

UCDAVIS
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Guide for
Solar Fruit Drying in
Totogalpa, Nicaragua

An initiative prepared by D-Lab, UC Davis
for Grupo Fénix, UNI and the Solar Women
of Totogalpa

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Solar drying is a food preservation technique that has been practiced for thousands of years. Dried fruits and vegetables provide almost the same nutritional value of their fresh counterparts and can be stored for longer periods of time. Solar drying also creates stable income and job opportunities.

This booklet has been created as an effort to support Grupo Fenix, UNI and the Solar Women of Totogalpa. It includes instructions on how to best handle the fruit in a clean and safe form, tips for drying different types of fruits, different methods of packaging the dried goods, and a variety of recipes.

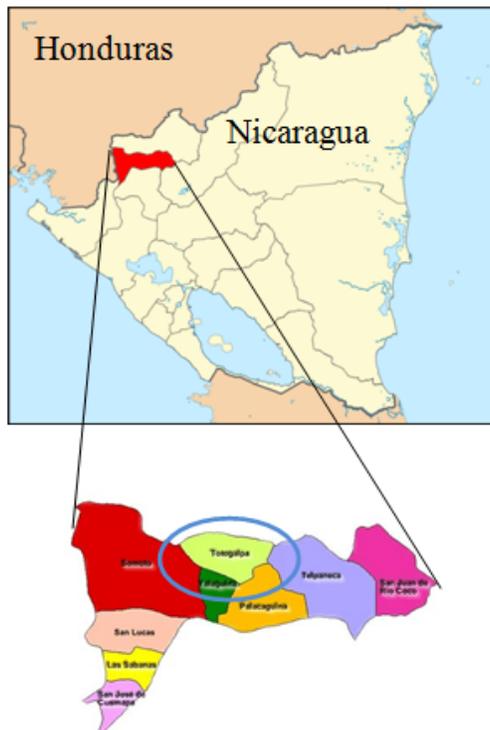
Table of Contents

1. Background.....	4
1.1 Location:.....	4
1.2 Climate:.....	4
2. Best Management Practices for Solar Fruit Drying.....	5
2.1 Selection and Cleaning	5
2.1.1 Pretreatments.....	5
2.1.2 Water Blanching:	6
2.2 Cutting and slicing	7
2.3 Positioning of the Dryer and Loading the Trays	7
3. Procedures for each fruit/vegetable	9
3.1 Dried Tomatoes	9
3.2 Dried Mangoes.....	10
3.3 Dried Banana	11
3.4 Dried Pineapple.....	12
3.5 Dried Papaya	13
3.6 Dried Sapote.....	14
3.7 Dried Pitaya (Dragon Fruit)	15
4. Packaging, labeling and storing.....	16
5. References.....	17

1. Background

This guide contains information specific to the Municipality of Totogalpa, Department of Madriz, Nicaragua.

1.1 Location:



1.2 Climate:

Average High Temperature: 22°-27°C

Low Temperatures: ~15°C

Annual Rainfall: 1.0-1.5 m

High Humidity: >70%

Daily Solar Radiation: 5.0-5.5 kW-h

2. Best Management Practices for Solar Fruit Drying

In this section of the booklet we will discuss some of the best management practices used in solar drying.

2.1 Selection and Cleaning

Although the main idea of this booklet is to use fruits that would otherwise be disposed as post harvest loss, there are some key characteristics that the fruit must have. The fruit should not be overripe; rather it should be generally classified as good quality. Do not use fruits that have sections that would otherwise be classified as spoiled; it could ruin the taste of all the fruit dried in that batch.

Most of these fruits have been left out in the open and could have been exposed to different animals and insects. Therefore, we should make sure that these are clean before processing. Each individual fruit should be washed with some type of disinfectant and plenty of cold water. Be sure to clean the fruit well, but take care not to break the skin of the gentler fruits; it could lead to the contamination of the inner tissue.

2.1.1 Pretreatments

Pretreatment in drying fruits is done for several reasons; including extending the shelf life and disinfecting. There are numerous processes that can be used as pretreatment. The following recommendations are an excerpt from a fruit drying manual created by the Oregon State University Extension Program:

“Although you can dry and store many foods without pretreatment, pretreatment generally improves quality, particularly for vegetables”.

Five major reasons for treating foods before drying are to:

1. Preserve color and flavor
2. Minimize nutrient loss
3. Stop decomposition (enzyme action)
4. Ensure more even drying
5. Extend storage life

Pretreatment Methods for Fruits and Vegetables

1. Ascorbic acid/citric acid dips Steam blanching
2. Steam blanching
3. Salt solution dip Water blanching
4. Water blanching
5. Syrup blanching
6. Honey dip
7. Sulfiting

2.1.2 Blanching with water or steam:

Blanching is used in to halt the action of enzymes. However, blanching of fruit is optional. Steam blanching is recommended because it prevents the loss of some nutrients and the products being dried will not adhere to one another. Do not under-blanch, because the enzymes will not be completely activated and the dried vegetables will deteriorate during storage.

Here is a blanching procedure recommended by the University of Fort Hare, Agronomy Department (2001):

Procedure

Pour several centimeters of water into a large cooking pot that has a close-fitting lid. Heat the water to boiling and place a wire rack or basket over it holding a

layer of the vegetables (not more than 5 cm deep). Maintain the rack high enough to keep clear of the water. Cover and let the vegetables steam for required time (according to the recipe), then test to make sure all pieces are reached by the steam.

A sample from the centre of the layer should be wilted and feel soft and heated through when it has been properly blanched.

Remove the fruit and spread them on paper towel or clean cloth to remove excess moisture while you steam the next load. Cover with towel while waiting for further treatment or before taking them to the drying trays.

2.2 Cutting and slicing

Cutting and slicing the fruits is of critical importance in solar drying. Not only can it be a major source of contamination, but it can affect the overall quality of the end product. For this reason knives used must be sterile. This can be done through the use of a bleach solution; surfaces for cutting should also be disinfected. Most importantly gloves should be worn, and hands should be washed.

In addition, thickness could either reduce or increase your drying time. This could play a major role in whether your fruit will survive or become spoiled before being completely dried. Thicker slices will take a longer time to dry, and may sometimes not dry completely; creating the potential for mold. On the other hand, very thin slices burn easily or become too brittle when being removed from the tray.

2.3 Positioning of the Dryer and Loading the Trays

Because this is a solar dryer, it should be placed in a location that has direct exposure to the sun, keeping in mind that it should be placed in a clean area to reduce the risk of contaminating the fruits from flies and other insects.

The wind direction is also important. If the wind blows predominantly in one direction for long periods the dryer should be placed with the side with the closed side (that side which does not have the open air vents) towards the wind. This will reduce the cooling effect of the wind blowing direct into the drying cabinet; lengthening drying times. It will also reduce the possibility of dust entering the cabinet (Fort Hare 2001).

Loading the trays properly is also critical for efficient drying. But before any fruit is loaded, make sure the trays are disinfected and cleaned from past batches. The spacing of the fruit on the trays is important. Too high density with too little spacing can create problems. Many sources recommend about 6mm of separation between slices.

3. Procedures for each fruit/vegetable

3.1 Dried Tomatoes

Peak Season: August-September

Drying Temperature: 60° C (140° F)

Thickness: 6-7 mm (1/4 inch)

Drying Time: 10 hours



Recipe:

- Select fresh tomatoes of good color
- Follow blanching treatments
- Wash tomatoes in clean water
- Peel the tomatoes
- Cut into sections of 6 mm
- Spread the tomatoes on the solar dryer tray. Remember to keep at least 6mm of spacing, for good air flow movement!
- Stir the pieces every half hour so that all surfaces are exposing to air
- Dry for 10 hours approximately
- Tomatoes should be hard and brittle
- Follow packaging and labeling instructions

Tip:

- Dry tomatoes as soon as you can after harvesting, do not choose unripe or too ripe tomatoes.

- You could dry tomatoes with skin, but peeled tomatoes are softer.
- When blanching do not overcook.

3.2 Dried Mangoes

Peak Season: March-April

Drying Temperature: 49° C (120° F)

Thickness: 6-7 mm (1/4 inch)

Drying Time: 16 hours



Recipe:

- Select firm, ripe mangoes (yellow-orange), without fibers
- Follow blanching treatments
- Wash mangoes in clean water
- Peel the mangoes
- Cut into sections of up to 6 mm
- Spread the mangoes on the solar dryer tray. Remember to keep at least 6mm of spacing, for good air flow movement!
- Dry for 16 hours approximately
- Mangoes should be pliable without sticking together
- Follow packaging and labeling instructions

Tip:

- Blanching is not necessary; it is just to enhance appearance.
- Mangoes are a rich source of Vitamin A.

3.3 Dried Banana

Peak Season: Year round (mainly rainy season)

Drying Temperature: 60° C (140° F)

Thickness: 6-7 mm (1/4 inch)

Drying Time: 4-5 hours



Recipe:

- Select good quality bananas, firm, ripe and fresh (no dark colors, bruises or soft spots)
- Peel the bananas
- Cut in slices of up to 6-7 mm
- Follow steam blanching treatments for 3-4 minutes
- Spread the banana slices on the solar dryer tray. Remember to keep at least 6mm of spacing, for good air flow movement!
- Lift banana slices of the tray so they do not stick on it.
- Dry for 4-5 hours approximately
- Bananas slices should be pliable but hard on the outside
- Follow packaging and labeling instructions

Tip:

- Try this: Before placing in oven to dry, dip banana pieces in a honey/lemon mixture then dip in shredded coconut or chopped nuts. It is a tasty treat!

3.4 Dried Pineapple

Peak Season: April/May

Drying Temperature: 57° C (135° F)

Thickness: 6-7 mm (1/4 inch)

Drying Time: 10 hours



Recipe:

- Select firm, ripe pineapples
- Wash pineapples in clean water
- Cut off the top and the base
- Peel and remove thorny eyes
- Cut in slices of 6-7 mm
- Spread the pineapple slices on the solar dryer tray. Remember to keep at least 6mm of spacing, for good air flow movement!
- Dry for 10 hours approximately
- Pineapple slices should be pliable, leathery and not sticky
- Follow packaging and labeling instructions

Tip:

- Pineapples could be blanched but is not explicitly required. If blanched follow syrup blanching process.
- Pineapples are rich in Vitamin A, B, C and natural sugars.

3.5 Dried Papaya

Peak Season: Jun/Sep (mostly dry season)

Drying Temperature: 38° C (100° F)

Thickness: 6-7 mm (1/4 inches)

Drying Time: 20 hours



Recipe:

- Select mature, smooth-skinned papayas
- Wash papayas in clean water
- Cut in half and remove the seeds
- Peel the papaya and slice into 6-7 mm
- Spread the papaya slices on the solar dryer tray. Remember to keep at least 6mm of spacing, for good air flow movement!
- Dry for 20 hours approximately
- Papaya slices should be pliable and leathery
- Follow packaging and labeling instructions

Tip:

- Papaya is a good source of fiber and rich in Vitamin A, B and C
- Try with long sliced cuts for a different look

3.6 Dried Sapote

Peak Season: Year round (mostly April-August)

Drying Temperature: 65° C (149° F)

Thickness: 6-7 mm (1/4 inch)

Drying Time: 17 hours



Recipe:

- Select ripe sapotes
- Wash sapotes in clean water
- Cut in slices of 6-7 mm
- Spread the sapote slices on the solar dryer tray. Remember to keep at least 6mm of spacing.
- Dry for 17 hours approximately
- Follow packaging and labeling instructions

Tips:

- Sapote could be dried with or without skin
- Sapote has high fiber content

3.7 Dried Pitaya (Dragon Fruit)

Peak Season: Jun/Nov

Drying Temperature: Not Found

Thickness: 6-7 mm (1/4 inches)

Drying Time: Not Found



Recipe:

- Select ripe pitayas
- Wash pitayas in clean water
- Cut pitaya across the long axis first
- Cut in slices of 6-7 mm
- Spread the pitayas slices on the solar dryer tray. Remember to keep at least 6mm of spacing.
- Dry for x hours approximately (data not found)
- Follow packaging and labeling instructions

Tip:

- If pitaya is overripe, you can still dry it as long as it is not spoiled
- Pitaya can be dried with or without skin
- Pitaya grows in cactus

4. Packaging, labeling and storing

This section has been taken from Fort Hare University Solar Drying Recommendations 2001

Packaging should be carried out immediately after unloading and cooling because the dried slices will reabsorb moisture and be susceptible to attack by insects and other pests.

Proper storage should take place in the absence of moisture, light and air.

*The use of brown paper bags folded tightly and then placed inside plastic bags is recommended.

*Store in small quantities to avoid large-scale contamination.

*Pack carefully to avoid crushing the vegetables.

*Glass containers are excellent, but these should be kept in a dark area.

*Each bag or glass container should be marked clearly with labels containing the date of packaging.

*The dried products must be stored in a cool, dry and clean area which is secure and protected against rodents and other pests.

5. References

- "Growing Pitaya Fruit and Drying Pitaya / Drying Dragon Fruit at Home | Dragon Fruit Pitahaya Fruit." *Foodlywise.com | Dragon Fruit Pitaya Fruit | Foodlywise.com | Dragon Fruit Pitahaya Fruit*. Web. 12 Mar. 2011.
<http://dragon.fruit.pitaya.fruit.foodlywise.com/growing_dragon_fruit_pitaya/growing_pitaya_fruit.html>.
- "How to Dry Foods - Google Libros." *Google Books*. Web. 12 Mar. 2011.
<http://books.google.com/books?id=aSBfsPQP_MQC&pg=PA32&lpg=PA32&dq=how to select papayas for drying&source=bl&ots=NHY06fxAMn&sig=Slhf0EcbqvnQG6XbVMdp3HG7HwE&hl=es&ei=UdV5TYmhOMuOrQGI4cmGBg&sa=X&oi=book_result&ct=result&resnum=4&ved=0CDMQ6AEwAw#v=onepage&q=how to select papayas for drying&f=false>.
- "How to Make Dried Mango - Dried Mango Recipe." *Money Making Business Ideas - Tips How to Make Money*. Web. 12 Mar. 2011. <<http://www.pinoybisnes.com/food-business/how-to-make-dried-mango/>>.
- Ledesma, Noris. "Mango Magic." *Virtual Herbarium*. Web. 12 Mar. 2011.
<<http://www.virtualherbarium.org/tropicalfruit/mangomagic.html>>.
- "Mamey Sapote." *HealthAliciousNess . Com*. Web. 12 Mar. 2011.
<<http://www.healthaliciousness.com/fruits/mamey.php>>.
- Mnkeni, Soundy, and Brutsch. "Solar Drying of Fruit and Vegetables." *Department of Agriculture, Forestry and Fisheries*. Web. 12 Mar. 2011.
<<http://www.nda.agric.za/docs/solar/solardrying.htm>>.
- Swanson, Marilyn A. "Drying Fruits and Vegetables." *Scribd*. Web. 12 Mar. 2011.
<<http://es.scribd.com/doc/19965106/Drying-Fruits-and-Vegetables>>.
- Troftgruben, Judy, and Mary Keith. "Drying Food." *College of Agricultural, Consumer and Environmental Sciences at the University of Illinois*. Web. 12 Mar. 2011.
<http://www.aces.uiuc.edu/vista/html_pubs/DRYING/dryfood.html#methods>.

Pictures from

Mango:

- "Resultados De La Búsqueda De Imágenes De Google De [Http://dishes.philipinoy.com/wp-content/uploads/2010/06/DriedMango.jpg](http://dishes.philipinoy.com/wp-content/uploads/2010/06/DriedMango.jpg)." *Google*. Web. 12 Mar. 2011.
<http://www.google.com/imgres?imgurl=http://dishes.philipinoy.com/wp-content/uploads/2010/06/DriedMango.jpg&imgrefurl=http://dishes.philipinoy.com/dried-mango/&usq=__PWAeihlOjvpODxNExfel_YCWofl=&h=453&w=340&sz=26&hl=es&start=29&zoom=1&tbnid=b4vJR_Gqu5Xt8M:&tbnh=162&tbnw=121&ei=V8x5Tc_1F4_6swPv6_yIAw&prev=/images?q=dried+mangoes&um=1&hl=es&biw=1280&bih=668&tbs=isch:10,565&um=1&itbs=1&iact=hc&vpx=1045&vpy=79&dur=1900&hovh=259&hovw=194&tx=172&ty=151&oei=Ucx5Tey-JJD6swPAkNT8Ag&page=2&ndsp=18&ved=1t:429,r:5,s:29&biw=1280&bih=668>.

Banana:

- "Resultados De La Búsqueda De Imágenes De Google De [Http://www.sunshinefoodintl.com/images/dried_banana.jpg](http://www.sunshinefoodintl.com/images/dried_banana.jpg)." *Google*. Web. 12 Mar. 2011. <http://www.google.com/imgres?imgurl=http://www.sunshinefoodintl.com/images/dried_banana.jpg&imgrefurl=http://www.sunshinefoodintl.com/&usq=__9lT3pm4SugmOdYC_tqu0707y9A4=&h=359&w=450&sz=38&hl=es&start=0&zoom=1&tbnid=Og1FSx8Ahe7kqM:&tbnh=123&tbnw=145&ei=-st5Tba7KJScsQO0tsmJAw&prev=/images?q=dried&um=1&hl=es&biw=1280&bih=668&tbs=isch:1&um=1&itbs=1&iact=hc&vpx=250&vpy=204&dur=0&hovh=200&hovw=251&tx=141&ty=105&oei=-st5Tba7KJScsQO0tsmJAw&page=1&ndsp=28&ved=1t:429,r:8,s:0>.

Pineapple:

- Resultados De La Búsqueda De Imágenes De Google De [Https://mtnman.com/frontend/images/3020zoom.jpg](https://mtnman.com/frontend/images/3020zoom.jpg)." *Google*. Web. 12 Mar. 2011. <http://www.google.com/imgres?imgurl=https://mtnman.com/frontend/images/3020zoom.jpg&imgrefurl=http://mtnman.com/frontend/index.php?main_page=index&cPath=3&usq=__jWN-DQGFLtXbsS6-7_s4mfA3-5E=&h=264&w=360&sz=20&hl=es&start=52&zoom=1&tbnid=P5jYem6kG6WT4M:&tbnh=158&tbnw=205&ei=ks15TfD9O4KgsQPEmdyCAw&prev=/images?q=dried+pineapple&um=1&hl=es&biw=1280&bih=668&tbs=isch:10,2028&um=1&itbs=1&iact=hc&vpx=141&vpy=114&dur=619&hovh=192&hovw=262&tx=150&ty=74&oei=h815TeykDYHGSAOk6vH9Ag&page=4&ndsp=17&ved=1t:429,r:11,s:52&biw=1280&bih=668>.

Papaya:

- "Resultados De La Búsqueda De Imágenes De Google De [Http://www.greenbulk.com/images/dried-papaya-slices.jpg](http://www.greenbulk.com/images/dried-papaya-slices.jpg)." *Google*. Web. 12 Mar. 2011. <http://www.google.com/imgres?imgurl=http://www.greenbulk.com/images/dried-papaya-slices.jpg&imgrefurl=http://www.greenbulk.com/-c-1.html&usq=__GM1ewsC2J4sEei96gSeBoE0jOmY=&h=461&w=640&sz=47&hl=es&start=0&zoom=1&tbnid=rxH1G_86ImOGUM:&tbnh=130&tbnw=173&ei=_c15TcSZGIW6sQP2_PGDAw&prev=/images?q=dried+papaya&um=1&hl=es&biw=1280&bih=668&tbs=isch:1&um=1&itbs=1&iact=hc&vpx=308&vpy=77&dur=1748&hovh=190&hovw=265&tx=145&ty=99&oei=_c15TcSZGIW6sQP2_PGDAw&page=1&ndsp=27&ved=1t:429,r:1,s:0>.

Sapota:

- "Resultados De La Búsqueda De Imágenes De Google De [Http://atrsolar.com/sapota.jpg](http://atrsolar.com/sapota.jpg)." *Google*. Web. 12 Mar. 2011. <http://www.google.com/imgres?imgurl=http://atrsolar.com/sapota.jpg&imgrefurl=http://www.atrsolar.com/solarairheater.htm&usq=__5ncsVO4H5j40qmW293EroCSC9eY=&h=270&w=405&sz=29&hl=es&start=58&zoom=1&tbnid=-mquA8RIVGnFZM:&tbnh=168&tbnw=220&ei=ec55TdThFliosQPOxJ3-Ag&prev=/images?q=dried+sapota&um=1&hl=es&biw=1280&bih=668&tbs=isch:10,1936&um=1&itbs=1&iact=hc&vpx=775&vpy=192&dur=625&hovh=183&hovw=275&tx=190&ty=68&oei=a855TajnG4KesQPa86WAAw&page=4&ndsp=16&ved=1t:429,r:14,s:58&biw=1280&bih=668>.

Pitaya

- "Resultados De La Búsqueda De Imágenes De Google De [Http://www.fotobank.ru/img/FC03-7232.jpg?size=l](http://www.fotobank.ru/img/FC03-7232.jpg?size=l)." *Google*. Web. 12 Mar. 2011. <http://www.google.com/imgres?imgurl=http://www.fotobank.ru/img/FC03-7232.jpg?size=l&imgrefurl=http://fotobank.ru/image/FC03-7232.html&usq=__WwLJxeKkCltdTl7l9iHPLXk9Z4=&h=358&w=500&sz=33&hl=es&start=28&zoom=1&tbnid=QOgAlGvTcxtZtM:&tbnh=152&tbnw=212&ei=r895TfXFL5G4sQO42qD_Ag&prev=/images?q=dried+pitaya&um=1&hl=es&biw=1280&bih=668&tbs=isch:10,554&um=1&itbs=1&iact=hc&vpx=974&vpy=290&dur=12&hovh=190&hovw=265&tx=124&ty=106&oei=hM95TduyE4jGsAPc_92VAw&page=2&ndsp=18&ved=1t:429,r:11,s:28&biw=1280&bih=668>.