrate (e.g., cabbage, cashews, green beans, and others) into boiling water for a short time, for 15 seconds or longer, followed by rapid cooling. Reasons for blanching include removal of spoilage organisms, removal of outer waxy substances, removal of chemicals that impart off-flavours, or interfere with fermentation.

**Brines or brining:** a brine is a solution of water, salts, and/or sugars and spices that are used in food fermentation. Brines can be made, with foods submerged into the brine, or brines may develop when salt is added to vegetables, causing rupture of the plant cells walls and release of water to create a salt-water brine. Brining is the activity of submerging food into a brine. Use food grade pickling salts. Iodized salts, sea salts and other speciality salts are not recommended as they may contain heavy metals, anti-caking agents or other agents that interfere with fermentation.

**Canadian Food Inspection Agency (CFIA):** Is a federal the science-based regulatory agency responsible food safety, animal health, plant health and international market access. They provide inspection service for federal food establishments and set up requirements for import and export of food within Canada.

**Canning:** is a method of food preservation where food is processed by heat (i.e., thermally processed), then stored in hermetically sealed containers, a type of reduced oxygen packaging.

**Atmospheric steam canning:** is similar to hot-water bath canning, using an aluminum container with a domed lid, less water than traditional hot-water canning, and generation of steam for not more than 45 minutes.<sup>4</sup>

**Hot-water bath canning/Boiling water bath canning:** is a method of canning for high-acid or acidified (pH<4.6) foods. Foods are preserved by heat treatment by immersing sealed glass jars into boiling water (at 100°C) for a period of time indicated in the validated recipe. Lower pasteurization temperatures for longer periods, for example 82°C for 30 min are also acceptable, a technique employed to reduce softening in the pickle.

**Pressure canning:** is a method of canning used for low-acid (pH>4.6) food. Food is preserved by at high temperatures under pressure to destroy spore-forming organisms. This technique for sterilizing food, in commercial canning “retort” processing, allows for a reduction of bacteria and bacterial spores. For example, foods are placed into canners and sterilized at 116° to 121°C (240° to 250°F) under 10psi (pressure per square inch) for 10 minutes or longer. Pressure canning times, temperatures and pressures are derived from validated recipes and specific to the food container and equipment reviewed by a processing authority.

**Case hardening:** is a term referring to conditions in sausages where the outer sausage covering (or casing) becomes hardened, and moisture loss does not occur properly causing the interior of the sausage to stay wet. Because it cannot dry properly, this creates conditions favourable for *C. botulinum* or *Salmonella* growth.

**C. bot or *Clostridium botulinum*:** is a Gram-positive, spore-forming, anaerobic bacteria that causes botulism when ready-to-eat foods contaminated with *C. botulinum* toxin are consumed. The toxin is deadly, one teaspoon of toxin (6 grams) is enough to kill 200 people. Improperly canned foods and improperly processed and packaged meats are common vehicles for botulism. Commercially canned foods undergo heating/pressure (see canning above) that allows for a 12-log reduction of *C. bot* spores, or 99.9999999999% reduction (that's 12 nines).

**Certificate of Analysis (CoA):** is a manufacturers' specification sheet for ingredient documentation, for example, for cashews or *Aspergillus* starter culture. A CoA may be known as a product specification sheet (PSS), suppliers' quality assurance (SQA), technical data sheet (TDS) or ingredient specification sheet (ISS).<sup>5</sup> All should include what the ingredient is, name and address of the manufacturer, storage and shelf-life of the product and test results for product quality and safety.

**Challenge study:** refers to one or more tests to determine whether a foodborne pathogen inoculated into the food can survive in the food. Studies are undertaken, and can also be modelled using software (e.g., PMP <https://pmp.errc.ars.usda.gov/PMPOnline.aspx>), to assess, for example, effectiveness of a heating lethality process, addition of antimicrobial agents, and growth rate of harmful pathogens over the intended shelf-life of the product.

**Codex Alimentarius:** the Codex Alimentarius, or "Food Code" is a collection of standards, guidelines and codes of practice adopted by the Codex Alimentarius Commission, to foster food safety, food trade between countries, and to serve as a resource to countries.

**Coliforms, total or fecal:** Total coliforms are Gram-negative, rod-shaped bacilli without spores, that are aerobic or facultative anaerobes, ferment lactose and grow best at temperatures of 35 to 37°C. Total coliforms are indicators of poor sanitation in foods (and water) and are common residents in soils, feces, and water. A positive total coliform result does not necessarily mean that feces are present. Total coliform genera include *Enterobacter*, *Escherichia*, *Klebsiella*, and *Citrobacter*. Fecal coliforms are a subset of total coliforms that are facultative anaerobes, ferment lactose and only occur in warm-blood animals linked to feces, i.e. *E. coli*. They grow optimally at 44°C.

**Controlled atmosphere storage :** refers to a storage method for foods where concentrations of atmospheric air (oxygen, nitrogen, carbon dioxide), temperature and humidity are optimized inside a room or building. Controlled atmosphere storage uses reduced oxygen to prolong the shelf-life of fruits, grains and other foods without packaging.

**Controlled atmosphere packaging (CAP):** is when foods are placed inside a gas impermeable package where the gaseous environment and ratio of carbon dioxide, oxygen, nitrogen, water vapor, and other trace gases has been changed and controlled to increase shelf life. It differs from modified atmosphere packaging (MAP) in that the ratio of gases in CAP are maintained, versus in MAP oxygen gas is always reduced, and gases may change over time with interactions with food.

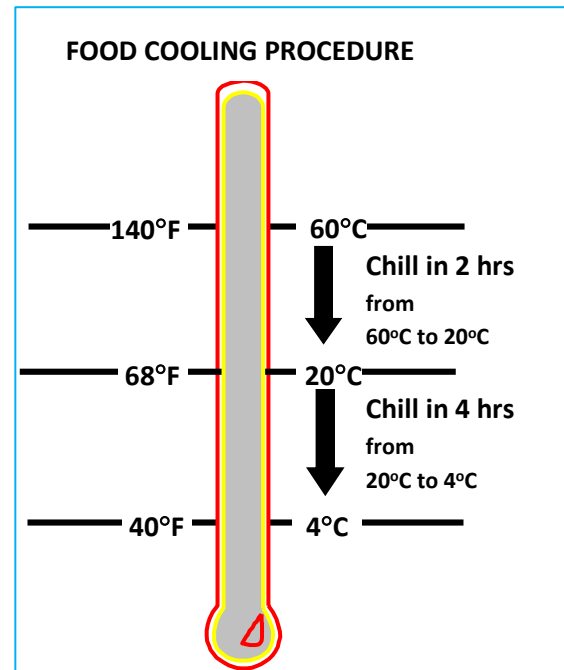
**Control or check point (CP):** a point at which a potential hazard may be additionally managed or controlled. For example, a CP could be a time/temperature control before a heating step is applied as the CCP. A specific hazard can have a check or control point only after it has a Critical Control Point.

**Cooling.** Cooling of food as a process follows Canadian practice and must be achieved within 6 hrs, or from 60°C to 20°C in 2 hrs, followed by 20°C to 4°C in 4 hrs<sup>6</sup>

**Combined fermentation:** see fermentation.

**Corrective Action (CA):** action that regains control of a hazard after Critical Limits or a Critical Control Point were not reached.

**Critical control point (CCP):** a point at which a potential hazard (biological, chemical or physical) must be controlled or managed because there is no other step in the process to manage the risk; after this point a specific hazard cannot be controlled. There can be different CCPs to control different hazards,



**Critical limit (CL):** an upper or lower limit of a measurable parameter that defines conditions that control the hazard at the Critical Control Point or Control Point. When the limit is reached, the hazard is controlled, and when limit is not reached the hazard is not controlled and a corrective action should be initiated. Limits should be measured, recorded, and tracked by the Operator and corrective actions initiated when limits are not reached.

**Cross contamination:** is the unintentional transfer of microorganisms, chemical contaminants (including allergens) or any foreign substance from food, person or object to another food product or surface. Surfaces include food contact, hand contact, counters, etc. and the transfer may be direct or indirect. For example, an ill food handler may directly contaminate food with dirty hands when touching and handling the food if gloves are not worn, or, the worker may indirectly contaminate the food, if the filth from the worker's hands touches a cutting board that is then used to chop salad ingredients on the cutting board, so the cross-contamination occurs from worker's hands to cutting board to salad.

**Degree-hours:** refers to a term used to assess time that fermentation of sausage spends above 15.6°C. This is calculated for *Staphylococcus aureus* control.

**Enterobacteriaceae:** are a large group of Gram-negative rod-shaped bacilli bacteria (over 100 species) that ferment glucose and are facultative anaerobes. Total and fecal coliforms are a sub-set of this group, and this group also includes *Shigella* and *Salmonella*.

**Fermentation:** is when foods made up of complex carbohydrates and proteins, for example soybeans, meats, or milk are transformed through desirable microbial activity into simpler carbohydrates, sugars, and amino acids, and preserving the food into, for example, miso (soybeans), cervelat salami (meats) and kefir (milk). Microbes that ferment foods include bacteria, yeasts, and moulds.

**Alkaline fermentation:** refers to fermentations occurring above a pH of 7 when microbes release ammonia during the fermentation process, decrease acidity and raise the pH of foods, generally to pH of 6 or higher so the final food is considered alkaline. For example, *Bacillus subtilis* starter culture will ferment soybeans to make natto in an alkaline fermentation. Spontaneous fermentations in fish with high levels of urea in their tissue, will also release ammonia during fermentation, for example, shark or skate.

**Combined fermentation:** occurs when more than one type of microbe is involved in the fermentation process, such as yeasts, bacteria and moulds in the fermentation of tea into kombucha via way of a SCOBY – or symbiotic culture of bacteria and yeast.

**Spontaneous fermentation:** also known as natural or wild fermentation, occurs when naturally occurring microbes on the food substrate, under optimal conditions, allow for fermentation to proceed. Introduction of salt would allow naturally occurring lactic acid bacteria to grow, reducing pH, when making, for example, sauerkraut or kimchi out of cabbage.

**Food and Agriculture Organization (FAO):** is an agency of the United Nations that is focused on world hunger and food security with membership including Canada, the European Union and 193 other countries (2024), <https://www.fao.org/about/about-fao/en/>. The FAO had its first session in Quebec City in 1945.

**Food flow chart:** this is a diagrammatic representation of the food recipe and process steps. In the fermented food guidance it includes identification of control/check points and critical control points in the process, along with critical limits, best practice and control measures for food safety.

**Food safety plan (FSP):** is a written document that identifies hazards and control steps in the process of food manufacture, distribution, and service of the food (e.g., in restaurants) or shelf-life of the food (e.g., manufacturer). FSPs may follow some or all of the seven steps of a Hazard Analysis Critical Control Point (HACCP) plan and may or may not be regulated by food governing authorities.

**Good manufacturing practices (GMPs):** are practices conforming to guidance recommended by food manufacturing agencies and industry. They include methods, equipment, premises, sanitation and hygiene best practices, and also include regulatory controls.

**Hazard:** In food safety, a hazard is any biological, chemical, or physical property that can cause a food to be unsuitable for consumption, such as food spoilage, or unsafe for human consumption, causing injury, illness or death.

**Biological hazard:** includes bacteria, parasites, fungi (moulds) and viruses. These may be naturally occurring in the food and an uncontrolled hazard, such as yeast spoilage, or introduced, such as norovirus contamination of food by an ill food handler.

**Chemical hazard:** include any chemical, such as a food preservative, allergen, pesticide or sanitizer, that can cause food process failure, or illness when food is consumed. For example, lead glazing of fermenting pots or excess sodium nitrite, although an allowable food preservative, if added in too high of a concentration, can cause illness.

**Physical hazard:** They are objects such as pieces of glass, metal, wood, that contaminate food. These may be introduced with ingredients (for e.g., stones in cabbage), or result from the process (for e.g., broken blender blades).

**Hazard Analysis Critical Control Point (HACCP):** A systematic preventive approach to food safety from biological, chemical, and physical hazards in production processes that can cause the finished product to be unsafe, and designs measurements to reduce these risks to a safe level.<sup>1</sup> The seven HACCP principles are (1) hazard analysis, (2) critical control point identification, (3) establishment of critical limits, (4) monitoring procedures, (5) corrective actions, (6) record keeping, and (7) verification procedures.

**Hermetically sealed:** any type of seal that makes a container air-tight preventing exchange of atmospheric air with the package, including cans, sealed jars, and vacuum-packs. Hermetically sealed containers, in food safety, are a type of reduced oxygen packaging (ROP).

**Heterofermentative.** Multiple fermentative products are being synthesized by a mixed microbial culture, e.g., LAB are producing lactic acid, acetic acid, ethanol, diacetyl, etc.

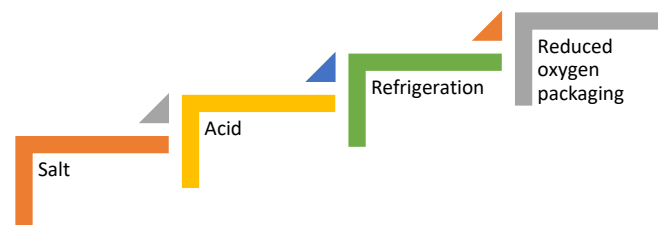
**Histamine:** is a harmful biogenic amine that causes illness and may be formed by microbial activity in a fermentation. Histamine is often linked to temperature abuse of tuna and other scombroid fish, where bacteria break down naturally occurring histidine in the muscle tissue of the fish and convert it to histamine.

**Homofermentative.** Predominantly one fermentative product is being synthesized by a mixed microbial culture, for example, LAB are producing lactic acid.

**Hot-pack:** refers to food processing method of placing hot food into hot, sterilized jars or other packaging before sealing.

**Hot-water bath canning.** See canning.

**Hurdle, microbial hurdle:** a hurdle is an obstacle or blockage. A microbial hurdle is a condition that limits or prevents microbes from growth or activity, for example, acidic pH, salt and lack of moisture (low water activity) that prevent microbial growth or survival. The more hurdles, the more difficult for harmful microbes to survive in food.



**Indicator organism:** in food and water microbiology, an indicator organism refers to a microbe that can be quickly, easily and cheaply tested that would provide information on whether harmful microbes were likely to occur in the sample. For example, a positive fecal coliform result indicates the potential for harmful shigatoxigenic *E. coli* to also be present.

**Lactic acid bacteria (LAB):** refers to Gram-positive, non-spore forming rods or cocci that are aerotolerant and facultative anaerobes. Genera of this group of bacteria include *Lactobacillus*, *Lactococcus*, *Leuconostoc*, *Pediococcus*, *Streptococcus*, *Enterococcus*, and many others. They have hetero and homo-fermentative pathways, and during LAB fermentation, the mixed fermentation (hetero) will lead to a more homogenous population of LAB. Their metabolic processes lead to production of lactic acid (lowering food pH) and other microbial inhibitors, including organic acids, bacteriocins, hydrogen peroxide, ethanol, diacetyl, depletion of nutrients and low redox potential.<sup>7</sup>

**Lacto-fermentation:** refers to lactic acid bacteria fermentation.

**Log reduction:** is the logarithmic base of 10 reduction of microbes by some means, such as a thermalization (cook) process. For example a 1-log reduction ( $1 \log_{10}$ ) would be a 90% or 10X reduction in a bacterial population. If the starting microbial population was 543 colony forming units (CFU) per mL then a 1- $\log_{10}$  reduction would mean 54.3 CFU/mL were remaining.

**Log sheets:** refer to observation records during food processing, for example, recording the temperature and time of a fermentation process, recording pH or aw, recording batch numbers for food identification, and many others. Log sheets may be written on paper or kept electronically. Generally these records are used to measure critical control points, record corrective actions, and other important information about foods.

**Microbial:** refers to a micro-organism or microbe, including bacteria, fungi (yeast or mould), or virus that is small enough it must be visualized under a microscope.

**Modified atmosphere packaging (MAP):** is a type of packaging with reduced amounts of oxygen, and higher amounts of nitrogen and carbon dioxide to allow for suppression of aerobic spoilage agents and longer shelf-life of packaged foods.

**Moulds:** are multi-celled and filamentous fungi. The term moulds is often used generically for the reproductive spores of a type of fungi, for example, blue-white coloured *Penicillium* mould, or gray-black coloured *Aspergillus* mould.

**Moulds and yeasts test:** refers to microbial testing for fungi spoilage organisms, including moulds and yeasts, on specialized microbial low pH agar, such as Sabouraud Dextrose or Rose Bengal agar and often contains bacterial inhibitors such as chloramphenicol.

**Mycotoxin:** is a toxic substance produced by fungal microbes, for example, aflatoxin produced by the mould, *Aspergillus*.

**National outbreak reporting system (NORS):** is a web platform used in the United States that allows states to report food and water outbreaks, including searchable outbreak data  
<https://www.cdc.gov/nors/index.html>

**Natural fermentation:** see fermentation.



**Nitrate and Nitrite:** nitrates have one nitrogen and three oxygen atoms (NO<sub>3</sub>) and nitrites have one nitrogen and two oxygen atoms (NO<sub>2</sub>), for example sodium nitrate (NaNO<sub>3</sub>) potassium nitrite (KNO<sub>2</sub>), etc. These chemicals are used as bacterial inhibitors and preservatives.

**Operator:** refers to the person in charge, or owner of a food premises manufacturing food.

**Organic acids:** are carbon containing chemicals that are often weak acids. Many types of organic acids are formed during fermentation processes, such as lactic acid. Addition of organic acids may also be recommended to lower acidity in a food, for example, adding acetic acid (vinegar) or citric acid. Examples of organic acids include acetic, citric, formic, lactic, oxalic, butyric, folic, uric and tartaric.

**Pasteurization:** is a process of food preservation using heat to eliminate pathogens and extend shelf life. Heat treatment destroys or inactivates microorganisms and enzymes that if present could cause illness or food spoilage.

**Flash pasteurization:** is a type of high-temperature-short-time (HTST) pasteurization often used to inactivate pathogens in juices and other foods. Foods are rapidly cooled after this pasteurization step. For fermented foods, HTST may be a term used to describe blanching of vegetables, the purpose is to remove spoilage agents prior to initiation of fermentation with starter culture.

**Pathogens:** are micro-organisms that can cause foodborne or other illness, such as bacteria *Listeria monocytogenes*, or parasite *Trichinella nativa*, or moulds *Aspergillus* or virus norovirus .

**pH:** is a measure of acidity or basicity of a product, where a pH of 7 is considered neutral and less than 7 are acidic (pH<7) and above 7(pH>7) are basic. The pH scale is logarithmic and goes from a pH of 0 (acid) to a pH of 14 (alkaline). The figure imitates the reaction of broad spectrum pH paper to fermented foods and other products.



**Poly-γ-glutamic acid (PGA):** refers to the characteristic stringy, sticky metabolite of *Bacillus subtilis* produced during the fermentation of soybeans into natto. PGA has also been linked to delayed onset allergic reactions in susceptible individuals.

**Potentially hazardous foods (PHF):** food with intrinsic properties favorable to microbial growth. For example moist (high water activity), neutral (pH of 7), high-protein or high-carbohydrate-rich food (source of nutrients) such as meats and rice.

**Prebiotic:** is referring to an ingredient that will stimulate the growth of a probiotic.

**Premises:** a place or location where food is manufactured.

**Prerequisite programs:** are programs and written policy standards captured under GMPs and HACCP necessary to produce safe goods (e.g., foods). Typical prerequisite programs include hygiene and sanitation, pest control, shipping and receiving, equipment and preventative maintenance,

environmental monitoring, employee training, employee wellness and vaccination programs, food recall programs and others.

**Preventative Control Point (PCP):** is a food safety term referring to the procedures, practices and processes that will minimize or prevent a hazard (vs. CCP or critical control point which is a control for a food safety hazard).

**Process flow diagram:** a diagrammatic representation of the food manufacturing steps.

**Product Specification Sheet (PSS):** see Certificate of Analysis (CoA).

**Probiotic:** is a microbe culture that is considered beneficial for health and improvements in microbiome for humans and other organisms.

**Public Health Agency of Canada (PHAC):** is an agency of the federal government of Canada with a mandate of preventing illness and disease (e.g., foodborne outbreaks) on a national scale.

<https://www.canada.ca/en/public-health.html>

**Publicly available international foodborne outbreak database (PAIFOD):** is a Canadian repository of local and international outbreaks managed by PHAC.<sup>8</sup>

**Putrefaction:** another term for spoilage, decay or rot.

**Ready-to-eat (RTE) foods:** refers to foods that are ready for immediate consumption at the point of sale. RTE foods may be raw, cooked, served hot or chilled, packaged or unpackaged, and are consumed without further treatment (e.g., without further heating).

**Reduced oxygen packaging (ROP):** is packaging that excludes or reduces atmospheric oxygen. ROP includes all types of reduced oxygen packaging such as hermetically sealed or vacuum packaged foods that exclude all air, and modified atmosphere packaging (MAP) that excludes some oxygen (including scavenger type packaging), and controlled atmosphere packaging (CAP) or controlled atmosphere storage where levels of nitrogen, carbon dioxide and oxygen are controlled in a package or in a building or a room to extend shelf-life of foods.

**Relative humidity:** is the amount of moisture in the air or in packaging and is affected by temperature and pressure. High humidity might lead to food spoilage, and low humidity might cause moisture loss in foods (lowering water activity,  $a_w$ ). During sausage fermentations if the humidity is too low, this can lead to outer case hardening preventing loss of moisture from the sausage that can set up conditions for botulism toxin formation. During tempeh fermentation, prolonged low humidity can lead to *Rhizopus* moulds sporulation, creating unsightly black spores on the tempeh surface.

**Ripening:** refers to a process where fruit becomes sweeter from release of ethylene gas by the fruit. This term has a different meaning when used to describe fermentation processes. For sausage, ripening refers to aging time during the fermentative process when sausages are hung. During this ripening time, the sausage will dry out, acquire flavours and become microbiologically and chemically stable. For fesikh, ripening refers to the time when fish is held for 24 hrs at 30°C, prior to addition of salt and initiation of fermentation. This putrefaction step is recognized as high risk, the purpose is to allow the fish to soften.

**Room temperature:** see ambient temperature.

**Sanitizer:** is a chemical substance used to reduce the numbers of microbial organisms on food contact surfaces for example, counters, utensils and purposely designed for food-processing equipment use.

**Sanitation plan:** is a written plan that describes how equipment, utensils and the premises are cleaned and sanitized. This may form part of the prerequisite program for a premises, may or may not be regulated, and should include log-sheets of activities performed. The plan should describe the cleaners and sanitizers used, how to make the solutions (steps for dilution), how to verify the concentration, how often an item is cleaned (e.g., once per day for floors, once per month for cleaning out drains) and when to clean (e.g., in the evening after closing for floors, last Sunday of every month for drains). The sanitation plan should include the basic steps for cleaning and sanitizing the item, for example, how to clean floors, or to remove and clean a floor drain, or how to disassemble, clean and sanitize a meat slicer.

**Shelf life:** is the length of time a food may be suitable for consumption. The date assigned does not imply the food is free from harmful microbes, rather it is the best estimation of when the food will retain the most desirable food taste and texture.

**Shelf life study:** a study of the shelf life will test how long the food retains optimal characteristics, such as taste, texture and smell (sensory evaluation), how long until the spoilage occurs (e.g., via microbial testing of moulds and yeasts), and assess how the food performs under consumer temperature abuse conditions.

**Shigatoxigenic *E. coli* (STEC):** refers to disease causing Gram-negative *E. coli* bacteria that have the ability to produce shiga-toxin, a toxin that causes bloody diarrhea and illness when foods contaminated with this bacteria are consumed.

**Smearing:** is a term used in sausage making. It refers to the fat pieces that are added to a meat mixture and stuffed into sausages. In fermented, dry-cured sausages, smearing may prevent moisture loss when sausages are being dried. Also, smearing refers to fat texture and meats getting pasty during grinding. Meat and added fat must be kept cold enough, otherwise fats will smear, and not stay as individual pieces. This compromises the texture and flavour of the sausage.

**Spoilage:** a change that deprives foods of good properties so that it becomes unacceptable for consumption. Different issues cause spoilage: insect damage, desiccation, over-ripening, and microbial spoilage when microbes transform the food into something unpalatable.<sup>7</sup> Interesting to food fermentation, the same microbes that cause beneficial fermentation can also cause spoilage.

**Spontaneous fermentation:** see fermentation.

**Spore-forming bacteria:** these are generally Gram-positive bacteria that have two types of bodies, a vegetative bacterial cell for growth and reproduction and a hard shell that is resistant and able to survive harsh environments, for example, can survive dry periods, inhabit soils, resistant to boiling, etc. Spores on foods, when conditions are optimal, can germinate or grow, and some have the ability to form toxins that can cause illness, for example, *Clostridium botulinum*, *C. perfringens* or *Bacillus cereus*.

**Standard plate count (SPC):** see Aerobic plate count (APC).

**Starter culture:** a starter culture is a microbial mixture used to initiate a fermentative process.

**Supplier Quality Assurance (SQA):** see Certificate of Analysis (CoA).

**Symbiotic culture of bacteria and yeast (SCOBY):** refers to a specific type of combined fermentation in manufacture of kombucha. The SCOBY looks like a floating fungal mat on top of the fermenting tea, sometimes referred to as the 'mother' culture, and includes the microbial liquid culture.

**Total volatile basic nitrogen (TVB-N):** Volatile compounds (trimethylamine, ammonia and dimethylamine) are considered as TVB-N and are produced as a result of destructive activities of microorganisms. TVB-N is used in industry to monitor freshness and the quality and safety of seafood products. For example, the TVB-N for white fish should be <20mg N/100g.

**Vacuum-packed:** is a type of reduced oxygen packaging that excludes all atmospheric air.

**Validated recipe/research-based recipe:** refers to a recipe that has been approved by a knowledgeable process authority. These recipes may be found on authoritative government sites, for example, canning recipes recommended by the USDA, <https://nchfp.uga.edu/> or those tested and verified by research (e.g., challenge studies), or approved by local authorities.

**Vinegar:** is a dilute solution of acetic acid in water. In the U.S., vinegars are required to contain at least 4% acetic acid, commonly household vinegar is at 5% and can vary up to 8%. It is made through a two-step fermentative process. In the first step, yeasts feed on sugar or starch from a substrate sources (for e.g., fruits, grains, potatoes, rice) and create alcohol. In the second step, acetic acid bacteria convert the alcohol to vinegar over weeks to months.<sup>9</sup>

**Washing:** food substrates (e.g., vegetables) may be washed prior to spontaneous fermentation. For example, cut cabbage may be rinsed in water before salting (for sauerkraut) or after salting (for kimchi). Washing generally refers to rinsing (the substrate) in potable water, but can include flash pasteurization by immersion in hot-water (also known as blanching), or sanitizing with a food-grade chemical (e.g., 100ppm food-grade chlorine bleach) before fermentation.<sup>10</sup> For example, flash pasteurization of peppers at 85°C for 2 min will inactivate enzymes that result in undesirable tastes.<sup>11</sup> Although washing, pasteurizing, or sanitizing vegetables will reduce overall microbial loads, residual fermentative LAB will be present allowing a wild fermentation to proceed.

**Lye washing:** refers to immersion of food substrate into a dilute solution of 1-2% lye (sodium hydroxide, NaOH) prior to fermentation. This is also known as a debittering step. Used for olives, carrots and other foods, this step will help remove waxy layers, stabilize cell walls, and remove bitter flavours. Food substrates are washed again several times in potable water before fermentation begins.

**Water activity or  $a_w$ :** is a measure of the available water or moisture content of the food, important as all microbes require water for their metabolic processes. The water activity scale ranges from 0 to 1. While most bacteria will not grow below a water activity ( $a_w$ ) of 0.92, some fungi are able to grow under very dry conditions, at  $a_w$  of 0.61.<sup>7</sup>

**Wild fermentation:** see fermentation.

**Yeasts:** are single-celled microbes in the fungi kingdom and occur naturally on many foods, such as fruits, vegetables and grains.

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