MANGO PROCESSING AND PRODUCTS

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Mangos are an important part of the diets in certain parts of the world. The edible portion of the fruit varies from 55 to 75 percent depending upon the variety. Most of the mangos can be characterized as having a high sugar content (15–20%) and a low acid content (0.2–0.5%), which would account for mangos' sweet, pleasant characteristics. Nutritionally, mangos are a good source of vitamins A, C, and fiber.

The variety of processed mango products is endless, and variations exist from country to country and region to region. We can peel, slice, chop, dice, and puree mangos, which we are able to preserve by dehydration, canning, bottling, freezing, and pickling. You would recognize these mango products as dried fruits in trail mixes, or as canned fruit slices in syrup, or as nectars, juices or blends in tropical fruit punches, or as jams and jellies, or as mango chutney. Chutney is derived from salted green mango slices and constitutes the largest commercial volume of processed mango products.

Mango products such as canned or dehydrated chunks or slices require considerable amounts of manual labor to peel, trim, and slice; hence most of these products are produced in developing or emerging countries where labor is inexpensive. For the developed countries where the cost of labor is prohibitive, highly mechanized processes are desirable. The manufacture of mango puree is a good example of a highly mechanized process which requires less labor and offers other advantages, such as that the process makes use of fruit not suitable for other products, and the product can be used in other products such as jams, beverages, and dairy products as a flavoring ingredient, or as a fruit filling in pastries. Such product diversity expands the market potential for mango puree.

Whether the final product is puree or slices, processed mangos undergo several common unit processes such as sorting, washing, and peeling. Peeling is generally done manually and is facilitated by steaming the fruit for 1–2 minutes to loosen the peel, which is slit with a knife, and the peel can be further removed manually.

Mango puree is produced by taking the steamed and slit fruits and passing the fruit through a Bertuzzi Mango Creamer pulper fitted with 0.060-inch screen and nylon bristles for paddles, which pulps the fruit and separates the pulp from the skins and seeds. The pulp is then passed through a finisher fitted with a 0.020-inch screen to further remove fibers to produce a smoother consistency. The puree is then acidified to pH less than 4.5 with the addition of citric acid to prevent botulism. The puree is then prepared for preservation by passing the puree through a heat exchanger. The heat treatment is necessary in the case of frozen storage to inactivate the fruits' enzymes, and, in the case of canning or aseptic processing, both enzymes and micro-organisms must be rendered inactive. The heat treatments can be accomplished using heat exchangers that heat and cool the puree. In the case of an aseptic or frozen product, the puree is acidified to pH 4.2–4.3 and then passed through a heat exchanger where the puree is heated to 204°F, held for two minutes in a holding tube, and then cooled to 85–90°F. The puree is then pumped, in the case of a frozen product, to a pre-chiller or a slush freezer, which chills the product to less than 40°F. The chilled product then is filled into 40-lb poly-lined cartons, which are then frozen in a blast freezer. In the case of an aseptic product, the puree is pumped after cooling to an aseptic filler where the puree is filled into a pre-sterilized polybag under aseptic conditions. The aseptic bags can vary from 1 to 300 gal. The most popular sizes are the 5-gal and 55-gal containers.

The puree appears commercially in nectars, juices, ice cream, yogurts, baby food, jam, jellies, and fruit syrups. Within the past few years the largest increase in consumption of mango products within the U.S. has been the consumption of mango juice and mango puree packaged in baby food jars. The large increase in consumption of mango juice is part of the world-wide increase in fruit beverages, and within the U.S. the increase in consumption reflects the changes in ethnic composition, which have prompted a large baby food manufacturer to promote tropical fruit ingredients in its food line.

References

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Appendix: Slide Presentation

The following comments provide a comparison of the differences in operation in terms of labor requirement between canned mango slices in Thailand and an aseptic mango puree operation in Guatemala.

Canned Mango Slices

This is a fruit canning operation in Ratchaburi, Thailand. I was accompanied on this visit by a group of food inspectors for the Thailand Export Standards Bureau. This is the fruit receiving station. Here the fruits are sorted out with the higher quality fruits being packed out for sale on the fresh market. The remaining fruits are allowed to ripen under a burlap cover.

Many workers are employed in hand peeling the fruit. The workers make 50 bhat per day, which is about $2.00. The workers are gowned, capped, gloved, and masked. It is a very clean operation; Thai export standards are very high.

The peeled fruits are placed in the tubs of brine solution to inhibit browning. The cheeks of the mango are sliced by hand from the sides of the mango seeds. The slices are packed into the cans by hand and checked for fill by weight. The fruit slices are then covered with a syrup. The cans with fruit and syrup are then placed in a steam box called an exhaust box to heat the fruit and syrup which expels air and oxygen from the product. The exhausted cans, while still hot, are covered with the cover lid and seamed. The canned mangos are then cooked in a pressure cooker called a retort to sterilize the product. As typical in many developing countries, the labeling is done manually; while this may appear to be inefficient, you must remember that these people are earning the equivalent of US$1.00-2.00 per day, and in this type of operation they are being paid piecemeal, or by the number of cans labeled.

Within the quality control lab was a display of the many products canned at this plant from asparagus to lychees, rambutans, bamboo shoots, mangos, and pineapples. All of these canned products require a considerable amount of hand labor.

The Mango Industry in Guatemala

I consulted for a fresh mango fruit packing and aseptic mango puree operation near Guatemala City. The mangos packed at this plant are of the 'Tommy Atkins' variety. This cultivar had been recommended by consultants from Florida; it is a good shipper but a poor processing fruit. About 500 hectares of 'Tommy Atkins' had been planted in Guatemala by the time EDB use was suspended. The plant also uses mangos collected from wild trees; these fruits are very stringy but make good juice.

The mangos are delivered in plastic lug boxes. The fruits are sorted by size and maturity and hand waxed. Each fruit is individually labeled. The mangos are then packed in cartons for delivery.

Within the same plant where the fresh fruits are packed is a mango puree plant. The mangos are allowed to ripen in their lug boxes. The fruits are dumped into an elevator/conveyor belt. On the conveyor belt the fruits are sorted and trimmed. For certain varieties of mangos, steaming the fruit for 1-2 minutes helps in removal of the skin during pulping. It also lowers numbers of microbes on the skin. Here the fruit are shown entering the steam tunnel. The fruit then traverse an inspection belt where the fruits are further trimmed and slit to help in the removal of the skin. The mangos are then passed trough a special piece of equipment called a destoner, which removes the skin, pulp, and seed. As shown from the waste discharge, the seed or pit is being discharged.

This shows the exposed inside of the destoner which consists of set of nylon bristles rotating against a set of large gapped screens. The pulp is then passed through a pulper to remove some of the fiber. The pulp is further screened through a second pulper fitted finer screen to produce a smooth consistency to the puree. Mango puree must be acidified if it is to be processed, in order to prevent botulism. Here the plant engineer is calibrating the citric acid metering pump. The acid is delivered during the finishing process were the acid solution is mixed into the puree to lower the pH to below 4.4. The acidified pulp is then pumped to a set of stainless steel vats where the pulp is further adjusted to for pH and the volume of puree is allowed to accumulate. The puree is pumped to a set of scraped surface heat

exchangers where the puree is heated to 204°F and held for two minutes to inactivate enzymes and kill the microorganisms to render the puree aseptic or germ-free. The puree is pumped from the holding tube to a triple tube for pre-cooling and then further cooled in a scraped surface heat exchanger to 85°F. The puree is then pumped to an aseptic filler where the product is delivered aseptically or germ-free to a sterile, gamma-irradiated plastic bag, which can vary in size from 1 to 55 gal.

This plant has, as any aseptic processing plant should have, an alternate power supply. If there is any power outage during a processing run, then the whole batch is ruined.

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Q: Is this processing equipment available in Hawaii? Are there companies here that do this kind of processing, and could they expand their product range to include mangos?

A: Most of this equipment is available in Hawaii, and there are fruit processing companies here that could adapt their processing facilities to accommodate mango. The main item of equipment they would need to add would be the mango destoner, which costs about $30,000. The problem would be with supply. You can't run these systems with a few lugs of fruit. The plant in Guatemala was processing 5,000–10,000 pounds per hour. They would run 24 hours a day, six days a week, clean up the system on the seventh day, and start again. Processors in Hawaii do not usually run all the time like that. But with most fruits the main share of production gets channeled to the fresh fruit market; you need a large enough industry to create culls before you can process culls. The farmer makes it on fresh fruit prices, not cull prices. Mango aseptic puree from Guatemala is selling for around 45¢/lb, and from that you can estimate how much the processor has to buy the fruit for to make his margin.

Q: Then labor for culling would be a limiting factor here?

A: I don't think so. You have to cull to get rid of the rotten fruits and keep the mold counts down, but the labor for aseptic puree processing is nothing compared to what is required for the canning operation I described.

Q: Sometimes we have a lot of green mangos blown off our trees. Can these be preserved with some combination of salt, sugar, shoyu, and MSG?

A: That's a local-style way of flavoring green mango, but it's usually consumed as quickly as it is made, or after being refrigerated for a short while. At the concentrations of ingredients added in those recipes, it is really for flavoring rather than preserving. Without refrigeration, mango prepared that way will rot. The rate of rot depends on temperature and microbial load, how clean your knife and cutting board was. MSG, by the way, is not in itself harmful; it is present naturally in many foods such as mushroom and tomato, and it is a building block of glutamic acid in our bodies.

Q: Sometimes in Zanzibar we have problems with fermentation in our pickled mangos. How can that be avoided?

A: That depends on the pickling process, acetic acid or salt brine. Usually sanitation is the main problem. Brine is a preservative, and the mango needs to be as clean as possible and get into the brine quickly. Heat processing will stop the fermentation, but there are a lot of variables that need to be considered when you develop thermal food processing methods.

Q: Dried mango as snack food seems to be an unexploited possibility; what would be involved in that?

A: A dried fruit operation would require hand peeling and hand slicing, which would be labor intensive for Hawaii. Much of the dried mango from Southeast Asia has been sugared. If it is at all moist and pliable and is shelf-stable, then it has been sugared. That means that for every pound of dried fruit you buy in that form, half of it is cane sugar.

Q: Can't we develop machinery to piece-cut fruits for processing?

A: It is very expensive. A contour peeler for papaya would cost about $100,000 to design and build. It would be expensive to run and difficult to maintain, and would have low throughput, not like a pineapple Ginaca machine.