University of California
Cooperative Extension

Master Food Preserver

The Art of the Dry

Drying, Dehydrating and Freeze Drying

Presented by
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The Art of the Dry

Preserving food by drying is the least expensive method available—and the oldest. Open air drying using the sun and wind has been practiced since ancient times. Columbus and his crew used dried fruits, grains and meats on their expedition to the New World. Native Americans dried a variety of foods, and early settlers dried food for winter. In 1795, the first food dehydrator was introduced by the French.

The scientific principle behind preserving food by drying is that by removing moisture, pathogens and spoilage microbes cannot grow. Water content of properly dried food varies from 5% to 25%, depending on the food.

Dried foods take up less storage space due to reduced volume, and can cost little to store at room temperature, although storing the dried product in a refrigerator or freezer will result in longer shelf life. Freeze drying has a larger up-front cost; however, freeze dried foods will keep for long periods of time at room temperature.

Food Safety

Organisms that can cause food spoilage (molds, yeasts and bacteria) are always present in the air, water and soil. Enzymes that may cause undesirable changes in flavor, color and texture are also present in raw foods.

While canning relies on appropriate levels of acidity, heat and time to kill food pathogens, drying relies on reducing water activity, the amount of water available in food that allows the growth of microorganisms. When water activity is reduced below the microorganism's ability to grow, the organism may or may not be killed, but it will not be able to multiply in number.

It was originally believed that the drying process inactivated pathogens that might be present. Although drying destroys most of the organisms present, some microbes including the pathogen *Salmonella, E. coli* and *Listeria*, may survive the drying process—remaining inactive but viable until a better environment for growth is encountered. Research indicates that 0.2% to 10% of fresh fruits and vegetables may have *Salmonella* contamination and that about 2% of that can survive the drying process. There is some indication that blanching vegetables and pretreating fruits with citric acid can enhance pathogen destruction.

To maintain safety and quality, several factors must be considered when drying fruits, vegetables and herbs. Keep in mind that specific food products often have recommendations that are unique to them. Drying removes the moisture from food so that microorganisms such as bacteria, yeasts and molds are less likely to grow; however, drying does not effectively destroy them. Because there is not a heat treatment that effectively destroys disease-carrying microorganisms, it is critical to use safe food-handling practices when growing and handling fruits, vegetables, and herbs for drying. The optimum drying temperature is 140°F. If higher temperature is used, the food will develop case hardening and moisture will not be able to

escape from the food; this, is turn, will lead to moldy food product. Therefore, do not rush the drying process. Low humidity is also needed when drying food. If the surrounding air is humid, the foods will not dry effectively. Increasing the air movement away from the food will assist in the drying process. Foods can be dried in the oven, under the sun, on the vine, or indoors using a dehydrator.

The Drying Process

Peeling is optional; however, the skin tends to toughen on apples and pears. The skin reduces surface area, preventing moisture from escaping. Sliced pieces will dry more quickly than fruit or vegetables left whole or cut in half. Pieces of the same size, shape, and thickness will dry evenly.

Pretreating Fruits

Some foods such as apples, pears, peaches, and apricots dry better when pretreated. Pretreatment reduces oxidation, giving a better color, reducing vitamin loss, and lengthening shelf life. Research studies have shown that pretreating with an acidic solution enhances the destruction of potentially harmful bacteria during drying. Place cut fruits in a solution of 3-3/4 teaspoons of powdered ascorbic acid 1/2 teaspoon of powdered citric acid in 2 cups water for 10 minutes before placing on trays to dry. Equal parts of bottled lemon juice and water can be substituted for the above pretreatment.

Other methods of pretreating fruit include syrup blanching, water blanching, and sulfiting. Syrup blanching involves simmering the prepared fruit for 10 minutes in a syrup of 1 cup sugar, 1 cup white corn syrup, and 2 cups water and letting it stand in the hot syrup for 30 minutes before draining, rinsing, and placing on drying trays. Syrup-blanched fruit is sweeter but also stickier than fruit treated by other methods.

Some fruits such as blueberries and cranberries need to be dipped into boiling water to crack the skins. Be careful not to leave the fruit in the boiling water for too long or the fruit will turn to mush. Chill quickly after cracking skins and blot dry.

Blanching Vegetables

Blanching in a solution that contains 1/2 teaspoon of citric acid per quart of water is recommended for most vegetables. This enhances the destruction of potentially harmful microorganisms and slows the enzyme reactions that will continue during drying and storage. Blanching also softens the cell structure, allowing moisture to escape, and allows the pieces to dry faster and later rehydrate faster. Blanched vegetables should be drained and placed on dryer trays. The heat from blanching will give them a head start in the drying process. Onions, garlic, peppers, and herbs do not need blanching.

Drying Fruits and Vegetables (Dehydration)

Place pieces on drying racks without allowing them to touch or overlap. Place trays in a preheated dehydrator. Initially, the temperature can be set at 145°F when there is surface moisture on the fruit or vegetable. After one hour reduce the temperature to 135 to 140°F to finish drying. If the food is dried at a temperature that is too high, the outer surface will harden, preventing moisture from escaping from the center of the slice—this is called case hardening. Food shrinks when it is dried, so use a fine mesh for smaller fruits and vegetables.

Conditioning and Storing Fruits

Fruits are dry when they are pliable and no beads of moisture form when pressed between your fingers. Condition dried fruit by packing it loosely into an air-tight glass or plastic container for several days to distribute the remaining moisture evenly. If condensation forms inside the container, further dehydration is needed.

Unpeeled fruit or uncovered fruit needs to be treated to destroy insect eggs that might have gotten on the fruit. Heat dried fruit in the oven at 160°F for 30 minutes or chill in the freezer at 0°F or below for 48 hours. The shelf life of dried fruit is increased when it is stored in the freezer or refrigerator.

Testing Dryness and Storage

Vegetables are tough, brittle, or crunchy when dry and do not need conditioning. Store dried vegetables in air-tight containers to prevent food from absorbing the moisture in the air. Storing them in a dark place retains the vitamin content of the food.

Rehydrating

Some dried foods are eaten as-is, in their dried condition. Others can be rehydrated for use in soups, stews, and other dishes.

Rehydrating Dried Foods

Product	Water to Add to 1 Cup Dried Food (Cups)	Minimum Soaking Time (Hours)
Fruits*		
Apples	1 1/2	1/2
Pears	1 3/4	1 1/4
Peaches	2	1 1/4
Vegetables**		
Asparagus	2 1/4	1 1/2
Beans, lima	2 1/2	1 1/2
Beans, green snap	2 1/2	1
Beets	2 3/4	1 1/2
Carrots	2 1/4	1
Cabbage	3	1
Corn	2 1/4	1/2
Okra	3	1/2
Onions	2	3/4
Peas	2 1/2	1/2
Pumpkin	3	1
Squash	1 3/4	1
Spinach	1	1/2
Sweet Potatoes	1 1/2	1/2
Turnip Greens and other greens	1	3/4

* Fruits – Water is at room temperature.
** Vegetables – Boiling water used.

The Art of the Dry Recipes

Fruits

Fruit	Drying Procedure
Apples	Select mature, firm apples. Wash well. Pare and core. Cut in rings or slices 1/8 to 1/4 inch thick or cut in quarters or eighths. Dip in ascorbic acid or other antidarkening/antimicrobial solution for 10 minutes. Remove from solution and drain well. Arrange in single layer on trays, pit side up. Dry until soft, pliable, and leathery; no moist area in center when cut (6-24 hours).
Apricots	Select firm, fully ripe fruit. Wash well. Cut in half and remove pit. Do not peel. Dip in ascorbic acid or other antidarkening/antimicrobial solution for 10 minutes. Remove from solution and drain well. Arrange in single layer on trays, pit side up with cavity popped up to expose more flesh to the air. Dry until soft, pliable, and leathery; no moist area in center when cut (24-36 hours).
Bananas	Select firm, ripe fruit. Peel. Cut in 1/8 inch slices. Dip in citric acid or other antidarkening/antimicrobial solution for 10 minutes. Remove and drain well. Arrange in single layer on trays. Dry until tough and leathery (6-10 hours).
Berries	Select firm ripe fruit. Wash well. Leave whole or cut in half. For berries with firm skins, dip in boiling water 30 seconds to crack skins. For berries with soft skins (strawberries), dip in ascorbic acid or other antimicrobial solution for 10 minutes. Remove and drain well. Place on drying trays not more than two berries deep. Dry until hard and berries rattle when shaken on trays (24-36 hours).
Cherries	Select fully ripe fruit. Wash well. Remove stems and pits. Dip whole cherries in boiling water 30 seconds to crack skins. May also dip in ascorbic acid or other antimicrobial solution for 10 minutes. Remove and drain well. Arrange in single layer on trays. Dry until tough, leathery, and slightly sticky (24-36 hours).
Citrus peel	Select thick-skinned oranges without mold or decay and no color added to skin. Scrub oranges well with brush under cool running water. Thinly peel outer 1/16 to 1/8 inch of the peel; avoid white bitter part. Dip in ascorbic acid or other antimicrobial solution for 10 minutes. Remove from solution and drain well. Arrange in single layers on trays. Dry until crisp (8-12 hours).
Figs	Select fully ripe fruit. Wash or clean well with damp towel. Peel if desired. Leave whole if small or partly dried on tree; cut large figs in halves or slices. If drying whole figs, crack skins by dipping in boiling water for 30 seconds. For cut figs, dip in ascorbic acid or other antimicrobial solution for 10 minutes. Remove and drain. Arrange in single layers on trays. Dry until leathery and pliable (12-24 hours).
Grapes and black currants	Select seedless varieties. Wash, sort, remove stems. Cut in half or leave whole. If drying whole, crack skins by dipping in boiling water for 30 seconds. If halved, dip in ascorbic acid or other antimicrobial solution for 10 minutes. Drain. Dry until pliable and leathery with no moist center (12-24 hours).
Melons	Select mature, firm fruits that are heavy for their size; cantaloupe dries better than watermelon. Scrub outer surface well with brush under cool running water. Remove outer skin, any fibrous tissue and seeds. Cut into 1/4- to 1/2-inch thick slices. Dip in ascorbic acid or other antimicrobial solution for 10 minutes. Remove and drain. Arrange in single layer on trays. Dry until leathery and pliable with no pockets of moisture (6-10 hours).
Nectarines and peaches	Select ripe, firm fruit. Wash and peel. Cut in half and remove pit. Cut in quarters or slices if desired. Dip in citric acid or other antidarkening/antimicrobial solution for 10 minutes. Remove and drain well. Arrange in single layer on trays pit side up. Turn halves over when visible juice disappears. Dry until leathery and somewhat pliable (6-36 hours).
Pears	Select ripe, firm fruit. Bartlett variety is recommended. Wash fruit well. Pare, if desired. Cut in half lengthwise and core. Cut in quarters, eighths, or slices 1/8- to 1/4-inch thick. Dip in citric acid or other antidarkening/ antimicrobial solution for 10 minutes. Remove and drain. Arrange in single layer on trays pit side up. Dry until springy and suede-like with no pockets of moisture (6-10 hours for slices; 24-36 hours for halves).
Plums and prunes	Wash well. Leave whole if small; cut large fruit into halves (pit removed) or slices. If left whole, crack skins in boiling water 1 to 2 minutes. If cut in half, dip in ascorbic acid or other antimicrobial solution for 10 minutes. Remove and drain. Arrange in single layer on trays pit side up, cavity popped out. Dry until pliable and leathery (6-10 hours for slices; 24-36 hours for halves).

Vegetables

Vegetable	Preparation	Blanching Time* (mins.)	Drying Time (hrs.)	Dryness test
Asparagus	Wash thoroughly. Halve large tips.	4-5	6-10	Leathery to brittle
Beans, green	Wash. Cut in pieces or strips.	4	8-14	Very dry, brittle
Beets	Cook as usual. Cool, peel. Cut into shoestring strips 1/8" thick.	None	10-12	Brittle, dark red
Broccoli	Wash. Trim, cut as for serving. Quarter stalks lengthwise.	4	12-15	Crisp, brittle
Brussels sprouts	Wash. Cut in half lengthwise through stem.	5-6	12-18	Tough to brittle
Cabbage	Wash. Remove outer leaves, quarter and core. Cut into strips 1/8" thick.	4	10-12	Crisp, brittle
Carrots, parsnips	Use only crisp, tender vegetables. Wash. Cut off roots and tops; peel. Cut in slices or strips 1/8" thick.	4	6-10	Tough to brittle
Cauliflower	Wash. Trim, cut into small pieces.	4-5	12-15	Tough to brittle
Celery	Trim stalks. Wash stalks and leaves thoroughly. Slice stalks.	4	10-16	Very brittle
Chili peppers, green	Wash. To loosen skins, cut slit in skin, then rotate over flame 6-8 minutes or scald in boiling water. Peel and split pods. Remove seeds and stem. (Wear gloves if necessary.)	None	12-24	Crisp, brittle, medium green
Chili peppers, red	Wash thoroughly. Slice or leave whole if small.	4	12-24	Shrunken, dark red pods, flexible
Corn, cut	Husk, trim. Wash well. Blanch until milk in corn is set. Cut kernels from the cob.	4-6	6-10	Crisp, brittle
Eggplant	Wash, trim, cut into 1/4" slices.	4	12-14	Leathery to brittle
Horseradish	Wash, remove small rootlets and stubs. Peel or scrape roots. Grate.	None	6-10	Brittle, powdery
Mushrooms**	Scrub. Discard tough, woody stalks. Slice tender stalks 1/4" thick. Peel large mushrooms, slice. Leave small mushrooms whole. Dip in solution of 1 tsp. citric acid/quart water 10 minutes. Drain.	None	8-12	Dry and leathery
Okra	Wash thoroughly. Cut into 1/2" pieces or split lengthwise.	4	8-10	Tough, brittle
Onions	Wash, remove outer paper skin. Remove tops and root ends, slice 1/8 to 1/4" thick.	4	6-10	Very brittle
Parsley; other herbs	Wash thoroughly. Separate clusters. Discard long or tough stems.	4	4-6	Flaky
Peas	Shell and wash.	4	8-10	Hard, wrinkled, green
Peppers; pimentos	Wash, stem. Remove core and seeds. Cut into 1/4 to 1/2" strips or rings.	4	8-12	Tough to brittle
Potatoes	Wash, peel. Cut into 1/4" shoestring strips or 1/8" thick slices.	7	6-10	Brittle
Spinach; greens like Kale, Chard, mustard	Trim and wash very thoroughly. Shake or pat dry to remove excess moisture.	4	6-10	Crisp
Squash, summer or banana	Wash, trim, cut into 1/4" slices.	4	10-16	Leathery to brittle
Squash, winter	Wash rind. Cut into pieces. Remove seeds and cavity pulp. Cut into 1" wide strips. Peel rind. Cut strips crosswise into pieces about 1/8" thick.	4	10-16	Tough to brittle
Tomatoes	Steam or dip in boiling water to loosen skins. Chill in cold water. Peel. Slice 1/2" thick or cut in 3/4" sections. Dip in solution of 1 tsp. citric acid/quart water for 10 minutes.	None	6-24	Crisp

*Blanching times are for 3,000 to 5,000 feet. Times will be slightly shorter for lower altitudes and slightly longer for higher altitudes or for large quantities of vegetables.

****WARNING:** The toxins of poisonous varieties of mushrooms are **not** destroyed by drying or by cooking. Only an expert can differentiate between poisonous and edible varieties.

Spices and Blends

Spices and herb blends will last up to 6 months when stored in an airtight container in a cool, dark place.

All Purpose Seasoning
Use for grilling meats, savory main dishes or side dishes

2 parts dried oregano
1 part dried rosemary
1 part dried fennel
1 part dried thyme
½ part dried garlic

Garam Masala
Traditional Indian spice blend used in curries and on meats and vegetables

2 parts ground cumin
2 parts ground coriander
1 part ground turmeric
½ part ground cinnamon
¼ part ground cloves
¼ part ground cardamon

Taco Seasoning
Use on tacos, fajitas, meats and chili. Works well in meat and bean dishes

2 parts chipotle powder
1 part paprika
1 part ground cumin
½ part dried onions, powdered
½ part dried garlic, powdered
¼ part cayenne powder (optional)

Homemade Italian Seasoning
Use for soups, stews and marinades

2 parts dried basil
2 parts dried oregano
1 part dried rosemary
2 parts dried parsley
1 part dried thyme
I part dried garlic, powdered
1 part red chili flakes (optional)

Source: "Amazing Herb Blends" by Rosalee de la Foret at Learning Herbs.

Italian seasoning
1/4 cup dried oregano
2 TBSP *each* dried thyme, dried basil, dried marjoram
1 TBSP *each* dried rosemary and rubbed sage

Ranch seasoning
2TBSP *each* dried tarragon, dried parsley, dried dill
T TBSP *each* garlic powder, onion powder, salt
1.5 tsp ground black pepper

Herbs de Provence
1 TBSP *each* dried thyme, dried marjoram, dried rosemary, dried basil, dried sage, dried parsley, dried tarragon, dried lavender blossoms

Source: MFP Liz Swenson, UC Master Food Preservers of Mariposa County

Using Dried Foods

Mango Date Energy Bites

2 cups pitted whole dates
1 cup raw cashews or almonds
1 cup dried mango or apricots
¼ tsp salt
Shredded, unsweetened coconut (opt)

Process dates, nuts, fruit and salt in a food processor until finely chopped. Take about 2 Tablespoons and form it into a ball. You will get about 20 balls. Sprinkle and roll in shredded coconut, if desired.

Developed by MFP Zara Durgaryan, UC Master Food Preservers of Mariposa County

Freeze Dried Zucchini Ragu

1 pound hamburger or ground sausage
2 pint cans diced tomatoes
2 pints freeze dried zucchini
1 Tbsp Italian seasoning
Salt to taste

Brown the meat and pore off the fat. Add rest of ingredients. Stir and simmer until hot and zucchini reconstituted. About 10 minutes.

You can also add ¼ cup black olives sliced and/or mushrooms about 1/2 cup sliced. I use 6 baby Bella's. If you like onions and garlic, they are good additions. Top with grated cheese to serve, such as cheddar for hamburger and mozzarella for ground sausage.

Developed by MFP Sharon Carlson, UC Master Food Preservers of Mariposa County

Ginger Carrot Soup

2 Tbls butter or oil
2 onions peeled and chopped
6 cups bone broth (or chicken broth)
2 lbs carrots peeled and sliced
One piece of ginger (or more)
1 cup coconut cream or milk
Salt and pepper

In a large soup pan melt butter and add onions to cook until limp. Add broth carrots and ginger. Cover and bring to a boil. Reduce heat and simmer until carrots are tender when pierced.

Remove from heat and transfer to a blender. Don't fill the blender more than half way. Do it in batches if you need to. Pulse the blender to start then puree until smooth. Return to the pan and add coconut milk(cream), stir over high heat until hot. For a smoother flavor bring soup to a boil, and salt and pepper to taste.

Developed by MFP Sharon Carlson, UC Master Food Preservers of Mariposa County

Chicken Noodle Soup Mix

1 Tbsp dried chopped onion
1 Tbsp dried minced garlic
1 bay leaf
½ tsp dried rosemary
½ tsp dried sage
½ tsp dried thyme
½ tsp celery seed
1 chicken bouillon cube
2 cups egg noodles

Heat 1 Tbsp oil in a saucepan over medium-high heat. Saute one diced carrot and one diced stalk of celery until just tender, about 5 minutes. Unwrap bouillon cube and add it to a large saucepan along with all the ingredients of the jar and 3 cups of water. Bring to a boil, reduce heat and simmer until the noodles are cooked through, about 7-10 minutes. Stir in 2 cups of chopped cooked chicken before serving. Season to taste.

Spicy Black Bean Soup Mix

1 ½ cups dry black beans
1 Tbsp dried chopped onions
1 Tbsp dried garlic
2 Tbsp cumin
1 tsp celery seed
2 bay leaves
1 tsp chili powder
1 vegetable bouillon cube
1 small dried chili pepper

Remove wrapper from bouillon cube and add it to a large saucepot with remaining ingredients from jar and 6 cups water. Bring to a boil over high heat, reduce heat to low and simmer until the beans are tender and soup is thick, about 90 minutes. Add more water as necessary to soften the beans. Remove and discard chili pepper and bay leaves before serving. Season to taste.

Source: "Homemade Soup Mixes in a Jar" by Wholefully.com

Resources for ***The Art of the Dry*** workshop

Recipes:

Main Dish/Soup Recipes
https://www.weedemandreap.com/dehydrator-recipes/
https://www.freshoffthegrid.com/dehydrated-minestrone-soup/
https://www.freshoffthegrid.com/wprm_print/12344
https://www.freshoffthegrid.com/backpacking-peanut-stew/
https://wholefully.com/homemade-soup-mixes-in-a-jar/

Spice Blends
https://andianne.com/homemade-spice-blends/
https://realsimplegood.com/10-easy-homemade-spice-blends/?epik=0QMlrEvIWX5R8

Pet Food
https://www.backpackingchef.com/dehydrating-dog-food.html#ingredients
https://www.wiggleworthy.com/dehydrated-dog-treat-recipes.html
https://peterdobias.com/blogs/blog/how-to-make-homemade-dehydrated-dog-food

Drying/Dehydrating General Information
https://mfp.ucanr.edu/Resources_/Extension_Document_Library/Publications__Dehydration/