



Fermentation is a process of breaking down foods into components. It is a safe, easy, and economical way to preserve food. Fermentation has been used for thousands of years to preserve food and is seeing a revival as people learn to ferment their own foods and beverages.

Whether the goal is to keep alive old traditions, create probiotic-rich foods, or experiment with new flavors, food fermentation is a rewarding endeavor. Microorganisms like yeast, bacteria, and mold play a role in the fermentation process, creating foods and drinks such as:

- Beer and wine
- Sourdough bread
- Sauerkraut
- Kimchi
- Yogurt
- Chocolate
- Pickles
- Tempeh
- Koji
- Miso

Lacto-Fermentation

The fermentation process results in lactic acid production from bacteria that are present on the surface of all fruits and vegetables. Lacto-fermentation refers to this process and is unrelated to lactose or sugar found in milk.

In an anaerobic or oxygen-free environment, these bacteria convert sugars into lactic acid, which inhibits harmful bacteria and acts as a preservative. It's what gives fermented foods their characteristic sour flavor.

The natural acids and other antimicrobial compounds produced by the fermenting bacteria inhibit the growth of other harmful bacteria, molds and yeasts that contribute to spoilage.

Additionally, the carbon dioxide produced during fermentation helps maintain the low-oxygen conditions necessary for the fermenting bacteria to flourish. Carbon dioxide also aids in the stabilization of flavor and color.

Of the many groups of fermenting bacteria, those from the lactic acid family are the most important in vegetable fermentation, specifically *Leuconostoc*, *Lactobacillus* and *Pediococcus* species.



Benefits of Fermented Foods

- Enhanced digestibility due to enzyme action.
- Increased vitamin levels, specifically B vitamins, and preservation of vitamins A and C.
- Improved gut health due to the presence of probiotics.
- Keep in mind that not all fermented foods bought in the store will contain live probiotics.
- Check the label for “Live Active Cultures.”

Use Quality Water

Filtered water or spring water is preferred.

Tap water usually contains chlorine, chloramines, and fluoride that must be removed before culturing. If using bottled water, check the source to be sure it is free of chemicals.

Do not use distilled water. Well water can be used, but it must be tested for contaminants before use.

Use Quality Salt

Salt used in fermentation should contain no additives. Canning or pickling salt is recommended since it contains no impurities and has a consistent granular size and weight.

Functions of salt in the fermentation process:

- Pulls needed water and sugars from vegetables.
- Aids in the growth of fermenting bacteria over spoilage bacteria, yeasts, and molds.
- Allows for crispier vegetables by hardening the plant pectin and decreasing the activity of pectinase, an enzyme that makes vegetables mushy.
- Slows the fermentation process, allows longer fermentation times, and decreases the chance of undesirable mold growth.
- Gives flavor to the final product.

Salting Methods

Dry Salting

Salt is added directly to the vegetables. After mixing in the salt, leave the mixture for 20 to 30 minutes to allow for natural juice extraction.

Massaging salted vegetables helps to speed up the process, and it usually takes 10 to 15 minutes to get enough liquid pulled out to cover the vegetables in the fermentation vessel.

Brining

Brining is best for whole or quartered pieces. Mix salt and water to form a brine before adding to the vegetables. This technique can allow for better coverage of the vegetables, lessening the risk of fermentation failure.

If there isn't enough brine to cover the vegetables from dry salting, make additional brine by mixing 1 quart of water with 1-½ tablespoons of salt.

Brine Concentrations

Shredded vegetables, such as cabbage, use a 3% concentration. Generally, use 5% salt concentrations for large vegetables, such as cucumbers and carrots.

Mix water and salt to achieve the desired concentration:

Strength	Water	Salt
3% solution	1 quart	2 tablespoons (1 ounce or 27 gr)
5% solution	1 quart	3 tablespoons (1.6 ounce or 45 gr)

*It is best to weigh salt for accuracy.

Preparation

- Wash the container, equipment, and food contact surfaces with hot, soapy water before beginning.
- Sanitizing is another crucial step. If chlorine bleach is used, the equipment should be rinsed thoroughly to remove any residues that may inhibit the growth of fermenting bacteria.
- Boiling containers for 10 minutes is also a safe method for sanitizing.



Fermentation Supplies

Tools and Equipment

Cutting, chopping, and pounding tools aid in extracting the vegetable juices necessary to cover the fermenting mixture. What is needed for chopping and cutting will depend on the desired final product.

Kraut boards, food processors, sharp knives, and mandolins all work well. Crushers, pestles, and sauerkraut pounders break the vegetable tissue, allowing more juices to be released.

Clean hands or gloved hands will also get the job done. May need to massage the shredded vegetables for 10 to 15 minutes until enough liquid has been extracted to cover the vegetables once transferred to the vessel.

Vessels and Containers

As a rule, plan to use a 1-gallon container for every 5 pounds of fresh vegetables.

- Use food-grade containers, such as glass or plastic, that are BPA-free.
- Quart-size glass jars with airlock lids are great for small batches.
- High-grade, commercial stainless steel can be used.
- **Do not use** copper, iron, or galvanized metal containers or lead-glazed crocks.

If the safety of the container is in question, err on the side of caution to avoid harmful materials leaching into your food.

Use plastic jar lids since metal lids may degrade under acidic and salty conditions.

Keeping Foods Submerged

It is critical for vegetables to remain submerged during the fermentation process to prevent spoilage. Fermenting products should be kept 1 to 2 inches below the brine's surface.

Options for Submerging Vegetables

- Ceramic or tempered glass weights
- A food-grade bag filled with brine
- Glass or pie plate in addition to the brine-filled bag
- Whiskey stones are good for smaller vessels; do not confuse whiskey stones with rocks.
- A cabbage leaf, weighted by a brine-filled bag, can help prevent vegetables from floating.

Controlling Mold

Exposure to oxygen can encourage and allow for both mold and yeast to grow. Submerge vegetables 1 to 2 inches below the juice/brine mixture to prevent spoilage.

- Use a jar with an airlock lid.
- Keep food submerged below the brine level.
- Control room temperature, keeping it ideally between 68 and 72 F.
- Select fresh, firm vegetables free of spoilage.

Call Your Local Office

Contact your local Illinois Extension office with your food safety questions: go.illinois.edu/FindILExtension.

References and Resources

- [Vegetable Fermentation](#), Virginia Cooperative Extension Fermented Vegetables, ASM Press, Washington, D.C.
- [So Easy to Preserve](#), University of Georgia Extension
- [USDA Complete Guide to Home Canning](#), USDA The Ball®Blue Book
- [National Center for Home Food Preservation](#), University of Georgia
- [What's Cooking with Mary Liz Wright](#), YouTube.com
- [Food Preservation Resources](#), University of Illinois Extension

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- Use the correct amount of salt.
- Clean and sanitize equipment and wash hands and surfaces often.

When in Doubt, Throw It Out

If the fermented product is slimy or smells spoiled or rotten, discard it. Clean and sanitize the container thoroughly and try again.

Moving to Cold Storage

Watch for these helpful signs to know when the product is ready to move into cold storage.

Bubbling

Fermented products should have bubbles in the brine mixture. This is because lactic acid bacteria produce gases, which show up in the form of bubbles.

Aroma

Fermented products should have a pleasant, but slightly sour aroma. If it smells spoiled or rotten, discard it.

Taste

Various ranges of fermented flavors will vary depending on the type of vegetables used. Generally, if a less sour product is desired, use a shorter fermentation time; allow vegetables to ferment longer for more tang. Expect subtle changes in flavor even during refrigeration as the process slowly continues.