STAHL: FROZEN TROPICAL JUICE

These wastes were pumped to the storage tank and used as required to make up the lime slurry for addition to the chopped peel. No inconvenience was experienced by the Feed Mill operators since the resulting mixture had much the same characteristics in operation as the straight lime slurry to which they had been accustomed. The sodium content in both our pulp and molasses increased, of course, but the ash content actually decreased. Scale formation in the molasses evaporators was practically eliminated and the system proved to be very successful.

Operators of feed mills using slurry should consider the advantages of using dilute waste. The average plant uses about 500 gallons of water per hour to make up the slurry. In our own case, a measurable improvement was effected by keeping this amount of waste out of our disposal system. An additional 200 tons of molasses was recovered per season with no increase in operating expense.

COMMERCIAL POSSIBILITIES OF FROZEN TROPICAL FRUIT JUICE CONCENTRATE

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It is just 8 years ago that I gave a paper on frozen orange juice concentrates and presented the first taste samples of frozen orange and tangerine juice concentrates to the 1944 Horticultural Meetings in Winter Haven. Everyone adjudged these samples as very good and immediately everyone was interested in the potential of frozen citrus juices as shown by these samples. We have gone a long way with the frozen concentrate since that day and are still working on problems of better quality and economy of those products. No one thought then that this item would be the number one in sales of all frozen foods in the United States in just 8 short years.

You will all have to agree that frozen citrus juices have become one of America's most important food items, largely because of its high nutritive value in addition to its good taste. What has been done in processing of orange and grapefruit juices can also be done with other of our fruit crops, especially those with equal or higher nutritive values and also of good flavor. A large percent of our frozen citrus juices are sold because of the high vitamin C content of the product. We will drink orange juice seven mornings a week because it is good and we know it is good for us, but every now and then even we Floridans desire a change and drink other fruit juices of lesser taste and vitamin content. These were mostly made from fruit grown in the temperate climates like prunes, apples, and grapes.

We have been finding by comparing the composition of fruits grown in the temperate zone with those grown in the tropics or subtropics that those grown in the tropics are much higher in food values. Most tropical fruits are on the tree from 6 to 12 months before maturing, as compared to 3 to 5 months for those grown in the temperate zone, thus allowing a longer time for food storage resulting in higher nutritive values in most all of our tropical fruits. Many of the tropical fruits do not lend themselves to long distance shipment and as a result, huge quantities of these fruits are wasted each year. Outside of citrus fruits and pineapples, very few tropical fruits are preserved whole or as juices. Very little research has been done on the preservation and processing of tropical and sub-tropical fruits and fruit products. The most common type of tropical fruit product has been the jams and jellies. So much of the vitamin content and nutritive value of our tropical fruits are destroyed in the long heat process of jelly making. Canning the whole fruit by heat preservation has resulted in mediocre products in most cases and have resulted in destruction...
of much of the nutritive value of the fruit. Many of the fruits grown in the tropics are low in acidity and are much too bland in flavor to make good single strength juices. We have therefore been researching for methods of preserving and processing these valuable foods whereby the high nutritive value would be preserved and the way in which they were presented would be tasty and acceptable or even preferred by the general public to those already on the market.

One of the lines of research which has resulted in products which seem to have the best potential for becoming widely accepted as every day foods is that of tropical frozen fruit concentrates. This paper is a short report of some of the better tasting and highly nutritious fruit concentrates made from those fruits which are grown in South Florida and in the Caribbean area, in great abundance in some cases and others being only found in wild state in abundance but which could be grown in large acreages.

For a breakfast drink, it has been proven that the public prefers a drink which has the consistency of orange juice, the brix of single strength orange juice and our acid-sugar ratio of orange juice. The public has accepted a slightly higher acidity in their party fruit drinks, but they are also high in sugars. They like that combination which is sweet yet acidly tart, like in lime and lemon drinks. Many of our fruits do not have this fortunate combination that occurs in nature in the orange, yet are even more nutritious than the orange, so the research job is to find ways in which these juices can be presented so that they will be accepted by the public and their high food values be beneficial to our hungry world.

Among the tropical frozen fruit juice concentrates which we have made, we have found the following ones to be most readily accepted by the public: Mango, guava, papaya, Barbados Cherry and antidesma.

When the juice of any of these was extracted and this juice concentrated either by the vacuum or by the freezing method, they were good but in most cases were too bland or too sweet for ready acceptance by the public. The variation in taste of the fruit is greater than it is in oranges so that a constant product can not be obtained. The juices of many of these fruits are too thin and have too few floating solids to make a good drink. The best juices were made with some of the pureed pulp added back to give color and substance to the drink. We have found that the American public likes a fruit drink which has floating particles in it or something they can feel as well as taste. Because we found none of these juices when used alone as good as orange juice for a breakfast drink, or lime or lemon juices for a party drink, we began a study of blending the fruit purees with these citrus juices.

**Blending Purees With Orange Juice**

Single strength orange juice was found to be a splendid matrix for mango, guava, papaya, and Barbados Cherry purees. We were trying here to find a use for the low internal quality oranges which cannot be readily marketed. Much of the low brix juice, especially that of the early orange varieties, can be made into wonderful drinks by the addition of one of these tropical fruit purees. In every case, the vitamin C was increased and the specific gravity raised from 8 or 9 brix to 11 or 12, thus resulting in a drink of high nutrition and at the same time being very tasty. In the case of the Barbados Cherry, the resulting juice was very much higher in vitamin C than the original orange juice. These juices were best when marketed under refrigeration (35 to 40° F.) but also could be frozen which brought in the problem of long thawing time. The additions of the purees to the orange concentrate (3 to 1) gave a much better product and a much easier product to market. Low quality fruit of 8 or 9 brix could be four times concentrated and the resulting concentration brought up to a 42 to 44 brix by adding the juice puree of these tropical fruits. Color improved in all cases, the yellow orange color of the papaya and mango caused a deeper orange shade of the juice, while the pink and red color of the guava and Barbados Cherry purees very definitely changed the color from yellow to orange. In all cases, it was an improvement over the original color of the orange juice. The taste was exceptionally good, the orange juice taste predominating, but the taste of the other fruit adding much to the bouquet.
Lime and Lemon Juices Blended With Tropical Fruit Purees

Using lime and lemon juices as the concentrate to which mango, guava, papaya, Barbados Cherry and antidesma purees or juices are added have resulted in some very outstanding economical, nutritional, and good tasting products.

Lime and lemon juices are concentrated by nature. They have from 5 to 7% acidity and to make them palatable, one has to dilute them from 5 to 7 times. Sugar must be added to make them palatable and even though the original juice has a goodly amount of vitamin C, the lime or lemon drink is low in Vitamin C. When enough of the purees of mango, papaya, Barbados Cherry, guava and antidesma and sugar are added to the extracted lime or lemon juice, the juice is brought down from 5 and 6 times concentration to 4 times concentration, the resulting mix being about 1/3 lime or lemon juice, 1/3 fruit puree and 1/3 sugar. The resulting concentrate is around 42 brix and is a soft frozen mass at 0° F. The resulting mixture is really not a concentrate in the true sense but by adding 3 parts of water to the frozen mass you have a fruit drink which has the flavor of the fruit puree added, the consistency of a good fresh fruit drink, the acid sugar ratio of a good citrus juice and a vitamin C content equal or above that of orange juice in the case of all but antidesma, and a really superior flavor.

The cost of production is low. In making these concentrates, it is not necessary to have the costly equipment needed in making frozen orange juice, but it is a case of extracting the lime juice, pureeing the pulp of the fruit to a fine consistency, and adding sugar. For example, one bushel of guavas will give you 4 gallons of puree. One bushel of guavas costs $1.25 per bushel. One bushel of limes will give you 3 gallons of juice and limes average around $2.00 per bushel. Roughly speaking, about 25 pounds of sugar are added and sugar is 8 cents per pound. We have a resulting mixture of roughly 9 gallons of concentrate. To this is added 3 parts of water giving 36 gallons of fruit drink per bushel of limes and guavas. Compare this to the volume of concentrate obtained from a bushel of oranges and you can readily see the economical aspects of these concentrates. Furthermore, no expensive equipment is necessary for the removal of water from the juice to make the concentrated juices.

Considering the problem of supply of the fruit for these food products, we would like to discuss each one in turn:

Mangos are produced in the southernmost counties of Florida and throughout the Caribbean area. In Florida there is a limited amount grown but many more could be grown. Every year tons of this fruit are wasted because the high fiber varieties are not utilized because of this fiber in the pulp. These fruit which are now being wasted in large amounts can be used for making the mango concentrate as the fibers can be removed by pureeing. Many of the varieties which produce heavily each year, but do not have as attractive appearance as our popular varieties which are sparse bearers, are ideal for this product and could be grown in abundance in Florida. A large amount could also be brought in from the Caribbean Islands and Central and South America where there is an enormous waste each year.

Guavas are most plentiful throughout the American tropics and many tons are wasted each year in Florida alone. Here is a crop which can be grown on all types of soils and has possibilities of being grown on our marginal lands to give high production. It has from 5 to 20 times more Vitamin C than orange so could well become a major crop in Florida.

Papayas grow well in Tropical America. It is a short time crop — mature fruit can be had 9 to 12 months after seedling planting. They do not lend themselves to long distance shipment so are planted sparsely now. Large productions could be obtained in a very few years if the demand for growing the fruit was made possible by such products as the frozen papaya concentrate.

Barbados Cherry has the best future of any fruit outside the orange that we could grow in Florida. It is easily grown, will do well on most soils and produces heavily and bears several crops a year. It has more vitamin C than any other food item we have tested and this one fact alone, along with its splendid flavor, should send it to the top as an American food item. It can be used alone or blended with many other juices. It is so easily processed in that the whole fruit can be placed into the puree machine and the seed removed.
automatically in this way. The University of Miami has planted five acres of Barbados Cherries 2 years ago which are already in production. We will soon have figures as to the production per acre and recommendations as to planting and cultural care of commercial plantings and indications are that they can be grown very economically.

Antidesma is another plant which is only grown in Florida to a limited degree, but could be planted in acreages. The production is very high per plant and tons of these berries could be grown should the demand for such products as the frozen concentrate become popular.

All of these frozen fruit concentrate products which we have discussed here require lime or lemon juices and sugar in their making. These are Florida products and could be grown in greater abundance. There are many limes and lemons grown in the American tropics which are wasted each year. Even in Florida, we have thrown away many limes especially mature ones because the fresh fruit trade has been educated up to a small green lime, and a mature lime is just turning yellow when it is at its best yet these are discarded. These give the best products when processed.

In reporting this research, it should be pointed out that the object of the research has been to find uses for waste material which is of high nutritional value and to find more crops for Florida. We need to have more than one fruit crop to make our State more economically sound. I don't mean that we should neglect the citrus crop, but we should find other crops which can be as easily or more easily grown on our soils which would help feed the fast growing population of the earth and at the same time give work and a better living to the ever increasing population of our good State of Florida.

We predict that in eight years time many of these fruit concentrates will be on the market and a familiar item to the many millions in North as well as South America. We have the guava concentrate already on the market and hope to have a pilot plant production of the others this next season. There is a great potential in many of our tropical fruits to be presented to the public in processed form. We are presenting samples for you to taste and hope that they will receive the same spontaneous reception and interest that those first samples of orange juice concentrate had just 8 years ago.

"PAIRED COMPARISON" TASTE PANEL PROCEDURES FOR CITRUS JUICE

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INTRODUCTION

Taste panel procedures generally require the tasting of two or more samples and decisions are made by comparison as to difference and preference. When the product has strong flavor characteristics which tend to linger in the mouth, taste acuity decreases rapidly and taste response becomes more confused as the number of samples or comparisons is increased.

Binomial designs (4) which include the triangle method (3) have been developed to increase sensitivity by increasing the number of taste comparisons an individual must make between two samples. Advantages gained through design in these methods are lost for many tasters of citrus juices because of a marked decrease in taste acuity as successive comparisons are made. Taste panel methods now in use (1) (2) (5) have been developed on various food products, but no systematic studies have been reported to show how applicable they are to citrus juices.

The method described in this paper has been developed and tested on orange juice. To reduce the confusion of tasters, no more than two comparisons are required at any one