1. SOLAR FOOD PROCESSING

Introduction

India is the third largest producer of fruits & vegetables in the world. Fruits & vegetables with their rich contents of minerals, vitamins, and dietary fiber & anti oxidants are the protective foods & considered as nature gifts for health & well being of humans. They are highly perishable in nature due to high moisture content (70-95%); soft texture etc bacterial rotting by microbial respiration as well as physiological breakdown is seen. Some times moisture degradation in the quality of fruits & vegetables also starts immediately after the harvest leading to drying & shriveling. Fruits & vegetables absorb environment gasses such as oxygen & produce carbon dioxide & ethylene. They also get infested easily with micro organisms like fungi, bacteria & insects affecting food safety. In villages where fruits & vegetables are grown in plenty, facilities for processing are not in existence & lot of them are wasted. In the country the whole food processing industry is still has not grown big & presently less than 4% of horticultural produce is being processed industrially.

Hence these fruits & vegetables are to be preserved & protected from deterioration in both quality & quantity. Recent statistics showed that nearly 50% of the losses also occur due to improper handling, inadequate infra structure facilities for processing, preservation, storage, distant markets, high cost & inappropriate packaging, out dated technologies & machinery. As a result the wastage in monetary terms is to the tune of Rs.2500-30,000 crores.

Appropriate location for specific post harvest management has to be made available in terms of processing methods besides crop protection measures, grading, pretreatment storage, packaging & transportation etc.

Present Status of Food Processing in India

Though the country is the largest producer of fruits & vegetables less than 4% is processed industrially. Very small quantity of fruits & vegetables are being used in the preparation of pickles, tomato ketchup, jams, dried & fried potato products like chips, baby foods, raw banana chips, canned items, purees, sauces, pastes etc. In view of globalization & in view of low out put of the processed fruits & vegetables, the food processing industry should grow in leaps & bounds. This is very important in future to supply wholesome safe, nutritious & acceptable food to consumers through out the year & also to earn foreign currency by exporting finished or semi processed products based on demand using quality raw material with consistent & regular supply.
2. DEHYDRATION

Dehydration of Fruits & Vegetables In Indian Scenario:
Sun drying of fruits & vegetables & is still in vogue in many countries. Dried fruits vegetables are easy to store & transport. At times of plenty processing by drying permits the preservation & utilization in lean seasons. Dried fruits are used several ways- in cookery, bakery, for eating out of hand, in ice creams, puddings etc. Dried vegetables are best used after dehydration in number of preparations. There are certain disadvantages with open drying-uncontrolled temperatures, uneven drying contamination etc. In almost in all parts of rural India cereals, pulses, leafy vegetables, raw mango, amla, tomato & several other fruits are also dried for making pickles, preserves etc. In tribal areas gums, tamarind, beans, mahua flower & seeds, myrobalans etc are dried.

Dehydration Process, Its Role & Importance:
Dehydrated food processing is going to be an important area in the coming years for the reasons like long shelf life, light weight, better handling during export & providing variety to the consumers. There is considerable reduction in bulk requiring less storage place & usually far cheaper these dried foods also can be put to a number of uses similar to fresh ones. The advantage is that during dehydration the water activity is reduced greatly and the microorganisms, molds & fungi do not thrive. This keeps the food for longer duration without spoilage. Dehydration offers a highly effective & practical means of preserving horticultural produce to reduce post harvest losses & offset the shortage in supply. The dried product has a weight only 1/4 to 1/9 of the fresh material. In olden days also food preservation in open sun drying is in vogue. With advancement of technology other methods have come to light & are being practiced continuously till to date. However the energy consumption in these conventional dehydration techniques is quite high.

Why Dehydration?
Dehydration is to preserve for longer time & in addition to reduce bulk & weight. This reduction in weight & bulk can result in economics in transport & cost of containers. It retains the size & shape of the original food. Dehydration produces convenience items like fruiting juice concentrates, fruit juice powders,
souping mixes etc. The consumer simply dehydrates the material & uses for the purpose.

Many fruits & vegetables available only during seasons with the help of dehydration process preserve them for all seasons. The biological forces acting upon foods are minimized. Spoilage of foods are easily controlled in drying process.

**Advantages of dried foods:**

◊ Dried foods are in more concentrated form

◊ Reduction in moisture content results in reduction in weight & volume hence it increases the ease of packing, handling, storage & transport.

◊ There is considerable reduction in volume, requires less packing, storage place.

◊ Dried product has a weight only 1/4 to 1/9 of the fresh material

◊ They are less costly than foods preserved by other ways due to low cost of labour.

◊ Enhanced shelf life of product

◊ Gives the product that has characteristics suitable for further processing.

◊ Products have greater convenience in use.

◊ Earlier dehydrated food products are particularly suitable for defense forces & now are being manufactured for common man’s use.
3. DRYING VS DEHYDRATION

Drying or dehydration means removal or reduction of water from any material may be vegetable, fruit, milk or meat.

**Drying** is carried under *open sunlight* directly.

Drying foods in open sun is being followed since ancient times. Foods containing high moisture content are simply dried under open sun during hot sunny days to the desired texture qualities. In these technique vegetables, fruits, greens, spices, legume-based products, wafers, papads etc are dried & stored for longer periods. Intermittently the foods are exposed to sunlight to prolong shelf life.

**Dehydration** is done under controlled conditions of temperature, humidity & airflow. The costs of processing are usually high. Air is used as drying medium. Temperature, moisture & velocity of air are controllable depending on the foods to be dried. Cooking quality foods are superior. Sanitary conditions are controllable with in a dehydration plant. It is a continuous fast process & the product is obtained with in a short period. Labour requirements are minimum. Dehydration of foods can be carried in all seasons for prolonged shelf life.
4. SOLAR AIR DRYING PROCESS

Due to abundant availability of solar radiation attention has been gradually diverting to utilize this renewable energy for a number of applications. Among these dehydration of food & non-food items is an important sector.

This solar drying enables Good Manufacturing Practices (GMP) & yields export worthy processed foods with long shelf life meeting the sanitary & phyto sanitary standards of the importing countries. This novel technology is a very viable & valuable one.

**Differences between Open Sun drying & Solar Air Drying**

<table>
<thead>
<tr>
<th>Open Sun Drying</th>
<th>Solar Air Drying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional method</td>
<td>More recent innovation</td>
</tr>
<tr>
<td>Delayed drying</td>
<td>Fast drying</td>
</tr>
<tr>
<td>Problems of contamination by birds, insects, etc</td>
<td>No contamination</td>
</tr>
<tr>
<td>Less hygienic &amp; less clean</td>
<td>Highly hygienic &amp; very clean</td>
</tr>
<tr>
<td>Inferior quality products</td>
<td>Best quality products</td>
</tr>
<tr>
<td>May not meet GMP</td>
<td>Meets GMP requirements</td>
</tr>
<tr>
<td>Drying possible only on sunny days</td>
<td>Drying possible on all days including cloudy and rainy days with electrical backup</td>
</tr>
<tr>
<td>Poor sensory qualities to products - Appearance / Colour &amp; Textures</td>
<td>Highly acceptable sensory qualities to products - attractive appearance &amp; colour &amp; Texture</td>
</tr>
<tr>
<td>Uneven drying</td>
<td>Even drying</td>
</tr>
<tr>
<td>Less suited for large/ commercial scale production</td>
<td>Highly viable for quality commercial production &amp; economically viable</td>
</tr>
<tr>
<td>More nutrient losses</td>
<td>Better nutrient retention</td>
</tr>
<tr>
<td>Low profit margins</td>
<td>Best profit margins due to quality products</td>
</tr>
</tbody>
</table>
5. SOLAR POWERED AIR DRYER

Principle:

Solar radiation passes through the transparent glass window located on the top of the cabinet, which is oriented to the South with a tilt equal to latitude to collect maximum solar radiation. The cabinet is made of anti corrosive material & modular nature to meet the varying sizes & loading capacities of food products ranging from 8 - 50 kg or more.

Construction & Functional Details Of Solar Dryer:

The construction of solar dryer involves a metal cabinet made of aluminum alloy, (anti corrosive material) with a glass window on the top. The inside of the cabinet is provided with trays to place the material to be dried & the cabinet is modular in nature.

The solar radiation passes through the transparent glass window, located on the top of the cabinet, which is oriented to South direction with a tilt equal to latitude 20° to collect maximum solar radiation.

The ambient air enters from the bottom of the cabinet from three sides & gets heated up with solar radiation incident from the top window. The heat energy is trapped in the cabinet & heats up the air. As a result the wavelength of solar radiation shifts to infrared region, causing green house effect. The hot air passes through the trays, carries the moisture from the product to the space below the glass. Then it is exhausted by three Solar Photo Voltaic (SPV) Fans arranged on the top of the cabinet. Thus the moist air is removed to the atmosphere by the forced circulation of the air. The outer side of the cabinet coated with a dark black paint helps in to keep the temperature of the walls higher than the ambient & maintaining higher temperatures inside. The dryer is also fixed with cast iron wheels for easy movement.

The dryer also has electrical backup with thermostat control to facilitate drying on non-sunny days.
The Solar Powered Solar Air Dryer has the capacity to evaporate 15kgs of water per day from the food being processed in a dryer with loading capacity of 50kg wet product in SDM-50 Model.

Considerable Research was carried in the R & D Laboratory of SEED, Hyderabad on Solar Air drying technology and about 50 products covering fruits, fruit bars, (Mango, Sapota, Papaya), green leafy vegetables, vegetables, spices, flower petals, herbs, coconut, fish, noodles, mushrooms, edible gums, honey, certain chemicals etc were processed using SDM-50 Model Solar Dryer.

**Salient Features of Solar Dryer:**

- Minimal thermal losses due to the direct penetration of solar radiation into the cabinet through the glass window.

- The temperatures achieved in the cabinet are in the range of 40-65 °C on a clear Sunny day.

- The temperature difference between the ambient & inside cabinet temperature is 15-30 °C on bright sunny days.

- Solar Photo Voltaic (SPV) fan for forced air circulation

Basing on this new concept, solar powered solar air dryer designed & developed by R & D team of SEED, Hyderabad.
• Provision of trolley system for loading & unloading of trays containing material to be dried.

• The dryer is rain proof, dust proof, rodent proof & insect proof due to fixation of EPDM gasket & can be easily replaced in case of breakage.

• The moisture control in the product is achieved by the regulation of drying time based on the intensity of solar radiation.

• Thermostat control at set temperature in mixed solar & electrical mode (optional for non-sunny & cloudy weather).

• The dryers are modular, easily transportable/ portable & configured according to the availability of open space in users premises.

• The scalability of the dryer is to the desired size on customer’s demand.

• Configuration can be tailored according to the availability of space.

• The dryers are guaranteed for long-term usage i.e. for a period of 10 years.

• A special glass filter arrangement is facilitated to cut off UV radiation & reduce solar Intensity for special applications (retention of vitamins).

• Clean & hygienically prepared products to meet international quality standards of importing countries (ASTA of USA & others).

**Applications of solar dryers:**

♣ The solar dryers are useful for drying a variety of materials. Both food & non-food materials can be effectively dried without changing basic properties.

♣ All types of cereal grains & their products (Flours, Maida, Wafers, vermicelli, Noodles etc.), legumes, green leafy vegetables, root vegetables, other vegetables, fruits & fruit products-bars, toffees, spices & condiments, herbs, flowers, gums, mushrooms, forest produce, meat, shrimps, fish, papads, chemicals etc are well dried in the solar dryer under clean conditions in a reasonably short time. The dryer ensures well-dried product irrespective of the season / climate / location.
Solar dried foods can be used much the same way as open sun dried items. In these days solar dried items / foods have immense value both from food & cosmetic points of view.

Solar drying technology enables processing fruits & vegetables under clean & hygienic conditions meeting the international standards for quality.

**Current Status Of Food Processing Using Solar Dryers**

In past two years intensive work has been carried in drying fruits, vegetables, forest produce like gumkaraya (edible gum), spices, herbs, etc using solar dryers. This work was taken up to test the effectiveness of the dryers on dehydration of a variety of products. The dehydration process requires pretreatments, addition of class I preservatives to enhance shelf life & fast drying for reducing moisture levels. Laboratory scale processing of more than forty different items were dried in the solar dryer for which the drying temperatures (both ambient & cabinet), time taken for drying, & permissible moisture levels were recoded. The results can be extrapolated for bulk production.
6. DATA ON SOLAR DEHYDRATION OF SELECTED FOODS

Process data for fruits, vegetables, green leafy vegetables, forest produce, spices, and food items is indicated in the following table.

**Data On Solar Dehydration Of Fruits, Vegetables, Green Leafy Vegetables, Forest Produce, Spices, Food Items**

<table>
<thead>
<tr>
<th>S.No</th>
<th>Product</th>
<th>Drying Time (hrs)</th>
<th>Yield (%)</th>
<th>Ambient Temp (°C)</th>
<th>Cabinet Temp. (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FRUITS</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Mango Bar (10mm Thick)</td>
<td>20</td>
<td>45</td>
<td>40</td>
<td>65</td>
</tr>
<tr>
<td>2.</td>
<td>Pineapple Bar (10mm Thick)</td>
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<td>30</td>
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<tr>
<td>3.</td>
<td>Papaya Bar(10mm Thick)</td>
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<td>Grapes</td>
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<td>Sapota Slices</td>
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<tr>
<td>7.</td>
<td>Sapota Bar (10mm Thick)</td>
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<td>9.</td>
<td>Donda</td>
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<td>10</td>
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<td><strong>GREEN LEAFY VEGETABLES</strong></td>
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<td>91.5</td>
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<td><strong>MEDICINAL &amp; HERBAL PRODUCTS</strong></td>
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<td>Fish</td>
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<td>45.</td>
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<td>80</td>
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<td>46.</td>
<td>Cellulose</td>
<td>7</td>
<td>50</td>
<td>32</td>
<td>60</td>
</tr>
</tbody>
</table>
7. FOOD SAFETY THROUGH SOLAR DRYING

Food safety is one of the most important dimensions of food quality. Consumer falls sick after consumption if the product quality is very poor due to the presence of pathogenic bacteria or may experience long-term effects of ill health like malignancies due to presence of pesticide residues or other contaminants.

Drying in Solar Dryer assures production of products of best quality & meet the defined standards within the accepted tolerances as indicated in the FAO/WHO Codex besides those of ISI, FPO & AGMARK. This solar drying enables Good Manufacturing Practices (GMP) & yields export worthy processed foods with long shelf life meeting the sanitary & phyto sanitary standards. This emerging novel technology is a very viable & valuable one.

WHAT IS FPO?

Food processing industry should get Fruit Products Order (FPO) license for processing fruits and vegetables from Government of India.

The FPO mainly stipulates the sanitary and hygienic requirements. It prescribes the conditions such as premises, clean, lighted and ventilated, fly proof doors and windows, efficient drainage and adequate provision of waste disposal, sanitary place and clean surroundings. The other requirements are water of high quality; necessary manufacturing equipment, clean cooking arrangements and space according to category.

FPO Requirements For Establishing A Food Processing Unit

- Rooms / halls/ sheds with proper ventilation, aeration & lighting
- Fly & mosquito proof windows & doors (netted)
- Rodent proof & insect proof work & storage areas
- Protected & assured water supply & bacteria free water
- Clean & hygienic environment
- Necessary pre processing & processing equipment & accessories
- Gas cooking facility
- Size of the land area depending upon the extent of processing
**Personal & Hygienic Practices To Be Followed While Processing**

Persons involved in food processing must be healthy free from diseases

- Short cut nails
- Washing hands thoroughly & wearing gloves
- Wearing head gear / shower cap to prevent falling of hair
- Wear a clean dress before & entering the processing area
- Wearing a clean apron / a coat to protect clothing
- Washing feet & wearing separate foot wear before entering process room
- Avoid licking & tasting while handling & processing

The pilot production of mango bar and a number of other products in the solar dryer has given excellent quality end products. It is not only hygienically processed but also saves drying time over open sun drying.
8. QUALITY CONTROL FOR SOLAR DRIED FOODS

The overall quality of any food is very important in terms of Physico chemical properties, shelf life & microbiological qualities. Absence of harmful microorganisms and other undesirable substances, look & appearance and other sensory parameters and nutritional values.

PHYSICO CHEMICAL QUALITIES

The foods before & after processing are to be tested for various physico chemical parameters to ensure and maintain uniform quality. Theses parameters include Moisture, Acidity, pH, Total Soluble Solids (TSS), Sulphur Dioxide & Browning Index. The parameters also vary from product to product.

SHELF LIFE AND MICROBIOLOGICAL QUALITIES

For all the processed foods the storage period & keeping quality are very important. The product must be fresh & acceptable during the entire & stipulated storage time. In order to ensure these products must be periodically tested for Physical characteristics, microbial loads – Total plate count, various pathogenic organisms.

NUTRITIONAL QUALITIES

From the consumer point of view nutritional qualities are important. Important & essential nutrients like minerals, Vitamins, fibre, protein, fat, Carbohydrates, Energy are to be analyzed from time to time depending on the type of product processed & preserved.

SENSORY QUALITIES OF SOLAR DRIED FOODS

Ultimately the processed has to satisfy the consumers interests & be acceptable. Physical Appearance, Colour, Texture, Taste & Flavour are essential features for accepting the product. Any deviation in the quality is likely to cause rejection. Hence sensory evaluation of the products is to be given top priority before the products are released commercially. This is possible by subjecting to a trained panel of tasters & their acceptance & suggestions are to be reckoned.
9. PACKAGING & ITS IMPORTANCE

Right type of package very essential for storing, preserving & marketing any product.

- Packing protects the food from light, heat & air & thus prevents spoilage.
- Proper packing protects the colour, appearance & taste of product
- Packing prevents the loss of nutrients
- Correct packing enables easy transport
- Attractive packing as per the size or shape of the product to promote quick sales by its aesthetic look
- Packing should be done in a scientific manner using right type of packaging material.
- Label on package must indicate brand, ingredients, preservatives used, quantity/weight/size of the product, date of manufacture, nutritional facts, price, etc.
- Price of the product at reasonable rate
- Packing in wax paper, aluminum foil, acceptable polypropylene pouches / sachets / boxes
10. TECHNIQUES OF FOOD PROCESSING IN SOLAR DRYER

In the preparation of a fruit bar the pulp or puree of a fruit or a mixture of fruits is usually used along with other ingredients. Sugar is used to enhance the taste. The fruit pulp with the added ingredients is dried in the form of a thin layer in stainless steel trays loaded in the solar dryer. During solar drying water is removed from the product under clean & hygienic conditions.

A). PROCESSING MANGO BAR

Mangos are one of the most important and most widely cultivated fruit in India. India produces around 1000 variety of mango fruits. Though variety of mango products are available in Indian market one of the important product manufactured in India is mango bar or “thandra”.

In the preparation of a fruit bar the pulp or puree of a fruit is usually used along with other ingredients. Sugar is used to enhance the taste. The fruit pulp with the added ingredients is dried in the form of a thin layer in stainless steel trays loaded in the solar dryer. During solar drying water is removed from the product under clean & hygienic conditions.

Process Details

Composition of Mango Fruit pulp mix for one layer

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thothapuri Mango Pulp (Kg)</td>
<td>9.30</td>
</tr>
<tr>
<td>Sugar +Glucose (Kg)</td>
<td>3.45</td>
</tr>
<tr>
<td>Citric Acid (g)</td>
<td>18.0</td>
</tr>
<tr>
<td>Pectin (g)</td>
<td>9.0</td>
</tr>
<tr>
<td>Potassium Meta Bi sulphite (g)</td>
<td>15.0</td>
</tr>
</tbody>
</table>
Method

Steps followed are given below:

- Canned mango pulp from Thotapuri or similar variety is best suited for making mango bar.
- Prepare Sugar syrup by adding 400 ml water & glucose.
- Add Citric acid & Pectin.
- Cool the syrup & mix the fruit pulps.
- Add potassium Meta bi sulphite.
- Using electrical hand mixer blend the pulp mix thoroughly
- Pour 900ml of fruit pulp mix in stainless steel trays & spread evenly.
- Carefully load the trays in Solar dryer for drying to make the first layer (Day 1), (at 40º-60º C)
- Repeat the above procedure on the second day & spread the mix on the dried up first layer to make the second layer (Day 2).
- Repeat the above procedure on the third day by spreading the mix on the dried up second layer to make third layer (Day 3).
- After the third layer is well set, cut into bars or small slabs of 3”x4” size / 100g / 150g / toffees of required size.
- Pack in polypropylene sachets & seal airtight.

Flow Diagram

Prepare Sugar Syrup on low flame

↓

Add liquid glucose

↓

Add citric acid & pectin

↓

Add pulp to syrup mix

↓

Add KMS to mixed pulp

↓

Stir it well using electrical mixer

↓

Spread in stainless steel trays

↓

Dry in solar dryer

(Layer upon layer for 3 days)
Product specifications
Moisture 11-12%

Yield
Finished Mango bar 40%

Salient features
No. Of sunny hours for each layer 8-10 hours
Cabinet temp 40-65º C

Cost Economics (one batch load)
Raw material weight 38kg
(Mango pulp, sugar, pectin, citric, acid etc)
Cost of Raw material & Rs.1, 200/-
Other Expenses Per Load
Mango Bar Yield / Out Put 17Kg
Sale Price Per Kg Rs.110/-
Sale Price Per 17 kg Rs.1870/-
Net Profit Per Load 17 Kg Rs.670/-
Number Batches Per Annum 70
Net Profit Per Annum Rs.46, 900/-

B). PROCESSING ALPHONSO MANGO BAR

Introduction:
Alphonso fruit has characteristic and delicate flavour among mango fruits. The production of the Alphonso fruit is mostly seen in Maharastra State. The fruit pulp is commercially available to make use into different products & forms.

Processing of Alphonso Mango Fruit Bar
Composition of Alphonso Mango Fruit pulp mix for one layer

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alphonso Pulp (Kg)</td>
<td>5.58</td>
</tr>
<tr>
<td>Thothapuri Mango Pulp (kg)</td>
<td>3.72</td>
</tr>
<tr>
<td>Sugar +glucose (kg)</td>
<td>3.60</td>
</tr>
<tr>
<td>Citric acid (g)</td>
<td>18.0</td>
</tr>
<tr>
<td>Pectin (g)</td>
<td>9.0</td>
</tr>
<tr>
<td>Potassium Meta Bi sulphite (g)</td>
<td>15.0</td>
</tr>
</tbody>
</table>
Steps followed are given below:

♥ Canned mango pulp from Alphonso and Thotapuri is best suited for making Alphonso fruit bar. Alternatively well ripe Alphonso mango fruit can be used after making the pulp in a food processor after sieving to make fibre free.

♥ Prepare Sugar syrup by adding 400ml of water & add glucose

♥ Add Citric acid & Pectin

♥ Cool the syrup & mix the fruit pulps

♥ Add potassium Meta bi sulphite.

♥ Using electrical hand mixer & blend the pulp mix thoroughly

♥ Pour 900ml of fruit pulp mix in Stainless steel trays & spread evenly

♥ Carefully load the trays in solar dryer for drying to make the first layer (Day 1), (at 40°-60° C)

♥ Repeat the above procedure on the second day & spread the mix on the dried up first layer to make the second layer (Day 2)

♥ Repeat the above procedure on the third day by spreading the mix on the dried up second layer to make the third layer (Day 3)

♥ After the third layer is well set & dried to 1/2 to 1/3 thickness, cut into bars or small slabs of 3”x 4” size / 100g / 150g / toffees of required size.

♥ Pack polythene sachets & seal air tight

**Flow Diagram**

Prepare Sugar Syrup on the flame

- Add liquid glucose
  - Add citric acid & pectin
    - Mix Alphorns & Thothapuri pulps to syrup mix
      - Add KMS to pulp mix
Stir it well using electrical hand mixer

Spread on stainless steel trays

Dry in solar dryer
(Layer upon layer)

**Product specifications**
Moisture 11-12%

**Yield**
Finished Mango bar 40%

**Drying Time & Temperature**
No. Of sunny hours for each layer 8-10 hours
Cabinet temp 40-65°C

**Cost Economics (one batch load)**
Raw material weight 38kg
(Alphonso pulp, Mango pulp, sugar, pectin, citric acid etc)
Cost of Raw material & Other Expenses Rs.1,570
Alphonso Bar Yield /Out Put 17Kg
Sale Price Per Kg Rs.140/-
Sale price Per 17 kg Rs.2380/-
Profit Per Load -17 Kg Rs.810/-
Number of Batches per Annum 70
Net Profit Per Annum Rs.56,700/-

**C). GUAVA MANGO FRUIT BAR (SANDWICH)**

**Introduction**
Guava is commercial fruit & seen throughout the year. It is a delicious fruit with excellent flavour the production of guava fruit is large after mango & is grown in many states in the country. The fruits are available at moderate price and mostly consumed in fresh form. The fruit has good nutritional values & especially rich in vitamin C (150-450 mg) and fiber (2-7%). The fruit is very high in pectin content (0.5-1.8%). & acid content (0.4%).

The fruit after plucking on maturity ripens very fast As a result post harvest losses are considerable. This fruit is used to limited extent in the food processing industry. Great potentiality for processing into value added products.
To a small extent guava fruits are used & preserved in the form of pulp /, puree, cheese, Jam, Toffee, Fruit flakes, squash, syrup, nectar, concentrate,
powder, wine, vinegar & ready to use snacks, drinks dehydrated canned products. Significant loss of vitamin C occurs on processing & storage.

Guava sandwich fruit bar has been standardized at SEED recently. The process details are given below.

**Method**

The steps followed are shown in the flow diagram for making **Guava pulp**

Select fully ripe fresh guava fruits

↓

Washing & thorough cleaning using water

↓

Removing stalks using stainless steel peeler

↓

Cutting into slices & Blanch in hot water at 85°C for 15 min

↓

Separating seeds using sieve

↓

Making fine pulp

↓

Sieving using stainless steel mesh sieve to separate fibers

↓

Packing in polypropylene pouches & storing in deep freezer until use.

**Composition of Guava Fruit Sandwich Bar Per Batch**

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Top Layer</th>
<th>Center Layer</th>
<th>Bottom Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guava pulp (kg)</td>
<td>-----</td>
<td>9.30</td>
<td>-----</td>
</tr>
<tr>
<td>Thothapuri Pulp (kg)</td>
<td>9.30</td>
<td>-----</td>
<td>9.30</td>
</tr>
<tr>
<td>Sugar + Glucose (kg)</td>
<td>3.60</td>
<td>3.60</td>
<td>3.60</td>
</tr>
<tr>
<td>Citric acid (g)</td>
<td>18.0</td>
<td>18.0</td>
<td>18.0</td>
</tr>
<tr>
<td>Pectin (g)</td>
<td>9.0</td>
<td>9.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Potassium Meta Bi sulphite (g)</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
</tr>
</tbody>
</table>
Method Of Making Guava Fruit Bar Sandwich:
Steps followed are given below:

**Bottom Layer**
♥ Weigh Thothapuri fruit pulp
♥ Prepare sugar syrup
♥ Add citric acid & Pectin.
♥ Cool the syrup & mix the fruit pulp
♥ Add potassium meta bi sulphite & stir well using electrical hand mixer
♥ Pour 900ml of mixed fruit pulp in stainless steel trays & spread evenly
♥ Carefully load the trays in Solar dryer for drying to make the first layer (Day 1) (40-60°C)

**Center Layer**
Weigh Guava fruit pulp
♥ Prepare sugar syrup
♥ Add citric acid & Pectin.
♥ Cool the syrup & mix guava fruit pulp
♥ Add potassium meta bi sulphite & stir well using electrical hand mixer
♥ Pour 900ml of fruit pulp mix in stainless steel trays & spread evenly
♥ Carefully load the trays in Solar dryer for drying to make the first layer (Day 2) (40-60°C)

**Top Layer**
♥ Weigh Thothapuri fruit pulp
♥ Prepare sugar syrup
♥ Add citric acid & Pectin.
♥ Cool the syrup & mix Thotapuri fruit pulp
♥ Add potassium meta bi sulphite & stir well using electrical hand mixer
♥ Pour 900ml of mixed fruit pulp in stainless steel trays & spread evenly
♥ Carefully load the trays in Solar dryer for drying to make the first layer (Day 3) (40-60°C)
♥ The third layer is well-dried cut into bars or small slabs of 3”x 4” size 100g / 150g / toffees of required size.
♥ Pack in polythene sachets & seal airtight
**Flow Diagram**

Prepare Sugar Syrup on low flame

↓

Add liquid glucose

↓

Add citric acid & pectin

↓

Add Thothapuri pulp to syrup mix

↓

Add KMS to mixed pulp

↓

Stir well using electrical hand mixer

↓

Spread in stainless steel trays

↓

Dry in solar dryer (First day for Bottom layer)

↓

Repeat the same procedure using guava fruit pulp
  (Second day for the Center layer)

↓

Repeat the same procedure using Thothapuri fruit pulp
  (Third day for the top layer)

**Product specifications**

Moisture 11-12%

**Yield**

Finished Mango bar 40%

**Salient features**

<table>
<thead>
<tr>
<th>No. of sunny hours for each layer</th>
<th>8-10 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabinet temp</td>
<td>40-65º C</td>
</tr>
</tbody>
</table>

**Cost Economics (one batch load)**

Raw material weight: 38kg

(Mango pulp, sugar, pectin, citric, acid etc)

Cost of Raw material & Other Expenses Per Load: Rs.1,200/-

Mango Bar Yield / Out Put: 17Kg

Sale Price Per Kg: Rs.110/-
D). MIXED FRUIT BAR – COMPOSITION & PROCESS

Mango mixed fruit bars in combination with different were developed at, SEED, Hyderabad. Fruit bars were processed with varying proportions of fruit pulps of Thotapuri, Guava, Sapota & pineapple juice. Soft seed variety of Guava fruits, Kalipatti variety of Sapota fruits & locally available big size pineapples are best for making pulp.

The details of making fruit pulps & fruit bars are given here under fruit pulps were processed

Thotapuri pulp: Commercially Available Canned Pulp

Making Guava fruit Pulp:
Process details are already indicated in under Guava Mango (Sandwich) Bar. Commercially Guava Pulp is available.

Making Sapota fruit pulp:
Sapota fruits are available through out the year & are grown mostly in hot climates. The fruit is very delicate with characteristic flavour and is mostly consumed in fresh form. There are many nutrients in the fruit & is considered to possess anti oxidant & anti carcinogenic factors. The fruit has high moisture on ripening & spoils easily. By bacterial rotting. Even under cold conditions the shelf life is short. Industrial processing of the fruit is not common. At SEED, Hyderabad recently the fruits have been used to prepare pulp to make mixed fruit bars.

The steps followed are shown in the flow diagram

Select fully ripe fresh fruits (Kalapatti or Local Pala Sapota variety) ↓
Wash thoroughly in clean water ↓
Remove stalks and peel using stainless steel peeler ↓
Cutting into slices & separate seeds ↓
Make fine pulp using food processor ↓
Sieve using stainless steel mesh sieve to get finer pulp
↓
Pack in polypropylene pouches/ containers
↓
Store in deep freezer until use

**Pineapple:**

**Introduction:** Pineapple fruit is most liked & grown in many humid coastal areas. The fruit is valued for its flavour & taste. Fresh fruit is used for juice extraction. Besides peeled & sliced fruit is used in many ways - in the preparation of squash, canned fruit, fruit salads, fruit yoghurt, deserts, puddings, cakes, in cookery, fruit toffees, cheese cakes etc. Today 90% of the fruit is available in the market in canned form. & Squash.

**Making Pineapple Juice:**

The steps followed are shown in the flow chart

Select fully ripe good quality pineapple fruits
↓
Wash thoroughly in clean water
↓
Scrape peel & cut into round sections / slices & remove eyes & core using stainless steel knife
↓
Steam blanch the fruit slices for 15min & cool
↓
Crush the fruit using Food Processor to extract juice
↓
Filter through a stainless steel sieve to separate fibers
↓
Pack the juice in plastic containers
↓
Store in deep freezer until use
Making mixed fruit bar:
The proportions of ingredients used are shown in the following table

**Composition Of Mixed Fruit Bar For Layer**

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thothapuri Pulp (kg)</td>
<td>3.72</td>
</tr>
<tr>
<td>Guava pulp (kg)</td>
<td>1.86</td>
</tr>
<tr>
<td>Sapota pulp (kg)</td>
<td>1.86</td>
</tr>
<tr>
<td>Pineapple juice (kg)</td>
<td>1.86</td>
</tr>
<tr>
<td>Sugar+ Glucose (kg)</td>
<td>3.600</td>
</tr>
<tr>
<td>Citric acid (g)</td>
<td>18g</td>
</tr>
<tr>
<td>Pectin (g)</td>
<td>9g</td>
</tr>
<tr>
<td>Potassium Meta Bi sulphite (g)</td>
<td>15g</td>
</tr>
</tbody>
</table>

**Method**

♥ Weigh different fruit pulps separately

♥ Prepare Sugar syrup & add citric acid & pectin

♥ Cool the syrup & mix the fruit pulps

♥ Add potassium meta bi sulphite

♥ Pour 900ml of mixed fruit pulp in stainless steel trays & spread evenly

♥ Carefully load the trays in Solar dryer for drying to make the first layer (Day 1) (40-65 °C).

♥ Repeat the above procedure on the second day & spread the mix on the dried up dried up first layer to make the second layer (Day 2) (40-65 °C)

♥ Repeat the above procedure on the third day by spreading the mix on the dried up second layer to make the third layer (Day 3) (40-65 °C)

♥ After the third layer is well set & dried cut into bars or small slabs of 3”x 4” size 100g /150g / toffees of required size.

♥ Pack in polythene sachets & seal airtight
Product Specifications

Moisture 11-12%

Yield
Finished Mango bar 40%

Drying Time & Temperature:
No. of sunny hours for each layer 8-10hours
Cabinet temp 40-65º C

Cost Economics (one load)
Raw materials Per load 38kgs
Cost of Raw material per load & Rs.1,050/-
Other Expenses
Mixed Fruit Bar yield / Out put 17Kg
Sale price per Kg Rs.110/-
Sale price per 17kg Rs.1870/-
Profit per load 17kg Rs.820/-
Number of Batches Per Annum 70
Net Profit Per Annum Rs. 57,400/-

EQUIPMENT & TOOLS NECESSARY FOR MAKING FRUIT BARS
- Solar Dryer SDM 50
- Food Processor
- Heat, sealing machine
- Electrical hand mixer
- Stainless steel vessels, ladles, spoons
- Stainless steel strainer
- Cutting knife & other accessories
- Gas stove and gas cylinder

Source of availability of solar dryers
Society for Energy, Environment & Development,
Plot no.30, Road No.5, Jubilee hills society, Hyderabad-500 033

Source of availability of other Tools Accessories
Local market / Home Appliances shops.

E) GINGER POWDER
The ginger is first soaked in water overnight. Then they are thoroughly washed in water. After thoroughly cleaning, the outer skin is removed carefully with a split of bamboo knife/wooden scrapers to preserve the pleasing aroma in dried ginger. The scraped ginger is cut into pieces and spread in a tray at a rate of 5g/sqm in solar dryer. This process can be
continued for 2 sunny days (16 hrs) in a solar dryer. The dried ginger is again ground into powder form and is well packed in a suitable DPE pouches.

The initial moisture content of ginger was about 80.9% and the final moisture content should be 4% or less. The yield of dry ginger should be 16-25% of wet weight.

**F) GREEN LEAFY VEGETABLES**

**Curry Leaves**

Process: The matured curry leaves are taken out from the stem and washed. The washed curry leaves are blanched with magnesium oxide 0.1% for 1 minute at 90°C and spread in a tray at a rate of 6 kg/sqm. After drying for 8 hours the leaves are ground into powder and packed in a DPE pouches.

**Carrot**

One of the vegetable products dried in Solar Dryer is Carrot in the form of cubes and shreds. The initial moisture content of Carrot was 86.0% and the final moisture content should be less then 4% for preservation and long shelf life. (Total yield is 15-18 percent of original weight).

Process – Generally large Carrots, high in solids but free from woody fiber carrots should be selected for dehydration. Clean/wash them, peel and slice into pieces or shreds. The sliced pieces are then blanched in 2% salt solution for 15 minutes. The blanched Carrots are then dried in trays in solar dryer. The time taken to reach 4% moisture content is 10-12 hours on good sunny day (1-11 days). After removing from the dryer, the dehydrated Carrots are packed and sealed in high-density polyethylene pouches.

**G). DESICCATED COCONUT POWDER**

Coconuts are available throughout the year in coconut growing coastal areas. But it is an expensive affair to export fresh nuts to distant areas. For this reason it is processed to various forms as dry coconut (copra), desiccated powder, and the water is also preserved. Oil is extracted is used both for cosmetic & cooking purposes. Desiccated powder is obtained by drying ground or shredded coconut kernel after the removal of brown test. It finds extensive use in confectioneries & in many other food preparations as a substitute for fresh coconut. In many coconut-growing states the desiccated is manufactured by many small scale units. There consumer demand for desiccated powder in consumer packs for household uses.
The Process:

Select fresh matured coconut (12 months old) and de husk and de shell. Sort to remove immature, germinated, rotten & spoilt nuts after breaking to two halves / cups the coconut meat / kernel is to be separated. The outer brown test / rind of the nuts is removed by shaving knives. Wash the pared of kernel in fresh water to remove invert sugars. Cut into small pieces (1 cm cubes). The parings are used for oil recovery. The pared kernels are sliced & dipped in water weighed. The slices are steam blanched for 20 minutes. The coconut pieces are to be crushed & disintegrated into small bits in a food processor. The gratings are to be spread on a muslin cloth over mesh tray to a depth of 6 mm and dry them in dryer. Periodically turn the product for uniform drying. The dried gratings are graded to obtain coarse & fine desiccated powder. The moisture is to be reduced from 45-52 % to 2.-3%. On an average 100 coconuts yield about 6 kg desiccated coconut powder.

Ingredients:

- Fully Matured Fresh Coconuts (12 months old) – 72 no (medium)
- Potassium Meta bi sulphite 3g / kg pieces
- Water 1 liter

Process details are shown in flow diagram

Method

Select fully, mature coconuts of one year old.
↓
Break into halves & separate water.
↓
Place in clean water.
↓
Remove the shell & again keep in water
↓
Pare the brown test & keep in water
↓
Cut into 3mm size pieces & place in water
↓
Wash meat thoroughly 2-3 times in water to remove surface milk
↓
Steam the coconut pieces in a steam / pressure cooker for 25 mts
Quickly cool the pieces by placing in ice cold water

Dip pieces in water containing potassium meta bi sulphite (3g / L)

Grind finely to powder in a food processor

Spread over a muslin cloth in a tray & load in solar dryer.

Dry for 3- 4hours & grade by sieving using 16 & 18 mesh sieves for fine & coarse powder

Pack in suitable poly ethylene pouches of 50g / 100g capacity

**Product specifications**

<table>
<thead>
<tr>
<th>Moisture</th>
<th>2-3%</th>
</tr>
</thead>
</table>

**Yield**

<table>
<thead>
<tr>
<th>Finished Product (72 Coconuts)</th>
<th>6kg (45-50%)</th>
</tr>
</thead>
</table>

**Drying Time & Temperature**

<table>
<thead>
<tr>
<th>No. of sunny hours</th>
<th>4-4.5 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabinet temp</td>
<td>40-65º C</td>
</tr>
</tbody>
</table>

**Cost Economics (one batch load)**

<table>
<thead>
<tr>
<th>Number of coconuts</th>
<th>72 no</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material weight</td>
<td>12kg</td>
</tr>
<tr>
<td>Cost of Raw material &amp;</td>
<td>Rs.216/- (Rs3 / Coconut)</td>
</tr>
<tr>
<td>Other Expenses per load</td>
<td>Rs 50/-</td>
</tr>
<tr>
<td>Sale price per Kg</td>
<td>Rs.75/-</td>
</tr>
<tr>
<td>Sale price per 6 kg</td>
<td>Rs 450/-</td>
</tr>
<tr>
<td>Profit Per Load</td>
<td>Rs.184/-</td>
</tr>
<tr>
<td>Number Of Batches Per Annum</td>
<td>400</td>
</tr>
<tr>
<td>Net Profit Per Annum</td>
<td>Rs.73, 600/-</td>
</tr>
</tbody>
</table>

**Equipment / Machinery**

<table>
<thead>
<tr>
<th>Solar Dryer SDM 50</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless steel vessels</td>
<td>4big</td>
</tr>
<tr>
<td>Paring Knife</td>
<td>2 no</td>
</tr>
<tr>
<td>Cutting Knife</td>
<td>2 no</td>
</tr>
<tr>
<td>Food Processor</td>
<td>1 no</td>
</tr>
<tr>
<td>Steam cooker / pressure cooker</td>
<td>1 no</td>
</tr>
<tr>
<td>Stainless steel Strainer</td>
<td>1 no</td>
</tr>
</tbody>
</table>
Muslin Cloth 1 meter
Storage Bins 2no
Heat sealing Machine 1no
Stainless steel vessels, ladles, spoons, sieves, 2no each
Gas stove and gas cylinder 1each

Sources of availability of machinery
For solar dryers
Society for Energy, Environment & Development,
Plot no.30, Road No.5, Jubilee hills society, Hyderabad-500 033

For other tools and accessories: Local market - Home Appliances shops

QUALITY PRODUCT

The pilot production of mango bar/jelly in the solar dryer has given an excellent quality product. It is not hygienically processed but also saved of drying time over open sun drying.

Sensory evaluation tests were conducted at P.G. Centre of Home Science, Acharya N.G. Ranga Agricultural University, and Hyderabad on three samples including our sample from different processing methods.

Sensory Evaluation of Mango Bar Samples

<table>
<thead>
<tr>
<th>Samples of Mango Bars</th>
<th>Colour</th>
<th>Appearance</th>
<th>Texture</th>
<th>Taste</th>
<th>Flavour</th>
<th>Overall Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Open sun drying</td>
<td>2.42</td>
<td>2.75</td>
<td>4.00</td>
<td>4.67</td>
<td>3.25</td>
<td>3.17</td>
</tr>
<tr>
<td>3. Electrical Tunnel drying</td>
<td>4.42</td>
<td>4.25</td>
<td>4.5</td>
<td>4.42</td>
<td>3.17</td>
<td>3.84</td>
</tr>
</tbody>
</table>

It is seen from table that solar dried sample is superior one and got highest score for overall acceptability.
11. PROJECT FOR SELF-EMPLOYMENT

The Solar powered Air Dryer is the best suited system for rural employment particularly for women & unemployed youth. The economic viability of utilizing these dryers as a small scale unit is presented here.

ECONOMICS OF PROCESSING IN SOLAR DRYER:

Food processing using solar dryer will certainly yield best results & give good returns in the first year itself. The economics of processing Sapota slices, powder and bar are worked out after thorough research. The cost & working economics of the project based on the pilot plant production data, current prices of raw material & its availability are cited here. These justify the profitability of the venture.

ECONOMIC VIABILITY

<table>
<thead>
<tr>
<th></th>
<th>For Single Dryer Of SDM-50</th>
<th>For four Dryers Of SDM-50</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>For Dryers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>Rs70,000/-</td>
<td>Rs2,80,000</td>
</tr>
<tr>
<td>Packing &amp; Forwarding</td>
<td>Rs.5,000/-</td>
<td>Rs.20,000/-</td>
</tr>
<tr>
<td>Transportation</td>
<td>Actual cost can be charged</td>
<td>Rs.20,000/-</td>
</tr>
<tr>
<td>Tools &amp; Accessories</td>
<td>Rs.15,000/-</td>
<td>Rs.35,000/-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>Rs.3,55,000/-</strong></td>
</tr>
<tr>
<td><strong>For Working Capital</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Towards Raw Material</td>
<td>Rs.1200/-Per Batch</td>
<td>Rs.96,000/-</td>
</tr>
<tr>
<td>Finished product Stock</td>
<td>Rs.10,000/- (125kg)</td>
<td>Rs.40,000/- (500kg)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>Rs.1,36,000/-</strong></td>
</tr>
</tbody>
</table>
Investment

Cost of Capital Equipment          Rs.3,55,000/-
25% grant from MFPI/KVIB           Rs.  88,750/-

Rs.2,66,250/-

25% User Share                     Rs.  66,562/-
75% Bank Loan                      Rs.1, 99,688/-

Say Rs.2, 00,000/-

Interest

@12% for capital equipment on Bank Loan of Rs.2,00,000/-  Rs.24,000/-
Interest on working capital @ 15% Rs.1,36,000/- for 3months  Rs.20,400/-

Rs.44,400/-

Total Expenditure

Interest on borrowed capital       Rs.  45,000/-
Manpower cost @15/-per kg (5.0tones)    Rs.  75,000/-
Other overheads                    Rs.  50,000/-
Raw material cost                  Rs 2,75,000/-

Say Rs. 4,45,000/-

Total Revenue on sales @120/-perkg for 5.0 tons  Rs.6,00,000/-
Profit = 6,00,000-4,45,000/- =1,55,000/-
Entrepreneur can retain 5000/- month         Rs 60,000/-
& Balance amount can be paid towards bank loan  Rs.95,000/-

Repayment period                  2,00,000

95,000
= 2years
12. ECONOMIC VIABILITY OF FOOD PROCESSING THROUGH SOLAR DRYERS

It is very essential that the cultivator should concentrate on the agricultural activity and send the products as raw material and food material to the cities and towns. It is more essential that village industries are encouraged so that that semi-finished products in certain areas and finished products in some other areas can also be exported to the cities on one side and quality control even to the other counties as well. If we accept this line of thinking, certain questions do crop up. Some of them are –

1. What sort of tools is needed to start village industries?
2. Which raw material can be processed at that level?
3. How to train the people who have to involve in such activities?
4. How to market the products?
5. How to get the energy? Which even today is scare in rural areas and the cost is exorbitant if the power is the energy to be used?

Let us find answers to these questions:

1. The tools to be used should be sturdy, easy to be operated and should last longer. It should be possible to repair the tools then and there.
2. The raw material used should be that which should not get spoiled either in transit or by retention for a reasonable period.
3. The processing should be simple which a common villager can understand.
4. The village development organisation and the Government should come forward to establish distribution agencies.
5. One cannot afford to use power as energy but prefer solar energy both from the cost factor and availability factor.

The best answer for this is the Solar Dryer. It would be shocking to learn that nearly 30% to 40% of the fruits and vegetables grown in rural areas get spoiled either due to lack of transport, lack of storage facilities or abundance of production. If only the excess can be stored and processed properly there is an automatic activity and employment at the village level and excellent returns as well. Let us see the economics of it.
PROCESSING OF MANGO JELLY

FIXED CAPITAL:  
- a) Solar Dryer of 50 Kgs capacity  
  Amount (Rs.) 75,000.00 
- b) Equipment & Office set up  
  Amount (Rs.) 15,000.00 
- Total  
  Amount (Rs.) 90,000.00 

COST OF RAW MATERIAL 
COST OF MANGOPULP PER KG.  
Rs. 23/- per kg

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Qnty/batch kgs</th>
<th>Price/kg.</th>
<th>Amount (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mango Pulp</td>
<td>28.00</td>
<td>23.00</td>
<td>644.00</td>
</tr>
<tr>
<td>Sugar</td>
<td>12.00</td>
<td>16.00</td>
<td>192.00</td>
</tr>
<tr>
<td>Liquid Glucose</td>
<td>0.60</td>
<td>17.00</td>
<td>10.20</td>
</tr>
<tr>
<td>Citric Acid</td>
<td>0.054</td>
<td>90.00</td>
<td>4.90</td>
</tr>
<tr>
<td>KMS</td>
<td>0.045</td>
<td>70.00</td>
<td>3.20</td>
</tr>
<tr>
<td>Pectin</td>
<td>0.027</td>
<td>850.00</td>
<td>23.00</td>
</tr>
<tr>
<td><strong>Cost per Batch</strong></td>
<td><strong>41.86</strong></td>
<td></td>
<td><strong>877.30</strong></td>
</tr>
</tbody>
</table>

Note: 
1. Yield per batch  
2. Time per batch 3 days (21 hours) 
3. No. of Batches in A MONTH  
4. Monthly production 200 Kgs 
5. Annual Production 2000 kgs 
6. Cost of RM Per Kg. Rs. 44.00 

FIXED EXPENDITURE 
- a) Salaries & Wages 
  1 unskilled labour @ Rs. 1000/- month x12 months  12,000.00 
- b) Rent @s. 1000/- per month 12,000.00 
- c) Electricity & Maintenance 1,800.00 
- **TOTAL** 25,800.00 

VARIABLE EXPENSES 
- a) Raw materials (RM) 87,730.00 
- b) Packing 40,000.00 
- **TOTAL** 1,27,730.00
ANNUAL WORKING CAPITAL
a) Raw materials 87,730.00
b) Fixed Expenses 25,800.00
c) Packing etc. 40,000.00
TOTAL 1,53,530.00

Working Capital per month = Rs. 12,800.00
Say = Rs. 13,000.00

TOTAL INVESTMENT
Fixed Capital 90,000.00
Working capital – 2 months 26,000.00
TOTAL 1,16,000.00

SOURCES OF FINANCE
a) Promoter contribution – 20% 23,200.00
b) Bank loan – 30% 34,000.00
c) MNES Subsidy – 50% 58,000.00
TOTAL 1,16,000.00

COST OF ANNUAL PRODUCTION
a) Working Capital 1,53,530.00
b) Interest on Bank loan @ 12% 4,200.00
c) Depreciation @ 10% 9,000.00
Total 1,66,730.00

SALES
a) Annual Sales 2,000 kgs x Rs. 105/- kg. 2,10,000.00

PROFIT
Profit = Sales – Annual Production Cost
Rs. 2,10,000.00 – Rs. 1,66,730.00 = Rs. 43,270.00

PROFIT RATIO
Profit Ratio = Rs. 43,270 / Rs. 1,16,000 x 100 = 37.4%

Marketing expenses may reduce the profit.
PROCESSING OF TOMATO, GINGER & CURRY LEAVE

FIXED CAPITAL

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Solar Dryer of 50 Kgs. Capacity</td>
<td>75,000.00</td>
</tr>
<tr>
<td>b) Equipment &amp; Office set up</td>
<td>15,000.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>90,000.00</td>
</tr>
</tbody>
</table>

COST OF RAW MATERIAL

a) Tomato (4 months production)

- Yield of dry powder: 4 Kgs
- Drying time: 2 Days
- No. of batches in a month: 15
- Raw materials for 4 months: 900 kgs.
- Dried tomato powder for 4 months: 240 Kgs.

Raw materials @ Rs. 4 Kg.: Rs. 3,600/-

Sale of dry powder at Rs. 120/- kg. X 240 kgs: Rs. 28,800.00

b) Ginger (4 months production)

- Ginger loading in 50 Kgs. Solar Dryer: 15 Kgs. wet
- Yield of dry powder: 3 Kgs
- Drying time: 2 Days
- No. of batches in a month: 15
- Raw materials for 4 months: 900 kgs.
- Dried tomato powder for 4 months: 100 Kgs.

Raw materials @ Rs.12 kg.: Rs. 10,800/-

Sale of dry powder at Rs. 162/- kg x 180 kgs: Rs. 29,700/-

c) Curry Leafy Product

CURRYLEAFY POWDER (4 MONTHS PRODUCTION)

- Curry Leafy loading in 50 Kgs. Solar Dryer: 15 Kgs. wet
- Yield of dry powder: 5 Kgs
- Drying time: 1 Days
- No. of batches in a month: 25
Raw materials for 4 months 1500 kgs.
Dried tomato powder for 4 months 240 Kgs.

Raw materials @ Rs. 8/- Kg. Rs. 12,000/-

Sale of dry powder at Rs. 115/- kg. X 500 kgs Rs. 57,500.00

**FIXED EXPENDITURE**
a) Salaries & Wages 1 Unskilled labour @ Rs. 1000/- per month x 12 months Rs. 12,000.00
b) Rent @ Rs. 1,000/- per month Rs. 12,000.00
c) Electricity & Maintenance Rs. 1,800.00
   Total Rs. 25,800.00

**VARIABLE EXPENSES**
a) Raw materials Rs. 26,400.00
b) Packing Rs. 18,400.00
   Total Rs. 44,800.00

**ANNUAL WORKING CAPITAL**
a) Raw material Rs. 26,400.00
b) Fixed Expenses Rs. 25,800.00
c) Packing etc Rs. 18,400.00
   Total Rs. 70,600.00

**TOTAL INVESTMENT**
Fixed Capital Rs. 90,000.00
Working Capital – 2 months Rs. 11,800.00
   Total Rs. 1,01,800.00

**SOURCES OF FINANCE**
a) Promoter contribution 20% Rs. 20,360.00
b) Bank Loan – 30% Rs. 30,540.00
c) MNES Subsidy – 30% Rs. 1,01,800.00

**COST OF ANNUAL PRODUCTION**
a) Working Capital 70,600.00
b) Interest on Bank loan @ 12% 4,200.00
c) Depreciation @ 10% 9,000.00
Total 83,800.00

SALES
a) Annual Sales of 3 products 1,13,500.00

PROFIT
Profit = Sales – Annual Production Cost

Rs. 1,13,500/- - Rs. 83,800.00 = Rs. 29,700.00

PROFIT RATIO
Profit Ratio = Rs. 29,700/Rs. 1,01,800 x 100 = 29.1%

Marketing expenses may reduce the profit.
ANNEXURE I

LAYOUT DETAILS SOLAR DRYER – SDM

1. It is advisable to install the dryer on the terrace of building.

2. The proposed system is to be installed in open space and there should not be any shadow, nearby, falling on the dryers between 8.00 am to 4.00 p.m

3. In case, it is to be installed on the ground the space requirement for single SDM-50 dryer is 10’ L (East to West) x 11’ W (North to South) x 12’ H Platform.

4. The dryer should be mounted on a clean platform on cemented or stone flooring to avoid dust. A ramp is to be provided for the movement of the dryer.

5. The dryers are to be oriented towards South in Open Space.

6. The dryer should be covered with canvas cover when not in use.

7. The dryer is supplied with castor wheels with locking system to avoid movement when in use and the necessary precautions are to be taken to protect from high-speed wind or gale. While in operation it is to be oriented to south only.

8. The glass sealing provided with EPDM beading will ensure the cabinet from rainwater seepage and other contaminants.

9. Electrical connection points of 220 V AC is to be provided on to the platform to plug in 3 electrical heaters of 1.2 K.W capacity each, with proper earthing. When electrical heater is operated, it should be protected from rain to avoid short circuit. Then it must be kept under roof and guarded from rain.

10. Day to day cleaning of glass is important for good results. To keep the cabinet warm inside, it is better to cover the glass of dryer in nights to avoid condensation during nights.

11. Small and short ornamental pots can be placed along the fence to keep away the dirt and dust and to beautify the environment.

12. Illustration of plan in enclosed general guidance for platform construction.
## ANNEXURE-II
### EQUIPMENT & TOOLS REQUIRED FOR SETTING A FOOD PROCESSING UNIT

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>DESCRIPTION</th>
<th>QUANTITY IN NOS.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STAINLESS STEEL WARE:</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>SS Vessels 9Big – 2Kgs) with lids</td>
<td>2 sets</td>
</tr>
<tr>
<td>2.</td>
<td>SS Vessels (Medium-8 Kgs) with lids</td>
<td>2 sets</td>
</tr>
<tr>
<td>3.</td>
<td>SS Vessels (Small – 4 kgs) with lids</td>
<td>2 sets</td>
</tr>
<tr>
<td>4.</td>
<td>SS Measuring Jug (1 litre)</td>
<td>2 sets</td>
</tr>
<tr>
<td>5.</td>
<td>SS Strainer (Big)</td>
<td>1 No.</td>
</tr>
<tr>
<td>6.</td>
<td>SS Spoons</td>
<td>6 Nos.</td>
</tr>
<tr>
<td>7.</td>
<td>SS Serving spoons</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>8.</td>
<td>SS Flat spoon</td>
<td>1 No.</td>
</tr>
<tr>
<td>9.</td>
<td>SS Coconut scraper (Big)</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>10.</td>
<td>SS Perforated ladle</td>
<td>1 No.</td>
</tr>
<tr>
<td>11.</td>
<td>SS Perforated Vessel plate (Medium)</td>
<td>1 No.</td>
</tr>
<tr>
<td>12.</td>
<td>SS Coffee Vessels</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>13.</td>
<td>SS SCISSORS (Medium)</td>
<td>1 pair</td>
</tr>
<tr>
<td>14.</td>
<td>Steel can opener</td>
<td>1 No.</td>
</tr>
<tr>
<td>15.</td>
<td>Vegetable cutting knife</td>
<td>1 No.</td>
</tr>
<tr>
<td>16.</td>
<td>Vegetable cutting raw edge knife</td>
<td>1 No.</td>
</tr>
<tr>
<td></td>
<td>PLASTIC WARE</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Hand Gloves</td>
<td>12 pairs</td>
</tr>
<tr>
<td>2.</td>
<td>Cutting board</td>
<td>1 No.</td>
</tr>
<tr>
<td>3.</td>
<td>Bucket</td>
<td>1 No.</td>
</tr>
<tr>
<td>4.</td>
<td>Mug</td>
<td>1 No.</td>
</tr>
<tr>
<td>5.</td>
<td>Plastic trays for keeping vegetables</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>6.</td>
<td>Plastic dust bin</td>
<td>1 No.</td>
</tr>
<tr>
<td>7.</td>
<td>Shower cap</td>
<td>12 pairs</td>
</tr>
<tr>
<td></td>
<td>ELECTRICAL WARE</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Electrical hand beater</td>
<td>1 No.</td>
</tr>
<tr>
<td>2.</td>
<td>Heavy duty mixer/food processor</td>
<td>1 No.</td>
</tr>
<tr>
<td>3.</td>
<td>Electrical Sealing machine</td>
<td>1 No.</td>
</tr>
<tr>
<td></td>
<td>CLOTH WARE</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Kitchen towels</td>
<td>6 Nos.</td>
</tr>
<tr>
<td>2.</td>
<td>Napkin</td>
<td>6 Nos.</td>
</tr>
<tr>
<td>3.</td>
<td>Aprons</td>
<td>4 Nos.</td>
</tr>
<tr>
<td>4.</td>
<td>Dusters</td>
<td>6 Nos.</td>
</tr>
<tr>
<td>5.</td>
<td>Muslin cloth</td>
<td>8 meters.</td>
</tr>
<tr>
<td></td>
<td>GLASS WARE</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Mercury Thermometer (0-100 Deg.C)</td>
<td>2 Nos.</td>
</tr>
<tr>
<td></td>
<td>CHEMICAL &amp; PRESERVATIVES</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Citric Acid</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Potassium Meta bi Sulphite</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Liquid Glucose</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Pectin</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Magnesium oxide</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Sodium benzoate</td>
<td></td>
</tr>
</tbody>
</table>
## ANNEXURE III

### INSPECTION AND TESTING CRITERIA FOR SOLAR DRIER SDM-50 OF SEED

<table>
<thead>
<tr>
<th>S L</th>
<th>CRITERIA</th>
<th>SPECIFICATION</th>
<th>TEST</th>
<th>METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Physical appearance</td>
<td>All Parts in proper shape and good condition. Proper paint/plating</td>
<td>No damage, no dents, no chipping of paint/plating</td>
<td>Visual</td>
</tr>
<tr>
<td>2</td>
<td>Assembly of parts</td>
<td>1) All nuts/bolts/screws/rivets fitted properly aligned.</td>
<td>1) No screw to be fitted misaligned. No rivet/nut/bolt loose.</td>
<td>Visual</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Smooth edges of parts.</td>
<td>2) No sharp edges or burrs.</td>
<td>Visual</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) Smooth and even welding.</td>
<td>3) No welding spatters or un-even joints.</td>
<td>Visual</td>
</tr>
<tr>
<td>3</td>
<td>Features</td>
<td>1) Max. cabinet temp. 65 degree C on clear sunny day.</td>
<td>1) At max setting, temp to be within 58-72 degree C on clear sunny day.</td>
<td>1) Thermometer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Max. cabinet temp. 65 degree C when electrically operated</td>
<td>2) At max setting, temp to be within 62-68 degree C when electrically operated.</td>
<td>2) Thermometer</td>
</tr>
<tr>
<td>4</td>
<td>Solar Window</td>
<td>Solar window area 2.23 sq.m</td>
<td>Solar window area not to be less than 2.12 sq.m.</td>
<td>Measuring tape</td>
</tr>
<tr>
<td>5</td>
<td>Drying Area</td>
<td>Total drying area 3.60 sq.m</td>
<td>Total drying area not to be less than 3.42 sq.m</td>
<td>Measuring tape</td>
</tr>
<tr>
<td>6</td>
<td>Operational Trial</td>
<td>Test dry some product/s for uniform drying, drying time and reduction in weight by solar operation.</td>
<td>Products to be uniformly dry. Time and reduction in weight to be approximately similar to the testing data supplied by the manufacturer.</td>
<td>Practical Trials</td>
</tr>
</tbody>
</table>
ANNEXURE IV

SOLAR DRIER SDM-50 CABINET TEMPPERTURE RECORD SHEET

Machine No.------------------------------------       Location--------------------------------
Recorded by.-----------------------------------        Date--------------------------------------

<table>
<thead>
<tr>
<th>TIME</th>
<th>WEATHER #</th>
<th>TEMP.AT POSITION 1</th>
<th>TEMP.AT POSITION 2</th>
<th>TEMP.AT POSITION 3</th>
<th>TEMP.AT POSITION 4</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.00 hrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.00 hrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.00 hrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.00 hrs</td>
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</tr>
<tr>
<td>14.00 hrs</td>
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</tr>
<tr>
<td>15.00 hrs</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>16.00 hrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.00 hrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#Weather condition at the time of recording the temperature if a bright clear sun or medium/less intense etc.
*Temperature to be recorded at 04 different locations covering the whole cabinet.
**ANNEXURE V**

Cost Analysis Performa

Date of Manufacture: …………. Place: ……………. Lot No. …………….

### A. INPUT

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Ingredients</th>
<th>Mfr/Var.</th>
<th>Supplier</th>
<th>Qty. Purchased</th>
<th>Rate</th>
<th>Qty. Used</th>
<th>Cost (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

**Total Input Cost**

### B. PACKAGING

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Ingredients</th>
<th>Size.</th>
<th>Supplier</th>
<th>Qty. Purchased</th>
<th>Rate</th>
<th>Qty. Used</th>
<th>Cost (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>HDPE</td>
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<td>3</td>
<td>Packing slip</td>
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</tbody>
</table>

**Total Packaging Cost**

### C. FUEL

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Ingredients</th>
<th>Size.</th>
<th>Supplier</th>
<th>Qty. Purchased</th>
<th>Rate</th>
<th>Qty. Used</th>
<th>Cost (Rs.)</th>
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</thead>
<tbody>
<tr>
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</table>

**Total Fuel Cost**
### D. LABOUR

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>No. of hours worked</th>
<th>wage/day</th>
<th>wage/hour</th>
<th>Cost (Rs.)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Supervisor</td>
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<td>Labour for preparation-1</td>
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<td>3</td>
<td>Labour for preparation-2</td>
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<td>4</td>
<td>Labour for packaging-1</td>
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<tr>
<td>5</td>
<td>Labour for packaging-2</td>
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<td>7</td>
<td>Labour for marketing-2</td>
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<td>8</td>
<td>Other</td>
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</table>

_Total labour cost_

### E. CAPITAL

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<tr>
<th>S. No.</th>
<th>Description</th>
<th>Type/Size</th>
<th>Life/Cycle</th>
<th>Qty. Purchased</th>
<th>Rate</th>
<th>Cycles Utilized</th>
<th>Cost (Rs.)</th>
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</table>

_Total Capital Cost_

### F. TOTAL COST

<p>| | |</p>
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<thead>
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</thead>
</table>

### G. OUTPUT

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<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>Weight</th>
<th>Rate</th>
<th>Total Cost of output</th>
<th>Qty. Sold</th>
<th>Rate</th>
<th>Total Cost of Sold Qty.(Rs.)</th>
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</thead>
<tbody>
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</tbody>
</table>

_Gross Revenue_

### H.

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
</table>

_Net Profit (G-F):_

_Profit Percentage (100*Net Profit/Gross Revenue):_