I'm not a robot

Freezing PhaseFreezing is the most critical phase of freeze drying, and there are many methods for it. Freezing can be done in a freezer, a chilled bath (shell freezer) or on a shelf in the freeze dryer. Cooling the material below its triple point ensures that sublimation, rather than melting, will occur. This preserves its physical form.Freeze drying is easiest to accomplish using large ice crystals, which can be produced by slow freezing or annealing. However, with biological materials, when crystals are too large they may break the cell walls, and that leads to less-than-ideal freeze drying results. To prevent this, the freezing is done rapidly. For materials that tend to precipitate, annealing can be used. This process involves fast freezing, then raising the product temperature to allow the crystals to grow.Primary Drying (Sublimation) PhaseFreeze dryings second phase is primary drying (sublimation), in which the pressure is lowered and heat is added to the material in order for the water to sublimate. The vacuum speeds sublimation. The cold condenser provides a surface for the water vapor to adhere and solidify. The condenser also protects the vacuum pump from the water vapor.About 95% of the water in the material is removed in this phase. Primary drying can be a slow process. Too much heat can alter the structure of the material.Secondary Drying (Adsorption) PhaseFreeze dryings final phase is secondary drying (adsorption), during which the ionically-bound water molecules are removed.By raising the temperature higher than in the primary drying phase, the bonds are broken between the material and the water molecules.Freeze dried materials retain a porous structure.After the freeze drying process is complete, the vacuum can be broken with an inert gas before the material is sealed.Most materials can be dried to 1-5% residual moisture. Freeze-drying stands out as a versatile dehydration method, adept at processing small research batches to large-scale commercial production. This method ensures many freeze-dried food items remain nutritious and stable for extended periods, illustrating its ability to extend shelf life and maintain material integrity. This discussion aims to delve into the various dimensions of the freeze-drying technique.An Overview of Freeze-DryingAt its core, freeze-drying employs sublimation, transitioning water directly from ice to vapor under vacuum conditions, bypassing the liquid state. This method sets itself apart from conventional drying techniques by better preserving the original shape, texture, flavor, and nutritional value of the product.Freeze-drying is particularly beneficial for preserving heat-sensitive substances, such as certain pharmaceuticals and volatile compounds found in culinary herbs, more effectively than standard drying methods. It minimizes cellular damage, allowing freeze-dried fruits like strawberries and apples to maintain their original appearance and taste, resulting in a rehydrated product nearly identical to its fresh counterpart.The Freeze-Drying Process ExplainedInitial FreezingThe freeze-drying process begins by cooling the material to -40C, solidifying the moisture into ice and readying it for sublimation. Rapid cooling is crucial to prevent the formation of large ice crystals that could damage the cellular structure, ensuring the product's quality is preserved.Applying VacuumFollowing the initial freeze, the chamber's pressure is reduced to create the optimal conditions for sublimation. This reduction in pressure lowers the boiling point of water, allowing the ice within the product to vaporize at lower temperatures and transition directly from solid to gas while maintaining its structure.Sublimation PhaseUnder the vacuum, gentle heating converts the product's ice directly into vapor. This careful application of heat facilitates sublimation without damaging the product, allowing it to dry while preserving its shape, texture, and nutritional content.Vapor CollectionDuring sublimation, a condenser unit captures the vaporized water, which then condenses back into solid ice. This step is crucial for trapping the removed moisture and preventing it from re-entering the product chamber, ensuring a thorough and efficient drying process.Factors Affecting Freeze-Drying TimeProduct Size and Shape: The size and complexity of the material affect sublimation time, with larger or more complex items taking longer to dry.Product Composition: The drying time varies based on the item's water content and molecular complexity. More water content takes a longer time to dry.Freezing Temperature: Lower cold trap temperatures can speed up sublimation, but it is technically difficult and more costly to achieve a lower temperature.Chamber Pressure: Optimal pressure settings are essential for efficient sublimation and preserving product integrity. A rough vacuum can accelerate the drying process, but they must be carefully controlled to avoid reducing product quality.Technological Advances in Freeze-DryingModern freeze-drying technologies incorporate sophisticated control systems for real-time adjustments of temperature, pressure, and sublimation rates, enhancing both drying efficiency and product quality. Innovations in pre-freezing techniques and the use of cryoprotectants also play a role in improving the freeze-drying process and expanding its application across various industries.Ensuring Quality in Freeze-DryingQuality assurance in freeze-drying relies on controlled parameters and stability testing to maintain product quality. Innovative sealing and packaging methods protect against moisture and light, while thorough testing ensures the biological and microbiological integrity of freeze-dried products, securing their longevity and effectiveness.For more insights into freeze-drying principles and its applications, feel free to reach out. Zhengzhou Laboao Instrument Equipment Co., Ltd (LABOAO) is a high-tech enterprise integrating R&D, production, sales, import and export, and is a leading laboratory equipment solution provider in China. LABOAO is headquartered in Zhengzhou, Henan, China. It has a group of excellent management and technical personnel who strive for excellence and constantly pursue progress and innovation. After fifteen years of hard work, it has achieved sustained and steady development, and its products are exported to Europe, America, Southeast Asia, the Middle East, Africa, etc. 100 countries, we are working hard to establish a global regional service agency to provide better services and products for global customers. Our company has always focusing on laboratory research, life science, biomedical engineering and other fields. So far, Our company has passed ISO9001 quality management system certification, EU CE, SGS, TUV, CNAS and other certifications. More The design of the freeze-drying machine automatic control system requires simple operation, starting from the material into the button, quick-freezing vacuum sublimation and drying in one go, prompting the shutdown after the freeze-drying is completed. Relevant temperature and pressure control points should be carefully selected and properly controlled. The correlation between quick freezing, vacuum holding and heating should be properly controlled, and the process curve should be set for different materials. The freeze dryer consists of a refrigeration system, a vacuum system, a heating system, and an electrical instrument control system. So what are the benefits of the freeze dryer? Let's take a look:1. Freeze-drying is carried out at low temperatures and is therefore particularly suitable for many heat sensitive substances. Such as protein, microorganisms and the like will not degenerate or lose biological vitality. Therefore, freeze dryers are widely used in medicine.2. Since the freeze dryer is dried in a frozen state, the volume remains almost unchanged, and the original structure is not concentrated.3. The material after drying in the freeze dryer is porous and spongy. After adding water, it dissolves quickly and completely restores the original trait almost immediately.4. Since the freeze dryer is dry under vacuum, there is very little oxygen, so some easily oxidizable substances are protected.5. The loss of some volatile components in the material when the freeze dryer is dried at low temperature is very suitable for some chemical products and foods to dry.6. The growth of microorganisms and the action of enzymes during the freeze-drying process cannot be carried out, so that the original sex can be maintained.7. Drying of the freeze dryer can eliminate more than 95-99% of water so that the dried product can be preserved for a long time without deterioration.8. Since the moisture in the material exists in the form of ice crystals after pre-freezing, the inorganic salt-dissolved substances originally dissolved in the water are evenly distributed in the materials;9. After drying in the freeze dryer, the material is loose and porous, and it is sponge-like. After adding water, the solution dissolves quickly and completely, and the original trait is almost immediately restored;10. Since drying is carried out under vacuum, there is very little oxygen, so some oxidizable substances are protected by drying in a freeze dryer. BasicsHealth benefitsCommon foodsDownsidesFreeze-drying at homeBottom lineFreeze-drying, also known as lyophilization, is a form of dehydration. Food is first frozen, then dried under pressure to remove its water content.It is widely believed that freeze-drying is the best method of drying. As such, it is a common practice in the food and pharmaceutical industries (1).In fact, from ready-to-eat meals to fruits or snacks, you may easily find a wide range of freeze-dried foods in your local supermarket.This article further explains what freeze-drying is and whether it is healthy or not.Share on PinterestFood Collection/ShutterstockFreeze-drying or lyophilization is a dehydration technique based on the sublimation of water in a product (1, 2).This means that the products water content transitions from a solid to a gaseous state or from ice to vapor without going through the liquid state (1).Freeze-drying is considered a high quality dehydration method for a couple of reasons, including (1, 2):it operates at low temperatures, which contributes to preserving a products nutritional value, taste, appearance, and heat-sensitive compoundsfreezing inhibits chemical and microbiological processes, which significantly delays the products deterioration (thereby extending its shelf life)Raw fruits, vegetables, and meats are primarily comprised of water, which can be divided into free and bound water. While free water freezes, bound water doesnt (1).In the freeze-drying process, all free water and some bound water must be removed, and free water must remain frozen at all times. In fact, this is the primary difference between freeze- and vacuum-drying and the most challenging step (1).The freeze-drying process can be divided into three steps (1, 3, 4):Freezing: The product is often frozen under atmospheric pressure.Primary drying: Also known as proper freeze-drying, this is the sublimation step in which frozen free water is removed.Secondary drying: Also known as desorption drying, its the drying of products to their desired humidity by removing the remaining bound water.Freeze-drying should be performed in controlled conditions that do not melt the water, seeing that the presence of liquid water may change the products composition, shape, and physical properties (1).That would likely lead to a significant reduction of the products shelf life (1).Once frozen water is removed via sublimation, the remaining product develops a highly porous structure. However, adding water rehydrates the product again almost immediately (1).SummaryFreeze-drying is a form of dehydration that removes a products water content by turning it from ice to vapor. The three-step process preserves a products nutritional value, taste, and appearance while extending shelf life.Freeze-dried foods are a healthy food choice. In fact, freeze-drying is one of the most common dehydration methods due to its numerous benefits.Freeze-drying is one of the best ways to retain the activity of beneficial plant compounds, such as phytochemicals, and nutrients while preserving color, flavor, and structure. Thats why its widely used to produce high-value food products (3, 5, 6).For instance, studies show that compared with other drying methods, freeze-drying is the most effective at retaining antioxidants, such as anthocyanins, flavonoids, and ascorbic acid or vitamin C (3, 7).Antioxidants are beneficial compounds that help fight off the damaging effects of oxidative stress in your body. Theyre also the compounds behind most fruit and vegetables health benefits (7, 8).However, while freeze-drying may sometimes even increase a fruits phytochemical concentration, the opposite may also be true, depending on the fruit (3).Additionally, given that decreased water activity inhibits the growth of most bacteria, yeasts, and molds, by removing a products water content, freeze-drying helps prolong a foods shelf life (2, 4, 5).This is especially important for fresh plant-based foods, which may not be available year-round (3).Lastly, removing a products water content leads to a reduced volume and weight, making it easier to handle, storage, and transport (2, 3, 4).SummaryFreeze-drying helps retain nutrients and phytochemicals in foods. Therefore, freeze-dried foods are a healthy food choice. It also prolongs a products shelf life and facilitates storage, handling, and transportation.Freeze-dried foods are often used for hiking, camping, space exploration, emergency and survival applications, and military rations. They are preferred over regular foods due to their light weight, long shelf life, portability, and ease of preparation (9).While plant-based foods are the most popular freeze-dried products, a wide range of foods can be preserved using this method.Heres a list of some of the foods that can be freeze-dried (3, 5, 9):Fruits: strawberries, apples, blackberries, bananas, pears, oranges, and fruit pureeVegetables: almost all vegetables, such as carrots, asparagus, mushrooms, peppers, pumpkin, and tomatoesMeats: beef, fish, chicken, eggs, pork, turkey, and shrimpGrains: cooked rice, beans, pasta, quinoa, and polentaLegumes: cooked beans, lentils, peas, and tofuFrozen meals: whole meals like Pad Thai, stews, chili, and snacksBeverages: milk, juices, coffee, and tea for instant drinksSpices: ginger, oregano, mint, basil, and garlicSweeteners: maple syrup for sugar powderSummaryA wide range of foods can be preserved by freeze-drying, including fruits, vegetables, meats, whole meals, grains, beverages, spices, and sweeteners.Freeze-drying makes an excellent food preservation method. However, there are some potential downsides to consider.First, while reducing a products water availability diminishes microbial growth, disease-causing microorganisms in raw meat or eggs can survive the drying process and remain present during storage. They can cause foodborne illness if eaten without cooking (4).Foods can be freeze-dried either cooked or raw. If you freeze-dry raw meat or eggs, you will have to label it properly and cook it before eating (10).Second, despite preserving foods antioxidant content, the high porosity of freeze-dried products allows easy access to oxygen, which may lead to higher levels of oxidation or degradation of bioactive compounds (2, 7).SummaryFreeze-drying doesnt kill all bacteria present in raw food. Thus, you must cook raw foods before freeze-drying to avoid foodborne illness. The high porosity of freeze-dried foods may lead to greater degradation of nutrients.Freeze-drying requires specialized and often expensive equipment that works under a specific temperature and pressure.Freeze-drying should not be attempted without proper equipment and training.SummaryFreeze-drying is a process requiring specialized equipment, and is not safe to try without it.Freeze-drying is a way of dehydrating frozen food via a process that transforms ice into vapor, also known as sublimation.It is a healthy food preservation method, as it retains most of the beneficial plant compounds and nutrients in foods, as well as their color, taste, and appearance.However, it doesnt kill harmful bacteria. Therefore, you should thoroughly cook freeze-dried raw foods like meat or eggs.Freeze-drying requires special equipment. If you do not have a home freeze-drying machine, do not attempt to freeze-dry foods. Share copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. We may earn money or products from the companies and/or products mentioned in this post. Get this post in a printable format. Sign up for the Printables Vault and get access sent to your inbox immediately! Then add it to your Freeze Drying Binder! Freeze drying for beginners is exactly what it says it is. Print this information off and put it into your freeze drying binder!What is freeze drying? Freeze drying is the laymans term for lyophilization, a process that is often used to extend the life of perishable materials. This can include food, herbs, medicines, pet foods, and more. Essentially, youre taking the liquid out of the item with a process that first freezes, then creates a vacuum around it, and then vaporizes the liquid using heat. The vacuum pressure pulls the vapor to the edges of the drums, thus drying the product.It does take a little bit of time and by a little bit, I do mean hours to days. But lets be honest, youre sleeping for a solid 8 of those, and then working, or watching YouTube videos or whatever it is that you do. So essentially, its a set it up and leave it until its done process. Then package it and start again.Its an easy process to get amazing, home-made freeze-dried foods (or whatever else youre doing).Check out this video I made where I talk about what lyophilization is all about! Why would you freeze dry food?So many people in this day and age work on storing food for a reason only known to them. Some do it for potential disasters, for potential slim economic times, to help others, to take camping/hunting/bug out. Some do it because they dont know why, but they feel like they should.We have a lot of people in our home 8 so far and our church leaders counsel that we strive to have a sizable amount of food in our food storage. This food storage could be used for us or for other church members or even for other members of the community. Wherever there is need, it is easier for us to store Mylar bags of virtually weightless food that can last up to 25 years versus 4 to 5 years of canned goods in glass containers.If theres an earthquake, the bags will be fine. Glass it breaks rather easily and it can freeze, and so many other arguments.Does freeze dried food lose its nutritional value?Not as much as you would think. According to multiple stats Ive found around the internet, freeze dried foods retain 98.9% of their original nutritional value. I think thats pretty good since similar stats reveal that canned food, frozen food, and dehydrated foods can lose up to 50% of their nutritional values after just the initial process of preparing the foods.Here are some reports to check out the more specific stats, if youre so inclined.Go Ask AliceWhy freeze drying is important to preserve nutritional valueCan I freeze dry herbs?Absolutely! In fact, some of my favorite herbs to dry include basil, oregano, parsley, and cilantro. Freeze drying herbs maintains the beautiful colors, shape, and flavors along with their organic medicinal values that we want with herbs. Of course, none of that matters when youre just going to crush them into flakes like I love cooking so much with.Another option, if youre interested, is freeze drying cannabis. Not many people think of freeze drying this herb for medicinal purposes, but it preserves the precious cannabinoids that many need for aches, pains, and migraines (I get these a LOT!). CBD is a great option to help me snap out of one of my migraine episodes.How do I freeze dry food myself?There are some ways to do things on your own without having to buy a freeze dryer, but Im not sure how reliable they are.I bought a medium sized freeze dryer from Harvest Right. So far? I love it. I had a couple issues with it three months ago and I called their customer service and over about a week (they had to ship me some things) of trial and error, we got it figured out and I was back on my way.Many people think its next to impossible to do the freeze drying for themselves. This is far from factual. Freeze drying at home is made easy by Harvest Right. They sell three different sizes of freeze-drying machines that do everything in the machine except prep and package. Thats up to you.For all intents and purposes, here at Freeze Drying Mama we use the medium sized freeze dryer. You can check out the sizes offered at Harvest Right here.What this machine does first is freeze the items on stainless steel trays to -41 degrees or lower. This takes about 10 hours or so.Then a vacuum pump turns on and creates a vacuum inside the drum. This is the drying stage and will vacillate the heat of the tray up and down to a pretty warm temperature. This makes the frozen items release any water in them in vapor form.The vacuum sucks the moisture to the drum and this collects in ice form on the inner circle of the drum. Then theres the final dry which is essentially the same thing, but with a time associated with it.What are the possibilities with owning my own freeze dryer?Well, let me just say I dont eat out a lot. Not just because I like saving money, but because I prefer my own cooking. I prefer knowing what is in the food Im eating and I prefer not to get charged when my kids want seconds, thirds, and even fourths of the foods they like.When I was buying food storage items, I wasnt sure what was in them. I was just going with what they had listed on the ingredients list. Well, just like with anything, how did I know if they had fillers in them or not? I didnt.But now, freeze drying my own foods, I can control what Im putting in my food storage and thats a big deal to me. Plus, lets be honest. There are some great options for food that is available out there for freeze dried options, but I cant get MY chili, Costco pizza, Spaghetti Os, or ground venison burger the way I like it unless I do it myself. Thats just a fact.The list of things we can do now that were saving money and packaging up our own food is limitless.Freeze dried food from a survival standpointYeah, everyone and their brothers are into survival prep these days. Sinking money into their preparations and not necessarily on the best things.What if you could make your money stretch further? With the cost of the machines making themselves back in the first six months of freeze drying, its a no-brainer when you can also add other options to what you do with the food. We supplement our costs by selling items that we freeze dry, doing the service for others and they pay us with extra food, storage supplies, etc. and more.From a survival standpoint, Im all for having 40 years worth of wheat in my food storage. People hear me tease about this all the time, but I do mean it when I say wheat I have, but its not as logical for me to store as say chicken noodle soup is, or raw egg powder, or ground venison, or even rotisserie chicken. I want to eat all of those things. Im not sure I want to survive if all I have to eat is a handful of raw wheat and a packet of dried milk powder (yep, I have that, too).Why survive when you can thrive? Im sure thats someones tagline out there and I just stole it for myself lol.Can freeze drying help me in my travels?You bet it can!Heres the thing. Food costs are higher in some places. For instance, Hawaii is isolated from the rest of the world and to get things in or out, someone has to transport it. This gets written into the cost of the item.Guess what? Flying with freeze dried foods is easy because theres no liquid. It doesnt go bad fast. And its virtually light weight which wont cost you an arm and a leg to take with you. Yay! TSA compliance is much easier to hit with freeze dried food than canned or packaged goods.How can I use freeze dried food?There are so many ways to use freeze dried food. Rather than go into recipes right now, Im just going to bring up examples of when freeze dried food would be beneficial to have.We already covered when youre traveling by plane.How about when youre traveling by boat or by dog sled? Not common, but saving weight is a big deal. Not to mention, when youre trying to go somewhere that might be off the grid or hard to get to, you wont have to work extra hard to get this there. Yes, we watch Building Alaska and Im constantly saying, they need freeze dried food up there.We like to take our freeze dried meals camping, hunting, hiking, dirt biking, and on long road trips.But food storage is important to have in case you lose a job and have no money to purchase food because youre trying to pay other bills like electricity. Then you have food there you dont have to spend money on.Another important factor is when theres an emergency.Where we live, we have power outages because of snow storms or summer thunderstorms. When you have that happen, you have to worry about the items in your freezers, your fridge, and how youre going to cook them.What if you already had bags of ravioli and all you had to do was hand them out to your kids? These go like cookies in our house! I had the kids asking for a power outage just so they could eat some Costco pizza crackers and Spaghetti Os crackers. You dont necessarily HAVE to reconstitute the foods before you eat them. It just makes it more palatable in some instances.Heres a list of how we use our freeze-dried goods (list is not exclusive)CampingHuntingDirt bikingHikingPicnicsAt home during emergenciesIn food storageSharing with neighbors and friends in needHanding out to the homelessIn giftsSnacksLeftoversTraveling72-hour-kit/bug out bagsSell freeze dried goodsHow do I get access to freeze dried foods or other items?That is such a great question! Im glad you asked it .There are two ways you can get freeze dried foods.You can buy them from other people or companies. You can do your own!Of course, I recommend this option for everyone who can swing it. You could even go in with a group of people to split the cost. There are a lot of ways to make this happen, but I highly recommend considering this option. It will save you money in the long run.This option is particularly useful for those people with food allergies, intolerances, medical conditions, and other medical indelicacies.How is freeze dried food stored? There are multiple ways you can store your freeze-dried food whether you do it yourself or buy it from the store. All options will have an investment on your part.#10 cansMylar bagsMason jarsBinsShelvesWhen you do store your freeze-dried foods that you make yourself, youll always want to include an oxygen absorber with them and make sure theyre sealed well. Oxygen deteriorates food along with sunlight, heat, and other gases.What can I freeze dry?Oh, honey, the question below this one is easier to answer. The list is endless of what you can freeze dry. Ill see if I can do a sufficient job answering it, if nothing else at least I can get your mind going on the possibilities. What cant I freeze? Honestly, I wish the answer was you can freeze dry everything under the sun, but thats just not logical. There are some hard and fast NOs in this list.The fat or sugar content will limit you first and foremost.Chocolate by itselfPeanut butter by itselfHoneyButterHigh fat content (not recommended)High sugar content (not recommended)You can cook these things into dishes and theyll freeze dry just fine. We do an oatmeal chocolate chip cookie bar that freeze dries amazing! Pork chops do awesome, too.Its not that it cant be done in some instances, either, like bacon. Its just the length of the life of the item is shortened because the fat can still go rancid if its not completely dried. Or the sugar isnt completely dried.These are the general things to steer clear of. If you figure out a way to freeze dry butter, let me know! Thats one I wish I could do. Ill be canning that stuff until I figure out a way to defy freeze drying limitations.How do I reconstitute food?So, the first thing you need to be aware of is that freeze drying removes the water. To reconstitute the food, you would add water back in or increase the moisture. Thats essentially it. Whether you soak the food in boiling water like ground meat, or you eat the food like a snack and it reconstitutes in your mouth, or even you add it into a casserole dish or a pan and cook it in with the other juices of other things, all you need to add is water.Each item has its own ways to reconstitute them, but the overall gist is add water. Do that, and youll reverse the freeze-drying effects.How long does freeze dried food stay good?The standard answer is 25 years if sealed well and stored properly in a dark, dry, cool place. Im comfortable saying 10 years and then pushing it out from there depending on the density of the item, the accuracy of the freeze drying process, the way its stored and sealed. But just think thats significantly longer than canned foods or frozen foods. Theres no chance youll have to deal with freezer burn when youre pulling the bag of food from a bin in your crawl space in five years.Is freeze drying for me?I cant answer that for you. But I can tell you that freeze drying is definitely for me.The things I researched before I started freeze drying fit under these four categories.CostIts not cheap to buy a machine, but like I said, it pays for itself after six months. The cost of commercially powdered eggs is about 10 times more than what I pay to do them. If youd like to see some scientific data based around the average cost to run a machine on the food youd like to do, check out this site. Its pretty amazing.Room neededDo you have space to store this sucker? Its not much bigger than a small apartment sized fridge. You need to elevate it though (not much) and then you need room for the vacuum pump and space to change the oil and have a drain bucket.Ours is stored in our office.MaintenanceYoull want to clean the machineYoull want to change the oil in an oil pump to remove the water and keep clean oil in the pumpDrain the bucket of defrost waste the ice has to melt and go somewhereSet upThe machine isnt light. Youll want to make sure you have help to set it up and get it in your house, etc. This is not a portable machine, but once you get it in where you want it, you shouldnt need to worry about moving it again.I highly recommend freeze drying for anyone serious about building up their food storage. With the constantly rising costs of food, this is a good idea for most people to have access to stock up on cost effective food.If you have a garden, this is a good idea for you as well.But maybe Im biased. Im into do-it-yourself and this is definitely do-it-yourself. Low temperature dehydration process"Instant freeze" redirects here. For the Batman episode, see Instant Freeze.Freeze-dried strawberriesFreeze drying, also known as lyophilization or cryodesiccation, is a low temperature dehydration process[1] that involves freezing the product and lowering pressure, thereby removing the ice by sublimation.[2] This is in contrast to dehydration by most conventional methods that evaporate water using heat.[3]Because of the low temperature used in processing,[1] the rehydrated product retains many of its original qualities. When solid objects like strawberries are freeze dried the original shape of the product is maintained.[4] If the product to be dried is a liquid, as often seen in pharmaceutical applications, the properties of the final product are optimized by the combination of excipients (i.e., inactive ingredients). Primary applications of freeze drying include biological (e.g., bacteria and yeasts), biomedical (e.g., surgical transplants), food processing (e.g., coffee), and preservation.[1]The Inca were freeze drying potatoes into chuo since the 13th century. The process involved multiple cycles of exposing potatoes to below freezing temperatures on mountain peaks in the Andes during the evening, and squeezing water out and drying them in the sunlight during the day.[5] The Inca people also used the unique climate of the Altiplano to freeze dry meat.[6]The Japanese koya-dofu, freeze-dried tofu, dates to the mid-1500s in Nagano and the 1600s on Mount Koya.[7]Modern freeze drying began as early as 1890 by Richard Altmann who devised a method to freeze dry tissues (either plant or animal), but went virtually unnoticed until the 1930s.[8] In 1909, L. F. Shackell independently created the vacuum chamber by using an electrical pump.[9] No further freeze drying information was documented until Tival in 1927 and Elser in 1934 had patented freeze drying systems with improvements to freezing and condenser steps.[9]A significant turning point for freeze drying occurred during World War II when blood plasma and penicillin were needed to treat the wounded in the field. Because of the lack of refrigerated transport, many serum supplies spoiled before reaching their recipients.[9] The freeze-drying process was developed as a commercial technique that enabled blood plasma and penicillin to be rendered chemically stable and viable without refrigeration.[9] In the 1950s1960s, freeze drying began to be viewed as a multi-purpose tool for both pharmaceuticals and food processing.[9]In 2020, freeze dried candy saw a major surge in popularity due to viral popularity on social media with freeze dried versions of popular candies such as Skittles, Nerd Gummy Clusters, and SweeTarts appearing in stores.[10][11][12]Freeze-dried ice creamFreeze-dried foods became a major component of astronaut and military rations. What began for astronaut crews as tubed meals and freeze-dried snacks that were difficult to rehydrate,[13] were transformed into hot meals in space by improving the process of rehydrating freeze-dried meals with water.[13] As technology and food processing improved, NASA looked for ways to provide a complete nutrient profile while reducing crumbs, disease-producing bacteria, and toxins.[14] The complete nutrient profile was improved with the addition of an algae-based vegetable-like oil to add polyunsaturated fatty acids.[14] Polyunsaturated fatty acids are beneficial in mental and vision development and, as they remain stable during space travel, can provide astronauts with added benefits.[14] The crumb problem was solved with the addition of a gelatin coating on the foods to lock in and prevent crumbs.[13] Disease-producing bacteria and toxins were reduced by quality control and the development of the Hazard Analysis and Critical Control Points (HACCP) plan, which is widely used today to evaluate food material before, during, and after processing.[14] With the combination of these three innovations, NASA could provide safe and wholesome foods to their crews from freeze-dried meals.[14]Military rations have also come a long way, from being served cured pork and corn meal to beefsteaks with mushroom gravy.[15] How rations are chosen and developed are based on acceptance, nutrition, wholesomeness, producibility, cost, and sanitation.[16] Additional requirements for rations include a minimum shelf life of three years, be deliverable by air, consumable in worldwide environments, and provide a complete nutritional profile.[16] The new T-rations have been improved upon by increasing acceptable items and provide high quality meals while in the field. Freeze-dried coffee was also incorporated by replacing spray-dried coffee in the meal, ready-to-eat category.[16]In a typical phase diagram, the boundary between gas and liquid runs from the triple point to the critical point. Freeze-drying (blue arrow) brings the system around the triple point, avoiding the direct liquidgas transition seen in ordinary drying (green arrow).There are four stages in the complete freeze drying process: pretreatment, freezing, primary drying, and secondary drying.Pretreatment includes any method of treating the product prior to freezing. This may include concentrating the product, formulation revision (i.e., addition of components to increase stability, preserve appearance, and/or improve processing), decreasing a high-vapor-pressure solvent, or increasing the surface area. Food pieces are often IQF treated to make them free flowing prior to freeze drying. Freeze dried pharmaceutical products are in most cases parenterals administered after reconstitution by injection which need to be sterile as well as free of impurity particles. Pre-treatment in these cases consists of solution preparation followed by a multi-step filtration. Afterwards the liquid is filled under sterile conditions into the final containers which in production scale freeze dryers are loaded automatically to the shelves.In many instances the decision to pretreat a product is based on theoretical knowledge of freeze-drying and its requirements, or is demanded by cycle time or product quality considerations.[17]During the freezing stage, the material is cooled below its triple point, the temperature at which the solid, liquid, and gas phases of the material can coexist. This ensures that sublimation rather than melting will occur in the following steps. To facilitate faster and more efficient freeze drying, larger ice crystals are preferable. The large ice crystals form a network within the product which promotes faster removal of water vapor during sublimation.[2] To produce larger crystals, the product should be frozen slowly or can be cycled up and down in temperature in a process called annealing. The freezing phase is the most critical in the whole freeze-drying process, as the freezing method can impact the speed of reconstitution, duration of freeze-drying cycle, product stability, and appropriate crystallization.[18]Amorphous materials do not have a eutectic point, but they do have a critical point, below which the product must be maintained to prevent melt-back[further explanation needed] or collapse during primary and secondary drying.In the case of goods where preservation of structure is required, like food or objects with formerly-living cells, large ice crystals break the cell walls, resulting in increasingly poor texture and loss of nutritive content. In this case, rapidly freezing the material to below its eutectic point avoids the formation of large ice crystals.[2] Usually, the freezing temperatures are between 50C (58F) and 80C (112F).[citation needed]During the primary drying phase, the pressure is lowered (to the range of a few millibars), and enough heat is supplied to the material for the ice to sublimate. The amount of heat necessary can be calculated using the sublimating molecules' latent heat of sublimation. In this initial drying phase, about 95% of the water in the material is sublimated. This phase may be slow (can be several days in the industry), because, if too much heat is added, the material's structure could be altered.In this phase, pressure is controlled through the application of partial vacuum. The vacuum speeds up the sublimation, making it useful as a deliberate drying process. Furthermore, a cold condenser chamber and/or condenser plates provide a surface(s) for the water vapor to re-liquify and solidify on.It is important to note that, in this range of pressure, the heat is brought mainly by conduction or radiation; the convection effect is negligible, due to the low air density.A benchtop manifold freeze-drierThe secondary drying phase aims to remove unfrozen water molecules, since the ice was removed in the primary drying phase. This part of the freeze-drying process is governed by the material's adsorption isotherms. In this phase, the temperature is raised higher than in the primary drying phase, and can even be above 0C (32F), to break any physico-chemical interactions that have formed between the water molecules and the frozen material. Usually the pressure is also lowered in this stage to encourage desorption (typically in the range of microbars, or fractions of a pascal). However, there are products that benefit from increased pressure as well.After the freeze-drying process is complete, the vacuum is usually broken with an inert gas, such as nitrogen, before the material is sealed.At the end of the operation, the final residual water content in the product is extremely low, around 14%.This section needs additional citations for verification. Please help improve this article by adding citations to reliable sources in this section. Unsourced material may be challenged and removed. (November 2015) (Learn how and when to remove this message)Freeze-drying causes less damage to the substance than other dehydration methods using higher temperatures. Nutrient factors that are sensitive to heat are lost less in the process as compared to the processes incorporating heat treatment for drying purposes.[2] Freeze-drying does not usually cause shrinkage or toughening of the material being dried. In addition, flavors, smells, and nutritional content generally remain unchanged, making the process popular for preserving food. However, water is not the only chemical capable of sublimation, and the loss of other volatile compounds such as acetic acid (vinegar) and alcohols can yield undesirable results.Freeze-dried products can be rehydrated (reconstituted) much more quickly and easily because the process leaves microscopic pores. The pores are created by the ice crystals that sublimate, leaving gaps or pores in their place. This is especially important when it comes to pharmaceutical uses. Freeze-drying can also be used to increase the shelf life of some pharmaceuticals for many years.Lyophilized 5% w/v sucrose cake in a pharmaceutical glass vialPharmaceutical companies often use freeze-drying to increase the shelf life of the products, such as live virus vaccines,[19] biologics,[20] and other injectables. By removing the water from the material and sealing the material in a glass vial, the material can be easily stored, shipped, and later reconstituted to its original form for injection. Another example from the pharmaceutical industry is the use of freeze drying to produce tablets or wafers, the advantage of which is less excipient as well as a rapidly absorbed and easily administered dosage form.Freeze-dried pharmaceutical products are produced as lyophilized powders for reconstitution in vials and more recently in prefilled syringes for self-administration by a patient.Examples of lyophilized biological products include many vaccines such as live measles virus vaccine, typhoid vaccine, and meningococcal polysaccharide vaccine groups A and C combined. Other freeze-dried biological products include antihemophilic factor VIII, interferon alfa, anti-blood clot medicine streptokinase, and wasp venom allergenic extract.[21]Many bio-pharmaceutical products based on therapeutic proteins such as monoclonal antibodies require lyophilization for stability. Examples of lyophilized biopharmaceuticals include blockbuster drugs such as etanercept (Enbrel by Amgen), infliximab (Remicade by Janssen Biotech), rituximab, and trastuzumab (Herceptin by Genentech).Cell extracts that support cell-free biotechnology applications such as point-of-care diagnostics and biomanufacturing are also freeze-dried to improve stability under room temperature storage.[22][23]Dry powders of probiotics are often produced by bulk freeze-drying of live microorganisms such as lactic acid bacteria and bifidobacteria.[24]Lyophilized biologics can be pressed into pellets and tablets for anhydrous and high-density, solid-state storage of biological products.[25]Freeze dried bacon barsFreeze-dried Bulgarian apricot, melon, meatball soup, taratorFreeze dried ice cream and chocolate, and spaghetti with baconThe primary purpose of freeze drying within the food industry is to extend the shelf-life of the food while maintaining the quality.[1] Freeze-drying is known to result in the highest quality of foods of all drying techniques because structural integrity is maintained along with preservation of flavors.[1] Because freeze drying is expensive, it is used mainly with high-value products.[4] Examples of high-value freeze-dried products are seasonal fruits and vegetables because of their limited availability, coffee; and foods used for military rations, astronauts/cosmonauts, and/or hikers.[4]Because of its light weight per volume of reconstituted food, freeze-dried products are popular and convenient for hikers, as military rations, or astronaut meals.[1] A greater amount of dried food can be carried compared to the same weight of wet food. In replacement of wet food, freeze dried food can easily be rehydrated with water if desired and shelf-life of the dried product is longer than fresh/wet product making it ideal for long trips taken by hikers, military personnel, or astronauts. The development of freeze drying increased meal and snack variety to include items like shrimp cocktail, chicken and vegetables, butterscotch pudding, and apple sauce.[13]Freeze-dried coffee, a form of instant coffeeCoffee contains flavor and aroma qualities that are created due to the Maillard reaction during roasting[26] and can be preserved with freeze-drying.[2] Compared to other drying methods like room temperature drying, hot-air drying, and solar drying, Robusta coffee beans that were freeze-dried contained higher amounts of essential amino acids like leucine, lysine, and phenylalanine.[26] Also, few non-essential amino acids that significantly contributed to taste were preserved.[26]With conventional dehydration, berries can degrade in quality as their structure is delicate and contains high levels of moisture. Strawberries were found to have the highest quality when freeze dried; retaining color, flavor, and ability to be re-hydrated.[27]Freeze-drying is used extensively to preserve insects for the purposes of consumption. Whole freeze-dried insects are sold as exotic pet food, bird feed, fish bait, and increasingly for human consumption.[28][29] Powdered freeze-dried insects are used as a protein base in animal feeds, and in some markets, as a nutritional supplement for human use.[29][28] Farmed insects are generally used for all of the aforementioned purposes versus harvesting wild insects, except in the case of grasshoppers which are often harvested out of field crops.[28]In chemical synthesis, products are often freeze-dried to make them more stable, or easier to dissolve in water for subsequent use.[citation needed]In bioseparations, freeze-drying can be used also as a late-stage purification procedure, because it can effectively remove solvents. Furthermore, it is capable of concentrating substances with low molecular weights that are too small to be removed by a filtration membrane. Freeze-drying is a relatively expensive process. The equipment is about three times as expensive as the equipment used for other separation processes, and the high energy demands lead to high energy costs. Furthermore, freeze-drying also has a long process time, because the addition of too much heat to the material can cause melting or structural deformations. Therefore, freeze-drying is often reserved for materials that are heat-sensitive, such as proteins, enzymes, microorganisms, and blood plasma. The low operating temperature of the process leads to minimal damage of these heat-sensitive products.[citation needed]In nanotechnology, freeze-drying is used for nanotube purification to avoid aggregation due to capillary forces during regular thermal vaporization drying.[citation needed]Freeze-drying is among the methods used to preserve animals in the field of taxidermy. When animals are preserved in this manner they are called "freeze-dried taxidermy" or "freeze-dried mounts". Freeze-drying is commonly used to preserve crustaceans, fish, amphibians, reptiles, insects, and smaller mammals.[30] Freeze-drying is also used as a means to memorialize pets after death. Rather than opting for a traditional skin mount when choosing to preserve their pet via taxidermy, many owners opt for freeze-drying because it is less invasive upon the pet's body.[31]