

Can I Freeze-Dry That? A Practical Guide to Safe and Effective Freeze-Drying

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Introduction

Highlights

- Freeze-drying is a food preservation method Extension Professor of Leadership | Founding Director, Utah Women & Leadership Project that removes water from foods by using a vacuum to turn ice into vapor.
- Freeze-drying can preserve most foodborne bacteria, and even when they cannot grow, they are still a hazard.
- Freeze-drying is popular because it preserves a food's texture, flavor, and nutrients.
- Freeze drying requires strict sanitation at every step.
- Foods like meats and eggs should be cooked before freeze-drying or after rehydration to make them safe to eat.

Freeze-drying can preserve most everyday foods, but not all foods work well. Whether you are preparing for a long trip or are interested in long-term storage, it is important to know which food can be freeze-dried safely and which ones should not be attempted. This knowledge helps ensure food safety, quality, and success. This fact sheet provides information on how freeze-drying works, the risks involved, and which foods can be more challenging to freeze-dry.

What Is Freeze-Drying, and Why Is It So Popular?

Freeze-drying (also known as lyophilization) is a method that removes water from foods by using a vacuum. This happens in three steps (Nowak & Jakubczyk, 2020):

Step 1. Initial freezing (turning all the water in the food into ice at very low temperatures, usually below 0 °F),

Step 2. Primary drying or sublimation (turning ice directly into vapor by raising the temperature under a vacuum), and

Step 3. Secondary drying or desorption (removing the last bits of moisture with higher heat).

Freeze-drying is popular because it preserves a food's original texture, flavor, and nutrients more effectively than other drying methods, such as dehydration and conventional drying. Although freeze-drying takes longer, requires a higher initial investment, and consumes more energy than other drying methods, it is considered the "gold standard" for high-quality food preservation (Bhatta et al., 2020).

Why Is Freeze-Drying Gaining Steam?

Freeze-drying uses low temperatures, which helps protect nutrients and flavor. Removing almost all the water makes food last much longer, aligning with long-term trends in food storage. It also makes food lighter and easier to transport. Many foods can be freeze-dried, including fruits, vegetables, dairy, meats, and even juices. While the cost of freeze-drying equipment remains high, prices have decreased compared to previous years, making it more accessible to home users.

Dangers and Food Safety Considerations

What Happens to Bacteria?

Freeze-drying does not kill bacteria and/or other microbes. It preserves them. Laboratory studies demonstrate that bacteria can survive the freeze-drying process and become active again when water is added back (rehydrated)(Nummer, 2019). Foods that are rehydrated before eating should have a "kill step" that destroys

bacteria, such as cooking. This is not usually required for ready-to-eat freeze-dried snacks.

Water Activity (Aw) and Shelf Stability

Water activity is a scale from 0 to 1 that measures the water available in food for bacterial growth. The lower the water activity, the harder it is for bacteria to grow and multiply in the food. Proper freeze-drying lowers the water activity to about 0.3 or below, with many products falling in the range of 0.08–0.33 (Nowak & Jakubczyk, 2020). At such low levels, most bacteria and spoilage organisms cannot grow, though they may survive in a dormant state, remaining alive but paused until conditions improve (Johnston, 2024). Low water activity means the food has a longer shelf life, because bacteria and mold will not grow. It also slows the natural chemical and physical changes in the food, such as color and texture.

For safety, maintain strict sanitation at every step. Bacteria can survive the freeze-drying process. It is recommended that rehydrated foods be cooked before consumption.

Challenges to Food Safety

Freeze-drying keeps food from spoiling, but it does not make it safer because it does not kill any bacteria, even those that are heat-sensitive (Cheng et al., 2022). If freeze-dried food is later exposed to moisture or humidity due to damaged packaging or improper storage, its water activity can rise, allowing bacteria to become active again (Johnston, 2024). Food safety requires strict control at every step. This includes pretreatments, cleanliness, complete drying, clean equipment, and proper packaging (Nummer, 2019).

Challenges to Food Safety

Structural and Machine Constraints

Some foods are harder to freeze-dry. Foods with crusts or casings (such as sausages) have dense outer layers that make the freeze-drying process less effective. This can lead to uneven drying and may even cause the product to collapse. These foods can also undergo case-hardening, in which the outer layer dries too quickly, trapping moisture inside (Bhatta et al., 2020). High-fat foods are challenging because fat does not freeze like water. This slows the process and increases the risk of spoilage (Nowak & Jakubczyk, 2020). Similarly, high-sugar foods also hold

onto water and resist moisture loss, prolonging drying and requiring more energy (Oyinloye & Yoon, 2020).

Chemical and Physical Barriers

Foods like salad dressings, alcohol, and mayonnaise are hard to freeze-dry because they do not freeze evenly, and this can ruin their texture. Thick foods, such as meat or casseroles, can take more than 2 days to fully dry. This slows the whole process down. For a home preserver, this means planning. Instead of trying to freeze-dry an entire casserole at once, they can freeze it in small portions first. Extension guidance recommends keeping most foods between ¼ and ½ inch thick, and meat pieces no thicker than about ¾ inch, to help them freeze and dry evenly (Robertson et al., 2025). Each load may still take a couple of days, so drying a big batch of casserole might take most of a week. Smaller portions and extra time help ensure the food dries properly (Co#kun et al., 2024).

Equipment Limitations



Freeze dryers, including home units, tend to use significantly more energy than dehydration methods, often several times as much (Yao et al., 2023). These at-home freeze dryers operate best at external temperatures between 45 °F and 80 °F, with good ventilation. Using them in areas outside this range, such as garages or basements, can make them less efficient and strain the machine (Cheng et al., 2022). Once the product has properly freeze-dried, sealed it immediately in packaging that blocks oxygen and moisture to maintain low water activity. Thick Mylar bags (5–7 mil) without clear plastic windows, paired with oxygen absorbers, provide the best long-term protection because windowed bags allow more air and moisture to pass through (Johnston, 2024).

General Advice for Home Freeze-Drying

It is helpful to follow a few general best practices. These support consistent drying, safe storage, and high final product quality:

1. Pre-freeze foods in your freezer before placing them in the freeze dryer. This helps achieve faster, more even drying and maintains better texture.
2. Cut foods into small, uniform pieces, ideally no larger than ½ inch thick, to ensure even freezing and drying throughout.
3. Avoid high-fat or high-sugar foods, when possible, as they take much longer to freeze-dry and can result in poor texture or incomplete drying.
4. Use clean equipment and work surfaces. Freeze-drying does not kill bacteria, so good cleaning and sanitation are essential.
5. Lay foods in a single layer on trays with space between pieces to allow for uniform drying.
6. Check that food is thoroughly dried before packaging; it should feel crisp, dry, or brittle, with no cold or soft spots.
7. Package immediately after drying in airtight, moisture-proof packaging (such as Mylar bags with oxygen absorbers or vacuum sealing) to maintain low water activity.
8. Store in a cool, dark, and dry place to extend shelf life and reduce the risk of moisture reabsorption.

What Can I Freeze-Dry, and What Should I Not?

Table 1 displays guidelines for safely and successfully freeze-drying various foods

Table 1. Guidelines for Safe Freeze-Drying

Food category	Can I safely freeze-dry?	Guidelines for safe home freeze-drying
Raw meat	No, it must be fully cooked.	Cook to 160 °F to eliminate foodborne pathogens.
Raw poultry	No, it must be fully cooked.	Cooking to 165 °F eliminates common poultry pathogens

Food category	Can I safely freeze-dry?	Guidelines for safe home freeze-drying
		<i>Salmonella</i> and <i>Campylobacter</i> .
Raw seafood	No, it must be fully cooked.	Cooking to 145 °F kills parasites and bacteria. Sanitation is critical.
Raw eggs and egg products	No, it is high-risk.	Raw eggs can contain <i>Salmonella</i> that survives freeze-drying. Use pasteurized liquid eggs or fully cooked scrambled eggs.
Raw milk, cheese, and other dairy products	No, it is high-risk.	Unpasteurized dairy can harbor <i>Listeria</i> , <i>Salmonella</i> , or <i>E. coli</i> . High-fat content increases the risk of rancidity during storage.
Pasteurized milk, cheese, and other dairy products	Yes	For high-fat cheeses, melt or blend and spread thinly before freeze-drying to reduce rancidity and ensure even drying.
Nuts	Yes	Low moisture makes nuts suitable. Avoid sugar- or oil-coated nuts that resist drying and can become sticky.
Grains and seeds	Yes	They are already low moisture, making them

Food category	Can I safely freeze-dry?	Guidelines for safe home freeze-drying
		safe. Store in airtight packaging to prevent moisture absorption.
Beans	Yes	Cooking or soaking improves texture after rehydration and helps prevent hard seed coats.
Raw flour and dough	No, it has safety and texture issues.	Raw flour can contain pathogens like <i>E. coli</i> and <i>Salmonella</i> . They tend to have poor rehydration and a gummy texture.
Cooked starches	Yes	Cooking improves rehydration and palatability. Mash or slice thinly to ensure consistent drying.
Homemade sauces and gravies	Yes, but emulsions may separate.	Emulsions can break during drying. Use thickeners for better stability and spread thinly.
Fermented foods	Yes, but quality may degrade.	Probiotic activity and flavor may decline over time. Dry after fermentation is complete.
Plant-based meat alternatives	Yes, if low in fat and well-bound	Pre-cook for safety. Avoid oily formulations that hinder drying.

Food category	Can I safely freeze-dry?	Guidelines for safe home freeze-drying
Oils and mayonnaise	No, it is not safe or practical.	High fat content prevents adequate drying, increasing the risk of rancidity and pathogen survival.
Pasteurized juices	Yes, though some sugars may dry very slowly.	High sugar slows drying. Freeze in thin layers to ensure thorough water removal.
Vegetables	Yes	Blanch or steam to inactivate enzymes, preserve color, flavor, and nutrients.
Fruits	Yes	Wash and peel to reduce microbial load. Pretreat with ascorbic acid or lemon juice to prevent browning.

Long-Term Storage

Freeze-dried foods can remain safe and stable for 10–15 years, and sometimes even up to 25 years, if stored in airtight, moisture-proof packaging (Mylar with oxygen absorbers) and kept in cool, dark, and dry conditions (Johnston, 2024). While quality remains high, nutrient degradation occurs over time, especially for sensitive vitamins such as vitamin C, which can decline significantly within 1–3 years (Rahman et al., 2013).

Research shows that correctly stored freeze-dried foods maintain low water activity and good texture for extended periods. Consuming home-frozen-dried products is not recommended beyond 5–10 years after processing, due to faster nutrient and quality loss compared to their commercial counterparts (Karwacka et al., 2024).

Not all foods are suitable candidates for freeze-drying, and it is important to understand the differences and limitations. Cooked meats, fruits, vegetables, and starches

freeze-dry well and can be stored safely. Raw meats, other animal products, and oily foods often do not freeze-dry well and can pose food safety risks, including contaminating equipment, trays, and later batches. Think about how you plan to use the freeze-dried food later to determine what best suits your needs. Remember, foods like meats and eggs that require rehydration must be cooked, either before the freeze-drying process or after rehydration, to make them safe to eat. Fruits, on the other hand, do not require rehydration and are safe to eat dry, since microbes such as bacteria and mold cannot grow. All in all, freeze-drying is a valuable preservation method and tool when used correctly. Understand your ingredients, limitations, and best practices before you freeze-dry.

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