Solar drying of fruit and vegetables

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For thousands of years people have sundried fruit and vegetables to preserve for leaner times. New technologies brought changed techniques, but at present the increasing demand for healthy, low-cost natural foods and the need for sustainable income, are bringing solar drying to the fore as a useful alternative for surplus products.

Save for tomorrow what you do not need today!
THIS PUBLICATION IS ABOUT

- Preparation and pretreatment of different fruit and vegetable types for drying
- How to dry these using basic solar dryers
- Proper storage of dried fruit and vegetables
- Recipes for dried fruit and vegetables.
ADVANTAGES OF SOLAR DRYING

Food in the cupboard for later use increases household food security.

It creates employment opportunities and a sustainable income.

- Dried products improve family nutrition because fruit and vegetables contain high quantities of vitamins, minerals and fibre.

- For diabetics dried fruit prepared without adding sugar is a healthy choice instead of desserts.

- Dried fruit can be used in stews, soups and casseroles or enjoyed as snacks. It can also be added to cereals for breakfast or used in making ice cream and baked products.

- It improves the bargaining position of farmers. Sometimes farmers sell at very low prices during the harvest season because they cannot store or preserve their surplus products.

- People are encouraged to establish their own gardens.
METHODS OF DRYING

Sun drying

Drying in the sun is very economical. You only have to spread the produce on a suitable surface and let it dry in the sun.

Disadvantages

Somebody has to stay at home throughout the drying period to chase off domestic animals, to remove the produce when the weather becomes too windy and dusty, or when it rains.

The dried product is often of poor quality as a result of grit and dirt.

The product is often unhygienic as a result of microorganisms and insects such as flies.

Solar drying

The technology and capital required to dry fruit and vegetables by solar dryers is basic and the entire operation can be completed in most kitchens. The structure can be very basic, e.g. a box frame covered with plastic sheeting.
Advantages of solar dryers

- Drying is faster because inside the dryer it is warmer than outside.
- Less risk of spoilage because of the speed of drying (if the drying process is slow the fruit starts to ferment and the product is spoilt).
- The product is protected against flies, pests, rain and dust.
- It is labour saving. The product can be left in the dryer overnight or during rain.
- The quality of the product is better in terms of nutrients, hygiene and colour.

THE DRYING PROCESS

Precautions

- Cleanliness and hygiene are very important in the processing of dried fruit and vegetables.
- To minimise the possibility of contamination, any person who is unwell or has infected wounds or sores, is ill with a gastric disorder or suffering from diarrhoea MUST BE EXCLUDED from the processing operations.
- All cuts have to be covered with waterproof dressing.
- Raw materials contaminated by moulds must not be used in processing.
Predrying treatments

Selection

- Use only ripe, good-quality fruit and vegetables.
- Select fruit and vegetables individually.
- Discard rotted, damaged or diseased fruit and vegetables.
- Remember, processing cannot improve poor-quality fruit or vegetables.

Washing

- Clean all working surfaces before handling fruit or vegetables.
- Water for cleaning must be treated with a household bleach solution.
- Prepare the cleaning solution as follows:
  - Pour 50 parts of clean water in a clean bucket (e.g. 20 l).
  - Add one part of any household bleach (e.g. 400 ml) containing chlorine
  - For safety reasons plastic gloves should be worn when mixing the solution.
- One bucketful of the treated water (20 l) is enough for cleaning 20 kg of fruit.
- Use a fresh cleaning solution every day.
• Selected fruit and vegetables should be washed and scrubbed individually in the treated water, while plastic gloves should be worn.

• Care must be taken to avoid breaking the skin of the fruit during cleaning and thereby contaminating the flesh.

• Washed fruit and vegetables should be placed into a clean basket or bucket and taken to the peeling or blanching area.

Blanching

Before drying, all vegetables should be blanched in steam 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 from adhering to each other. Do not underblanch, because the enzymes will not be inactivated totally and the dried vegetables will deteriorate during storage.

Procedure

• Pour several centimetres of water into a large cooking pot that has a close-fitting lid. Heat the water to boiling and place over it (high enough to keep clear of the water) a wire rack or basket holding a layer of the vegetables (not more than 5 cm deep). Cover and let the vegetables steam for half the required time, 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 blanched properly.
• Remove the vegetables and spread them on paper towelling or clean cloth to remove excess moisture while you steam the next load. Cover with towelling while waiting for further treatment or before taking it to the drying trays.

**Peeling**

• Hygiene is of utmost importance when peeling.

• Peeling should not take place in the area where the raw materials are washed.

• The area should be swept thoroughly and washed before handling the fruit.

• Peeling knives and working surfaces should be cleaned in fresh bleach solution before use.

• The operator should wash his/her hands and arms thoroughly with clean water and unperfumed soap.

• Clean, sharp stainless steel knives must always be used.

• Careful peeling with minimum removal of the flesh is important.

• Peelings and seeds should be disposed of as soon as possible because they attract flies and other insects.

• Peelings can be used as animal feed or as mulch, or be buried if there is no alternate use.
Cutting and slicing

Thickness of fruit pieces depends upon the kind of fruit being dried.

• Thicker slices will dry at a slower rate than thinner pieces.
• Very thin pieces tend to stick to the drying trays and will be difficult to remove.
• Thicker pieces may not dry fully and may subsequently deteriorate after packing.
• Packages of dried pieces of varying thickness appear relatively unattractive.
• Cutting knives and working surface have to be cleaned with a bleach solution before use.
• Slices should be placed in clean bowls which have been rinsed with clean water ready for loading onto the drying trays.
• Before loading the trays, these have to be brushed clean and washed.
Dryers

A basic box-type low-cost solar dryer can be constructed at home or by village artisans. It is made of wire-mesh trays in a wooden framework surrounded by a clear plastic sheet. The solar cabinet dryer type has a surface of 10 m² and is capable of drying 20 to 35 kg of fresh produce (depending on commodity) over a period of 3 to 4 days. Smaller portable models of the dryer can be constructed, depending on available funds for the dryer, construction and the purpose of drying (home consumption or marketing).

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**Tray loading**

- Trays should be washed and cleaned to remove any fragments of dried fruit or contamination.

- Start to load during slicing rather than waiting until all the fruit has been sliced or cut. (This reduces the problem of sticking together in the bowls and will allow drying to start as soon as possible.)

- Lay the pieces of fruit on trays carefully and close to each other without overlapping to ensure the trays are loaded fully.

- Keep flies away and load trays quickly and continuously.

**Dryer loading**

- The dryer should be positioned in a level area unobscured by trees or buildings so that it is fully exposed to the sun throughout the day.

- If the wind blows predominantly in one direction for long periods the dryer should be placed end-on to 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.
• Before loading, the inside of the drying cabinet should be swept clean and then wiped out with a clean, damp cloth.

• The plastic covers outside should be brushed or washed clean of dust because dirty plastic will reduce dryer performance and increase drying times.

• The doors should be closed immediately after each tray has been loaded and not left open until the next tray is fetched.

It is important to keep flies and other insects from entering the cabinet and off the fruit because of the risk of contamination.

Drying

• During the first few hours of drying, particularly during very hot and sunny weather, fruit may dry at such a rate that moisture condenses on the inside of the plastic covers.

• This can be avoided by opening the loading doors slightly (20 mm) to improve air circulation. The gap should, however, be covered with mosquito mesh.

• Doors should be kept open for a minimum period of time and closed again as soon as the weather becomes cloudy.
In poor weather drying will stop. Rain will rapidly cool the dryer and this will result in a moisture film on the cover because of condensation. It will be some time before the dryer functions again after the sun breaks through. Therefore, protect the dryer from rain.

Under fine and sunny conditions the fruit slices should be dry after 2 full days in the dryer. However, it is essential to test slices. If the slices are not sufficiently dry, they will become mouldy in a short time. A test for dryness is conducted for specific products.

If the slices are not sufficiently dry, the process should be allowed to continue for 1 or 2 hours before checking again.

The final moisture content of dried fruit should be approximately 10% (on a wet basis).

Unloading the dryer

When the fruit is considered to be dry, the dryer should be unloaded as soon as possible. This must not be carried out in the early morning because dew and high humidity overnight may cause condensation of moisture onto the fruit. The best time to unload is in the afternoon on a sunny day.

Trays should be removed from the dryer and taken to a clean and covered area for removal of the dried product.

The operator must wash his/her hands and ideally wear clean gloves when handling the fruit.

The dried fruit should be stored temporarily in clean dry baskets before packaging so that the product can cool down.
PACKAGING AND STORING

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.
Specific products

FRUIT

Mangoes

Select firm, ripe mangoes
Wash with clean water
Peel
Cut into slices (2–3 mm thick)
Arrange on trays for loading into the dryer
Test for dryness: slices should be pliable, without sticking together.

Pineapples

Select firm, ripe fruit
Wash
Cut off the top and base
Peel
Cut into slices (2–3 mm thick)
Arrange on trays ready for loading into dryers
Test for dryness: slices should be pliable, without sticking together.
**Bananas**

Select good-quality fruit

Wash

Peel and remove the 2 tips

Slice into pieces (5 mm thick)

Arrange on trays for loading into dryer

Test for dryness: slices should be pliable, without sticking together.

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**Apples**

Select good-quality fruit

Wash

Peel

Split

Core

Cut into regular slices (2–3 mm thick). As you cut, dip the slices into lemon juice to retain the colour temporarily

Steam blanch for 5 minutes and remove excess moisture

Arrange slices on trays ready for drying

Test for dryness: leathery, no moisture when cut and squeezed.
Cactus pears (prickly pears)

Select large, ripe fruit

Using a clean cloth remove the glochids, dust and dirt

Wash and cut away both ends

Peel as thinly as possible

Remove the soft peel and keep to one side
(If it is easier to remove if the fruit is cut in half)

Juice the flesh and sieve
(This can be done by using a blender or a mixer)

Boil the juice

Add the soft peel into the juice together with sugar, lemon juice and salt. Cook for about 1 hour
For 1 kg peel, you need 750 g sugar, 65 ml lemon juice and a pinch of salt

Pour onto a sieve and allow to drain

Allow to cool

Arrange the pieces on trays and load into the dryer

Test for dryness: slightly sticky.
VEGETABLES

Pumpkin leaves

Select fresh, tender leaves
Peel off the hairy outer skin
Wash in clean water
Steam blanch for 3 to 5 minutes
Place on trays ready for drying
Test for dryness: crumbles easily.

Tomatoes

Select fresh ripe fruit
Wash in clean water
Slice into regular pieces (vertically)
Arrange the pieces on the tray for drying
Test for dryness: a handful will spring apart after squeezing.
Cabbage

Peel off the outer leaves
Wash in clean water
Cut the cabbage in two
Core
Chop into thin strands
Steam blanch for 5 to 8 minutes
Arrange on trays for drying.
Spread evenly, not more than 1.5 cm deep
Test for dryness: extremely tough ribs, the thin edges crumble.

Amaranthus sp.

Select young, tender and crisp leaves
Wash
Place loosely in a steaming basket and steam for 3 to 5 minutes or until well “wilted”
Spread sparsely on drying trays, keeping overlaps to a minimum
Test for dryness: crumbles easily.
Sweet potatoes

Select firm, smooth potatoes
Wash
Steam in small quantity of water until the potatoes are just tender (30–40 minutes)
Peel
Slice into pieces (3–5 mm) or shred
Arrange the pieces on trays for drying
Test for dryness: slices extremely leathery, not pliable, shreds are brittle.

Carrots

Choose crisp, tender carrots without woodiness
(Not necessary to peel good, young carrots)
Steam until cooked through but not mushy (about 15–20 minutes depending on size)
Remove whiskers, tails and crowns
Cut into rings (2–3 mm) or shred
Arrange on trays for drying
Test for dryness: slices very tough, but can be bent. Shreds are brittle.
**Beetroot**

Choose small ones without woodiness

Leave 1 cm of the tops (they will bleed during precooking if the crown is cut)

Steam until cooked through (20–30 minutes)

Cool, trim roots and crowns and then peel

Shred with a coarse blade of a vegetable shredder (slices are not recommended because they take a long time to dry)

Spread thinly on trays for drying

Test for dryness: shreds are brittle.

**Pumpkin**

Deep orange varieties with thick solid flesh make the best product

Cut in half (manageable pieces for peeling) and remove seeds and all pith

Shred with the coarse blade of a vegetable grater

Place in shallow layers in the basket, steam for 6 minutes

Arrange shreds on drying trays ready for drying

Test for dryness: shreds are brittle.
Green beans

Select young and tender stringless beans
Wash thoroughly
Steam for 2 to 3 minutes
Cut into short pieces or lengthwise
Arrange on trays for drying
Test for dryness: extremely tough ribs, the thin edge crumbles.
HERBS

This category includes celery leaves as well as other aromatic herbs such as parsley, basil, sage, tarragon, etc. All these should be dried at temperatures not exceeding 40 °C. (If it exceeds this temperature oils valued for flavour will be lost.)

For best products

- Water the herbs well the night before harvest.
- Harvest on a sunny morning soon after the dew has dried and choose plants that are reaching flowering stage.
- Harvest with sufficient stem, then strip off tougher leaves growing lower than 10 cm on the stalk.
- Hold in small bunches by the stem and swish the leaves through cold water to remove any dust or soil.
- Shake off the water and lay on absorbent towelling to allow all surface moisture to evaporate.
- Cut off the handle stems and spread the leafed stalks one layer deep on the drying trays.
- Put the dryer under a shade and cover the unventilated sides with a cloth to reduce the light on the herbs.
- Turn the herbs several times to ensure even drying.
- Test for dryness: crumbles readily.
RECIPIES FOR DRIED FRUIT AND VEGETABLES

Cooking of dried vegetables

Water removed during drying must be replaced either by soaking, cooking or a combination of both. Root, stem and seed vegetables should be soaked for half an hour to 2 hours in sufficient cold water (only cover) until nearly restored to their original texture. Never supply more water than they can take up and always cook in the water they have been soaked in. Greens, cabbage and tomatoes do not need to be soaked. Add only sufficient water to keep covered, then simmer until tender.
Amaranthus (morog) croquettes

100 g amaranthus
4 tablespoons gram flour or bread flour
1 tablespoon masala
2 eggs, beaten
salt
pepper

- Mix the amaranthus with gram flour or bread flour, masala, egg and seasoning
- Leave in a cool place to firm up a little (preferably a refrigerator)
- Form the firm mixture into cakes or croquettes, roll in the flour and fry briefly both sides until uniformly golden.
Amaranthus or cabbage relish

100 g dried amaranthus or cabbage
1 large onion (chopped)
1 large tomato (chopped) or 1 tablespoon tomato paste
1 green pepper (seeded and chopped)
1 carrot (grated)
2 tablespoons cooking oil
½ cup coconut milk or skim milk
salt
pepper

- Heat the cooker plate or coil until hot
- Add onions and fry until glazed
- Add the carrots and green pepper and stir for 2 to 3 minutes
- Add the tomatoes or paste and keep stirring for another 2 to 3 minutes
- Add the amaranthus or cabbage and coconut milk or skim milk. Allow to simmer at low heat for 5 minutes, stirring occasionally
- Add salt and pepper to taste
- Allow to simmer for 2 to 3 minutes while stirring occasionally and then remove from heat
- Serve with stiff porridge or rice.
Pumpkin fritters

1 cup dried pumpkin
125 ml (½ cup) brown bread flour or wholewheat flour
10 ml (2 tablespoons) baking powder
60 ml (¼ cup) brown sugar
2 eggs, beaten
pinch of salt

• Soak pumpkin in enough water to cover and let stand for 1 hour
• Mash the pumpkin well
• Mix pumpkin, flour, baking powder, salt and pepper together
• Stir in beaten eggs and drop spoonfuls onto a lightly-oiled pan, over medium heat
• When bubbles appear, turn and cook on the other side
• Serve with a sprinkling of cinnamon and sugar.
Banana walnut loaf

200 g chewy banana chips
pinch of salt
1 level teaspoonful bicarbonate of soda
50 g soft margarine
1 egg, beaten
50 g walnut, chopped
250 g selfraising flour
½ teaspoon vanilla essence

• Put banana chips, salt, bicarbonate of soda and soft margarine into a bowl
• Pour over 2 cups of boiling water to melt the margarine and allow to cool, then blend roughly
• Mix the egg, walnut, flour and vanilla essence and add the banana mixture and mix to a smooth malleable consistency
• Bake the dough in a greased 1 kg-loaf tin in the centre of the oven at gas mark 4 (180 °C) for approximately 50 minutes
• Once out of the oven allow to cool for 10 minutes before turning over
• Serve slices buttered or toasted.
Pineapple and chicken wings

150 g sundried pineapple
1/3 cup butter or margarine
¾ cup tomato sauce
1 small clove of garlic (crushed)
1.5 kg chicken wings separated
1 cup fine, dry breadcrumbs
1/3 cup syrup
1 tablespoonful of lemon juice
½ teaspoon ground ginger
1 tablespoonful of Worcestershire sauce

- Soak the pineapples in 1 cup water for 1 hour and cut them into small chunks
- Heat oven to 200 °C
- Put butter or margarine in a large shallow baking pan and set in an oven to melt
- Combine tomato sauce and garlic. Brush the mixture on separate wings, then roll in breadcrumbs to coat all sides
- Place in the baking pan turning them over in the butter
- Bake for 30 minutes
- Remove pan from oven and turn the chicken wings
- Drain pineapples, measuring the juice (about a 1/3 cup liquid is required)
- Combine the liquid with syrup, lemon juice, ginger and Worcestershire sauce sauce and pour over wings
• Bake for about 30 minutes or until chicken is very tender, adding pineapple chunks in the last 5 minutes
• Remove from oven and serve with rice

Sundried mango ice cream

100 g sundried mango

White wine or tropical juice

3 eggs, separated

140 g castor sugar

½ l double cream, lightly whipped

• Soak mango in white wine or, for non-alcoholic alternative, in a tropical juice
• Use enough liquid to cover the fruit. After ½ hour of soaking, puree fruit with soaking liquid
• Whisk egg whites until stiff, then whisk in half of the castor sugar
• Whisk the cream
• Using a bowl, whisk the egg yolk and remaining castor sugar until thick
• Add the purée of mangoes
• Fold in the whipped cream and finally the egg whites
• Freeze.
Pumpkin cookies

\[
\frac{1}{3} \text{ cup shortening} \\
1 \text{ cup sugar} \\
2 \text{ eggs} \\
1 \text{ tablespoonful vanilla essence} \\
1 \text{ teaspoonful lemon extract} \\
1 \text{ cup dried pumpkin} \\
2\frac{1}{2} \text{ cups flour} \\
4 \text{ teaspoonfuls baking powder} \\
\frac{1}{4} \text{ teaspoonful salt} \\
\frac{1}{2} \text{ teaspoonful ginger} \\
\frac{1}{2} \text{ teaspoonful nutmeg} \\
1 \text{ cup seeded raisins} \\
\frac{1}{2} \text{ cup chopped nuts}
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- Soak pumpkin in enough water to cover for about ½ hour
- Mash the pumpkin well
- Cream shortening and sugar, beat eggs in well
- Stir in the vanilla and lemon extract
- Put pumpkin through a sieve and add into the mixture above, mixing well
- Sift dry ingredients and add to the mixture
- Add the raisins and nuts. Mix thoroughly
- Drop teaspoonfuls onto a greased cookie pan and bake for about 15 minutes in a 190 °C oven (makes 48).
Dried-fruit patties

Select equal parts of dried fruit
(e.g. cactus pear, peaches, pineapples, raisins, prunes, etc.)

- Run them through a food chopper using a coarse blade
- Add chopped walnut or pecans
- Mix well and form into small balls the size of walnut
- Press lightly between the palms of the hands to flatten
- Roll in powdered sugar and place in the refrigerator to chill
- These patties can be used as substitutes for sweets or cookies for picnics, deserts, snacks, etc.
Dried apple fruit cake

3 cups dried apples
3 cups light syrup
1 cup raisins
3 cups flour
1 cup softened shortening
3 eggs, beaten
1 teaspoonful baking soda
1 teaspoonful cinnamon
½ teaspoonful nutmeg
¼ teaspoonful cloves

- Soak apples overnight in enough water to cover
- In the morning, cut apples quite fine, add syrup and cook until apples are very tender
- Add raisins and cook for another 5 minutes
- Remove from heat and cool
- Add shortening and eggs
- Sift dry ingredients together and add to the mixture above
- Blend well, then pour into 2 standard size bread tins lined with waxed paper
- Bake in a 180 °C oven for 1 hour or until a knife poked in the centre comes out clean
- Cool on a rack.
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