

## SECTION 2

# DRYING FRUITS AND VEGETABLES WITH THE CHIMNEY SOLAR DRYER

Once the chimney solar dryer has been built, you are ready to use it to dry your products

## TEST THE DRYER

We recommend giving the dryer a test run to make sure all the pieces fit well together, that there are no air leaks or gaps in the plastic, and to measure the temperature (if possible) at different locations within the dryer table. If the dryer is working well, strips of tissue paper hanging from the center pole under the clear plastic will flutter, the plastic over the table will be concave (due to suction from the chimney), and you will see shimmering at the top of the chimney's shadow.



Load fruits and vegetables onto trays to dry. Peeling and removing pits (such as with mangos, above right) and slicing thinly (tomatoes, above left) will shorten time needed to dry.

## PREPARE PRODUCT FOR DRYING:

Produce should be clean and undamaged. Bulky products dry faster if they are cut into pieces prior to drying. It is best to begin the drying process in the morning to give the maximum drying time before sunset.

## PRODUCT SIZE

Thin items like herbs and leafy greens may dry in a few hours, while large products like whole apricots or whole bananas will require several days to dry. You can decrease drying time by removing pits, peeling the product, and/or cutting it into thin (6 mm) slices.



Product will shrink as it loses moisture, so it can overlap slightly when loaded onto the trays.

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**A chimney solar dryer ready for drying fruits and vegetables. Leave the first tray space (left side of photo) empty as a “preheat area.”**

### **LOAD THE TRAYS**

Load the trays with whole or sliced products (fruits and vegetables). The pieces can overlap slightly because they will shrink as they lose moisture. Make sure the tray is not too heavy to lift.

## **DRYING PRODUCT IN THE CHIMNEY SOLAR DRYER**

### **PREHEAT AREA**

The first tray space (farthest away from the chimney) should be left empty (see photo). Leaving the first tray space empty allows the air to heat before it contacts the product.

### **ROTATE TRAYS DURING DRYING**

Rotate the trays according to the thickness and water content of the product. Generally, thicker and moister products require more time and thus more rotations compared to leaves and other similar products. It is advised that you rotate the trays 2 to 3 times during the drying process. Move the trays closest to the chimney to the opening of the dryer and the trays from the opening next to the chimney. Switch the bottom tray with top tray if trays are stacked. By rotating trays and leaving an open preheat area, you will get a more uniform moisture content across all of the product in the dryer.

### **PLASTIC COVER AND AIRFLOW**

The clear plastic that covers the trays should not touch the fresh product; this may cause burning or incomplete drying. The plastic should be as taut as possible, creating a tent over the product and trays. Make sure that there is plenty of airflow through the dryer, especially above and below the product. Remember, ambient air enters, quickly warms up and dries the product. Warm, humid air exits through the chimney.

## **CONDITIONS THAT AFFECT DRYER PERFORMANCE**

### **AIR TEMPERATURE**

High air temperature speeds drying. However, air temperature must not get too hot or it could damage the product. Excessively hot air results from too little airflow. Make sure the openings at the front of the drying table and the chimney are not obstructed. The clear plastic cover should not touch product.

Maximum air temperature during drying of most fruits and vegetables should be in the range of 60 – 65°C (140 – 150°F). Cabbage and onions should not be dried at temperatures above 57°C (135°F). Grains and most nuts should not be dried above 54°C (130°F) with the exception of walnuts that should not be dried above 43°C (110°F). Air temperatures above these recommendations cause quality loss, such as darker color or decreased storage life. Test products in the dryer to be sure of the conditions required for best quality. Operators should regularly monitor air temperature in the drying area. An inexpensive dial thermometer works well for this purpose.

## **SOLAR RADIATION**

Direct radiation on the top trays will result in faster drying than product on the lower trays. More uniform drying can be achieved by rotating tray positions once or twice during the drying process. Rotating trays is also beneficial because exposure to direct solar radiation may cause bleaching of some items and this light color may or may not be desirable by consumers. Product on the top tray may be exposed to excessive heating, which usually causes quality loss. In addition to rotating trays, the top trays can be covered with a light colored fabric, which should not touch the product and be layered underneath the plastic, to partially shade sensitive products.

## **AIRSPEED**

Faster airflow increases the rate of moisture loss from the product and speeds drying. Make sure the air entrance is not blocked or covered in any way. A few centimeters of headspace over the product is enough to provide for the free flow of air and allow for air to heat up. If the plastic covering is too high above the trays, air speed will be slowed and drying times will increase.

## **HUMIDITY**

When the relative humidity of the ambient air is low, drying speeds are faster. Heating of the air from solar radiation further reduces its relative humidity. Even in locations with high ambient relative humidity, the dryer heats the air enough to produce the low relative humidity levels required for rapid drying.

## **AMOUNT OF PRODUCT ON TRAYS**

Adding more product (by weight) to the trays increases the overall amount of product dried per drying cycle; however, it also increases the length of the drying cycle. Users should experiment with the product load to determine what works best under their conditions. Light tray loadings associated with drying of flowers, herbs or products weighing less than 2.5 kg/m<sup>2</sup> (0.5 lbs./ft<sup>2</sup>) will dry in less than one day. The dryer has been modified by some users to dry grapes in bunches, producing equivalent tray loadings of more than 50 kg/m<sup>2</sup> (10 lbs. per ft<sup>2</sup>). In preliminary experiments, complete drying was achieved in about 5 to 7 days.

## **STACKED TRAYS**

The dryer can be used with two or more trays stacked on top of each other. Because air temperatures are higher at the top of the drying table, the top trays will dry faster than the lower trays. Rotating trays may also reduce bleaching, an effect of direct solar radiation that may not be desirable. Bleaching may also be reduced by covering the top trays with a light shade cloth.

## **ADVERSE WEATHER CONDITIONS**

The dryer works in cloudy to sunny conditions, and even occasional rain showers are not a problem. However, drying should not be attempted during periods of continuous rain or heavy clouds.

## **STORING DRIED PRODUCT**

Properly dried fruits and vegetables can be stored for several months to a year. Dried products should be stored in a cool, dry and dark area. After drying, the produce should be allowed to cool and then packed into dry, airtight containers or sealed plastic bags. Do not be afraid to pack the dried product tightly together. Storing at cool temperatures increases storage life of dried products.

## **HOW DRY IS DRY ENOUGH?**

The moisture content of fresh produce at harvest ranges from 20 to 95 percent. Crops must be sufficiently dried to be safely stored. High sugar content fruit should be dried to approximately 20 percent moisture content; this means that the fruit will still be pliable, but not sticky or tacky. Dried berries should rattle when shaken in a container. Vegetables are sufficiently dried when they are hard and brittle or tough and leathery, depending on the vegetable. Sufficiently dried beans, corn and peas are hard and can shatter. Dried leafy, thin vegetables should be brittle, and larger chunks or slices of vegetables should be leathery. At this stage, the produce should contain about 10 percent moisture.

The best method of determining safe product for storage is to measure the relative humidity of the air in the dried product storage container. Mold will not grow when relative humidity is lower than 65 percent. One inexpensive method for measuring relative humidity is to use a DryCard™ indicator (more information at <http://drycard.ucdavis.edu>).

# ADDITIONAL RESOURCES

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