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 de hydration 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 & off set 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

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

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

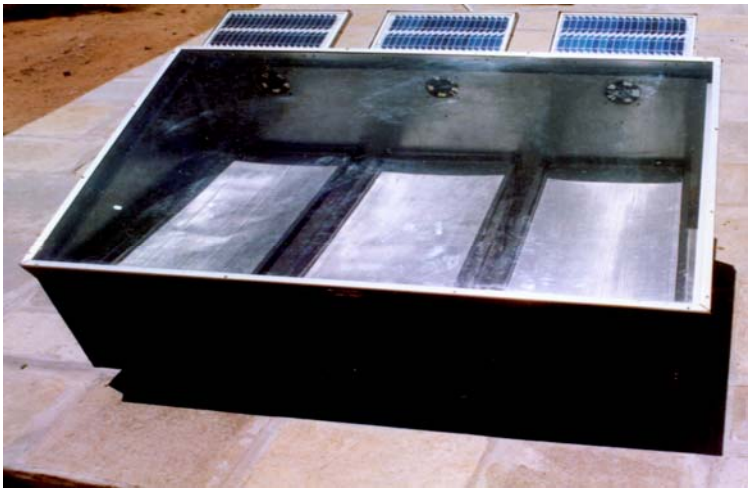

Fig.:1 SOLAR POWERED DRYER – SDM-50

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 pre treatments, 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

S.No	Product	Drying Time (hrs)	Yield (%)	Ambient Temp (°C)	Cabinet Temp. (°C)
F R U I T S					
1.	Mango Bar (10mm Thick)	20	45	40	65
2.	Pineapple Bar (10mm Thick)	20	45	30	51
3.	Papaya Bar(10mm Thick)	20	45	30	51
4.	Guava Bar (10mm Thick)	35	45	31	48
5.	Grapes	25	20	31	53
6.	Sapota Slices	8	27	34	49
7.	Sapota Bar (10mm Thick)	20	36	34	42
V E G E T A B L E S					
8.	Potatoes	4	30	31	50
9.	Donda	19	30	31	51
10.	Carrot	10	15	31	51
11.	Tomato	10	10	33	60
12.	Mushrooms	12	15	33	50
13.	Bitter gourd	6	11	26	42
14.	Onion	18	17	31	51
15	Amchur powder	7	10	31	60
16	Coconut	5	5	31	50
G R E E N L E A F Y V E G E T A B L E S					
17.	Curry leaves	8	35	29	55
18.	Spinach leaves	15	8	29	55
19.	Fenugreek leaves	6	13	27	40
20.	Tamarind leaves	12	11	29	55
21.	Gogu leaves	15	16	30	55
22.	Mint leaves	5	17	29	55

23.	Drumstick leaves	5.5	15	29	55
24.	Coriander leaves	6	12	30	51
SPICES					
25.	Ginger powder	20	15	31	50
26.	Mango Ginger	10	16	26	40
27.	Garlic Powder	4	33	26	45
28.	Red Chilies	15	34	32	56
29.	Green chilies	6	12	40	25
30.	Pepper	8	34	30	55
FOREST PRODUCE					
31.	Karaya Gum	19	30	35	58
32.	Karakkaya	44.5	47	29	44
33.	Sugandapala(Budipalagadda)	26	26.5	29	62
34.	Alovera	9	2.8	33	49
35.	Amla	6.5	32	31	50
36.	Honey	5.5	91.5	39	65
MEDICINAL&HERBAL PRODUCTS					
37.	Rosemary	15	30	32	58
38.	Spirulina Powder	6	18	25	60
39.	Tulasi leaves	6	12	31	50
FOOD ITEMS					
40.	Maida	4	96	32	56
41.	Vermicelli	4	35	31	49
42.	Noodles	4	77	28	44
43.	Pickled Chilies	24	25	31	49
44.	Fish	8	40	28	52
CHEMICALPOWDER					
45.	Silicon Carbide	3	80	31	60
46.	Cellulose	7	50	32	60

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

Ingredients	**Quantities**
Thothapuri Mango Pulp (Kg)	9.30
Sugar +Glucose (Kg)	3.45
Citric Acid (g)	18.0
Pectin (g)	9.0
Potassium Meta Bi sulphite (g)	15.0

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	8-10hours
Cabinet temp	40-65º C

Cost Economics (one batch load)

Raw material weight (Mango pulp, sugar, pectin, citric, acid etc)	38kg
Cost of Raw material & Other Expenses Per Load	Rs.1, 200/-
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

Ingredients	**Quantities**
Alphonso Pulp (Kg)	5.58
Thothapuri Mango Pulp (kg)	3.72
Sugar +glucose (kg)	3.60
Citric acid (g)	18.0
Pectin (g)	9.0
Potassium Meta Bi sulphite (g)	15.0

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	40-65º 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 15min
↓
Separating seeds using sieve
↓
Making fine pulp
↓
Sieving using stain less steel mesh sieve to separate fibers
↓
Packing in polypropylene pouches & storing in deep freezer until use.

Composition of Guava Fruit Sandwich Bar Per Batch

Ingredients	**Top Layer**	**Center Layer**	**Bottom Layer**
Guava pulp (kg)	-----	9.30	-----
Thothapuri Pulp (kg)	9.30	-----	9.30
Sugar +Glucose (kg)	3.60	3.60	3.60
Citric acid (g)	18.0	18.0	18.0
Pectin (g)	9.0	9.0	9.0
Potassium Meta Bi sulphite (g)	15.0	15.0	15.0

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

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

Cost Economics (one batch load)

Raw material weight (Mango pulp, sugar, pectin, citric, acid etc)	38kg
Cost of Raw material & Other Expenses Per Load	Rs.1,200/-
Mango Bar Yield / Out Put	17Kg
Sale Price Per Kg	Rs.110/-

Sale Price Per 17 kg	Rs.1870/-
Profit Per Load 17 Kg	Rs.670/-
Number Batches Per Annum	70
Net Profit Per Annum	Rs.46,900/-

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 stain less 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. To day 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 stain less 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

Ingredients	Quantities
Thothapuri Pulp (kg)	3.72
Guava pulp (kg)	1.86
Sapota pulp (kg)	1.86
Pineapple juice (kg)	1.86
Sugar+ Glucose (kg)	3.600
Citric acid (g)	18g
Pectin (g)	9g
Potassium Meta Bi sulphite (g)	15g

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 & Other Expenses	Rs.1,050/-
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
- Stain less 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, Hydeabad-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 5Jg/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

Moisture	2-3%

Yield

Finished Product (72 Coconuts)	6kg (45-50%)

Drying Time & Temperature

No. of sunny hours	4-4.5 hours
Cabinet temp	40-65º C

Cost Economics (one batch load)

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

Equipment / Machinery

Solar Dryer SDM 50	
Stainless steel vessels	4big
Paring Knife	2 no
Cutting Knife	2 no
Food Processor	1 no
Steam cooker / pressure cooker	1 no
Stainless steel Strainer	1 no

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, Hydeabad-500 033

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

QUALITY PRODUCT

The pilot production of manage 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

Samples of Mango Bars	Colour	Appearance	Texture	Taste	Flavour	Overall Acceptability
1. Open sun drying	2.42	2.75	4.00	4.67	3.25	3.17
2.Solar Drying	4.50	4.50	4.17	4.58	3.83	3.92
3. Electrical Tunnel drying	4.42	4.25	4.5	4.42	3.17	3.84

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

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

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/-
	Say Rs.45,000/-

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/-
	Rs.4,45,000/-
	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 $\frac{2,00,000}{95,000}$ = **2years**

12. ECONOMIC VIABILITY OF FOOD PROCESSING THROUGH SOLAR DRYERS

It is very essential that the cultivator should concentrate on the agricultural activity 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 to 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: Amount (Rs.)

a) Solar Dryer of 50 Kgs capacity	75,000.00
b) Equipment & Office set up	15,000.00
Total	90,000.00

COST OF RAW MATERIAL

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

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

Note:

1. Yield per batch	20 Kg.
2. Time per batch	3 days (21 hours)
3. No. of Batches in A MONTH	10
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	Amount (Rs.)
a) Solar Dryer of 50 Kgs. Capacity	75,000.00
b) Equipment & Office set up	15,000.00
TOTAL	90,000.00

COST OF RAW MATERIAL

a) Tomato (4 months production)

Tomato loading in 50 Kgs. Solar Dryer	15 Kgs.
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 contaminates.

9. Electrical connection points of 22o 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

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

ANNEXURE III

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

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

ANNEXURE IV

SOLAR DRIER SDM-50 CABINET TEMMPERTURE RECORD SHEET

Machine No.---------- Location----------

Recorded by.---------- Date----------

TIME	WEATHER #	TEMP.AT POSITION 1	TEMP.AT POSITION 2	TEMP.AT POSITION 3	TEMP.AT POSITION 4	REMARKS
10.00 hrs						
11.00 hrs						
12.00 hrs						
13.00 hrs						
14.00 hrs						
15.00 hrs						
16.00 hrs						
17.00 hrs						

#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

S. No.	Ingredients	Mfr/Var.	Supplier	Qty. Purchased	Rate	Qty. Used	Cost (Rs.)
1							
2							
3							
4							
Total Input Cost							

B. PACKAGING

S. No.	Ingredients	Size.	Supplier	Qty. Purchased	Rate	Qty. Used	Cost (Rs.)
1	Butter Paper						
2	HDPE Wrapper						
3	Packing slip						
4							
Total Packaging Cost							

C. FUEL

S. No.	Ingredients	Size.	Supplier	Qty. Purchased	Rate	Qty. Used	Cost (Rs.)
1	LPG						
2	Kerosene						
3							
4							
Total Fuel Cost							

D. LABOUR

S. No.	Description	No. of hours worked	wage/ day	wage/hour	Cost (Rs.)
1	Supervisor				
2	Labour for preperation-1				
3	Labour for preperation-2				
4	Labour for packaging-1				
5	Labour for packaging-2				
6	Labour for marketing-1				
7	Labour for marketing-2				
8	Other				
Total labour cost					

E. CAPITAL

S. No.	Description	Type/Size	Life/Cycle	Qty. Purchased	Rate	Cycles Utilized	Cost (Rs.)
1	Solar Dryer					5/hr	
2							
3							
4							
Total Capital Cost							

F.

TOTAL COST	

G. OUTPUT

S. No.	Description	Weight	Rate	Total Cost of output	Qty. Sold	Rate	Total Cost of Sold Qty.(Rs.)
1							
2							
Gross Revenue							

H.

Net Profit (G-F):	
Profit Percentage (100*Net Profit/Gross Revenue)	