JULIE MANGO
IN THE EASTERN CARIBBEAN

A comprehensive manual

Caribbean Agricultural Research and Development Institute (CARDI)

The Technical Centre for Agricultural and Rural Cooperation (CTA)

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CARDI
P.O. Bag 212,
University Campus
St Augustine
Trinidad and Tobago
West Indies

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CTA, Postbus 380, 6700 AJ Wageningen, The Netherlands

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Safety

Safety is of paramount importance in developing a mango product. Microbiological considerations are the most significant safety problem and all products must be safe from food poisoning hazards. In general, products should have a pH of less than 4.4. Product safety can be improved with the correct use of permitted preservatives. In the processing of mango products, good manufacturing practices in relation to factory, equipment, and worker sanitation should be strictly observed.

Range of Products

Generally, mangoes with high acidity levels (lower than pH 4.5) are the preferred types for processing. Julie mango is not acid and is therefore mostly used as a fresh fruit and to a limited extent for juice and pulp.

Ripe mangoes are available in abundance for a short period each year. Full use of this production as fresh fruit may not at all times be possible. Therefore storage of the ripe mangoes in a form suitable for further processing is sometimes desirable.

Ripe mangoes can be successfully stored as pulp using a number of techniques such as freezing and heat processing. Mango processing in Jamaica is mainly in the form of drinks. Larger companies such as Grace Kennedy & Co. and a few others produce mango nectar and mango blended with other fruits into drinks. The puree for these operations is acquired mainly from fruits of Jamaica Company Ltd., which puree a variety of fruits for use by these companies.

Fruits of Jamaica process approximately 700 t of mango annually. Grace Kennedy reported that they were never able to acquire enough mangoes locally for their operations and often had to import puree to satisfy their need.

Certain procedures are common to the production of several different processed mango products.

Mango Processing Procedures

Fruit selection: Fruit should be fully ripe and free from disease or larvae for pureeing. This will give the desired colour, flavour, and yield.

Storage and ripening: The mature fruit can be stored in wooden racks in single layers. The racks should be designed to allow good air circulation and exposure to light. The fruits do not ripen well in poorly lit and ventilated rooms. Also, based on the production schedule, the quantities of fruit for processing can be controlled at this stage, i.e. the ripening process can be retarded by lowering the temperature, or accelerated by increasing the temperature.

Washing: To remove dirt, latex and foreign matter the fruit is washed in a soaker-washer with brushes. A detergent and 20 ppm chlorine can be added. It is then rinsed in a rotary

washer.

Manual Peeling: Using a paring knife.

Blanching: To aid skin removal, steam blanch for 2.5 minutes. This is followed by water cooling and then slitting the peel with a knife for easy removal.

Lye peeling: Fruits are kept at 90°C for 3 minutes in 20% lye (sodium hydroxide – NaOH). Water sprays and tumbling removes more than 90% of the peel.

In Trinidad, Chase Foods found that steam and lye peeling did not work satisfactorily for any variety (including Julie) due to the wide variety of shapes and sizes of the fruit.

Drying: This can be achieved using a solar drier in the Caribbean to maximize the use of abundant solar resources. Tunnel dehydration, drum drying, spray drying, vacuum drying, vacuum-puff drying, foam mat drying, osmotic dehydration, and freeze drying have been established as commercial processes for some time.

Pulp extraction: Complete separation of skins from pulp is not necessary at this point and inclusion of skins may even improve the flavour. Pulp extraction may be carried out by cutting and sieving; using paddle pulpers; dispersal in water using blenders followed by paddle pulping (unsuitable for green mangoes as it would cause darkening); or using a power stirrer followed by a combination of sawtoothed and regular propeller blades.

Pulping: This converts pulp to a smoother, finer puree. A paddle pulper and screen or a pulper with revolving nylon brushes and a screen, can be used to remove the fibre and the smaller pieces of peel.

Processing of Pulp

pH adjustment and acidification: At pH in excess of 4.5 110 °C is required to kill *Clostridium botulinum* spores but if the pH is adjusted to less than 4.5, lower temperatures are required and flavour changes are minimized. This lowering of the pH can be achieved using citric acid or acidic fruit juices such as lime. (In India the ideal pH may be achieved by blending pulp from various types of mangoes, thus avoiding any additives.)

Preservation of puree: This can be achieved by canning or freezing.

Canning:

- cans or polyethylene containers (PCs) can be used. PCs require the addition of sodium benzoate.
- flash pasteurize at 90 °C, can, and immerse in cool water.
- heat to boiling 100 kg puree with 0.5–3.5 gallons 70 °Brix syrup (depending on the sugar required in the final product). Alternatively heat with 80 °Brix syrup to 90 – 93 °C and hold for 2 minutes. Can, seal and hold for 5 minutes prior to cooling.
- some export markets require no added sugar. In this case heat pulp acidified to pH 4 to 85 °C, fill into hot cans, seal and invert. Heat process in boiling water for 15 minutes.

Freezing:

- heat to 90–93 °C for 2 minutes, cool rapidly to 32–38 °C.

Add sweeteners to achieve 42.5 °Brix. Can, seal, and freeze in a blast freezer at minus 67 °C for 3 hours.

- heat to 90 – 93 °C, hold for 2 minutes, cool rapidly to 32–38 °C and fill into 15 kg tins with polyethylene liners and freeze at minus 23 °C.

Bulk storage:

- bring the acidity to pH 4 by addition of Citric Acid. Heat to 65—71°C for 2 minutes. Cool to room temperature. Add 1000 ppm sulphur dioxide in the form of potassium metabisulphide.

Mechanization of these processes can be complicated by the fact that production levels in the Caribbean region are relatively small and thus, imported equipment is generally oversized, resulting in higher capital and operating costs.

CARIRI (Caribbean Industrial Research Institute), based in Trinidad and Tobago is engaged in a programme which focuses on the research, design, development and commercialisation of machinery and equipment for the agricultural and agro-industrial sectors. Presented below is a list of locally developed pieces of equipment available for mango processing.

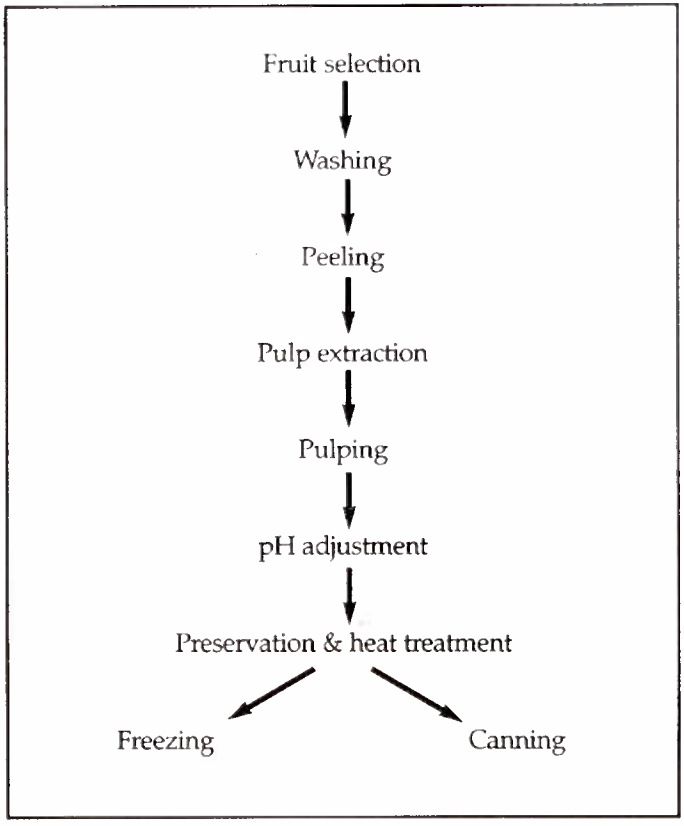
Juice Extraction (Pulp extractor)
Blancher/Cooler - 2 versions available
Multi-purpose Food Press
Semi-solids Filler
Mechanized Grater
Fruit Chopper

Mango pulp

This is the most common form of processed mango. Mango pulp is derived from sound, ripe mangoes. The fruit is cleaned, pulped and strained, before either aseptic canning or freezing.

For frozen pulp the product should be chilled before filling and then frozen promptly and stored at minus 14 °C. Frozen pulp should be packed in new, clean, polyethylene

Figure 12.1 Mango Pulp Flow Diagram



bags, usually containing 25 kg (55 lb) net. Canned (hot pack) pulp is normally packed in suitably lacquered A10 cans holding 3kg (6.6 lb) net. They should be stored at temperatures no higher than 21°C.

Mango pulp has a wide variety of uses, including baby foods, frozen dessert, ice cream, yoghurt, drinks, bakery products, syrups and toppings.

Mango nectar

Standards of identity have been established for various fruit products in many countries in order to maintain the quality of finished products and also to prevent and minimize deceptive processing practices. The State of Hawaii Standards of Identity for mango nectars, for example, specify a minimum of 33% mango pulp. However, practical experience has shown a nectar with 20–25% mango pulp to be more acceptable. Nectars containing more than 25% pulp are generally much too viscous to be considered a drink.

Formulations for mango nectars vary according to local and regional preferences. The following formulae have been developed:

Hawaii

Mango puree	43.5 kg
Sugar	13.6 kg
Citric acid	560 g
Water	77.2 kg

Philippines

Mango pulp	81 kg
Sugar	18 kg
Citric acid	0.4 kg
Water added to	180 L

India

Mango puree	52.5 kg
Sugar syrup (45 °Brix)	46.5 kg
Citric acid	50g
Water	52kg

Dried mango

In Dominica it was found that Julie mango was more suitable for drying that the fibrous Long mango. Any mango containg at least 50% pulp was reported to be acceptable.

Mangoes should be harvested at maturity stage II (when shoulders are level) and allowed to ripen in crates in a warm storeroom. They are then selected for processing at the 'firm ripe' stage or at 14–15 °Brix. The processing steps are as follows:

- wash in cold water and weigh
- hand peel and slice flesh off the seed on both sides. Cut the slices longitudinally in two
- immerse slices in 50% sugar solution (white refined), which has been inverted by previously boiling for 15 minutes with 0.1% citric acid. Leave in the syrup overnight.
- drain and wash in cold water
- dry in an electrically heated cabinet at 50 °C for 10 hours to a moisture content of 15%. The yield of dried product is 15%

- pack in 50 g packages, seal and label.

Dried mango cubes

Peel, cut into 1 cm cubes, soak in 30° Brix syrup for 2 hours. Spread on a black low density polythene sheet directly in the sun, or in a tent-type or cabinet-type solar drier. Tent-type driers take approximately 7 days to dry the fruit, while cubes take approximately 10 days in the open sun.

13 Economics

Mango production systems

Mango production systems commonly found in the region vary between landscape trees planted close to a dwelling, isolated trees planted amongst other crops or as windbreaks, and orchards. Farmers say that mango trees are sometimes planted to increase land values or to increase access rights to a questionable piece of land. Land owners and farmers therefore have different motivations for growing mangoes, not all of which are closely related to producing high yields of good quality fruit.

The orchard system represents the highest level of 'order', where the farmer or manager's objective is normally to maximise profit from mango. Such a system is less well suited to risky production and marketing environments. By contrast, an intercrop system represents a lower level of order where the farmer is more likely to be maximising expected income in a riskier environment from an assortment of crop enterprises, one of which is mango.

While arguments for and against monocrop systems continue amongst the technicians, farmers meanwhile assess the various trade-offs as they affect them every day. It seems reasonable to suggest that with increasing access to markets, improved production technologies and increased access to finance, farmers will increasingly adopt more intensive systems.

Since the early 1980s Julie mangoes have been established either as monocrop orchards or interplanted with bananas, with the intention of removing the bananas as the mangoes increased in size.

Costs and returns

The costs and returns of mango cultivation (Table 13.1) have been updated from calculations made in the early 1990s in Dominica and other Eastern Caribbean countries. These figures represent an unintensive orchard system with around 125 trees/ha at 1995 prices. It should be noted that these costings do not include pest and disease control, which was not practised by most farmers at that time, and is still not practised by many farmers. In addition, Grenada and St Vincent are free of fruit fly, and do not need to practice control of this pest.

The following discussion is based on these figures.

Yield

Extreme variability in yield has been observed between trees of the same age in different locations within the region. A combination of agro-ecological zones and management factors is normally the cause of this variation.

Figure 13.1 illustrates yield data collected as part of cost of production studies carried out in the Eastern Caribbean. This data shows that maximum marketable yields are attained when the mangoes are 6–8 years. The slower speed with which mango in the Leewards matures may relate to water stress and can be overcome through water