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Small Scale Processing of Mangos

Methodist University College, Ghana

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HORTICULTURE INNOVATION LAB

UCDAVIS UNIVERSITY OF CALIFORNIA

Introduction and Purpose

Mangos are an economically important fruit and are a significant source of income for many farmers in tropical areas. However, harvested mangos are highly perishable and can spoil quickly if not harvested, stored, and transported correctly. The purpose of this manual is present postharvest processing options for mango growers to increase the value and shelf life of harvested mangos.

This manual was produced as part of the 2018 project "TRAINING IN VALUE ADDITION OF MANGOS IN KINTAMPO MUNICIPALITY" through the Methodist University College, Ghana, and the Horticulture Innovation Lab at the University of California, Davis. This manual is meant to be used as supplemental material for the above-mentioned project's workshops. To the best of the authors' knowledge, this manual contains popular and effective practices in for increasing the value and shelf life of mangos. However, the authors cannot guarantee the effectiveness of the following methods in every instance and do not take responsibility for loss or injuries caused while following these recommendations.

This manual is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the Horticulture Innovation Lab, at UC Davis, and do not necessarily reflect the views of USAID or the U.S. Government.

Authors

Nicholas F Reitz, M.S.
Graduate Student Consultant
University of California, Davis

Sidrah Rafique,
Visiting Scholar at the University of Florida

Daniel Owusu Kyerematen, M.S.
Project Coordinator
Methodist University College, Ghana

The recommendations in the manual are based on the following resources. These resources are recommended for more in depth information on the topics covered below.

Fruit Juice Processing: Technical Brief. The Schumacher Center for Technology and Development. Rugby, UK

Bates, R., Morris, J., & PG, C. (2001). Principles and practices of small - and medium - scale fruit juice processing. University of Florida: FAO. Retrieved from http://www.fao.org/docrep/005/Y2515E/y2515e00.htm

How yogurt is made - manufacture, making, used, composition, product, machine, Raw Materials. (n.d.). Retrieved July 17, 2018, from http://www.madehow.com/Volume-4/Yogurt.html

Mango Jam. (n.d.). Retrieved July 30, 2018, from http://www.washingtonpost.com/recipes/mango-jam/14639/

Misra, Roy, and Miraoka. (2003) *On Farm Composting Methods*. FAO, Rome.

Reason and Importance of processing

After harvest, mangos remain living and undergo many of the biological processes common to living plants. These include consumption of energy and oxygen, production of heat, production of carbon dioxide, and deterioration of quality. Additionally, as mangos are stored after harvest, they become increasingly susceptible to mold and decay. As such, the shelf life of mangos is limited, and significant losses occur due to spoilage.

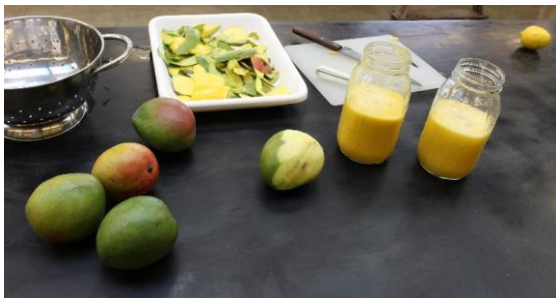
Processing can extend the shelf life of mangos by stopping many of the biological practices that decrease quality and by creating an adverse environment for microbes responsible for spoilage. Processed products such as juices and dried fruit are no longer living, thus spoilage is no longer related to biological factors, but rather microbial growth and chemical reactions related to quality loss. As such, processing conditions, the products, and packaging must be optimized to slow or prevent microbial growth and chemical degradation. It should be noted that some processed products, such as fresh cut fruit, are still living and thus biological processes should be considered along with microbial growth and chemical degradation.

Following are procedures for the processing of mango products on a small scale. Because waste is produced during the processing of many of these products, a short guide to composting mango wastes is included.

Juice Processing and Bottling

Introduction

Fruit juice is a commonly consumed fruit product with a long shelf life and potential nutritional benefits. Many types of juice exist, most varying in the amount of added sugar or evaporation of water from the raw juice. As such, many different juices can be produced from the same raw products, increasing the marketing options of the producer.



Safety considerations

A properly processed and packaged juice can have a shelf life of 6 months to a year. However, some safety issues should be considered. Pathogenic or spoilage organisms live on raw mangos and can contaminate juice products. Because juice is high in water and sugar, these organisms can grow in juices creating a dangerous or low-quality product. To eliminate this risk, juices should be pasteurized to kill spoilage and pathogenic organisms. Pasteurization is the heating of a product to a specific temperature for a specific amount of time known to kill relevant organisms. Pasteurization protocols presented here or in other official resources should be strictly followed to eliminate the risk of illness to customers.

Additionally, it is recommended to keep the pH (a measure of acidity) of fruit juices below 4.6 because the growth of spoilage and pathogenic organisms is greatly reduced below pH of 4.6. The pH of mangos ranges from 4-5 depending on the variety and stage of ripeness. To ensure a pH of below 4.6 is achieved, the addition of acidic ingredients, such as citrus juice or citric acid, is recommended. Color changing litmus paper strips called can be used to quickly test the pH of juices. It is recommended that each new formulation of juice is tested for pH and that an acidic ingredient is added to juices with a pH higher than 4.6. If a

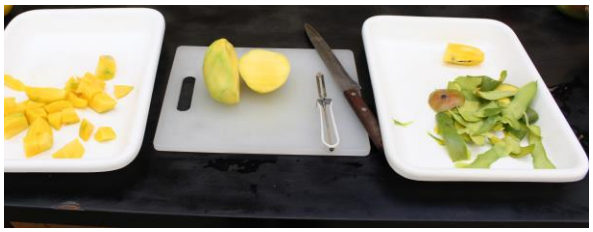
testing method is unavailable, adding an acidic ingredient to each batch is highly recommended to ensure safety.

Procedure

The procedure below is recommended to produce mango juice with added acidic ingredients in glass bottles. It is recommended that all equipment and materials are prepared prior to beginning processing. Delays can lead to misprocessed products, spoilage, and safety concerns.

Raw materials

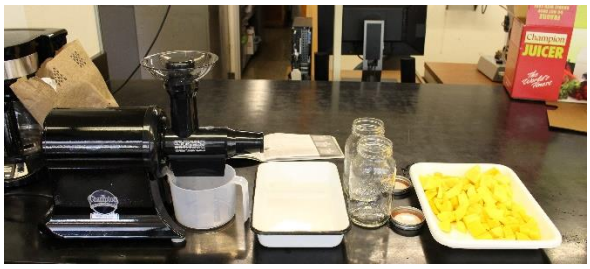
1. **Select** ripe, good quality fruit. Under ripe, overripe, moldy, or decaying fruit can cause unpleasing flavors and safety risks.
2. **Wash** fruit in potable water
3. **Peel** fruit and **remove stones**. **Chop** fruit flesh into medium cubes. If not processed immediately, cut mango should be placed in water containing lemon juice at a concentration of 250ml/1L.



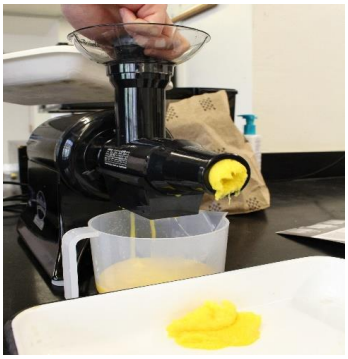
Juice extraction

4. **Clean** and **assemble** juice extractor including containers for juice and waste products.

Many different types of juicers are available and prices, production rate, and quality vary. A juicer should be chosen based on budget, power source (manual or electric), desired product, and desired juicing rate. Also consider how the juicer will be cleaned and stored.



5. **Load** fruit into juice extractor and **extract** according to manufacturer's instructions. The extractor's speed and mesh size should be optimized for each fruit type.



6. **Collect** juice and waste in clean containers for further processing

Many options exist for juice processing. The most commonly used for mango is the pulping model shown in the figure below. This uses either hand or mechanical power to push fruit against a mesh, separating juice from fibrous pulp.

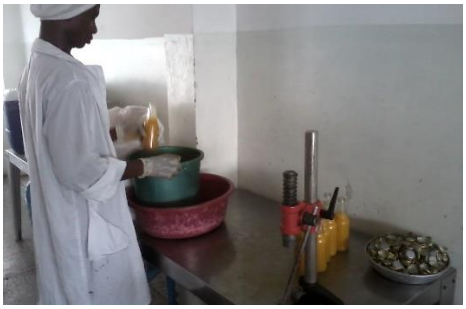
Filtering (optional)

7. **Filter** juice using a clean cloth or metal filter

Filtering will produce a clearer juice, which may be preferable for some consumers. Additional clarification can be achieved through the addition of pectic enzymes.

Standardization and additions

8. **Measure** the soluble solids content and pH of the juice to ensure it meets your predetermined standards
9. **Make additions** of water, sugar, citric acid, or other juices as needed. A final soluble solids content of 10% and pH below 4.6 is recommended

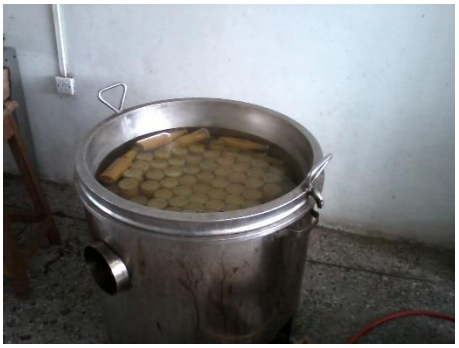


Bottling

10. **Clean bottles** and caps/corks
11. **Heat** juice to 60-80°C
12. **Fill** bottles with hot juice and **cap/cork**

Pasteurization

13. **Pasteurize** bottles with juice by submerging is water and **heating** to 85°C for 35 minutes.
14. **Cool** by placing in cool water and store at room temperature. Do not store in direct sunlight.



Packaging

Glass bottles are highly recommended for small scale juice production because, unlike plastic bottles, juice can be pasteurized inside glass bottles. This ensures proper pasteurization of both the bottle and juice, reduces risk of contamination after pasteurization, and reduces food safety risks.

Milkshakes

To make mango milkshakes, follow juice recipe above and add 5% milk powder. This will create a nice flavor and added nutrition.

Mango Jam

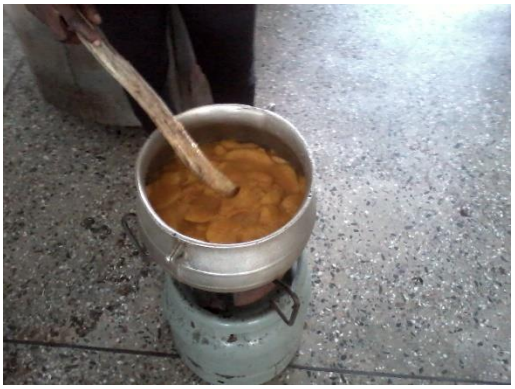
Introduction

Mango jam is a versatile sweet tasting paste that is simple to make and has a long shelf life. Jams are made by cooking fruit, sugar, and sometimes acid for an extended period of time until thickened. Jams are most often jarred and held at room temperature.

Protocol

Jam preparation

1. **Sterilize** cleaned canning glass jars by placing in boiling water for at least 1 minute.
2. **Wash**, **peel**, and **dice** mangos
3. **Combine** diced mango, sugar, and lemon in a ratio of 1 liter of mango, 0.75 liters sugar, and 15 milliliters of lemon juice (or 5-10 grams citric acid).
4. **Boil** and **stir** mixture for around 45 minutes.
5. **Test consistency** to ensure proper thickness. If not thickened, cook 4 minutes and test again.



Canning

6. **Sterilize** clean jars by placing in boiling water for 10 minutes.
7. When at the desired thickness, **fill** jars immediately, while jam is still hot. Leave at least 1.25 centimeters of air space at the top of the jar.
8. **Clean** rims of jars and **seal lids** on jars
9. **Submerge** jars in boiling water. **Boil** for 10 minutes, starting from when the water returns to a boil.
10. **Cool** jars in cold water and **check** seals. Store out of direct sunlight at room temperature.

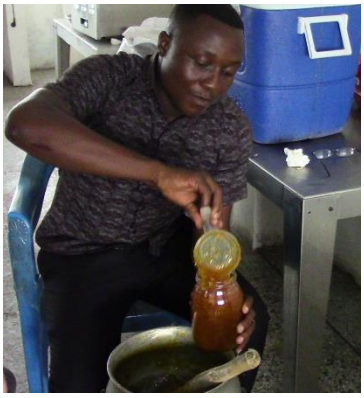
Fresh Cut Mango

Fresh cut mangos can be sold as a convenient snack or precut ingredient for customers of all ages. While processing of fresh cut mangos is simple some key factors must be considered.

First, fresh cut mangos are high in moisture and unpreserved. Thus, molds and bacteria can easily contaminate and grown on fresh cut mangos. Whole fruit should be washed and disinfected prior to processing. An example of an adequate disinfecting solution consists of 200 ppm (0.02%) bleach, which can be made by adding 5mL of 5% bleach to 1 liter of water. This solution should be changed regularly because the bleach loses effectiveness after multiple washes. Fresh cut mangos should be refrigerated at 4°C until consumption. Fresh cut mangos stored at 4°C have a shelf life of 7-10 days.

Second, mangos are damaged during the cutting process. Due to this damage, quality loss, particularly color change and flavor loss, will occur much faster than in whole mangos. Mangos should be dipped in an anti-browning solution, such as citrus juice in water, after cutting.

Third, mangos will continue to ripen after cutting. While fully yellow mangos should be used, firm mangos can be cut and will continue to ripen and soften throughout storage.



Mango Yogurt

Fermented milk products are among the most popular dairy products in the word. These products are high in protein, vitamins, and minerals. Yogurt is simple to make and can be mixed with mango products to produce a marketable, healthy snack.

Safety considerations

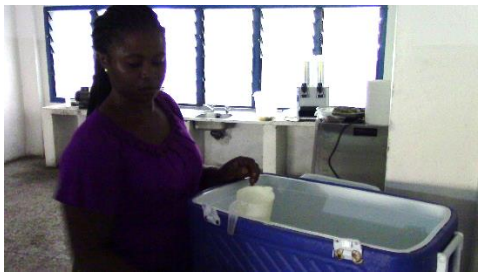
Dissolving milk powder in very hot water ensures milk safety and a successful fermentation. Any additions to the yogurt, such as mangos, should be pasteurized prior to mixing with the milk. Finally, ensure all materials that touch the product are clean and sanitized.

Protocol

Below is a protocol for the production of mango flavored yogurt. As with juicing, it is important to have all materials prepared prior to the start of processing.

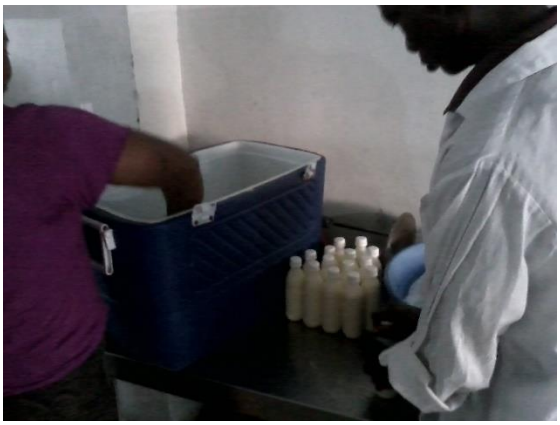
Materials

Milk powder and starter culture should be obtained from a trusted source and should be of good quality.



Fermentation

1. **Dissolve** milk in 90°C water.
2. **Cool** milk to 46°C
3. **Add** starter culture to cooled milk and mix thoroughly
4. **Ferment** at 43-46°C overnight.
5. **Add** mango juice or mango jam and stir. Recommended ratio of mango to milk is 3:10.
6. **Fill** and **Seal** bottles or packages
7. **Keep** refrigerated or frozen until consumed



Frozen Mango Dessert

The juice and yogurt mentioned previously can be used to produce many delicious and healthy deserts. Production of these desserts is often very simple and large profits can be made by selling these products. These products can either be packaged and sold frozen individually at stores and stands, or sold at markets by the producer.

Frozen mango bar

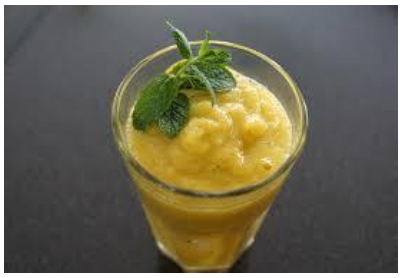
To produce frozen mango bars, simply freeze mango juice with added sugar or concentrated juice in rectangular molds. To help with marketing and consumption, a clean wooden stick can placed in each bar during freezing. Designing a child friendly label is suggested to help with sales. Mango yogurt can also be used to produce a different flavor and nutritional benefits. Recommended long-term packaging for frozen mango bars is sealed flexible plastic.

Soft frozen yogurt desert

Combining yogurt, frozen mango pieces, and sugar in a blender until smooth produces a smooth, soft, cold treat. This can be eaten with a spoon or out of an edible cone. Preparing frozen yogurt fresh at markets provides a cold treat on hot days and can provide customers with a fun, interactive experience. Recommended long term packaging for frozen yogurt is a rigid, waxed paper cup with a lid.

Mango smoothie

Mixing mango pieces, ice, and yogurt in a blender until smooth produces a pleasant, fruity, cold drink. Adding other fruits depending on the season will create new flavors and let customers add what they enjoy to their drink. Mango smoothies are recommended to be consumed soon after blending.



“American” Mango Milkshakes

Much like a mango smoothie, mango milkshakes can be made by blending mango pieces or a cooked mango product with ice cream and milk to produce a smooth, sweet beverage.

Composting Mango Waste

Introduction

Many of the processes discussed in this manual produce significant amounts of waste not useable in food products. Composting can be used to efficiently turn this waste into useful soil additions. Composting utilizes microorganisms to break down material until it is suitable for use in soil. Applying compost to the soil can add nutrients to the soil, as well as increase the amount of nutrients the soil can hold. Additionally, compost can help regulate soil moisture.

Composting is accomplished by mixing carbon rich “brown” material and nitrogen rich “green” material. Brown material can include dead (brown) plant material, woody material, or sawdust. Green material includes food processing wastes, living (green) plant material, or manure from livestock. A proper ratio of theses mixtures is key to efficient use of material and a beneficial end product. Below is a short protocol for the production of compost based mainly on FAO recommendations.

Protocol

1. **Build compost pile** by alternating layers of brown and green material. For best results, use two parts green material (such as mango juice waste) to one part brown material.
    a. For warm climates, make smaller piles to reduce over heating
    b. Minimum dimensions: 1 m^3
2. **Mix in** finished compost or topsoil to introduce microorganisms.
    a. Within the first week, the pile will increase in temperature to 60-70°C
3. **Turn** and **aerate** pile 1-3 times per week to aerate the pile and release heat. **Measure temperature** when turning pile to monitor composting progress
    a. Ensure compost reaches at least 60°C and does not exceed 70°C. High temperatures can kill composting microorganisms and cause fires.
4. Compost is finished and ready to use when the temperature reaches ambient temperature. **Spread compost** over agricultural land to improve soil nutrients and texture.

Considerations

Signs of a successful include the following:

- Reducing particle size
- Color change to brown
- Low or pleasant odors
- Growth of white fungus
- Steam rising during turning

Moisture content must be kept at between 40 and 65% for optimum composting. Too much moisture reduces aeration and can reduce heat production. Too little moisture will reduce microbial growth and slow composting.

If your compost pile smells like ammonia, your carbon to nitrogen ratio is too low. Brown material should be added to make the most effective use of the nitrogen present in your waste.