



Safe Plates for Home Food Preservation
Fermentation

Learning Objectives

- Define fermentation
- Discover how lactic acid bacteria aids in fermentation
- Understand the basics of fermentation and conditions needed for fermentation
- Identify common fermented foods

Learning Objectives

- Demonstrate the basic process of fermenting foods and using approved equipment
- Identify different storage methods for fermented foods
- Discover additional fermentation resources

Key Terms

- **Fermentation** – conversion of carbohydrates (sugar and starches) into alcohol and carbon dioxide
- **Lactic acid bacteria (LAB)** – bacteria that breaks down a food and produces lactic acid
- **Lacto-fermentation** – metabolic process that converts sugar to acids, gases, and/or alcohol
- **Culture** – a starter has been introduced rather than relying upon organisms that are spontaneously present

Key Terms

- **Pathogens** – microorganisms that cause disease
- **Spoilage** – process that occurs that makes food unacceptable to consume; spoilage may be attributed to spoilage microorganisms
- **pH** – a measurement of how much acid or base is in a substance
- **Cross-contamination** – the transfer of a harmful substance from one food item to another, usually from raw to cooked or ready-to-eat food



The Basics of Fermentation

Discussion

What are the reasons why people ferment food?



Reasons to Ferment

1. Preservation
2. Flavor
3. Tradition
4. Potential health benefits



Discussion

Which of the following is safer to eat: Raw or fermented vegetables? Why?



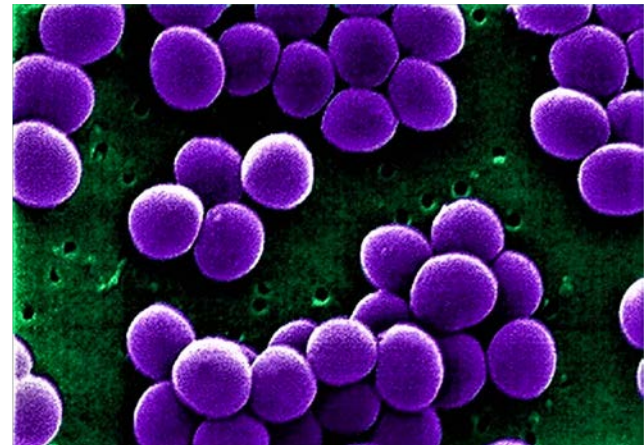
Pathogens of Concern

- *E. coli* O157:H7
 - Acid resistant
 - Reduction of *E. coli* in fermented product depends on time and pH
- *Clostridium botulinum*
 - Concern when canning sauerkraut or other vegetable fermentation
 - Can not survive below pH 4.6

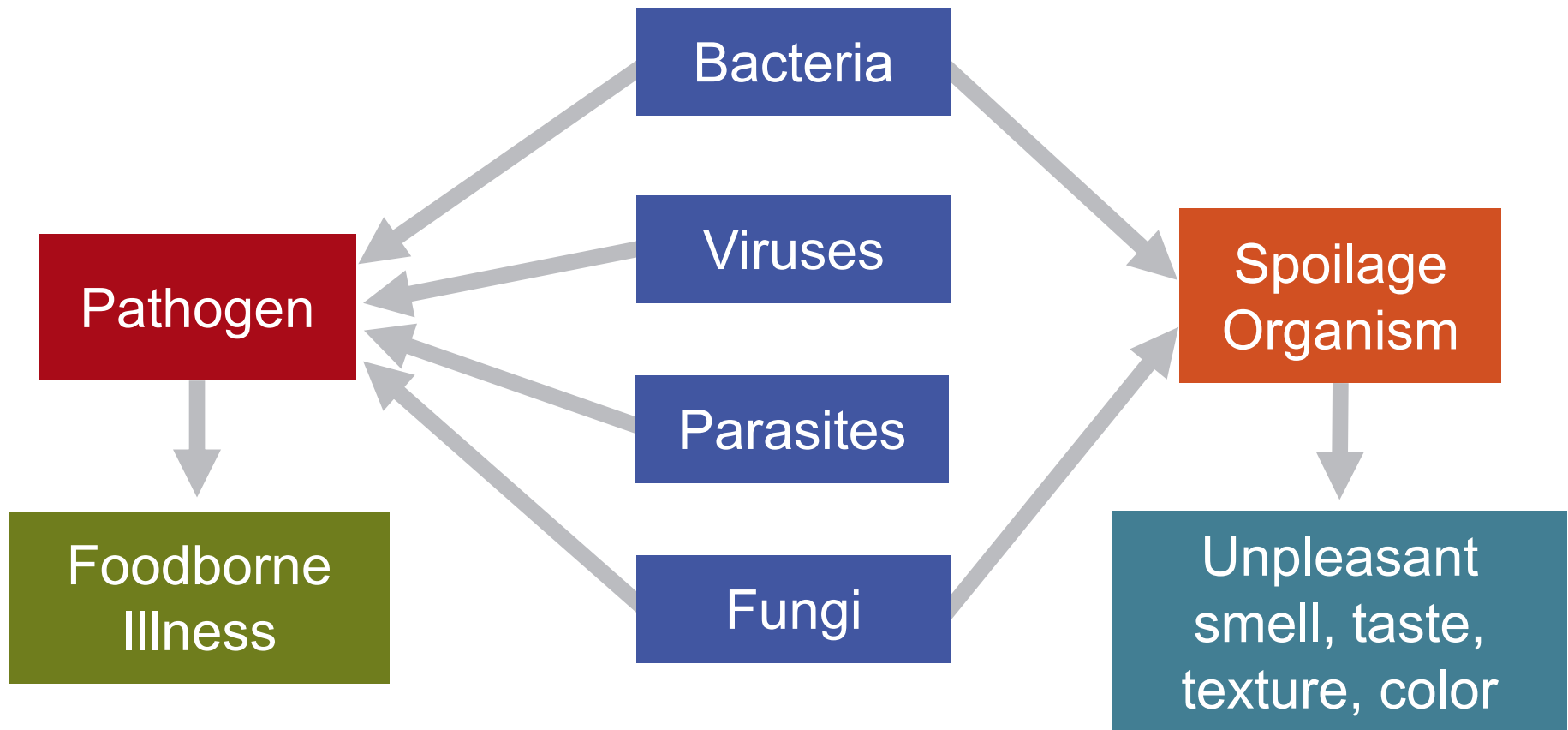


Pathogens of Concern

- *Staphylococcus aureus*
 - Concern with yogurt fermentations
 - Acid resistant
 - Produces toxin
 - Commonly found in nasal passages and skin of humans



Pathogens vs. Spoilage Organisms



Lactic Acid Fermentation Process

- Create an environment that selects for the growth of lactic acid bacteria
- LAB grow using sugars as fuel and produce acid lowering the pH so that other bacteria can't grow
- Desired flavor and texture change of product is achieved



Vegetable Fermentation Process

- In the first 48 hours, vegetables have begun to transform:
 - Foaming or bubbles will start to form as bacteria breaks down carbohydrates
 - Color, flavor, texture will change
 - Brine will start to become clear
- Check fermenting foods several times a week



Cross-Contamination

- After the fermentation process, ensure that fermented foods do not come into contact with:
 - Other foods
 - Unwashed hands or other bad sanitary habits
 - Unclean food contact surfaces





Conditions for Fermentation

Conditions for Fermentation

- Create an environment that encourages growth of bacteria responsible for fermentation
- Conditions to manipulate for optimum growth
 - Acidity
 - Temperature
 - Oxygen
 - Moisture
 - Salt
 - Nutrients



Acidification

- An acidic environment encourages growth of bacteria responsible for fermentation
- Advantages:
 - Minimizes spoilage microorganisms
 - Reduces pathogenic microorganisms and prevents development of toxins
 - Flavor and texture modification



Temperature

- Different optimum fermentation temperatures for different ferments
- Temperature too high
 - Encourages growth of unwanted bacteria
 - Creates potential for spoilage
- Temperature too low
 - Does not encourage growth of lactic acid bacteria



Salt

- Two methods: dry-salting and brining
- Affects type and extent of microbial activity
- Helps keep vegetables from becoming soft
- Measure salt carefully and by weight during preparation process
- Use canning or pickling salt without anti-caking agents



Foods to Ferment



Sauerkraut

Sauerkraut

- Originated in China
- Naturally fermented product using cabbage and salt
- Bacteria needed for fermentation is present on the cabbage
- Sour taste is created when fermentation bacteria convert cabbage's carbohydrates to lactic acid



Sauerkraut Equipment

- Wide mouth glass jar
- Ceramic crock
- Food grade porcelain container
- Food grade plastic
- Measuring spoon



Sauerkraut Equipment

- Sharp knife
- Mandolin (optional)
- Vegetable pounding tool (tamper)
- Food weight or sealable food grade plastic bag
- Boiled cheesecloth/muslin



Sauerkraut: Understanding the Science

- LAB use sugars and other nutrients released from cabbage leaves to grow
- Fermentation process
 - *Lactobacillus* works together to break down sugars and convert them to acid
 - Acid prevents growth of unwanted bacteria and creates desired flavor
- pH typically drops to between 3.2 and 3.4

Sauerkraut: Understanding the Science

- Final product of kraut fermentation includes:
 - Lactic acid
 - Small amounts of acetic and propionic acids
 - Gas mixtures consisting mainly of carbon dioxide
 - Small amounts of alcohol
 - Aromatic compounds



Sauerkraut: Getting Started

- Start with fresh, firm heads of cabbage
- Determine amount of salt to use by weighing cabbage and using three tablespoons per five pounds of shredded cabbage
- Work with approximately five pounds of cabbage at a time
- Follow proper sanitation practices during preparation
 - Wash hands properly
 - Use clean equipment, utensils and surfaces



Sauerkraut: Basic Steps

- Prepare cabbage
 - Discard outer leaves, remove spoiled or damaged spots
 - Rinse under cold water
 - Thinly slice or shred cabbage into uniformly sized pieces
- Salt cabbage
 - Place cabbage in larger container and layer with salt
 - Mix thoroughly with clean hands
 - Allow cabbage to rest 5-10 minutes so that it wilts and juices are released
 - Massage cabbage until it is soft and juice draws out of cabbage

Sauerkraut: Basic Steps

- Pack container
 - Use tamper or hands to tightly pack cabbage into a suitable fermentation container until cabbage is about 2-4 inches from the top of container
 - Ensure cabbage is covered with about 1 inch of brine
 - Leave 1 inch of headspace above brine
 - Cover and weigh down cabbage



Sauerkraut: Basic Steps

- Ferment
 - Store container in a well-ventilated location with a temperature of 68-72°F for 7-14 days
 - Check that cabbage is under brine after about 2-3 days or once bubbling has stopped
 - Remove and discard any white or pink yeast scum from the surface
 - Taste after about 7 days and store or continue fermenting based on desired taste

Storage: Canning

- Use boiling water bath canner
- Follow a tested recipe
- Test jar seals after processing
- Store in a clean, cool, dark, dry place (50-70°F)



Storage: Refrigeration

- Flavor preference determines when to refrigerate
- Tightly cover container leaving $\frac{1}{2}$ inch headspace
- Keep kraut covered with brine
- Release pressure from the built up gases
- Refrigerate for up to 3 months for best quality
- Remember bacteria will continue to ferment slowly

Storage: Freezing

- Set freezer at 0°F
- Place in freezer bags
 - Bags may be placed inside plastic containers for protection from leakage
- Beneficial bacteria may die during the freezing process





Kimchi

Kimchi

- Originated in Korea
- Naturally fermented vegetables including Napa cabbage, radishes, green onions, garlic, ginger, and Korean red pepper
- Bacteria needed for fermentation is present on raw ingredients
- Short fermentation time of 1 - 2 days



Kimchi Equipment

- Food processor or blender
- Sharp knife
- Cutting board
- Measuring cups, spoons and mixing utensils



Kimchi Equipment

- Saucepan
- Food grade plastic or glass storage container
- Large mixing bowl (glass, plastic or stainless steel)
- Single-use gloves



Kimchi: Understanding the Science

- Differs from sauerkraut
 - Less acid and is carbonated
 - Made from Chinese cabbages and radishes and typically contains garlic, green onion, ginger and hot pepper
- Bacteria responsible for fermentation include *Lactobacillus*, *Streptococcus* and *Pecicoccus* species found on cabbage leaves

Kimchi: Understanding the Science

- Sugars are converted to lactic acid, acetic acid, carbon dioxide and ethanol by the LAB
- Fast fermentation
 - Longer salting or brining time
 - Desired flavor of kimchi achieved earlier in fermentation process as compared to sauerkraut
- Optimum final pH of 4.2 to 4.5

Kimchi: Basic Steps

- Prepare cabbage
 - Use Napa cabbage
 - Discard outer leaves and any bruised or damaged spots
 - Rinse under cold water
 - Remove core of cabbage
 - Cut cabbage into 2 inch pieces



Kimchi: Basic Steps

- Salt cabbage
 - Prepare saltwater solution
 - Dip cabbage in solution
 - Drain and place cabbage in a bowl
 - Salt with 1 cup of non-iodized salt
 - Massage into cabbage
 - Allow cabbage to sit at room temperature for 3 to 6 hours
 - Rinse cabbage 3 to 4 times with cold water
 - Drain in colander 30 minutes



Kimchi: Basic Steps

- Prepare seasonings
 - Boil water and sweet rice flour then set aside to cool
 - Mince garlic and ginger and mix with sweet rice flour and Korean red pepper powder to make a seasoning paste
 - Slice Julienne style radish, green onions, and an Asian pear (if so desired)
 - Mix sliced vegetables and fish sauce with seasoning paste
 - Combine cabbage with veggie paste



Kimchi: Basic Steps

- Pack container
 - Pack kimchi tightly until it is two-thirds full
 - Cover tightly
 - Place in container to catch any overflow
- Ferment
 - **Option 1:** Place at room temperature for 1 - 2 days
 - **Option 2:** Refrigerate for 3 - 4 days
 - Taste regularly until desirable flavor achieved



Kimchi Storage

- Store in a tightly closed container
- Refrigerate immediately
- Keep kimchi packed down to reduce exposure to air
- For best quality eat within 1 week as the quality of kimchi deteriorates over time





Fermented Dill Pickles

Fermented Dill Pickles

- Originated from Tigris Valley area of India
- Naturally fermented cucumbers
- Uses brine containing vinegar and seasonings
- Bacteria for fermentation is present on the cucumbers
- Ferments approximately 3 to 4 weeks



Fermented Dill Pickles Equipment

- 1-gallon container such as stone crock, food-grade plastic or glass containers
- Measuring cups and spoon
- Plate or glass pie plate for keeping cucumbers under brine



Fermented Dill Pickle Equipment

- Heavy towels
- Unchipped enamelware, stainless steel, aluminum or glass pan for heating pickling liquid
- Wide-mouth jars



Fermented Dill Pickles: Understanding the Science

- Soaked in brine solution that draws sugar and water out of cucumbers
- *Lactobacillus* convert sugars to acid
- Color change from bright green to olive green a result of acids interacting with chlorophyll
- Interior color change from white to translucent is result of air being forced out of the cells

Fermented Dill Pickles: Basic Steps

- Prepare cucumber
 - Select un-waxed mature pickling cucumbers
 - Wash cucumbers
 - Remove the blossom end by cutting 1/16 slice off
- Prepare brine of canning salt, vinegar and water



Fermented Dill Pickles: Basic Steps

- Pack container
 - Place dill and spices in suitable container
 - Add cucumber and additional dill and spices
 - Pour brine over cucumber
 - Add weight to container
- Ferment
 - **Option 1:** Place at room temperature for about 3 to 4 weeks
 - **Option 2:** Place at cooler temperature, 55 – 65°F, for 5 to 6 weeks
 - Check containers regularly and remove scum or mold
 - Throw away pickles if they become soft, slimy or smell bad

Storage: Refrigeration

- Flavor preference determines when to refrigerate
- Tightly cover container leaving ½ inch headspace
- Keep pickles covered with brine
- Use within 4 to 9 months for best quality
- Release pressure from the built up gases
- Remember: Bacteria will continue to ferment



Storage: Canning

- For shelf stable storage
 - **Option 1:** Process using boiling water bath canner
 - **Option 2:** Process using low-temperature pasteurization
- Follow tested recipe
- Test jar seals after processing
- Store in a clean, cool, dark, dry place (50 to 70°F)



Vegetable Fermentation Tips

- Keep ferments away from direct sunlight
- Cut vegetables like carrots or beets into small pieces
- If recipe calls for water, be mindful of chlorine levels that may affect the fermentation process



Fermenting Vegetables Safely

- Use good quality fresh vegetables that have not been exposed to manure or compost
- Wash produce, hands, preparation surface and all equipment before starting recipe preparation
- Consider the following when fermenting vegetables
 - Measure ingredients carefully as the proportions of acid, salt, food and water are important
 - Mix recipes well so that there is a uniform level of acid throughout the product





Yogurt

Yogurt

- Fermented milk product that originated in Eastern Europe and Western Asia
- Uses a starter culture or “mother” culture
- Short fermentation time



Yogurt Equipment

- Double boiler (optional) or pot
- Thermometer
- Mixing bowl
- Whisk or spoon to mix
- Measuring cups and spoons
- Food-grade plastic or glass containers



Yogurt Equipment

- Sterilized strainer or boiled muslin
- Incubator:
 - Oven
 - Insulated cooler
 - Crockpot
 - Commercial yogurt machine



Yogurt: Understanding the Science

- Differs from vegetable ferments in that it requires heat in addition to acidity
- Bacteria responsible for fermentation include *Streptococcus* and *Lactobacillus* species
- These bacteria ferment sugars in the milk into lactic acid
- Final pH about 4.0



Yogurt: Basic Steps

- Heat milk in a double boiler to 180°F
 - Maintain temperature for 10 minutes for thinner yogurt and 20 minutes for thicker yogurt
- Allow milk to cool to between 108 and 115°F
- Add yogurt culture
 - **Option 1:** Add 2 – 3 tsps. of new culture per cup of total milk being used for yogurt
 - **Option 2:** Add ¼ cup of commercially produced yogurt containing live cultures



Yogurt: Basic Steps

- Stir gently
- Pour milk/yogurt starter mixture into clean, sterilized warm containers and cover
- Cover and incubate for 6 to 10 hours looking for desired consistency
 - Oven
 - Insulated cooler
 - Crockpot
 - Commercial yogurt machine



Yogurt Storage

- Refrigerate once congealed stopping bacterial growth that produces acid
- Shelf life is 10 - 21 days in refrigeration (41°F or below)
- Discard any yogurt that shows signs of spoilage



Yogurt: Food Safety

- Two hurdles prevent bacteria growth
 - Heat
 - Acidity
- Use commercially pasteurized milk
- Use clean and sanitized equipment
- Use clean and sterilized strainer or boiled muslin, If straining yogurt to make Greek style yogurt
- Wash hands when preparing yogurt





Kombucha

Kombucha

- Originated in China
- Fermented sweet tea produced using a symbiotic colony of bacteria and yeast (SCOBY)
- Continue to add sweetened tea to fermenting vessel
- Discard SCOBY and kombucha if any mold growth occurs



Kombucha Equipment

- Measuring cups and spoons
- Large glass jar, stainless steel or food grade plastic for brewing
- Funnel
- Coffee filter or clean fine weave towel
- Bottle or jars



Kombucha: Food Safety

- Use sterile containers and utensils
- Use black or green tea
- Sweeten the tea as sugar is needed for fermentation
- Cool tea rapidly and reduce the pH by adding starter culture quickly
- Ferment at room temperature or slightly cooler (>62°F), not in the sun or outside

Kombucha: Storage

- Option to store at room temperature for 1-3 days
 - This will allow for potential carbonation
 - Be aware carbon dioxide can accumulate and explode the bottle
- Refrigerate immediately



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Resources



Extension Resources

- Colorado State Farm to Table: Fermented Foods;
<http://farmtotable.colostate.edu/prepare-ferment.php#.Wse5QBPwbLY>
- Washington State University Extension: Yogurt Made Simple; <http://extension.wsu.edu/clark/wp-content/uploads/sites/36/2014/04/Yogurt-FS173E.pdf?x24221>
- National Center for Home Food Preservation;
<http://nchfp.uga.edu/>



Review

- Lactic acid bacteria
- Basics of fermentation
- Conditions for fermentation
- Typical foods to ferment and basic steps
- Approved equipment
- Storage methods
- Resources