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Making Yogurt at Home

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What is Yogurt?

Yogurt is a semi-solid sourish food prepared through the fermentation of milk by adding lactic acid bacteria, normally *Lactobacillus bulgarius* and *Streptococcus thermophilius*. Lactic acid produced during the fermentation preserves the milk from spoilage and pathogen growth. Yogurt was developed and consumed in the Middle East as early as 2000 BC.

Fig. 1. Homemade yogurt.

Yogurt Products

Nowadays, based on the texture, yogurt products are classified as solid-set, stirred, and drinking. Solid-set yogurt is a firm yogurt made in a container without disturbing, often containing fruit on the bottom. Stirred yogurt is a mixture of yogurt with fruit preparation without the solid-set texture. Drinking yogurt is a mixture of yogurt with milk, fruit juice, syrups, and flavors. In the market, yogurt products are also categorized as plain yogurt, Greek yogurt, fruit yogurt, and frozen yogurt. At home, you can use yogurt to prepare yogurt parfait, yogurt smoothie, yogurt cocktail, or yogurt dips.

Health Benefits from Probiotics

Yogurt is a natual probiotic product providing good, live bacteria. The health benefits of probiotics include improving lactose digestion, preventing gastrointestinal disorders, enhancing the immune system preventing *H. Pylori* infection, preventing osteoporosis (calcium, vitamin D), reducing constipation, improving nutrient absorption, and/or reducing blood cholesterol. Probiotic cultures added in yogurt often contain *Lactobacillus acidophilus*, *Lactobacillus casei*, and *Bifidobacteria*; some probiotic yogurt may have more than ten probiotic strains. Consumption of an adequate amount (10^8-10^{10} cfu/day) and a variety of strains of probiotics is critical for health benefits. One tablespoon of fresh yogurt can meet the recommended daily amount of probiotics for health benefits.

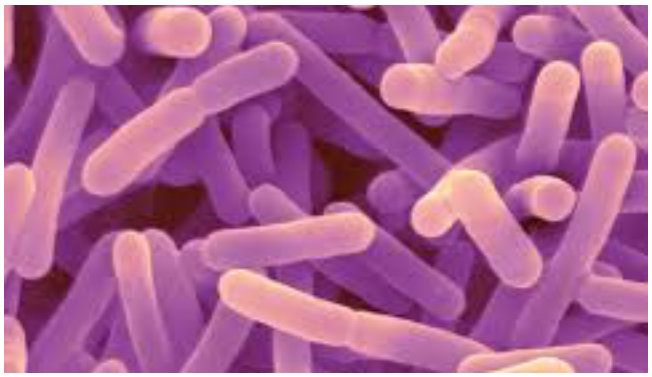

Fig. 2. Probiotics.

Yogurt Consumption

The yearly average consumption of yogurt in the world is from 25 to 275 cups/person (125 g/cup, 8 oz/cup). People in the U.S. consume about 70 cups of yogurt each year. People spend about 7.6% of their total snack budget on yogurt. The consumption of yogurt in the U.S. has increased continuously since 2000.

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Why Make Yogurt at Home

There are many commercial yogurt products on the market; why do we need to make yogurt at home? Because fresh home-made yogurt can: (1) provide a high number of probiotics; (2) avoid or control unnecessary ingredients, such as sugar, fat, sweeteners, artificial colorants, flavoring, and stabilizers; (3) provide fresh and clean taste with controllable sourness and sweetness; and (4) save money - about half price of commercial yogurt. In addition, making yogurt provides you a fun food experience.

Tools and Ingredients for Making Yogurt

Tools	Ingredients
A yogurt maker or an incubator is required to maintain temperature at 110°F for lactic acid bacteria to ferment milk to yogurt.	Milk - use either whole, reduced, or non-fat pasteurized fresh milk or UHT milk; Milk powder (optional) - add either nonfat or whole dry milk to increase the milk solids for firm-texture yogurt.
Jars, cups, or containers with lids for yogurt.	Cultures - *Lactobacillus bulgaricus* and *Streptococcus thermophiles* are the two main starter cultures that US law requires for all "yogurts". Either freeze-dried cultures or previous batches of commercial or home-made yogurt can be used as starter cultures.
A saucepan, measuring cups and spoons, mixing bowl, and whisk for adding and mixing ingredients.	Stabilizers - improve the yogurt texture, including gelatin, pectin, agar, guar gum, tapioca starch, and modified corn starch.
A thermometer and a timer for checking temperature and time during pasteurization and incubation.	Others - improve the flavor of yogurt, including sweeteners (sugar, honey, maple, or maple syrup), fruit (tropical fruits, berries, or jams), and flavors or extracts (vanillin).

Procedures to Make Yogurt

The procedures to make yogurt include adjustment, pasteurization, cooling, inoculation, incubation, and refrigeration.

Adjustment: Although commercial fresh milk can be used directly for making yogurt, you can also adjust the milk composition to meet your desired milk solids content or needs in sensory quality of yogurt. For example, adding nonfat-milk-solid can increase the protein content to firm texture of set yogurt. Adding stabilizers enhance the milk's water-binding ability, improving the texture of yogurt. Adding sugars, flavors, and colors can improve the taste, flavor, and appearance.

Fig. 3. Mixing ingredients and culture with milk.

Pasteurization: Pasteurization is a step to kill pathogens and spoilage microorganisms (vegetative cells) for food safety and quality. For yogurt, the heat during pasteurization also denatures milk proteins (changes protein structures) to enhance protein-water-binding capacity, promoting gelation and improving the firmness of yogurt. To kill vegetative microorganisms and denature the milk protein, pasteurization of milk for yogurt requires a temperature at 185°F (85°C) for 30 minutes or at 203°F (95°C) for 10-20 minutes. Without this heat-treatment, yogurt made directly from commercial pasteurized-milk will have a soft texture.

Fig. 4. Pasteurizing milk.

Cooling: After pasteurization, milk must be cooled to 107-110°F (41-43°C) for the fermentation of lactic acid bacteria. Otherwise, the high temperature of the milk will kill the starter cultures added during inoculation.

Inoculation: After cooling, a mixture of *Streptococcus thermophiles* and *Lactobacillus bulgaricus*, with or without other probiotic organisms, should be added to the pasteurized milk. You can use either commercial freeze-dried cultures or fresh yogurt (commercial or self-made) as starter cultures. If using the commercial culture powders, follow the manufacture's instruction. If using fresh yogurt, add about 3-5% by weight.

Incubation: After inoculation, pour the inoculated milk in clean and sanitized jars or containers and then place them in a yogurt maker or an incubator at 110°F (43°C) to ferment for 6-12 hours. The fermentation time depends on the temperature of the incubator, the size of jars and containers, and the activity of starter cultures. During the fermentation, the starter cultures use lactose (milk sugar) to produce lactic acid. The lactic acid decreases the pH of milk below 4.6, forming yogurt-like texture. In addition, cultures also produce the characteristic flavors of yogurt, inhibit the growth of spoilage and harmful bacteria, and produce polysaccharide materials increasing the thickness and stability of the yogurt gel.

Fig. 5. Yogurt maker and supplies.

Refrigeration: After incubation, check the quality of yogurt. If the texture, taste, and flavor of yogurt meet your quality criteria, place the covered yogurt in the refrigerator (40°F, 4°C) to stop the process of fermentation. Yogurt stored in refrigerator will have a shelf-life of 2-3 weeks. During prolonged storage, yogurt can be spoiled by molds, yeasts, and slow-growing bacteria.

Practice to Make Plain Yogurt

Procedure	Application
1. Add milk powder into fresh milk and mix them well.	Completely dissolve non-fat or whole milk powder (about 3% milk by weight) in a portion of milk (a half-cup) and mix it well.
2. Heat (pasteurize) the milk to 203°F (95°C) for 10-20 min.	Add milk in a saucepan, heat and stir milk constantly to avoid scorching, and check the temperature with a thermometer.
3. Cool the pasteurized milk to 107-110°F (41-43°C) with cold water.	Place saucepan in cold water immediately, stir the milk, and check the temperature with a thermometer. Change the water if needed.
4. Add starter culture in the cooled milk and mix them well.	If commercial starter culture is used, first dissolve the starter culture with some milk then mix it with the rest of milk. If commercial or home-made fresh yogurt is used, first dissolve yogurt (3-5% milk by weight) in a half-cup of milk then strain and mix the mixture with the rest of the milk.
5. Place the inoculated milk in jars or containers and close them with lids.	Use cleaned and sanitized glass jars or food-grade plastic containers and lids.
6. Incubate the milk in yogurt maker or an incubator at 110°F (43°C) for 6-12 hours.	Use a yogurt maker or a temperature-controllable incubator. The incubation time depends on the incubation system and the size of jar or container.
7. Check the quality of yogurt to stop the incubation.	Determine the end of incubation by checking the texture, taste, and flavor of yogurt.
8. Cool and store the yogurt in refrigerator at 40°F (4°C).	Consume the yogurt within 2-3 weeks.

Following the above procedures, you will make a plain yogurt with good quality and a thick texture. If you would like to simplify the procedures and save time, you can make yogurt with a relative thin texture using the following modified procedures: (1) use new opened and fresh commercial pasteurized milk; (2) omit procedures 1, 2, and 3; (3) warm milk to 110°F (43°C); and (4) follow the same procedures 4-8. The reason that you could omit pasteurization is because the commercial pasteurized milk is free of vegetative pathogens and spoilage bacteria.

Making Fruit and Drinking Yogurt

To make fruit yogurt, you can simply add fruit on the bottom of a cup then pour the inoculated yogurt on top and then follow the procedures of making plain yogurt. Or you can blend fruit with the plain yogurt to make a stirred-fruit yogurt. To make drinking yogurt, you can mix the plain yogurt with fruit or fruit juice, syrup or honey, and/or other flavor mixes.

Fig. 6. Yogurt parfait made with plain yogurt.

Making Greek Yogurt and Enjoying Yogurt in Different Ways

You can easily make Greek yogurt with plain yogurt. Place fresh-prepared yogurt in a strainer or a cheese cloth bag and drain it in a refrigerator for 4-12 hours. You will obtain a thick and creamy delicious Greek yogurt. In addition, you can also use plain yogurt to make frozen yogurt, yogurt parfait, yogurt smoothie, yogurt cocktail, and yogurt dips.

Desirable Sensory Properties

Plain set-yogurt has desirable sensory properties, including a smooth appearance, firm and cuttable texture, and fresh, clean, and acidic taste. Stirred yogurt has a smooth, glossy, and thick texture and fresh, clean, and acidic taste. Drinking yogurt has a refreshing mouthfeel and a low level of solids with various thick or thin textures.

Fig. 7. Evaluating yogurt with various recipes.

Troubleshooting Yogurt

Defects	Cause of defect
Fail to coagulate after incubation for 8-10 hours.	The incubation temperature is too hot or too cold; use a thermometer to check and control the temperature at 110°F; the quality starter culture is poor; or the milk is too hot when adding the starter.
Bad or undesirable taste.	Start culture may be contaminated; incubation of yogurt is too long; milk is scorched while heating; or jars or containers may not be clean
Excessive whey separation.	Incubation of yogurt is too long; or yogurt is agitated while it is setting.

Food Safety Practice for Making Yogurt

To make yogurt safely, following these steps: practice good personal hygiene; use soap and warm running water to wash your hands and bandage cuts and burns on hands before handling food; avoid cross-contamination; clean and sanitize equipment and utensils, rinse well, and air dry. Ingredients added to yogurt should be of good quality and uncontaminated. Discard batches that fail to set properly and discard any yogurt samples with visible signs of microbial growth or any odors other than the acidity of fresh yogurt.

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