Solar Powered Food Storage

Why Dry Food?

Food dehydration is an excellent option for the extended storage of excess fruits, vegetables, herbs and meats. Essentially, the primary goal in food dehydration is to remove enough water from the product to enable prolonged storage without decay by bacteria or fungi. Many fruits and vegetables have a moisture content of 80-95% and up to 75% for meats. Dehydration acts to reduce both the weight and volume of food products. Dried foods can be eaten as is or re-hydrated with relative ease.

Why Solar?

Solar dehydrators operate on free abundant solar energy and passive design principles, making them incredibly efficient and cost effective as compared to electric dehydrators which can draw anywhere from 350-1000 Watts or more.

And what's better yet? When all your drying is done for the year and you're busy keeping your living space warm, your solar dehydrator can double as a **passive solar space heater** by simply placing it in a sunny window and allowing the warm air to pass freely through the room!

Food Drying Principles

Successful drying of fruits, vegetables, meats and herbs hinges on two main factors - the temperature of the air surrounding the product and the rate of air movement.[1] As warm, dry air passes over the exposed surfaces of drying food, it absorbs moisture. The rate of drying thereby increases as the air temperature and rate of movement increases. 'Air at a temperature of 82 °F will carry over twice as much moisture as 62 °F air, and air at 130 °F has over eight times the moisture-carrying capacity of 62 °F air.'[2]

Temperature

Ideally, food is dried at a low temperature (somewhere between 120 and 185 F). Here the goal is to maintain a low enough temperature as to avoid cooking and/or crusting as well as any degradation of the vitamin and mineral content while at the same time avoiding fermentation or spoilage by creating a high enough temperature to inactivate the enzymes that initiate these process.

Passive Air Flow

Passive, rather than active or forced airflow, is in many cases a superior drying agent in that it provides sufficient airflow while providing a more balanced drying. Forced air can actually cause crusting when it dries the outside of the food faster than the inside.

Optimize the 'Angle of Incidence'

Because solar energy is the primary 'fuel' in this system, it's important to maximize the capture of this energy by accommodating the sun's local 'angle of incidence'. This refers to the angle at which the sun's light intersects with the earth's surface. A 90 degree angle of incidence represents the most efficient angle at which to collect solar energy. Thus, generally speaking, by building a solar collector inclined to match your localized latitude, you will thereby optimize the year round efficiency of your dehydrator by approximating a 90 degree angle of incidence.

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[1] Solar Drier for Fruits and Vegetables. C. V. Privette, Associate Professor, Agricultural Engineering Clemson University

[2] Ibid

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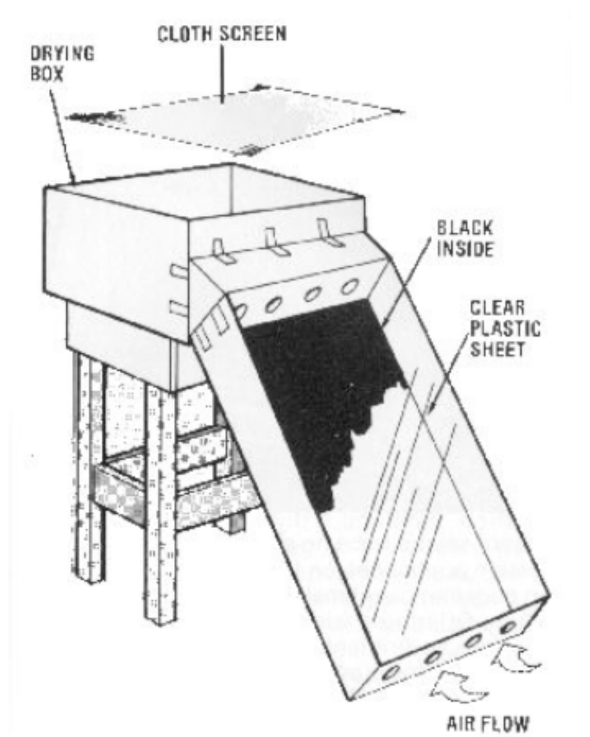
Materials
Glazing (glass or greenhouse plastics) is important to concentrate solar energy and seal out rain (see attached table - 'properties of glazing materials'). A black backing surface further absorbs heat. Food to be dried should be placed on food-safe screen to enable moisture movement on all sides - stainless steel or food grade polypropylene screening (available from www.dryit.com) are the best options. **Be absolutely certain not to place food in contact with any surface that is not food-safe.*[3]

Insulation
If you wish to increase the efficiency of your dehydrator, simply insulate the bottom and sides of the solar collector and dehydrator. This could be done by creating a gap around the sides which is then stuffed with an insulative material such as cotton batting, wool, sawdust, old clothes, straw, perlite, etc. or by tacking on some sort of insulative material to the exterior of these components. This will help to minimize heat loss and make better use of the stored and transmitted solar energy.

The Components



Most solar dehydrators consist of three parts - the solar collector, the dehydrator and the stand. Because we want to take care not to overheat the food we're drying, it's important that the food is not directly exposed to concentrated solar energy. Instead, heat is collected and concentrated in the collector and then passively transmitted into and through a separate chamber which functions as the dehydrator.

Probably the simplest (but least efficient) means of drying food is to leave it out in a warm, airy spot. Some folks use barn and car roofs, the top of cold frames, tree stumps, etc as effective drying locations. Of these strategies, a corrugated metal roof is likely the best. The corrugations create spaces for air movement underneath drying screens so air passes along all sides of the food, the existing roof pitch helps to optimize the solar collection potential (the 'angle of incidence'), and the metal acts as a reflector, further helping to dry the food effectively. Using this technique, folks at the Subsistence Pattern Blog, explain that they make fruit leather by crushing fresh berries into a puree, spreading them out evenly (about 1/4" thick) on a pizza pan so as to ensure even drying and carefully flipped after about 5-8 hours of sun. The entire process will take one or two days depending on conditions.

Probably **the most inexpensive, effective, effective passive solar dehydrator** can be made from nothing more than two cardboard boxes, clear plastic wrap and some tape (see illustration). Build the collector using a long, thin cardboard box, lining the bottom with a black plastic garbage bag or a coat of black paint and covering the top with clear plastic wrap or window glass. Create holes in the top and bottom ends to enable airflow through the collector. For the dehydrator, select a taller box, nearly square in size, into which you set the drying racks. Ensure that you create airflow channels into the drying box and an air exhaust at the top back of the box. The box top can be covered with a

[3] http://www.ecohuddle.com/wiki/how-to-make-your-own-solar-food-dehydrator

cloth screen and the boxes can be fastened to one another using tape. If you find yourself unable to locate boxes of the right dimensions, feel free to make your own using taped joints. To improve the efficiency, consider encasing both boxes in some type of insulation. They completed system can simply be placed on a chair or table so as to maximize the angle of incidence.[4]

You can also choose to make a more durable, permanent version of this same design out of wood. Drying screens can be made 18" or 2' square with the remaining components built around these dimensions. In this case, it's best to use glazing (either plastic or glass) for the collector and line the inside of the collector with metal flashing painted black.

Another take on the same problem:
Here four 2'x2' screened frames are placed within each 4'x4' glazing section (see image to right). Please note that these dimensions can be modified to suit available materials. Each glazing panel is backed by a black painted aluminum sheet which rests directly above the drying screens. The leftmost panel, glazing and aluminum backing, are raised to show drying racks below. As sunlight passes through the glazing and is concentrated within the panel, it heats the metal which radiates heat onto the food below, thereby heating the food while keeping from exposing it to direct sunlight.

Food Preparation

It's generally best to do some prep work before dehydrating food. Begin by cutting the material into pieces aiming for 3/8-1/2" thickness. Vegetables like beans, broccoli, carrots, cauliflower, celery and peas have hard cell structures and will be more easily re-hydrated if they are slightly softened first by steam blanching. Finally, meat should be 'cured' in an oven for one hour at 160 F to effectively kill any potential bacteria.

Is it dry?

When testing food to see if it is dry, first grab a handful and let it cool for a few minutes before making your decision. From there, check the feel and physical appearance of the food before deciding. Vegetables will be brittle when dry whereas fruit will be tough and pliable and it will not be possible squeeze out any additional moisture. Sliced tomatoes will generally take about two days to fully dry.

Storage

When adequately dry, store food in air-tight containers (preferably glass but food-grade plastic will suffice). To prevent potential losses due to spoilage, store dried foods in small quantities (so as not to contaminate a large batch) and check them frequently. Keep in a cool, dry place between 40 and 70 degrees F.[5] Dehydrated food can generally be kept in sealed containers for up to one year.[6]

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4 http://www.thefarm.org/charities/i4at/surv/soldehyd.htm

5 Ibid

6 http://thecoconutchronicles.com/?p=68

Re-hydration

To prepare dried foods for eating, add fruit to boiling water in a saucepan and simmer, covered for 10-15 minutes, sweetening, if desired, at the end of cooking. With the exception of greens, vegetables can be soaked in cold water (just enough to submerge them) until they're reached their original texture. For greens, submerge them in just enough boiling water to cover them and simmer until they've reached the desired texture.

This document is only intended to provide an overview of the principles and recommended designs for solar dehydrators. For a more detailed description of the construction of several solar dehydrators, see the websites below. And most importantly, please remember to focus on the principles, rather than the details. You can adapt the recommended dimensions and materials to suit your own drying needs as well as the materials and space you have available.

For additional details on solar dehydration and plans to make your own, visit
http://www.thefarm.org/charities/i4at/surv/solarchm.htm
http://www.cultivatinglife.com/Solar-Vegetable-Dryer.html
http://www.ecohuddle.com/wiki/how-to-make-your-own-solar-food-dehydrator

Glazing Material Options Summary

Glazing	Material	Characteristics
Kalwall, Filon, Lascolite, etc.	FRP, fiberglass-reinforced polyester	Durable, light, impact-resistant, good light transmission, surface degrades over time and yellows slightly, rough surface of old glazing requires occasional scrubbing to keep it clear, easily cut
Glass	Glass	Fragile, heavy, variable impact resistance, great light transmission, no surface degradation or yellowing over time, cheap if recycled, hard to cut to size
Lexan, etc.	Polycarbonate	Very durable, light, highly impact resistant, great light transmission, no visible yellowing or surface degradation, expensive, easily cut to size
Plexiglass, etc.	Acrylic	Somewhat fragile, light, poor impact resistance, good initial light transmission, cracks and yellows with exposure to sun and heat, fairly inexpensive, hard to cut without cracking
Thin films	Polyethylene, etc.	Fragile, very light, fairly impact resistant, great light transmission, degrades quickly in sunlight unless cross-linked polymer, UV-resistant material is used, cheap if recycled from commercial greenhouses but can be pricey otherwise, very easily cut to size

Chart taken from http://www.ecohuddle.com/wiki/how-to-make-your-own-solar-food-dehydrator