



MINISTRY OF AGRICULTURE ANIMAL INDUSTRY & FISHERIES

FRUVASE-MUK

JACKFRUIT JUICE PROCESSING TRAINING MANUAL

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1.0 INTRODUCTION

1.1 Introduction

The jackfruit (*Artocarpus heterophyllus*) tree is adapted to humid tropical and near-tropical climates (Morton, 1987) creating its potentiality to be widely produced in Uganda. Jackfruit which originated from East Asia, known to be the largest tree born fruit weighs up to 30kg and yields 50-80 tons per hectare annually. Jackfruit comprises of 28-33% pulp and 67% waste from which a lot of value-added products can be processed. Postharvest losses and limited value addition have been identified as core points for the development of fruit and vegetable sector (jackfruit value addition) in Uganda. However, currently little information exists on the production capacity, utilization and processing of jackfruit in Uganda. Information on jackfruit production and utilization is crucial for the improvement of the economic value of this fruit in the country. This manual, therefore is aimed at addressing jackfruit diversity in utilization and reduction of post-harvest losses through value addition.



Figure 1: Jackfruit tree with mature fruits

1.2 Training objectives

This training manual is designed to address jackfruit diversity in utilization, reduce post-harvest losses through value addition and increase the economic value obtained from jackfruit and its products through skilling stakeholder farmers. The manual puts emphasis on skilling individuals in processing of jackfruit juice to create a shelf stable product that is of high quality.

Specifically, the training manual seeks to impart the knowledge and skills among individuals in the jackfruit value chain with respect to:

1. Development jackfruit juice as a value-added product
2. Increase the quality, safety and shelf-life of jackfruit juice to improve its competitiveness on the local market

1.3 Target audience for the manual

The target audience includes extension workers, individual producers and producer associations, processors, and policy makers as well as any other trainers supporting the jackfruit value chain.

1.4 Guide to the Trainer

This manual is designed as a handy working guide for extension workers and trainers working to skill and support jackfruit farmers in postharvest management and value addition through processing. It is aimed at equipping the trainer with teaching and communication skills so that they can prepare and teach the trainees better. The manual is practical, and will require an introductory field visit to a site(s) where jackfruit is grown, marketed and or processed. Alternatively, if possible, a short video or still printed pictures could also be used.

1.5 Preparation of materials and venue

As a trainer, you should endeavor to establish the nature of the audience, their educational background, what they do, their training needs and expectations. The more you know about your audience, the better you will be able to deliver the knowledge and skills.

1.5.1 Inviting the trainees

Invite the trainees in good time. This should allow them to plan and schedule their activities accordingly so as to allocate time and focus on the training. The invitation to the trainees should be simple and clear indicating what the training is about, when and where the training will be conducted, the duration of training and how the training will benefit them. Also indicate what the trainees need to carry to the training and how any other logistical issues will be handled.

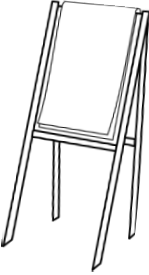
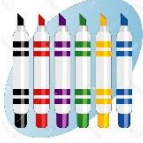


Clarity at invitation helps manage trainees’ expectations and will keep unserious and ‘career trainees’ away.







1.5.2 Training materials

All training materials including: black/white board or flipcharts; chalk or white board markers; erasers; note books, pens and hand-outs for trainees; your training plan, session or lesson plan; and all demonstration materials required for a particular session should be prepared at least one or two days before the training.

Prepare a checklist of all the required materials. Designate a place or box where all the materials will be assembled. Tick off each set of training material once it is prepared and ready in a designated place. A checklist helps you not to forget anything, or realize it is missing when the training has started.

Table 1: Checklist for materials required for training

No.	Training Item		Checked as present
1	Flip charts	 <small>©clker.com</small>	√
2	Permanent markers	 <small>©123rf.com</small>	√
3	Masking tapes	 <small>©123rf.com</small>	√
4	Manila paper	 <small>©lazada.com.ph</small>	X

5	Notebooks	 ©line.17qq.com	X
6	Pens	 ©kissclipart.com	X
7	Ingredients needed (fruits, preservatives)	 ©vectorstock.com	√
8	Spoons, knives, blender	 ©dreamstime.cqm ©the goodguys.com	√
9	Sanitizer	 ©istock.photo.com	√
10	Masks	 ©vectorstock.com	√

11	Saucepans, jerrycans, stoves		✓
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1.5.3 Trainer preparation for the actual teaching

Well before the training, read and understand the particular session in this training manual that you will be teaching. Practice how you will go about teaching the session. Bear in mind that some of your trainees may have been exposed to the things in the session before – through similar trainings or personal experience. Therefore, prepare to identify them during self-introductions. Be aware that they may ask you certain specific details or questions that can also be a valuable resource in the training especially when you encourage them to share their personal experiences. As a trainer, always anticipate some questions and prepare how to respond to them.

1.5.4 Training area

Choose a location which is quiet, cool and well lit. The location should also be well ventilated and protected from weather like direct sunshine and rain. The training area should also be away from distractions. For the practical sessions, the participants can be divided into smaller groups for easy handling. This kind of arrangement enhances a one-on-one contact and interaction between the trainer and trainees.

Note: *The sitting and working arrangement SHOULD also adhere to the Ministry of Health and WHO COVID-19 management guidelines by observing social distancing. The trainers and all the trainees should put on recommended masks during the training.*

1.6 Effective training delivery for behavior change

As a trainer you should always be aware that you are a change agent aiming at stimulating and fostering positive change in key behaviors of the trainees and communities. Therefore, in order for you to succeed as a change agent you must be the right messenger with the right message

and the right method to deliver the message. Some of the key qualities of a good change agent or communicator are:

- i. **Credibility:** Be trustworthy. Stimulate thought. Be an influencer.
- ii. **Candor:** You should be able to admit if things that aren't working well.
- iii. **Clarity:** You should connect with your audience/trainees
- iv. **Compassion:** You should be empathetic. Put yourself in the shoes of the trainees. Be able to see things from their perspective.
- v. **Commitment:** Stay focused and emphasize key messages.

When training:

- i. Be smart, confident, enthusiastic and make eye contact with your trainees. This inspires confidence and interest among trainees.
- ii. Do not be timid, shy, nervous and apprehensive. This does not inspire confidence in your trainees. It only undermines your capacity as a trainer.
- iii. In your verbal communication, speak clearly and audibly (loudly). When speaking, do not be too fast neither too slow.
- iv. Keep what you say simple. Use simple words and not complex jargon and terminologies.
- v. Introduce yourself and let the trainees introduce themselves as well. Structure the self-introduction to include the person's name, where they are from, what they do for a living, and their educational background.
- vi. In an inclusive approach, agree on the ground rules with the trainees. This may include agreeing on mutual respect, confidentiality, one person speaking at a time, when questions or clarifications may be sought, how to handle cell phone calls and text messaging, photography, the program and time management etc.

Make the training an inclusive and participatory two-way process. Stimulate the involvement of the trainees by asking questions and encouraging them to ask questions as well as share personal experiences related to the subject of training. Inspire and stimulate discussions. Inclusiveness or participation may also be fostered through assigning simple tasks such as time keeping, giving monotony breakers (energizers) and monitoring training progress (what went well and what didn't go so well) to either different individuals or teams every day – and the individuals or teams report back at the end of every day. At this point, you may share the objectives of the training and get deeper into the subject matter of the training.

1.7 On site practicals, demonstrations

The aim of demonstrations and hands-on skills practicals is to show the trainees how things practically work and also let the trainees learn how to do a particular process or task. Before the training, the trainer should always take off time (1-2 days) to view, make trials and comprehend the whole session so that he/she is able to understand exactly what kind of practical activity it requires. This will help the trainer to know how the procedure works, what to expect and if the procedure needs a little bit of adjustment. There is also need to prepare the required items for the practical activity.

2.0 OVERVIEW OF JACKFRUIT UTILIZATION IN UGANDA

Learning outcomes for this session

On completion of this session, participants should be able to:

- i. Describe the importance of jackfruit in people's livelihoods
- ii. Describe the strategic importance of jackfruit to the national economy
- iii. Describe the nutritional value and importance of jackfruit in diets

Materials required for teaching this session

The materials needed for teaching this session are:

- i. Writing board, which could be white or blackboard or flip charts. Flip charts are the best for adult learning since you can always refer back to what was discussed and written earlier, should there be need.
- ii. White board markers, chalk or permanent marker pens
- iii. Appropriate board erasers
- iv. Paper masking tape
- v. A projector with a screen (optional)

2.1 Background

Jackfruit (*Artocarpus heterophyllus*) is a medium sized ever green tree with a height ranging from 8 to 25 m and produces the heaviest tree born fruit weighing up to 80 kg (Rahman *et al.*, 2016). Due to the big size of its fruits, in Uganda, jackfruit is known as *Ffenensi* or *Ffene* derived from a *Luganda* language phrase “*Ffena ensi tulya kuno*,” literally meaning that the fruit can feed the whole world (Nakintu *et al.*, 2019).

Jackfruit harvest season in Uganda has two peaks; from March to April and from November to December, with the latter season yielding more fruit. Jackfruit is categorized into white, orange and yellow types based on the pulp color, hard or soft according to pulp texture (Balamaze *et al.*, 2019). In some countries such as the Philippines, jackfruit is a highly valued fruit providing sustainable income to farmers through local markets and export (Borines *et al.*, 2014) and this is gradually being realized in Uganda with jackfruit marketing and consumption being evident in most urban centers of the country. Over the last decade, jackfruit has presented itself as a fruit crop with the potential of alleviating poverty and providing food security for both rural and urban communities (Magcale, 2010). In the Central and Eastern regions of Uganda, about 78% of households produce jack fruit mainly for home consumption, 16% of the

households sell the fruit, 6% feed it to animals while 1% of the household process them into dried chips or jackfruit wine (Balamaze *et al.*, 2019).

About 60% of the whole jackfruit consists of inedible parts such as the outer prickly rind, inner perigones, and central core and only around 35% of the whole fruit consist of edible flesh. Due to its high perishability, jackfruits are usually transported to the market as whole fruits and since more than half of the fruit consists of inedible waste materials, this makes it less cost effective. The inconsistency of the size and shape of the fruit make the design of packaging very complicated whereas the rough outer thick skin and the latex make preparation difficult (Xu, 2018).

2.2 Nutritional and Health Benefits of Jackfruit

Jackfruit bulbs are a healthful source of vitamin C, potassium, dietary fiber, and some other essential vitamins and minerals. Jackfruit is rich in magnesium, which is important for the absorption of calcium and helps strengthen the bones and prevents bone related disorders such as osteoporosis. Iron in jackfruit helps to prevent anemia and aids in proper blood circulation while copper plays an important role in thyroid gland metabolism. Jackfruit contains phytonutrients that have anticancer, antihypertensive, antiulcer and antiaging properties.

2.3 Jackfruit Utilization

Despite its nutritional values and enormous health benefits, the jackfruit is underutilized and not classified as a commercial crop. It is rarely grown on regular plantation scale due to its short shelf life and insufficient processing facilities in the regions where it is grown. At the same time, there is a growing consumer demand for wholesome, nutritional, and convenient food products. Therefore, in recent years, there has been a growing market for minimally processed fruits thereby increasing the need to minimize postharvest losses through mishandling of fruit and poor storage methods. Processing of jackfruit into value-added products such as extracted fruit juice may remove the difficulty in separating the bulbs from the rind and conserve time thereby increasing its utilization among the urban population. It also enhances the crop's potential through reducing the raw jackfruit transportation costs, maintaining the quality, shelf-life and freshness.

2.4 Jackfruit recipes

2.4.1 Jackfruit Jam

Ingredients

- 1 Cup fully ripe jackfruit
- ½ Cup sugar
- 1 Cup water
- ½ Tsp. Ginger powder

Method

1. Finely dice the jackfruit and set aside.
2. In a clean pan, combine diced jack fruit with sugar, water and ginger powder. Bring the mixture to a boil.
3. Once it has boiled, reduce the fire to medium and let the mixture simmer till the jackfruit is almost translucent and the water has reduced to half.
4. Remove from fire and let the jam cool. Store in a jar and keep refrigerated for three weeks.

Source: <https://akitcheninuganda.com/2016/07/19/jack-fruit-jam/>



2.4.2 Curry Spiced Jackfruit Seeds

Ingredients

- 2-3 Cups Jackfruit Seeds
- 2 Tsp. Curry Powder
- Salt
- 2-3 sprigs of rosemary/thyme
- A splash of Vinegar



Observations

- Make sure you are using ripe jackfruit seeds.
- Make sure to use seeds that have not started to sprout. If a seed shows any slight sprouting or looks green, discard it.
- The size of the seeds depends on the type and species of the jackfruit flesh you are eating. Some fruits have thin flesh while others have plump flesh.
- Jackfruit seeds have 3 layers of protective coverings. Two will be removed. to reveal a third layer which is edible and you do not need to remove it.

- Drying the seeds helps loosen the second protective covering so that it is easier to remove.
- If you don't fancy curry, you can use whatever spice blend you have/ prefer. Salt and pepper work well too.

Method

1. Slice the jackfruit.
2. Remove and set aside all the seeds.
3. Remove the initial gummy-like protective covering from each individual seed and wash them.
4. Place seeds in a clean pan, add water and bring them to a boil. Boil seeds for about 30 minutes or until they are soft and tender when pierced with a fork
5. Drain the seeds and place them on a tray/flat plate to allow cooling and drying. They should dry for about 6 hours.
6. After they have dried and the second protective covering has loosened a bit, peel off the covering from each seed.
7. After peeling all the seeds, place a frying pan on high heat. Add oil, salt, curry powder and the seeds and mix well.
8. Let the seeds cook in the oil for about 20 minutes on medium-high heat. Stir occasionally so that heat is evenly distributed.
9. You can bake your seeds if you have an oven.
10. Add a splash of vinegar/lemon juice to the seeds and 2-3 sprigs of rosemary/thyme to add to the flavor.
11. Remove the seeds from fire once they turn a vibrant golden-brown color and are crispy on the outside.
12. Serve as a snack or a substitute for roast potatoes.

Source: <https://akitcheninuganda.com/2020/10/03/curry-spiced-jackfruit-seeds-video/>

3.0 PROCESSING OF JACKFRUIT JUICE

Learning outcomes for this session

On completion of this practical session, participants should be able to describe:

- i. The materials one needs to do processing of jackfruit juice
- ii. The steps involved in processing of jackfruit juice
- iii. The Good Hygienic Practices and Good Manufacturing Practices required while processing juice

3.1 Good Hygienic Practices (GHPs)

These are practices to ensure safety throughout the food chain, with emphasis on prevention and control of microbiological, chemical and physical hazards.

Points to be considered while processing Jackfruit juice

1. Use only well ripened jackfruits as far as possible. Raw fruits have low sugar content and are difficult to pulp. Over-ripe fruits facilitate easy oxidation of the final juice made and may create off-flavors in the product.
2. Avoid working in dusty and dirty places as these will result in cross-contamination of the product.
3. Make sure that the equipment and other material to use is clean enough in order to develop a safe product for consumers.
4. Ensure that the workers are well dressed in clean work coats and follow the right Standard Operating Procedures during processing.
5. As a trainer, ensure that after processing, the work place is left as clean as possible.

3.2 Good Manufacturing Practices (GMPs)

These are practices aimed at controlling and preventing hazards associated with the food process chain, ensuring a safe and wholesome product, while minimizing the negative impact of the practices on the environment and on workers' health.

Design of a process to follow during production is a fundamental role in preventing potential contamination during processing. The processing should therefore be designed to have a clear zoning that will provide an environment that fosters hygienic production.

3.2.1 The principles of GMP

All the processors should;

1. Have a moral responsibility to produce safe, good quality food
2. Comply with relevant legal requirements regarding quality and safety
3. Satisfy customer requirements
4. Be aware of cost constraints
5. Try to minimize differences in both intrinsic and extrinsic factors in the raw materials used
6. Ensure that processing is carried out safely and effectively

3.3 Processing of Jackfruit Juice

3.3.1 Materials required

- Jack fruits
- Preservative
- Water
- Sugar
- Saucepan
- Weighing scale
- Measuring cylinder
- Electric blender
- Heat source
- Bucket
- Ladles and table spoons
- Packaging bottles
- Cheese cloth

The steps involved are indicated below;

- Step 1 The jackfruit must be washed in clean water using brushes to remove dirt from their surface.
- Step 2 These are then rinsed in clean running water to ensure that no dirt remains.
- Step 3 Using a sharp knife, the jackfruit is cut open, the middle core also cut out and the sap/ latex removed using a clean towel/ paper or polythene.
- Step 4 Sort the bulbs out using fingers or knife and place them in a clean bucket.
- Step 5 Remove the seeds from the bulbs to remain with the fleshy bulb part.
- Step 6 Wash the fleshy bulbs in clean water and weigh the amount of the bulbs.
- Step 7 Blend the fleshy bulbs in an electric blender until you obtain fine jackfruit pulp.
- Step 8 To the pulp add water in a ratio of 2:1 (pulp to water) in a bucket.
- Step 9 Using a wooden ladle stir the mixture and strain the product through a cheese cloth.

Step 10 The filtered juice is then placed into a sauce pan and then placed on fire for pasteurization.

Step 11 Add the sugar and preservatives to the mixture while heating.

Step 12 Heat the mixture of juice while stirring until it reaches a temperature of 90°C.

Step 13 Cool the juice to 80°C and fill into clean sterilized bottles.

Step 14 Cap immediately and cool to room temperature.

3.3.2 Energy requirements for processing jackfruit juice

- **Size reduction**

A food processor or blender is required to make pulp from the jackfruit arils.



Figure 2: Food processor
©twiga.com



Figure 3: Blender
©thegoodguys.com.au

- **Pasteurization**

A heat source such as a gas or electric cooker is needed for pasteurizing the juice.



Figure 3: Gas/Electric cooker
©tufumbe.com



Figure 4: Gas stove
©konga.com

PROCESS FLOW CHART FOR JACK FRUIT JUICE PROCESSING

Wash the jack fruit using clean water and brush.



Slice the jack fruit and remove bulbs.



Remove seeds from the bulbs



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



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



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



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

3.3.3 Packaging of juice

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



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