# JACKFRUIT PROCESSING TRAINING MANUAL

## Preamble

This manual has been developed for agroprocessors involved in fruit processing, specifically drying and juice processing. Through these processes, agroprocessors will provide a broader range of nutritious products with a higher content of bioactive compounds compared to the existing products on the market.

## Training Methodology

The adult learning concepts are proposed to underpin the training and enable participants to learn the technical content based on specific objectives. Although participative and experiential methods should be dominant, formal classroom-style presentations should also be used to provide key materials and knowledge. The language of instruction for the training will be both English and Luganda

## Outline of the training manual

The training manual is organized into two modules, covering the two processed food products of focus.

1. Module 1: Dried jackfruit
2. Module 2: Jackfruit juice

## Introduction

Food processing aims to make food more marketable and attractive to potential consumers, often giving processed food a longer shelf-life. Fruit can go through numerous types of processing, including canning, drying, and juicing. Some types of processed fruit are fruit preserves, canned fruit, dried fruit and fruit juices.

## Nutritional benefits of jack fruit

1. Jack fruit contains Vitamin A, vitamin C, thiamin, riboflavin, calcium, potassium, iron, sodium, zinc, and niacin, among many other nutrients.
2. Jackfruit root extract has also been used to control asthma and treat skin problems.
3. Jackfruit contains phytonutrients, including lignans, isoflavones, and saponins which can prevent the formation of cancer cells in the body, can lower blood pressure, fight against stomach ulcers, and can slow down the degeneration of cells that make the skin look young and vital.

## Main objective

To teach agro-processors about the production of quality dried jackfruit products and jackfruit juice.

## Specific objectives

By the end of the training, participants should be able to:

1. Appreciate drying as a method of preservation.
2. Learn the use of good manufacturing practices and procedures in the production of quality dried jackfruit and jackfruit juice.
3. Understand the novel drying technology-Refractance window Drying Technology (RWDT) and its benefits.
4. Appreciate the competitive advantage of the new technology.

## Module 1: Dried jackfruit

Drying of agricultural products is the oldest and most widely used preservation method. Drying aims at reducing the water content as much as possible to stop microbial activities and deterioration. Moisture left in the dried foods varies between 2-30%, depending on the type of food. Drying lowers the product's weight and volume, hence lowering transportation and storage costs. However, drying also reduces the product's nutritional value, e.g. through loss of vitamin C. Drying can lead to changes of colour and appearance that might not be desirable. Jackfruit can be dried into several consumption forms depending on the final use or the customer requirements. Some dried fruit forms include flakes, powder, leather and dice.

## Why consider drying?

Drying has the following advantages.

- It is possible to engage in drying with a relatively low investment
- Dried foods are shelf stable and can be stored without refrigeration
- Drying reduces the volume occupied by food, thereby reducing storage, packaging and transportation needs
- In addition to preservation, drying also contributes to increasing the diversity of food products
- There are a number of simple drying techniques which can be performed even without training
- Drying can be undertaken using solar energy, i.e. no energy costs need to be incurred

## Commonly used drying methods

### Sun drying

Sun drying (used almost exclusively for fruit) and solar drying (used for fruit and vegetables) of foods use the power of the sun to remove the moisture from the product. Sun drying of fruit crops is limited to climates with hot sun and a dry atmosphere. Fruit can be dried in substantial quantities without much technical aid by simply spreading it on racks, trays, or roofs and exposing them to the sun until dry. Advantages of this process are its simplicity and its small capital investment. Disadvantages include complete dependence on the elements and moisture levels no lower than 15 to 20 percent (corresponding to a limited shelf life).

## Solar drying

Solar drying utilizes black-painted trays, solar trays, collectors, and mirrors to increase solar energy and accelerate drying. Solar dryers are affordable, have a short payback period and are easy to construct, operate and maintain. However, the basic solar dryer systems are not efficient and restrict the volume they are able to produce. The basic solar dryer systems are generating an increasingly high proportion of rejects on the export market. The rejects are attributed but are not limited to: bad and particularly inconsistent weather, poor mass transfers, poor dryer material selection and hygiene issues, all contributing to product quality variation, among others.

Static bed box type solar model dryer (Galyaki, C)

PPI tunnel solar dryer model (Galyaki, C)

Kawanda cabinet solar dryer (Wajkira et al., 2011)

Hybrid tunnel solar dryer model(Galyaki, C)

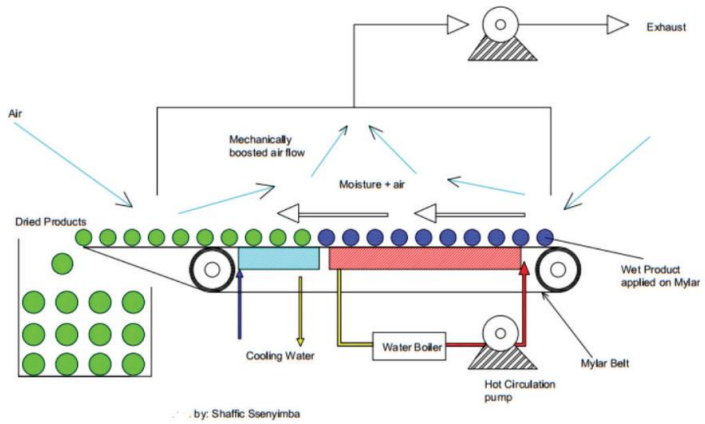
UNIDO solar hybrid dryer model (Galyaki, C)

**Improved solar dryer**

## Refractance window Dryer

The RWD has four main components: the water circulation system, the food conveyance system, the air circulation system and automation system

The dryer comprises a moving conveyor belt onto which food product is placed, and drying is achieved by circulating hot water in a tray below the moving conveyor belt. The dryer uses electricity to heat the water circulated throughout the system. The moving conveyor belt is covered by a hood that protects the products from contamination as they are conveyed. A washing unit helps to scrub and wash the belt after scrapping off the dried fruit.




**Hybrid RWD**

The hybrid RWD is a batch type of dryer where liquid foods, purees and slices are dried on one side of a thin plastic film using hot water. The dryer uses both electricity and biomass.

**Electric component**

Consists of electric immersion heaters that raise the water temperature in a trough. A drying belt covers the trough onto which fresh fruit products are placed. A hood to carry out moist air, a water reservoir, an electric water heater and a temperature control system.

**The Biomass Operation**

In the absence of electricity, the dryer uses biomass in the form of firewood to heat water and dry fruit products. The rocket stove is a clean burning and fuel-efficient cooking stove which uses thin sticks as fuel and doesn't require constant fanning. This means that the Rocket Stove is more efficient than open fires since it uses less firewood, reducing long-term household expenditure.

## Advantages of the RWDT Dryer

- Relatively easy operation with automation.
- It can achieve very low moisture content, up to about 7-10%.
- It produces high-quality products with respect to appearance, flavour, low moisture content and low microbial load.
- It maintains the nutritional value of the products.
- Various products, e.g., powder, flakes, and purees, can be produced.
- The technology has an incomparable shorter drying time. (45-60minutes per batch).
- Weather susceptibility: RWDT is not susceptible to weather changes, thus minimizing losses and maximising working time.

## Considerations and processes in fruit drying

## Basic hygiene requirements

Food products are prone to contamination, which can affect consumers' health. To have a good, processed product, hygiene standards must be followed and maintained during preparation, drying and storage.

## Personal hygiene

- Avoid rings, bangles and nail polish during processing.
- Wash hands carefully with soap and running water.
- Do not be involved in processing when you are sick and/or when you have open wounds.
- Maintain personal cleanliness, including body and clothes.
- Keep nails short and clean.

## Cleanliness of equipment and utensils

The equipment and utensils should be properly cleaned before and after use:

- Scrub equipment, e.g. tables and benches, with soap, water and brushes and then rinse thoroughly.
- Dry the utensils on a dish rack or wipe them dry with a clean cloth and store them in a dust-free place

## Selection of fruits and vegetables for drying

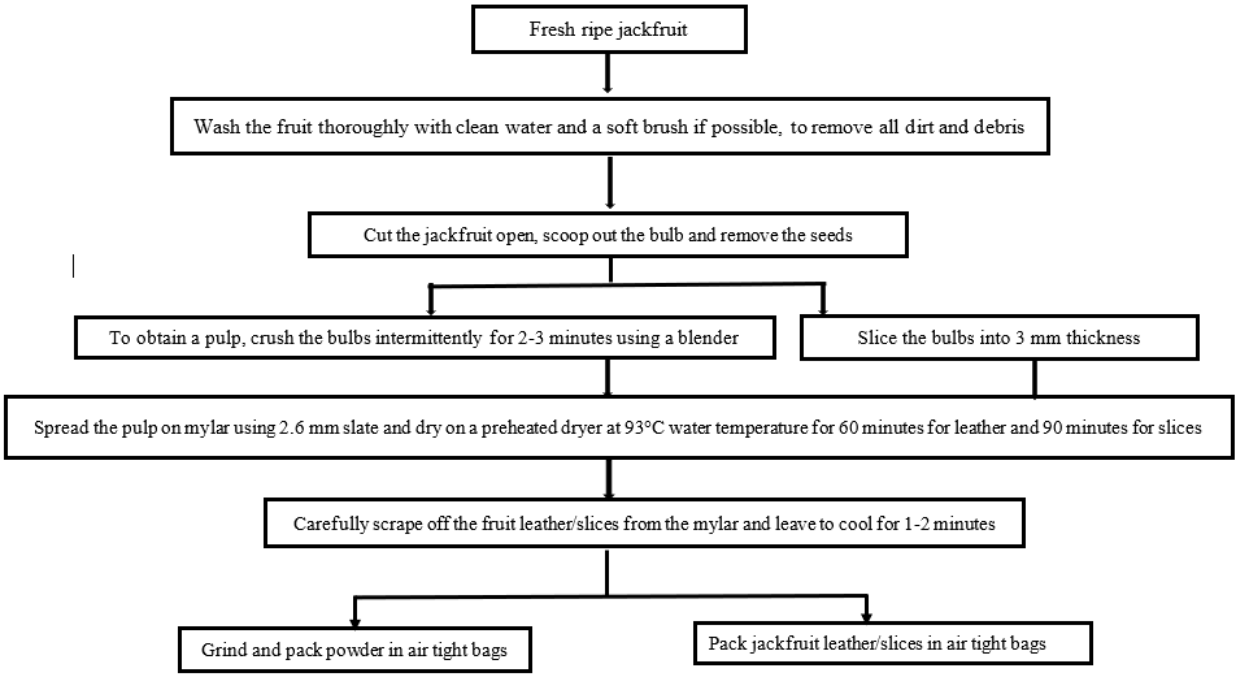
- Fruits to be used for drying should be fresh and of good quality.
- Avoid pest-infested fruits and vegetables or those damaged in any way.
- The appearance and wholesomeness of the raw material have a direct bearing on the quality of dried products

## General procedure for drying jackfruit using the RWD

- Select firm ripe fruit. Avoid overripe or underripe fruits to obtain good products.
- Wash the fruit thoroughly with clean water and a soft brush, if possible, to remove all dirt and debris.
- Section the fruit into parts and remove any damaged and discoloured parts. Remove the arils/bulbs and deseed them.
- Slice/cut into thin, uniform slices or cubes. Stainless steel knives are recommended for peeling and cutting the slices or pieces.
- To obtain a pulp, crush the bulbs intermittently for 2-3 minutes using a blender.
- Spread the pulp on the mylar sheet using a 2.6 mm slate and dry at 93°C water temperature for 60 minutes for leather and 90 minutes for slices
- Carefully scrape off the fruit leather/slices from the mylar and leave to cool for 1-2 minutes

- Pack jackfruit leather/slices in airtight bags or grind the leather and pack the powder in airtight bags
- Pack the dried product in moisture-proof packs.
- Store in a cool, dark, dry, well-ventilated place.

## Process flow on how to dry jackfruit using RWD




## Packaging and storage of dried fruits

- After drying, cool the fruit before packaging.
- Packaging food warm can lead to sweating and moisture build-up.
- Excessive delays in packaging could allow moisture to re-enter food.
- Dried fruits should be stored in airtight containers to prevent the absorption of moisture in the air.
- Glass jars, metal cans or freezer containers are suitable storage containers if they have tight-fitting lids.
- Plastic bags are acceptable, but they are not insect and rodent-proof.
- Place the fruit in a plastic bag before storing it in a metal can.
- Most dried fruits can be stored for 6-12 months under ambient conditions, while dried vegetables can be stored for up to 6 months.
- Dried produce must be stored in a dry atmosphere, in insect-proof containers and away from light.

## Packaging materials for dried jackfruit

### a) Aluminum foil lamination


Aluminium packaging is light, flexible and easily recyclable. It is hygienic, non-toxic and helps keep the dried fruits' aroma. It keeps the fruits fresh for a long time and protects from light, ultraviolet radiation, oils and grease, water vapour, oxygen and microorganisms.

### b) Polythene vacuum packaging

Vacuum packaging is often used in commercial and residential applications to preserve fruits. This type of packaging is relatively cheaper and hence can be afforded by most small-scale fruit processors

## Use of dried fruits

Dried fruits can be eaten in the dry form or used in various products such as reconstituted juices, yoghurt and bakery products.

## Incorporation of RWDT dried fruits into cake

**Materials and equipment**

- Bowels (where mixing will be done) or buckets, preferably stainless steel
- Whisker
- Tablespoons
- Hand towel
- Baking Oven
- Weighing scale
- Weighing containers
- A knife and chopping board
- Disinfectant
- Sugar
- Eggs
- Butter/Fat/Margarine
- Leavening agents (baking powder)
- Baking Flours
- RWDT Fruits (dried dices)
- Milk

- Vanilla
- Glucose Syrup
- Calcium

**Recipe**

Diced Fruits 75g
Wheat Flour 425g
Sugar 250g
Baking powder 40g
Eggs 5 eggs
Milk 250 ml
Vanilla 5mls
Calcium 5g
Water 10mls

**Procedure**

1. Grease the baking containers and preheat the oven.
2. Before you begin baking, grease and flour the pans you are using.
3. It's important to have all of the ingredients prepared before making the batter. Weigh the ingredients following the above recipe
4. It's important to correctly measure and mix the dry ingredients so the cake will have an even and proper rise. Use a wire whisk to combine the flour with the leavening agents for the best results.
5. Using an electric beater or mixing by hand, add a little of the sugar at a time to the butter and then mix until you have incorporated the full amount to form a full cream.
6. Add the whisked eggs to the butter and sugar mixture and mix well until blended.
7. For a RWDT fruit cake, flour with fruit dices and milk are added to the butter and sugar mixture. First, start with the fruit dices. Be sure to incorporate it completely with the combined butter, sugar, and eggs.
8. Then, alternately add the dry ingredients and milk to the wet ingredients. Mix well until it is smooth and uniform.
9. Pour the batter into the pan. If making a layer cake, carefully divide the batter between two round cake pans. If you're using a rectangular or Bundt pan, scoop out all of your batters into your prepared pan of choice. Gently tap the pans on the counter to even the tops and remove air bubbles. If necessary, use a spatula to smooth the tops before baking. Place the pans in the oven for 20-30mins for queen cakes or 1 hour for round pans at 180 degrees Celsius. Remove the pans from the oven and allow them to cool.

## Incorporation of RWDT dried fruits into yoghurt

Adding dried fruits in their various forms (dried slices, juices or powders) can improve the sensory acceptability and nutritional content of yoghurt. The incorporation levels differ depending on the type and form of the fruit added; the levels of fruits added to yoghurt can range from 0.5 to 10% and even more depending on the desire of the customers. Sensory evaluation tests should be conducted to determine the optimal incorporation levels of each form of the dried fruits into yoghurt.

## Materials and equipment

Below are the materials and equipment required to use RWDT dried fruit as ingredients in yoghurt.

- Bowels (where mixing will be done) or buckets, preferably stainless steel
- Ladle
- Empty bottles (for packaging)
- Cup and funnel (to aid in filling yoghurt into the storage containers
- Hand towel
- Cold storage (refrigerator)
- Weighing scale
- Weighing containers
- A knife and chopping board
- Plain yoghurt
- Fruits (dried jackfruit slices or jackfruit powder)

## Yoghurt flavouring and mixing procedures and processes

Below is a step-by-step description of the procedures and rations for incorporating flavours into yoghurt.

1. After fermentation, when the yoghurt has attained a PH of about 4.5, measure out 1 litre of plain yoghurt and place it in a clean, sterile bucket/ container.
2. Mix about 200ml of plain yoghurt and pre-weighed fruit powder/ slices in a small container.
3. Add the yoghurt fruit powder mixture to the remaining portion of the yoghurt and mix gently (Take care to mix gently to avoid thinning the yoghurt - syneresis)
4. Pack the flavoured yoghurt into clean and sterile containers.
5. Label and keep the packed yoghurt under cold storage (40°C) for 24 hours to allow flavours to diffuse.

## Precautions to take when mixing RWDT dried fruits in cake mixtures and flavouring yoghurt

1. Always use clean and aseptic raw materials (fruit dices and powders) and clean processing equipment and materials.
2. The personnel must be clean and dressed in appropriate gear to avoid contaminating the cakes and fruits.
3. To attain the optimal quality of the flavoured product, always use the standard fruit dices to flour proportions. Ensure to use calibrated equipment, for example, during weighing.
4. Creaming of butter and sugar should result in a smooth mixture
5. The mixing should generally be done in equipment and a clean environment.

## Potential target markets for the dried jackfruit and jackfruit products

Some of the target market destinations for dried jackfruit may include:

• Fruits and beverage industry, e.g., Pepsi
• Bakery and confectionaries
• Diary processing companies
• Supermarkets and shops
• Hypermarket/ Supermarket
• Food and Drink Specialty Stores
• Convenience Store
• Schools
• Online Retail
• International markets for export

## Module II: Jackfruit Juice

### Key considerations

- Use only well-ripened jackfruits as much as possible. Raw fruits have low sugar content and are difficult to pulp.
- Avoid working in dusty and dirty places as these will result in cross-contamination of the product.

### Materials required for processing Jackfruit Juice

- Ripe jack fruits
- Preservative
- Water
- Sugar
- Saucepan
- Weighing scale
- Measuring cylinder
- Electric blender
- Heat source
- Bucket
- Ladles and tablespoons
- Packaging bottles
- Cheesecloth

## Process Flow Chart for Jack Fruit Juice Processing

Wash the jackfruit using clean water and brush.

Slice the jack fruit and remove bulbs.

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Remove seeds from the bulbs

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Blend the arils to form a pulp using an electric blender or mortar and pestle.




To the pulp add water in a ratio of 2:1 (pulp to water) and sieve the mixture thereafter.

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The filtered juice is then placed into a sauce pan and then placed on fire for pasteurization.

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Cool the juice to 80°C and fill into the clean sterilized bottles and cap immediately.

## Packaging of juice

Packaging options for processed juice include plastic, glass, and tetra packs.




## UNBS standards on dried fruits, yoghurt, flavoured milk, fruit juice, bread and cake (UNBS, 2019)

| Standard code | Standard description |
|---|---|
| US 570:2006 Code of hygienic practice for dried fruits | This code of practice applies to all fruits that have been dried by natural or artificial means or a combination of both. The fruit is dried to the extent that the greater part of the moisture has been removed, and the fruit may be subjected to a safe and appropriate treatment in preparation and packing to permit marketing in normal trade channels. |
| US 640:2006 Code of practice for production, handling and processing of solar dried fruits | This code of practice applies to all fruits that have been dried by natural or artificial means or a combination of both. This code does not apply to fruits commonly known as "dehydrated fruits" with a moisture content not exceeding 5 %. |
| US 877: 2011, Dried fruits — Specification | This Uganda Standard specifies requirements and methods of sampling and testing for tropical dried fruits and other fruits that |

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|---|---|
| | have been suitably treated and offered for direct consumption or further processing. |
| US 882: 2011, Fruit chips and crisps — Specification | This Uganda Standard specifies requirements and methods of sampling and testing for fruit chips and crisps that have been suitably treated and offered for direct consumption or further processing. |
| 628. US ISO 4125:1991, Dry fruits and dried fruits — Definitions and nomenclature | This Uganda Standard defines the terms “dry fruits” and “dried fruits”, together with the common names, in English, French and Russian, of the most common fruits grown commercially worldwide for human consumption. |
| US 282:2000/EAS 41-0 Fruit, vegetables and derived products – Sampling and test methods – General | This standard specifies a method of sampling fruits, vegetables and their products, forming the subject of international trade, intending to determine the quality or particular characteristics of the goods |
| US 62:2011, Fruit juice drinks – Specification | This Uganda Standard specifies the requirements and methods of sampling and testing for drinks containing fruit juice. (This Uganda Standard cancels and replaces US 62- 1:2000, Specification for fruit drinks – Part 1: Fruit juice drinks and US 62-2:2000. Specification for fruit drinks – Part 2: Comminuted fruit drinks which have been revised and combined in the current Uganda Standard). |
| US 818:2019, Fruit juices and nectars — Specification (2nd Edition) | This Uganda Standard specifies requirements and methods of sampling and testing for fruit juices, nectars and concentrated fruit juices intended for direct human consumption or further processing. (This standard cancels and replaces US 818:2011, Fruit juice and nectars — Specification, which has been technically revised). |