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THROUGHPUT AND COSTING OF SOFT FRUIT PROCESSING

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ABSTRACT

West Indian Cherry (*Malpighia glabra*) fruits were harvested, cleaned, and either pressed immediately or frozen. Fruits were either crushed, or thawed and crushed in a one-horsepower stainless steel grape crusher at a rate of 20 kg per minute. The crushed pulp was top-loaded into a 70 l. capacity bladder press, which utilizes water capacity at 3 atm. to expand the bladder, thereby squeezing the pulp. The press capacity is about 230 kg of pulp with a load and press cycle taking 25 minutes. Juice recovery was approximately 65% for fresh fruits and 70% for frozen fruits. Juice was filtered and introduced into either new 2 l. plastic drink bottles or 19 l. lined pails and frozen. A three-person crew was able to complete a crushing, pressing, and filling cycle which produced 150 kg juice in 40 minutes, for a direct labour cost of U.S.$.05 per kg. Press equipment, containers, freezing and building costs are discussed.

INTRODUCTION

The modern food system is a complex integration of primary production, food processing, packaging, distribution and retailing operations. Each component builds value by improving food marketability. To remain competitive, smaller economies should be aware of trends in consumer societies. Changes in cost allocation have occurred in the United States food system over the last 40 years. While the total value increased five-fold from U.S. $71 billion to 350 billion, the farmer's share has declined from 27% to 20%. Presently, processors receive approximately 21% and the distribution sector (wholesale and retail) obtain 42% of the final selling price of food (Members of the Research Committee, I.F.T., 1988).

Export agriculture in the West Indies has typically consisted of primary producers selling their crops to extra-regional companies who can distribute the produce and/or have the technical expertise and facilities to convert the raw product into finished goods. Raw cane sugar, spices, fresh oranges, mangoes, bananas, cotton and root crops are all either exported "as grown" or primarily processed in order to facilitate handling and shipping. This is appropriate for low technology systems, for local consumption or for crops with special characteristics, but it is difficult to satisfactorily move volumes of perishables into outside markets.

Food processing takes a product and manipulates it using chemical, biological, or mechanical means to change its qualities (Ibid.). The agricultural goals of self sufficiency, minimizing the swings of glut/scarcity cycles, extending shelf life, meeting escalating consumer demands, and providing increased employment through value added product have highlighted the need for processing and packaging facilities throughout the region. These

goals are subject to the acceptance of the finished product which must be evaluated on the "six components of consumer preference - convenience, price, nutrition, variety, quality, and good taste" (Veblen, 1988).

There are few Caribbean success stories due to many factors, including but not limited to the underavailability or excessive costs of raw product for processing, inconvenient scale of equipment sizing (small may be inefficient and large too costly for the volumes of production available), lack of suitable cultivars for processing, expensive packaging costs, small local markets, expensive transportation to larger markets, lack of sophisticated technology to compete in the global marketplace, and marketing which fails to keep pace with that in the industrialized nations (Bates and Brokaw, 1987).

For those entrepreneurs who do not wish to export, but would rather take advantage of lucrative local markets, food processing may become a viable cottage industry. Individuals or cooperatives within the farming community may be able to conceptualize and obtain financing for small processing plants, and it is anticipated that many diminutive operations could be suitable for island producers. It is in this context that a report on our experiences with the Barbados (West Indian, or acerola) cherry are presented.

With the high vitamin C content of these fruits (Asenjo, 1953), and the currently increasing world market demand and scarce supply, it offers an opportunity for specialization in a large marketplace, or in the local and tourist trades.

METHODS AND MATERIALS

Fruits were harvested either by shaking the tree and collecting the fruits falling onto a mat placed under the tree, or by hand picking. They were cleaned in a fiberglass trough, the culls sorted, and then either frozen whole in a standard .5 m^3 freezer, subsequently thawed and crushed, or put through the crusher as raw fruit. The crusher is an Italian-made one-horsepower grape crusher, consisting of a worm-drive screw and two intermeshing plastic drums. All the pulp is collected after falling through the plastic drums.

Pulp was passed through a 70 l. bladder press also manufactured in Italy. This has a heavy-gauge steel bottom and lid and wooden slat sides, lined with a fibreglass pressing cloth with openings measuring 2mm. A durable synthetic rubber bladder can be expanded using either air or water pressure, which is supplied through valves on the underside of the press. Safety against over-pressurizing is provided by pressure release valves opening at 3 atmospheres.

The pulp was top-loaded into the press, the lid secured, and water introduced into the bladder to make it expand, pressing the pulp against the wooden slat sides. Juice began pouring out before the pressing began, but flow increased as pressure increased.

The expressed juice was collected in cleaned buckets and pumped through a cloth filter. Pad filters could also be used, but we were not interested in producing a highly clarified product.

Filtered juice was put in new 2 l. plastic containers, or bulk packed in 19 l. pails with plastic liners, and frozen. No preservatives or other additives were used.

RESULTS AND DISCUSSION

Pulping is accomplished at a rate of 20 kg/min., whether the fruit is fresh ripe or thawed. Processing delays were encountered in cleaning and sorting the cherry fruit or waiting for frozen fruit to thaw.

Peak juice expression declined after 15 minutes of pressing. The juice was quite clear as it flowed from the press. Juice yield was approximately 65% by weight from the fresh cherries, and 70% from frozen cherries.

Juice transfer into bottles or pails was easily effected. Juice taste remained good to excellent following slow freezing and subsequent thawing. Time delays in processing resulted in some fermentation of the product.

A complete cycle can be run in 40 minutes with a crew of three people. "On the job" training was the only instruction given, and all that was necessary, the equipment being simple to operate.

The processing runs were successful in producing palatable juice from the fruit. The fruit did not always arrive in good condition, so that on several occasions large-scale culling was necessary. Other times, the fruit was in perfect condition.

Washing and culling proceeded without problems. The crusher and the press worked well and consistently. Juice collection was straightforward.

The problems encountered were predominantly storage problems, both of the fruit and the juice. Fruits are picked during the working day, and often arrive late in the afternoon, necessitating either overnight storage or overtime employment. With our highly perishable crop, cold storage is required. Juice is easier to store due to the reduction in bulk. However, large BTU freezers are recommended to freeze the juice quickly and reduce the chance of spoilage.

Efficiently filling small containers requires special equipment, which was not available. However, the exit hose from the filter can direct juice into the 2 l. bottle opening. Bulk filling was easily accomplished.

It appears that the actual processing is cost compensating. In Barbados, handling and freezing costs are expensive (see Table 1).

To provide 60 mg (100% of the U.S. Adult Minimum Daily Requirement) of vitamin C, we need to ingest only 4 ml of cherry juice. The market seems willing to pay up to 1 cent per serving, or $2.50 per kg Our cost in 19 liter containers was $1.22 per kg before overhead and profit.

When used with an inexpensive base, it appears that cherry juice production is a viable product for small scale processing.

Table 1. Costing of cherry processing in U.S. Dollars, for small cale processing of Barbados cherry. Costing does not include office expenses, overhead, or profit.

ITEM	MATERIAL COST	LABOUR COST (/Kg)	OPTION 1 (2 l cont., / Kg).	OPTION 2 (19 l pail / Kg).
MATERIALS				
Fresh Fruit	$.50/Kg			
Fruit @ 65% yield	.77/Kg		.77	.77
2 liter container	.37/Kg		.37	
19 liter pail (used, cleaned, + liner)	.08/Kg	.04		.12
200 liter drum, (used, + liner)	.04/Kg			
PROCESSING				
Commercial freezing	.09/Kg	.025		.115
Own freezing	.03/Kg	.005	.035	.035
Clean and sort		.022	.022	.022
Pulp		.01	.01	.01
Press		.02	.02	.02
Filter and fill		.02	.02	.02
Utilities	.01/Kg		.01	.01
EQUIPMENT AND PLANT				
Crusher	$1800.00		.10	.10
Press	5000.00			
Filter	1500.00			
Freezer	1250.00			
Building	6000.00			
	$ 15550.00		$ 1.35/Kg	$1.22/Kg

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