

Fermentation 101

Yogurt

Yogurt is made by adding beneficial bacteria (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*) into heated milk. After this inoculation the milk is held at 110°F ± 5°F until firm. The milk is thickened by an increase in acidity from lactic acid produced by the bacteria.

Yogurt (Makes 4-5 cups of yogurt)

- 1-quart milk (cream, whole, low fat, or skim) — In general the higher the milk fat level in the yogurt the creamier and smother it will taste. Note: raw milk must be pasteurized before preparing yogurt.
- Nonfat dry milk powder. Use 1/3-cup powder when using whole or low fat milk, or use 2/3-cup powder when using skim milk. The higher the milk solids the firmer the yogurt will be.
- Commercial, unflavored, cultured yogurt — Use 1/4-cup. Be sure the product label indicates that it contains a live culture. Also note the content of the culture. *L. bulgaricus* and *S. thermophilus* are required in yogurt, but some manufacturers may in addition add *L. acidophilus* and/or *B. bifidum*. The latter two are used for slight variations in flavor, but more commonly for health reasons attributed to these organisms. All culture variations will make a successful yogurt.

Processing

1. Pour milk of choice into a double boiler and heat to 180°F. This will kill competing bacteria, and the whey proteins will denature and coagulate to enhance the viscosity and texture of the final product. Maintain temperature for 10 minutes for thinner yogurt, 20 minutes for thicker yogurt.
2. After the milk has reached 180°F for the desired time, remove from heat and allow to cool to 108°F to 112°F.
3. When the milk is cooled, scoop out one cup of milk into a small mixing bowl. To this cup of milk, add the 2 to 3 teaspoons of yogurt starter per cup of milk. For example, for a quart of milk add 8 to 12 teaspoons (2 1/2 to 4 tablespoons) yogurt starter.
4. Pour this mixture back into the larger portion of heated milk and stir gently. Pour milk/yogurt starter into clean, sterilized warm container. Cover and place in incubator.
5. Incubate the yogurt by setting it in a warm place for 6 to 8 hours undisturbed. The goal is to maintain constant temperature to allow the yogurt to ferment. The time will vary depending upon the size of the inoculation culture, temperature, lactose content of the milk, and/or the freshness (vitality) of the yogurt starter used. Any one or a combination of these factors will increase the time to complete the process.
6. Refrigerate yogurt immediately once the yogurt has congealed to a jell-like consistency. Rapid chilling stops the development of acid.

Incubation

1. *In the oven.* Pre-warm oven to 200°F, then turn off. Turn oven on for short periods so that the temperature does not drop below 100°F. If a gas oven is used, the pilot light may maintain the temperature.
2. *In an insulated cooler.* Fill with warm water and place jars in warm water bath. Alternatively, line the chest with a heating pad and maintain at lowest setting.
3. *In a crockpot.* The crockpot can be used to heat the milk, allowed to cool then add yogurt starter for fermentation. Wrap the crockpot in a towel and allow to set in a warm area.
4. *In a commercial yogurt machine.* These are available to maintain constant temperature. Follow instructions from the manufacturer.

Source: Washington State University Extension, Yogurt Made Simple, FS173E, 2015

Uses For Acid Whey (from yogurt)

1. Add to bread, pancake, dough, etc.
2. Submerge chunk feta, like they do in delis.
3. Makes excellent sauerkraut, fermented bean dip. Add salt.
4. Feed outdoor plants, especially acid loving ones.
5. Mix 50-50 with iced tea or juices.
6. Make crème fraiche: 1 T whey or plain yogurt plus 1 cup heavy cream. Mix well and keep in warm place 8-24 hours.
7. Thin out batch of homemade humus or pesto.
8. Use as cooking liquid for quinoa or rice.
9. Use when making oatmeal.
10. Use as buttermilk.
11. Feed to pets.
12. Add to mayonnaise to thin it & make it last longer.
13. Make sourdough starter: 1 C 2% milk. Heat to 100°. Add 3 T yogurt or whey. Cover with paper or cloth and let set 24 hours in a warm place. It will look like yogurt. Add 1 C bread flour and stir. Keep on counter 3-5 days and then refrigerate or use it. Take what you need, then add 1 C flour and 1/2 C whey. Stir and let sit until it bubbles. Refrigerate or use.
14. Smoothies.
15. Soak seeds; chia, oats, flax, quinoa, grains and nuts.
16. Use in salad dressings and sauces.
17. Feed to livestock.
18. Add to compost.

Flavored Yogurt

Add extracts during the process when you're adding the starter: lemon, almond, peppermint, cinnamon, nutmeg, ginger, honey, maple syrup, malt, agave, molasses, or stevia. Add solids after the yogurt is made and cooled down (and after you make the Greek yogurt if you're doing that): solid or fresh, canned fruit.

Other ways to make yogurt without a machine

1. You can heat and cool the milk in any size pot or pan that holds the volume you're making.
2. You can use serving size jars or larger containers. You might have to experiment to see what works for you.
3. Temperatures remain the same: heat milk to 180°, cool it to 115°. Add starter and liquid flavoring. Keep temperature at +/- 110° to 115° for 8+ hours. Heating milk by hand requires CONSTANT stirring or the milk will burn, or use a double boiler.
4. You can incubate the milk a) in an oven (turn on the light for more heat; b) in a slow cooker that stays around 110°; c) in a cooler. Preheat it with hot water at 130°, add the jars, and cover it to keep the heat in.

The longer you incubate the yogurt the more sour it will become.

Let the yogurt cool before you move it around or stir it. It has to set up first or it will turn into a liquid.

Sweet whey is a by-product of making cheeses using rennet. It is high in protein so it's often dehydrated and used in protein powders and energy bars.

Kombucha

Kombucha is a fermented, slightly sweetened and slightly tangy tea that has been around for centuries. It is thought to have a variety of health benefits and contains high levels of antioxidants, b-vitamins, and probiotics. SCOBY (Symbiotic Colony of Bacteria and Yeast) is a mix of cultures of bacteria and yeast present when making kombucha, kefir and other foods made through symbiotic fermentation.

Kombucha

Ingredients (Makes about 1 gallon)

- 1/4 cup green and/or black tea (in mesh bag), or 4-8 tea bags
- 1 gallon of filtered water
- 1 cup cane sugar
- 1-2 cups Kombucha Starter Liquid (from a previous batch)
- 1 SCOBY

Directions

1. Heat water. In brewing vessel, make tea. Steep tea for 10 minutes.
2. Remove tea leaves or bags. While water is still hot, stir in sugar and completely dissolve.
3. Allow sweetened tea to completely cool to room temperature.
Note: Alternative method to cool faster: heat only half the water in step #1, to make a strong sweet tea, then add the remaining water as cold water.
4. Once cooled to room temperature, with washed hands, add SCOBY and Kombucha Starter Liquid to sweetened tea.
5. Cover with clean cloth or coffee filter. Secure with a rubber band or bungee cord to keep insects and contaminants out but allow air flow. Record start date.
6. Allow kombucha to ferment at room temperature (ideally 64-79°F/18-26°C) for 7-14 days. A new SCOBY will develop on the surface of the liquid, starting as a light haze that gradually turns whitish, then opaque and thicker as time progresses. Check the kombucha flavor after a week. Stop fermenting when you like the flavor.
7. To “stop” fermenting: pour kombucha into clean jars or bottles sanitized by rinsing with boiling water or vinegar, retaining SCOBY and at least 1-2 cups for your next batch. Save more, at least 20%, if following continuous brew technique (see below).
8. Flavor finished kombucha as desired with 10-20% juice or clean fruit, and experiment with clean herbs and spices based on preference. Cap tightly. Leave at room temperature 1-3 days for potential carbonation or refrigerate immediately.
9. **CAUTION:** Longer time capped at room temperature could result in carbon dioxide accumulation and even explosion of the contents.

Repeat batches using continuous brew technique:

To minimize handling the SCOBY and reduce introduction of contaminants, it is better to leave the SCOBY and starter liquid in the vessel and not wash the vessel between uses, but only if it becomes built up with yeast. Gently pour in new sweetened, cooled tea along the inside of the jar to limit disturbing the SCOBY. SCOBY growth can be peeled and shared with others or stored for several weeks in a similar cloth covered vessel, covered by kombucha.

Source: Colorado State University Extension, Farm to Table

Kimchi

Makes about 2 quarts

2 medium heads Napa cabbage (about 6-8 pounds total)	1 cup Korean red pepper powder (specific “for kimchi”)
1-1/2 cups coarse salt, non-iodized, divided (baked or sea salt recommended)	1/2 Korean radish (about 1-1.5 pounds), or daikon radish
1 gallon + 1/2 cup cold water, divided	1 Asian pear (optional)
2 Tbsp. sweet rice flour	10 green onions
1-10 cloves garlic, depending on taste preference	1 tsp. fish sauce (optional)
About 3 slices fresh ginger root (about 0.2-0.4 oz.)	2 tsp. finely ground salt (optional, as needed)

1. Prepare Napa cabbage:
 - a. Rinse heads under cold water and drain. Cut away and discard any spoiled or damaged spots.
 - b. Cut Napa cabbage into four quarters and remove core from each. Chop quarters into 2-inch pieces.
2. Salt cabbage:
 - a. Prepare saltwater solution of 1/2 cup coarse, non-iodized salt and 1 gallon cold water in large mixing bowl.
 - b. Dip cabbage pieces briefly in the saltwater solution, to facilitate penetration of salt into the cabbage pieces. Discard saltwater solution.
 - c. Drain and place cabbage pieces in a bowl. Sprinkle 1 cup of coarse, non-iodized salt over the cut cabbage and massage it into the cabbage well. Allow cabbage to sit covered at room temperature for 3 to 6 hours (a longer time will make it saltier).
 - d. Rinse cabbage pieces 3 to 4 times with cold water to rinse away the salt, then place in a colander to drain out excess water from the cabbage for at least 30 minutes.
3. Prepare seasonings:
 - a. Add sweet rice flour to 1/2 cup water in small saucepan. Bring to a boil and set aside to cool.
 - b. Clean, peel, and finely mince (or use blender with small amount of water) garlic and ginger. Mix the cooled sweet rice flour paste and add Korean red pepper powder.
 - c. Clean and peel radish, clean and trim green onions, and if desired, clean and peel Asian pear. Slice all Julienne style, or into match sticks about 1 inch in length.
 - d. Using clean hands and disposable food handler gloves, mix above seasoning paste and Julienned vegetables together in large mixing bowl. Then mix in fish sauce to create a spicy veggie paste. Add salt only as needed.
 - e. Combine cabbage with the spicy veggie paste, rub together and mix thoroughly.
4. Pack container:
 - a. Pack kimchi tightly into container, minimizing air exposure and encouraging brine formation. Fill container and 2/3rd full, as fermenting microorganisms will release carbon dioxide and create bubbling and fizzing.
 - b. Cover tightly. If using jars, seal to finger-tip tight. If using bags, squeeze out excess air. Place on plate or in bowl to catch potential overflow.
5. Ferment:
 - a. Option 1: Kimchi may be placed in refrigerator so it ferments slowly over 3 to 4 days. This may be preferred, especially during hot weather.
 - b. Option 2: Place sealed container in a well-ventilated location (may become pungent), with a relatively constant room temperature, around 68°F is ideal. Ferment only 1 to 2 days at room temperature, tasting it daily until it reaches preferred tangy taste and desired texture.
6. Store and enjoy:
 - a. Store fermented kimchi covered tightly in the refrigerator. Keep it pressed down to minimize air exposure. Kimchi may become more sour over time. Discard if you observe indications of surface mold.
 - b. Kimchi can be enjoyed in countless recipes! Try it with eggs, rice, noodles, potatoes, in stir fry, fried rice, soup, pancakes, or on a sandwich or hot dog. Happy kimchi making!

Source: *Colorado State University Extension, Farm to Table*

Fermented Cabbage (Sauerkraut)

Lacto (Lactic Acid) Fermentation: Lactic acid bacteria (LAB) are present in the soil and, therefore, on the things that grow in the earth. Lacto (lactic acid) fermentation is the craft of preserving foods by methods that attract this naturally occurring good bacteria. These probiotics transform the sugar in foods into lactic acid keeping food safe from bad bacteria and other food spoilers and creating tangy-tasting ferments. There are three methods used to ferment vegetables and fruits: dry salted (sauerkraut method), brined, and kimchi (which uses a combination of dry salt and brine methods). All of these methods draw the moisture from vegetables and fruits and create brine in which the food remains submerged throughout the ferment. It is this brine that attracts good bacteria and produces the acids that create an environment inhospitable to bad bacteria. The key to a successful ferment is to keep the vegetables and fruit completely submerged in the brine.

Mold: Occasionally, mold will appear on the surface of the ferment. It can be round and fuzzy, blue, black or pink. Don't get mold confused with Kham yeast, which looks like a white milky film. Mold forms when the ferment is exposed to air, if the salt ratio is wrong, if the vegetables and tools aren't clean, if you used chlorinated water, and other things. If there are small amounts of mold forming on pieces of vegetables that are above the brine, throw those pieces away. If there is a thin layer of mold on top of the brine, either skim it off or throw the entire ferment away and start over. In theory, everything below the brine should be fine. Some people are sensitive to mold and should avoid it completely, while it doesn't affect others. If mold forms inside the fermentation jar, don't eat it! Something is wrong with it.

Step 1. Discard outer cabbage leaves, reserving one or two large, unblemished leaves, if desired, for covering the cabbage (see Step 5). Rinse heads and reserved leaves under cold running cold water and drain.

Step 2. Cut heads into halves or quarters and core. Slice or shred the cabbage to about the thickness of a quarter.

Step 3. Weigh cabbage. Working with no more than 5 pounds at a time, place it in a mixing bowl or tub and sprinkle with the correct amount of canning/pickling salt (see table below for the correct ratio of salt to cabbage). Mix well with clean hands, gently massaging the shredded cabbage, to distribute the salt uniformly. Allow the salted cabbage to stand for about 5-15 minutes, until it wilts slightly and juice begins to be drawn out.

Yield	Container Size	Cabbage	Salt
1 Quart	Quart Jar	2 lbs.	3½ tsp.
2 Quarts	Half Gallon Jar	4 lbs.	7 tsp.
3-4 Quarts	Gallon Jar or Crock	5 lbs.	3 tbsp.
6-9 Quarts	5-Gallon Crock or Bucket	25 lbs.	¾ cup

Step 4. Transfer a layer of cabbage into the fermenting container, pressing firmly with a wooden spoon, tamper, or your hand until enough juices are drawn out to cover the cabbage. Repeat until the container is filled to the desired depth and the cabbage is completely covered with 1-2" of juice. If using glass jars, fill to the shoulder, leaving room for 1-2" of juice. If using crocks, leave at least 4-5" of headspace between the cabbage and the top of the container. If the juice does not cover the cabbage, add brine (boil 1 quart of water and 1½ tablespoons of salt; allow to cool).

Step 5. Cover the shredded cabbage with the reserved leaves, if using, ensuring that the leaves are covered with 1-2" of juice. Weight down the cabbage so it remains under the juice and cover the fermenting vessel. This step is essential, since the fermentation process requires anaerobic conditions (without oxygen). If using a large crock or bucket, a brine-filled plastic bag is one of the easiest ways to both cover and weight down the cabbage. Be sure to use a clear, heavy-duty, watertight plastic bag intended for food use. Clear freezer bags sold for packaging turkeys are suitable for use on 5-gallon containers. Fill the bag with salted water (6 tablespoons salt in 1 gallon water) to a depth of 3-4", allowing the bag to completely cover the cabbage. An alternate method is to cover the cabbage with a clean cloth or clear plastic, fitting the covering snugly against the container sides. Then put a plate or other

nonmetallic disk that just fits inside the container so that the cabbage is not exposed to air. Put a weight on top of the cover so the juice comes to the cover but not over it. A jar filled with water or brine makes a good weight.

If working with glass jars, put a sterilized lid on the jar just tightly enough to keep out air, or use an airlock. A brine-filled bag as described above can also be used.

Step 6. Place the container on a tray or in a pan to collect juice that may leak out during active fermentation.

Note: Do not pour any juice that bubbles out back into the container. Set the container in a well-ventilated place with a relatively constant temperature. If kept at room temperature (70° to 75°F), large batches of kraut should be ready in 3 to 4 weeks; small batches should be ready in about 2 to 3 weeks.

At higher temperatures, fermentation will proceed more rapidly and the kraut will be ready sooner, but the kraut may become soft. If kept at temperatures lower than 70°F, fermentation will be slow, and it may be incomplete if the temperature drops to below 60°F. It is desirable to provide 70° to 75°F temperatures during the first several days to begin production of the acid that will preserve the cabbage. Then, if you want a slower fermentation, the container could be stored in a cooler area such as a basement or unheated garage. If the temperature drops below freezing, fermentation will stop, but will start again when the temperature rises into a favorable range.

Step 7. Check the kraut 2-3 times per week (or even daily) and remove any scum if it forms. If any discoloration appears within the top inch of kraut, remove it. If you are using a cloth covering, rinse or replace it each time you remove scum or spoiled cabbage. Fermentation is complete when the cabbage turns from opaque green-white to a translucent golden color, and the product smells like sauerkraut. The absence of bubbles may also be an indicator that the kraut is ready.

Storage

There are four alternatives for storing sauerkraut after fermentation is complete. For shorter-term storage, kraut may be refrigerated or left in the crock. For longer-term storage, freezing and canning will maintain high quality.

Refrigerating: Place the kraut in tightly closed jars or sealed freezer bags and stored in the refrigerator for as long as several months. Check the kraut after fermenting to ensure that there is still enough juice covering it. If more liquid is needed, add a weak brine (boil 1 tablespoon of salt in 1 quart of water and cool).

Leaving in the Crock: If you have a cool basement (65-75°F), garage or other storage area, the sauerkraut may be kept in the crock indefinitely as long as the surface is not exposed to air, which may cause spoilage. No refrigeration is required. After removing portions, cover and weight down. A small amount of spoilage may appear after each opening, but you can remove it the next time you open the crock.

Freezing: Pack sauerkraut and juice in rigid plastic moisture- or vapor-proof freezer containers, in glass freezer jars (leaving 1½ inches headspace), or in heavy, tightly sealed plastic freezer bags. Freeze.

Canning

- **Hot pack** – Bring kraut and liquid slowly to a boil in a large kettle, stirring frequently. Remove from heat and fill jars rather firmly with kraut and juices, leaving 1/2-inch headspace.
Raw pack – Fill jars firmly with kraut and cover with juices, leaving 1/2-inch headspace.
- If there is not enough sauerkraut juice to cover all the kraut in the jars, use a boiling hot, weak brine (2 tablespoons salt for each quart of water).

- Adjust lids and process in a boiling-water or atmospheric steam canner per the recommendations below.

		Process Time at Altitudes of			
Style of Pack	Jar Size	0 - 1,000 ft.	1,001 - 3,000 ft.	3,001 - 6,000 ft.	Above 6,000 ft.
Hot	Pints	10 min	15 min	15 min	20 min
	Quarts	15	20 min	20 min	25 min
Raw	Pints	20	25 min	30min	35 min
	Quarts	25	30 min	35min	40 min

Spoilage Problems

Spoilage in sauerkraut causes undesirable color, off-odors, soft texture and unpleasant flavor.

- Softness** may result from insufficient salt, high temperatures during fermentation, uneven salt distribution or air pockets caused by improper packing.
- Pink color** in kraut is caused by the growth of certain types of yeasts on the kraut surface. These may grow if there is too much salt or unevenly distributed salt, or if the kraut is insufficiently covered during fermentation.
- Rotted kraut** is usually found at the surface, where the cabbage has not been covered sufficiently to exclude air during fermentation.
- Darkness** in kraut may be caused by unwashed and improperly trimmed cabbage, insufficient juice to cover the cabbage during fermentation, uneven salt distribution, exposure to air, high temperatures during fermentation, processing or storage, or by a long storage period.

Sources

[National Center for Home Food Preservation.](#)

[Washington State University Extension, Yogurt Made Simple, FS173E, 2015](#)

[“Understanding and Making Kombucha”](#), Colorado State University Extension, Colorado Farm to Table, <http://farmtotable.colostate.edu/prepare-ferment/kombucha.pdf>

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