STATION CIRCULAR 149 APRIL 1943

Home Fruit and Vegetable Dehydration

E. H. WIEGAND
THOMAS ONSDORFF
ALYCE HOLMES

Oregon State System of Higher Education
Agricultural Experiment Station
Oregon State College
Corvallis

TABLE OF CONTENTS

Home Fruit and Vegetable Dehydration

E. H. WIEGAND,[1] THOMAS ONSDORFF,[2] and ALYCE HOLMES[3]

RESTRICTIONS that are being imposed in order to conserve essential materials for war needs make it imperative that methods of food preservation other than canning be adopted to assist in building up adequate food supplies. Many families are not in a position to can vegetables properly, because pressure cookers are not available. Glass jars, rubber jar rings, and many of the other accessories to canning are becoming scarce. The army, the navy, and the lend-lease program are taking large volumes of our commercially packed foods, making some of the important food items hard to obtain.

The Victory Garden Campaign will increase the raw material supply to most families, and provision should be made by these families to preserve the surpluses from their gardens. Where pressure cookers are not available to preserve these surplus vegetables, a simple small drying unit, used to conserve these products, can be made or obtained at a nominal cost.

DEHYDRATION PRINCIPLES

The fundamental principle of preservation by drying is that of moisture reduction. When fresh fruits or vegetables contain their normal amounts of water, they are subject to spoilage. Removing this moisture preserves the material, because it removes the principal element necessary for the growth of organisms, such as yeasts, molds, and bacteria.

To remove moisture from fresh products, it is necessary to supply energy in the form of heat. This heat energy changes the water in the fruit or vegetable to a vapor that is carried away by the circulating air. These changes can be accomplished with such heating devices as those indicated in Circular of Information 309, "Construction and Operation of a Home Electric Food Dehydrator." All evaporation processes are dependent on three factors—heat, circulation, and humidity (or moisture) present in the air. Heat then furnishes the energy to evaporate the water. The dryness of the air partly governs the rate of evaporation, and circulation further assists by carrying off the water vapor.

[1]Food Technologist in Charge, Food Industries Department.
[2]Associate Food Technologist, Food Industries Department.
[3]Research Assistant, Food Industries Department.

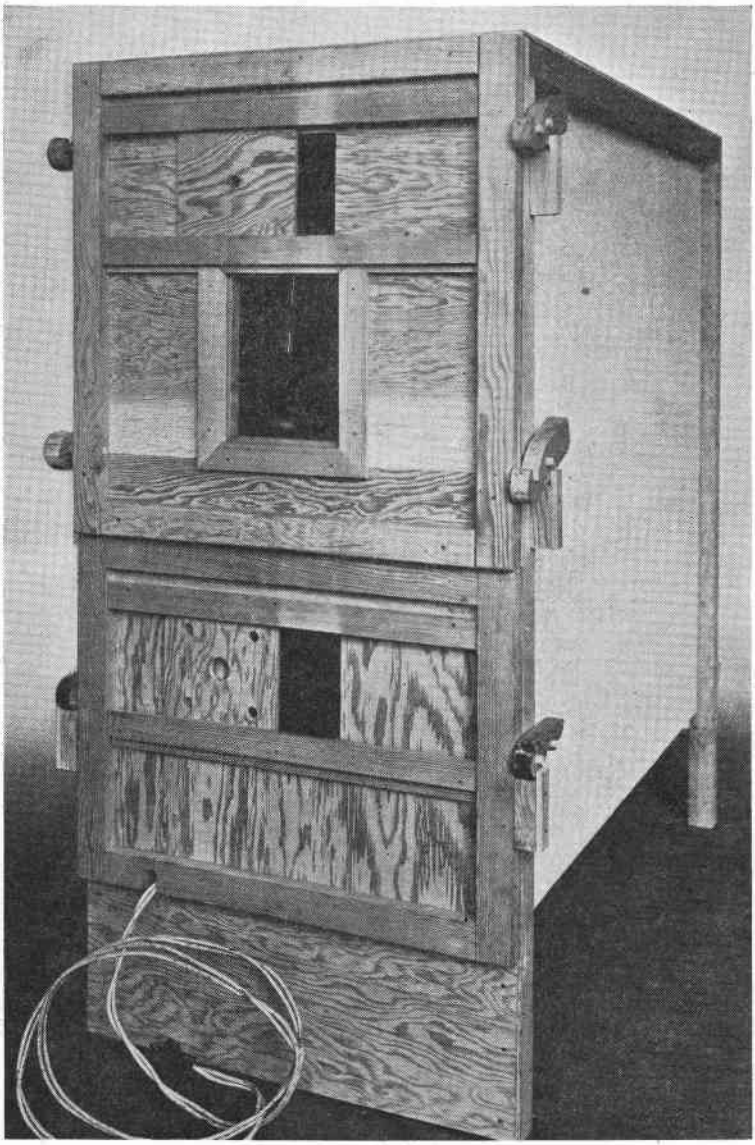

Figure 1. Home Dehydrator design illustrated in Circular of Information 309.

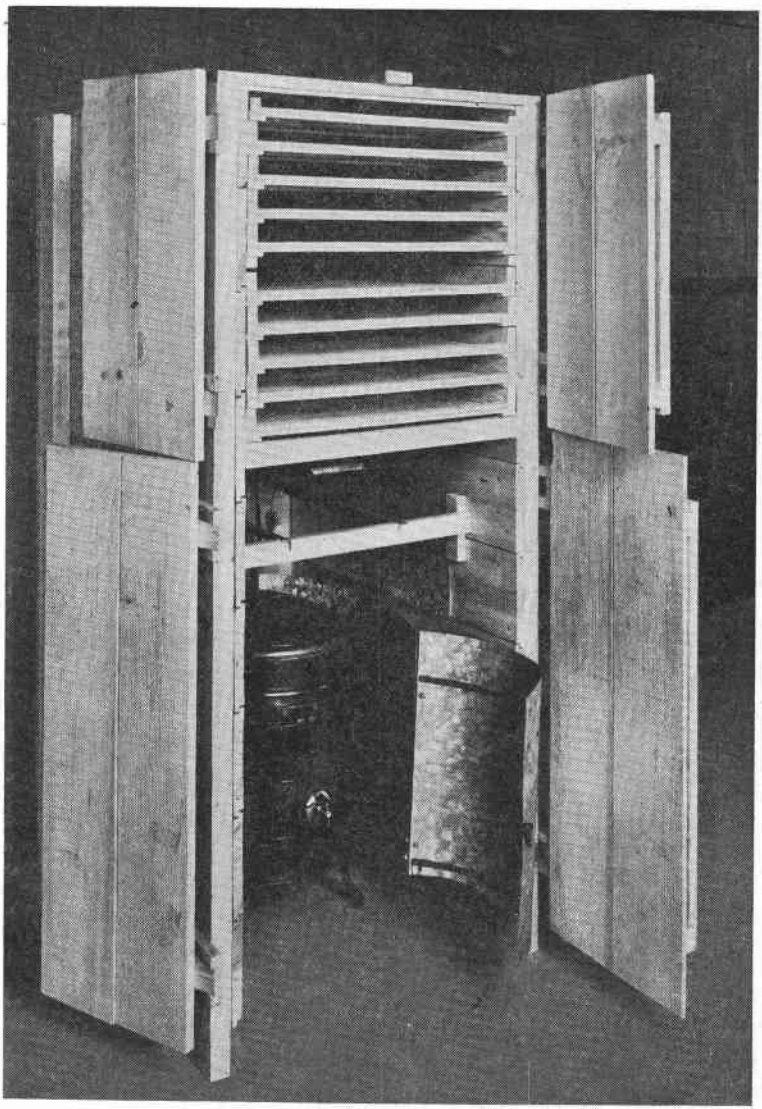

Figure 2. Drier designed for areas where electricity is not available. Adaptable for drying fruit or vegetables.

The small home dehydrator is so constructed that all these principles are ingeniously incorporated. Thus with a unit of this type, if the temperature is maintained at from 150° to 155° F., drying will proceed rapidly and the products will be properly dried.

All products, when first placed in the dehydrator, give up their moisture freely. Later when the moisture in the product is reduced to less than half, the rate of evaporation is materially reduced. This slowing up of the drying rate is due principally to the loss of liquid from the cells that slows up the flow of the moisture from the interior of the fruit or vegetable. Sliced or cut products will give up their moisture more freely than whole products. All raw products tend to resist excessive evaporation because the cells are still alive and active. After blanching, the cells lose their ability to resist and water passes through more freely. This is indicated in blanched vegetables. Where whole fruits like prunes or cherries are dried, many hours of heating are necessary to reduce the moisture content to a safe preserving point. Here the outer skin tissue tends to slow down evaporation.

As temperature is the most important controlling factor, it should be maintained at 150° to 155° F. to insure rapid evaporation. Higher temperatures than this tend to impair the quality of the finished product. When operating the dehydrator, be sure to maintain the temperature as close to 150°-155° F. as possible.

SELECTING THE FRESH PRODUCT

To insure success in the finished product, select fresh fruit or vegetables of good quality. Use only ripe fruit that has reached its full development and is in prime eating condition. Vegetables that are mature but still tender and succulent should be used. Overmature vegetables tend to be tough, stringy, and flavorless.

Varieties recommended for use in freezing are usually suitable for dehydration. Early morning harvest of vegetables while the products are fresh and succulent is recommended. Rapid handling then will conserve vitamins ordinarily lost through long holding and storage. Under no conditions should succulent vegetables be held longer than 6 hours after harvest before drying, and it is essential they be kept cool during this time.

Make your dehydration plans to supply a variety of those fruits and vegetables that will provide the greatest amount of nutritive material. Your selection of foods should include items that will give variety in color and flavor, as well as nourishment.

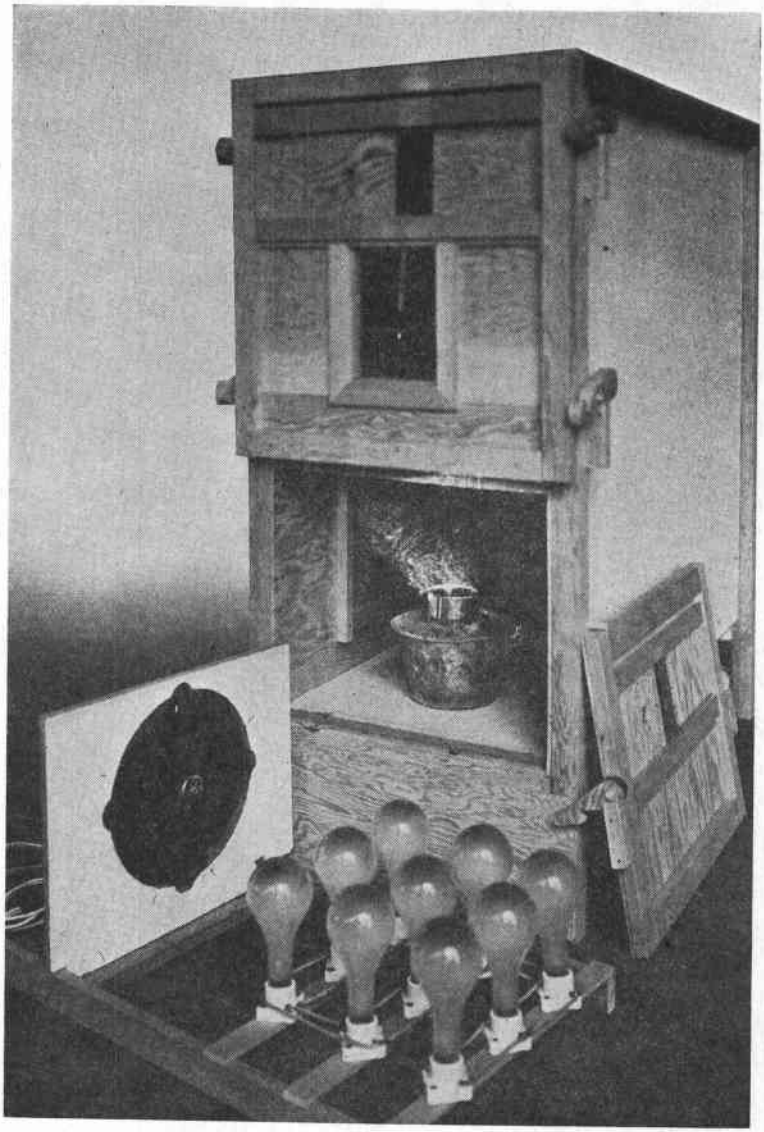

Figure 3. Illustrating method of burning sulphur to preserve the color of cut fruits.

IMPORTANCE OF PROPER PREPARATION

Fresh fruit and vegetables contain many nutritive substances that are easily lost in storage, handling, and preparation. Conservation of these is important. Chief among these elements are vitamins, sugars, proteins, and minerals—all essential to the body. When preparing the products, certain steps are necessary to conserve some of these essential materials. Many, like Vitamin C, oxidize readily in the presence of air. Others, like sugar and minerals, dissolve in the washing or blanching procedure and are lost. With greater care given to each step in the preparation, more of these elements can be retained in the product.

PREPARATION OF FRUITS FOR DEHYDRATION

Washing is the first step in preparation. After cleaning, some fruits, like apples, are hand-peeled, cored, and sliced. Others, such as apricots, are cut in half and the pit is removed. Peaches are usually cut, halved, and pitted. Peeling is optional; if peaches are sliced, they should be peeled.

Peeling such fruits as peaches is easily accomplished by immersing a small quantity of fruit in quite a large volume of boiling water. After the fruit is immersed in this water for 1 to 1½ minutes, dip in cold water to cool. The skin of properly ripened fruit will slip readily. Longer immersion may be needed for underripe fruit.

Sulphuring fruit. Fruit that is sliced or cut is most subject to oxidation or discoloration because the soft tissue is exposed. Oxidation is caused by enzymes and the oxygen of the air coming into contact with the cut surfaces of the fruit. As soon as the fruit is peeled or sliced, the cut surfaces should be temporarily protected. This can be done best by dipping the product in a weak salt solution (approximately 3 tablespoons per quart of water). Best protection during the drying process is afforded the product by subjecting the fresh cut fruit to the fumes of burning sulphur. This treatment will also afford protection against insects to the dry fruit in storage. All highly acid fruit that tends to oxidize or discolor readily, needs to be sulphured and must not be dried on wire-screen trays. To safeguard the product, use only wood-slat trays.

Sulphuring takes from 30 minutes to 2 hours for most fruit products. (See Table 1.) Pears, peaches, and apricots can, however, be subjected to these fumes (sulphur dioxide) for as long as 8 hours without injury. Long sulphuring bleaches the color, which will return as the product dries. The sulphur absorbed by the fruit

acts as a preservative, as well as an antioxidant, and is almost completely driven off when the product is cooked.

PREPARATION OF VEGETABLES FOR DEHYDRATION

In general, the preparation of vegetables for dehydration is not different from their preparation for any other home use. Precautions should be taken to see that the pieces of the prepared product are of uniform thickness as indicated for that product in Table 1.

Blanching is the most important step in the preliminary treatment of vegetables. If the products are not thoroughly blanched, they will not retain their flavor, color, or nourishing qualities. All fresh, uncooked vegetables contain quantities of enzymes. These enzymes are complex organic substances that cause changes in living tissue. They are present and active during the life of the vegetable and continue to function in breaking down plant materials unless they are inactivated. Blanching is the most practical process by which we can stop the action of enzymes that produce off flavors and odors during storage and make the dehydrated products undesirable for consumption.

Figure 4. Blanching vegetables by steaming method. Small batches are necessary to insure thorough heat distribution. Note steam escaping due to pressure generated.

The blanching can be accomplished with the use of steam or hot water. Steam is often hard to obtain in quantity. The use of large 4 to 6 gallon cookers or soup stock pots in which a large flat area of water can be heated quickly will materially assist in the formation of steam. Construct a wire basket that will fit the cooker and can

Figure 5. Spread blanched vegetables while still hot.

be suspended above the water. Cover the bottom of the cooker with about 2 inches of boiling water. Place enough prepared vegetable material to fill one tray only, or not more than 1½ inches of vegetables in the basket at one time. Support the basket on a wire rack in the steam above the boiling water, closing the lid tightly. When a light pressure is formed, indicated by the pressure of escaping steam from below the lid, the blanching of the vegetables will proceed quickly. The time of blanching, after pressure is created, is governed by the product and its compactness. (See Table 2.)

It is recognized that steam blanching will be somewhat slower than hot water blanching. This is due to the lack of distribution of heat through the cold vegetables. Hence for steam blanching not more than 1½ inches of vegetables should be placed in the basket. Batches of vegetables will blanch more quickly in hot water because of the quicker distribution of heat.

When hot water is used as a blanching medium, use a large vessel as indicated under steam blanching. Fill vessel at least half full of water. Place on largest burner to supply heat quickly. Bring water to a vigorous boil. Place enough vegetables for one tray in the wire basket, submerge in boiling water, and agitate by stirring gently or by raising and lowering the basket during blanching. (Refer to Table 2 for exact blanching time.) It must be recognized that large quantities of water drop less in temperature than small quantities when the cold vegetables are introduced. It becomes evident, therefore, that the use of a large vessel for blanching in hot water is imperative. Before blanching another basket of vegetables, be sure the water has again come to a vigorous boil.

OPERATING THE DEHYDRATOR

Some time before starting the drying operations, heat up the dehydrator. By the time the fruit or vegetables are prepared, the dehydrator should be up to a temperature of 150°-155° F.

After blanching, spread the hot vegetables on the tray immediately and place in the preheated dehydrator. It is important when operating the dehydrator to have the prepared blanched material go into the unit as hot as possible. This will prevent too great a fluctuation in the temperature of the drying unit.

To dehydrate fruits or vegetables quickly, careful attention should be given to the following items:

1. The temperature of the dehydrating unit should be established at 150° to 155° F. Check the temperature of the unit at regular intervals to see that it is maintained throughout the drying period.

2. The sliced fruit and vegetable load should never exceed 1 pound per square foot of tray surface. Spread the material evenly on the trays to prevent wet spots (2½ to 3 pounds per tray for home dehydrator illustrated in Circular of Information 309).

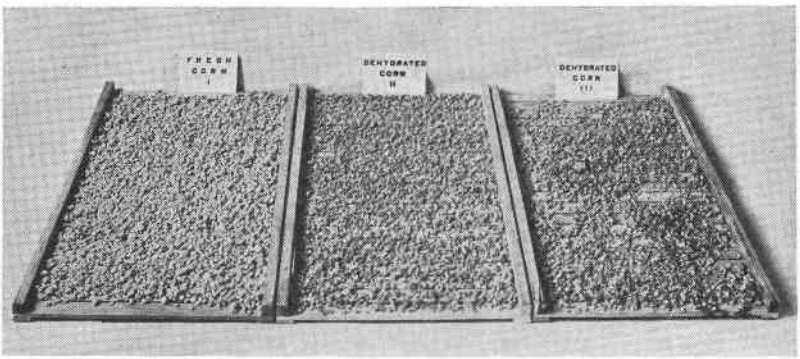

Figure 6. Load trays carefully with proper amount of raw materials. Spread evenly on tray to insure uniform drying. Note spread and effect in illustration.

3. The spread where halved fruit is used should not exceed 1½ to 2 pounds per square foot of tray surface (3 to 5 pounds per tray for home dehydrator illustrated in Circular of Information 309).
4. Maintain heat constantly at temperature indicated above.
5. For the best results fill dehydrator gradually.
6. Reverse trays from end to end if necessary to assist drying.
7. Dry fruit until it loses enough moisture to become leathery. (See Table 1. If in doubt, dry further.) The center of the piece, when broken, should show no free moisture.
8. Dry vegetables until they lose enough moisture to become brittle and snap sharply in two when bent. Make test only after the vegetable has been cooled to room temperature.

PACKING AND STORAGE OF DEHYDRATED PRODUCTS

Keeping quality of dehydrated products is dependent, to a considerable extent, on their final moisture content. The lower the moisture content, the better the keeping quality. After drying, fruits and vegetables will take up moisture from the surrounding air if allowed to remain exposed for any length of time. This absorption

takes place rapidly on days when the natural humidity of the air is high. To avoid absorption and to improve keeping quality, store under moisture proof conditions immediately after drying.

The best types of containers for dehydrated products are glass jars with tight seals such as rubber rings, composition gaskets, or the like. If the jars have been previously used for coffee or vegetable oils, it is extremely necessary to clean them well to remove all traces of odor that might contaminate the dehydrated products. Dried vegetables such as carrots are quite susceptible to flavor changes and foreign odors.

Figure 7. Containers that can be used for proper storage of dehydrated vegetables. All these containers can be made airtight.

Cans with tight seals or heavily waxed fiber board containers that are moisture proof can likewise be used. It is imperative, however, that any type of container used must be sealed to prevent air leakage. The addition of the better grades of sealing tape will further prevent the entry of moisture. Air leakage means moisture absorption and the possibility of insect infestation. Before placing the freshly dehydrated products in containers, be sure that the cans, jars, or containers have been thoroughly dried out by heating in an oven. Place the freshly dehydrated product in the hot or still-warm container. Fill the containers as full as possible and use smaller containers to avoid opening and exposing large batches of dehydrated fruits or vegetables.

Large tin cans with airtight covers can be used to store many small vapor-proof cellophane packages. These small packages should contain a complete serving for the family. Use of small packages best preserves the product against breakage and moisture absorption. Removal of a bag for serving, therefore, is a simple procedure and avoids damage to the balance of the food material stored in the can.

Cool storage is essential for long keeping of packaged dried material.

PREPARATION OF DEHYDRATED FOODS FOR COOKING

Some dehydrated foods benefit by preliminary soaking, while others, especially the green, leafy vegetables, refresh during cooking. The size of the pieces determines, to a large extent, the length of time for soaking. The larger pieces take up the water more slowly, while the smaller pieces, such as shreds, dices, slices, etc., have more surface per unit volume for absorption of water and refresh more quickly. If a food is left to soak too long, it may become water-logged and produce an unattractive product when cooked. Peaches soaked 24 hours, then cooked, do not have the attractive shape, firmness, or flavor of peaches soaked only 12 hours before cooking.

Fruits can be soaked over night without spoilage, but dehydrated vegetables, if allowed to soak more than 2 hours, may show evidence of spoilage. To refresh dehydrated carrots or cabbage to be used as a fresh product in preparing salads, soak over night in a refrigerator or ice box to prevent spoilage.

Foods that have been soaked should be cooked in the water in which they were soaked. Just enough water should be used to allow for refreshing and for cooking. As the majority of vegetables have been precooked or blanched before drying, they will not require as long to cook as fresh vegetables. This will depend on the stage of maturity at the time the vegetables were dried. When soaking and cooking, use $1\frac{1}{2}$ to 2 measures of water for every measure of dehydrated vegetable with the exception of green, leafy vegetables. Cook all foods until tender. The foods may be soaked in the container in which they are to be cooked. More water can be added before cooking, if needed.

Table 3 gives the amount of water, time of soaking, and time of cooking for some common dehydrated foods. These figures will vary with the style and size of cut and maturity of the product when dehydrated.

For example, the pumpkin was shredded before dehydration and after being dried was put through a food chopper and ground almost to a powder. The powdered vegetable takes up less space than shredded and is easy to use for making pies and custards.

The reconstituted or refreshed foods may be used in the same manner as fresh-cooked foods—buttered, creamed, sautéd, pickled, etc. Cabbage and carrots refreshed over night in a refrigerator or ice box without cooking can be used in salads.

Onions to be used as flavoring may be powdered and a bit of powder added as seasoning to foods without refreshing. If onion slices are wanted, the slices should be soaked for 15 minutes in water, then simmered gently for 20 to 30 minutes. One tablespoon of onions will need 3 tablespoons of water for refreshing.

Dehydrated foods that have been properly prepared make attractive and flavorful dishes on reconstitution.

Table 3. APPROXIMATE AMOUNTS OF WATER NECESSARY FOR REFRESHING FRUITS AND VEGETABLES

Product	Weight per cup	Reconstitution proportions		Time of soaking	Time of cooking
		Volume of dehydrated product	Volume of water		
	Ounces	*Cups*	*Cups*		*Minutes*
Apples	2.3	1	1	1 hr.	10
Apricots (packed)	7.0	1	1½	8–12 hr.	15
Cherries	7	1	2	8–12 hr.	20–30
Cranberries	2.0	1	1	5–6 hr.	Till tender
Peaches	3.0	1	1¼	8–12 hr.	15
Pears	2.4	1	1¼	8–12 hr.	15
Prunes	5.5	1	1	8–12 hr.	15
Raspberries	2.0	1	1½	8–12 hr.	10
Rhubarb	1.3	1	1½	30 min.	15
Strawberries	2.5	1	2	8–12 hr.	10
Asparagus	2.0	1	1¼	30 min.	15
Beans (snap or green)	2.2	1	2	30 min.	20
Beans (Lima)	4.1	1	2½	30 min.	15
Beets (shredded)	1.5	1	2	30 min.	10
Broccoli	0.5	1	1	30 min.	5
Cabbage (shredded)	0.7	1	1½	none	10
Cabbage (red)	0.7	1	1½	none	10
Carrots (shredded)	1.0	1	1¼	30 min.	10
Celery	0.7	1	2½	30 min.	30
Corn	5.5	1	2½	30 min.	15
Parsnips	1.8	1	2	30 min.	15
Peas	4.0	1	2½	30 min.	10
Peppers	0.1	1 Tblspn.	2 Tblspn.	30 min.	10
Potatoes (Irish) (Julianne)	1.8	1	2	30 min.	20
Potatoes (Sweet)	4.3	1	1½	30 min.	30
Pumpkin (shredded)	1.0	1	1	30 min.	10
Pumpkin (ground fine)	2.0	⅛	5	none	20
Rutabagas	2.0	1	2½	30 min.	10
Spinach	0.5	1	⅝	none	10
Squash	1.0	1	1	30 min.	10
Swiss chard	0.5	1	⅝	none	10
Tomatoes	1.8	1	1½	none	15
Turnip	2.0	1	2½	20 min.	10

Table 1. Directions for Preparing and Dehydrating Fruit*

Product	Stage of maturity	Preparation	Treatment before dehydration		Spread per square foot of tray surface	Approximate yield from 100 pounds of fresh material		Dehydration temperature	Approximate drying time	Dehydrated product	
			Method	Time		Prepared	Dehydrated			Condition when dry	Keeping quality
					Pounds	*Pounds*	*Pounds*		*Hours*		
Apples	Firm ripe	Peel, core, slice or cut in eighths; light brine dip protects color of fruit while handling	Sulphur	1–1½ hours	1¾	60	10	150°–155°	6–8	Springy	Good
Apricots	Firm ripe	Cut in halves; remove pit	Sulphur	1–1½ hours	1¾	90	18	150°–155°	12–18	Leathery	Good
Berries	Firm ripe	Carefully spread on trays to prevent bleeding	None	None	1	100	15–18	150°–155°	10–15	Springy	Good
Sweet and sour pitted cherries	Well ripened	Pitted sweet or sour cherries dry quicker than unpitted. Spread carefully on tray	Sulphur	½ hour	1¾	Pitted 78–80	Pitted 26–30	150°–155°	8–12	Leathery	Good
Unpitted						Unpitted 97–98	Unpitted 28–30				
Cranberries	Full ripe	Whole or chopped; chopped dry best	None	None	1¼	100	10–14	150°–155°	4–8	Brittle	Good
Peaches	Full ripe	Cut in halves; remove pits	Sulphur	1–1½ hours	1¾	85–90	15–20	150°–155°	15–20	Leathery	Good
Pears	Firm ripe	Cut in halves; core	Sulphur	1½ hours	1¾	80–85	17–20	150°–155°	15–20	Leathery	Good
Prunes	Full ripe	Whole or halved prunes can be dried. Pitted fruit dries more rapidly	None although a light sulphuring can be used	½ hour	1¾	100	33–35	150°–155°	15–24	Pliable	Good
Rhubarb	Mature	Trim, wash, cut in slices ½ inch thick	Steam	2–4 minutes	1¼	55–60	6–9	150°–155°	10–15	Tough	Good

* Wherever possible, freeze or can fruits.

Table 2. Directions for Preparing and Dehydrating Vegetables*

Product	Stage of maturity	Preparation	Treatment before dehydration		Spread per square foot of tray surface	Approximate yield from 100 pounds of fresh material		Dehydration temperature	Approximate drying time	Dehydrated product	
			Method	Time		Prepared	Dehydrated			Condition when dry	Keeping quality
				Minutes	*Pounds*	*Pounds*	*Pounds*		*Hours*		
Asparagus	Tender tips; stalks soft not woody	Wash, trim, cut into 1½" lengths; split large pieces	Steam blanch	4	¾	65–75	6–8	150°–155°	7–9	Brittle Greenish–black	Good
Beans (green)	Mature, tender, not stringy	Snip, cut into 1-inch lengths	Steam blanch	10–12	¾	90	9–12	150°–155°	8–12	Brittle Greenish–black	Good
Beans (Lima)	Tender, immature	Shell, wash	Steam or boiling water blanch	5–6	¾	30–35	15–18	150°–155°	8–10	Hard Wrinkled	Good
†Beets	Good for table use	Wash, trim and cook for 15 min., peel, slice or strip ⅜ inch thick	Steam blanch	5–6	¾	75–80	8–12	150°–155°	8–10	Brittle	Good
Broccoli	Good and succulent	Trim, wash, and slice lengthwise	Steam blanch	4–5	¾	80	10–12	150°–155°	8–10	Brittle	Good
†Cabbage	Good and succulent	Trim, core, and wash. Cut in ⅛ inch shreds	Steam blanch	4–5	¾	85	6–9	150°–155°	10–12	Brittle	Good
†Carrots	Medium sized, succulent	Wash, peel, trim. Cut in slices or strips	Steam blanch	5–6	¾	80–85	8–9	150°–155°	7–8	Brittle	Fair
Celery	Medium sized, succulent	Wash, cut stalks into thin slices. Dry leaves separately for soup	Steam blanch	2–3	¾	100	12–14	150°–155°	8–10	Brittle	Good
Corn	Milk stage	Husk, wash, cut from cob after blanching	Boiling water	8–10	1	35–40	8–10	150°–155°	8–10	Brittle	Good

* Wherever possible, freeze or can vegetables.
† Store for use during fall or early winter. Spoilage will be reduced and quality retained if these vegetables are dried for use in late winter and spring months.

Table 2. DIRECTIONS FOR PREPARING AND DEHYDRATING VEGETABLES*—*Continued*

Product	Stage of maturity	Preparation	Treatment before dehydration		Spread per square foot of tray surface	Approximate yield from 100 pounds of fresh material		Dehydration temperature	Approximate drying time	Dehydrated product	
			Method	Time		Prepared	Dehydrated			Condition when dry	Keeping quality
				Minutes	*Pounds*	*Pounds*	*Pounds*		*Hours*		
†Onions	Mature succulent	Trim, remove outer leaves, wash, slice ⅜ inch thick	None	None	¾	88–90	8–9	150°–155°	10–12	Brittle	Good
†Parsnips	Mature, tender not woody	Wash, peel, trim. Cut in ⅜ inch slices or shreds	Steam blanch	6–8	¾	77–82	12–16	150°–155°	8–9	Brittle	Good
Peas (Sugar)	Full grown but not hard or over-ripe	Pod and wash	Steam blanch	2–3	1	55–60	18–23	150°–155°	7–8	Hard Wrinkled Brittle	Good
†Potatoes	Proper condition for table use	Peel, trim, wash, cut into shreds, ¼ inch slices or strips	Steam blanch	5–7	1	72–76	10–12	150°–155°	5–7	Hard Brittle	Good
†Pumpkin	Good table condition	Peel, seed, wash and shred	Steam blanch	3–4	¾	70–72	7–12	150°–155°	10–14	Tough Brittle	Good
Spinach or Greens	Good table condition	Cut off roots ; wash and sort	Steam or water blanch	1–2	½	60–75	8–10	150°–155°	7–9	Crisp Brittle	Good
Sweet Potatoes	Good table condition	Trim, peel, wash ; slice in ½ inch slices or strips	Steam blanch	2–3	1	80–85	26–28	150°–155°	10–14	Hard Brittle	Good
Tomatoes	Good, firm table type only	Light blanch, peel, core ; cut into ⅜ inch slices	Steam blanch	2–3	¾	88–92	4–5	150°–155°	15–18	Tough Brittle	Good
†Turnips or Rutabagas	Good table condition	Trim, peel, wash, slice, strip, or shred	Steam blanch	3–4	¾	81–85	8–10	150°–155°	15–18	Tough Brittle	Good

* Wherever possible, freeze or can vegetables.
† Store for use during fall or early winter. Spoilage will be reduced and quality retained if these vegetables are dried for use in late winter and spring months.