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 drying 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 slightly concave (due to suction from the chimney), and you may see shimmering at the top of the chimney's shadow.

Load fruits and vegetables onto trays to dry. Peeling and removing pits and slicing thinly will shorten time needed to dry. Uniform slices help with even drying time.

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

PRODUCT SELECTION

Dry only fully ripe or even over-mature produce (freshly harvested) for best quality and flavor. Drying cannot improve poor quality produce. If you are drying multiple foods at a time, try not to mix products with very strong flavors or aromas (for example, if you dry apple and onion together, the strong smell of the onion may alter the taste and smell of the apple). In addition to large or normal-sized produce, small or "b-grade" product can be used, which can help recover otherwise lost income. You can dry partially damaged product if you can cut away the damaged portion. Avoid product that is rotting or moldy. Avoid drying produce recently sprayed with chemical pesticides.

PRODUCT SIZE AND CUTTING

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 and peeling the product though peeling may remove valuable nutrients. Cutting product into thin (6 mm) slices allows for faster water loss, reducing the amount of drying time required. Furthermore, slicing the product into uniform sizes/widths is crucial for more complete and even drying.

FILL THE TRAYS WITH PRODUCT

Fill the trays with enough whole or sliced products to maximize the space, but the pieces should not overlap too much to ensure efficient drying. The pieces can overlap slightly because they will shrink as they lose moisture. It is a good practice to place the same product onto one tray because of similar drying time, and to utilize a separate tray for chili peppers, which can impart their spiciness to other food products. Make sure the tray is not too heavy to lift. Product cut into wedges should be positioned on the drying tray so that the peel portion of the cut product is parallel to the sides of the drying table. Product peel, or skin positioned toward the opening of the dryer can impede airflow and slow down drying.

Left: proper wedge alignment for product with a peel vs. right: overloaded tray.

DRYING PRODUCT IN THE CHIMNEY SOLAR DRYER

PREHEAT AREA

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

PLACING TRAYS ONTO THE DRYING TABLE

When you do not have a full drying load and are only drying a few trays of product, if you place those trays closer to the chimney-end of the drying table, they will dry faster than if you place them closer to the entrance of the drying table because the chimney end is usually the hottest part of the dryer. However, you should place trays of leafy greens or other fragile products near the opening of the dryer where temperatures are lower compared to other positions on the drying table.

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

SHUFFLE TRAYS DURING DRYING

Move the trays according to the thickness and water content of the product to different locations within the dryer. Temperatures are generally higher closer to the chimney, therefore shuffling the trays to different positions (front to back, top to bottom) ensures more uniform drying. Generally, thicker and moister products require more time and thus more shifts in position compared to leafy greens and other similar products. It is advised that you shuffle 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.

PLASTIC COVER AND AIRFLOW

The clear plastic that covers the trays should not touch the fresh product; this may cause product damage 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 tunnel openings at the front of the drying table and the chimney are not obstructed. The clear plastic cover should not touch product.

If the inside of the dryer gets too hot and is damaging products, either orient the chimney solar dryer so the opening of the drying table faces windward, allowing a higher amount of cooler air to flow above and below the drying product, or consider drying during relatively cooler periods of the day. Leafy greens, herbs, and other fragile products require frequent monitoring during drying due to their rapid water loss and potential for being burned or damaged. Do not slice or shred the leafy greens into pieces small enough that they will fall through the mesh of the drying trays once they become dried. It is not recommended to dry herbs in the chimney dryer in extremely hot conditions.

If the temperatures become too cold in the dryer and thus products are not drying quickly enough, they may spoil. Low temperatures could occur if the dryer is in the shade and not receiving enough sunlight, or if outside ambient temperatures are very low. 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 try to 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 2-3 times during the drying process. Rotating trays is also beneficial because exposure to direct solar radiation may cause bleaching and this light color may or may not be desirable by consumers. Product on the top tray may be exposed to excessive heating, which can cause quality loss. In addition to shuffling trays, the top trays can be covered with a light colored fabric, which should not touch the product and can be layered underneath the plastic or above the trays on top of 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 tunnel 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^2 (0.5 lbs. /ft^2) 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^2 (10 lbs. per ft^2). In preliminary experiments, complete drying was achieved in about 5 to 7 days.

STACKED TRAYS

The dryer can be used with two 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 product should be allowed to cool a short time 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?

Crops must be sufficiently dried to be safely stored. 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. Sufficiently dried fruit will still be pliable, but not sticky or tacky. Dried berries should rattle when shaken in a container.

However, the best method for accurately determining safe product dryness for storage is to measure the relative humidity of the air in the dried product storage container. Mold will not grow when equilibrium relative humidity in the air around the sealed product is lower than 65 percent. One inexpensive method for measuring equilibrium relative humidity is to use a **DryCard™** indicator (more information at https://horticulture.ucdavis.edu/drycard).

DryCard™ dryness indicator. Pink is not sufficiently dry, purple or blue is sufficiently dry.

The moisture content of fresh produce at harvest ranges from 20 to 95 percent depending on the product. High sugar content fruit should be dried to approximately 20 percent moisture content. Dried leafy or thin vegetables should contain about 10 percent moisture

ADDITIONAL RESOURCES

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