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HAWAII TROPICAL FRUIT FLAVORS

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HAWAII TROPICAL FRUIT FLAVORS IN ICE CREAMS, SHERBETS, AND ICES

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Fresh tropical fruit flavors in ice creams, sherbets, and ices have been gaining greater acceptance by the buying public. Many of these fruits have distinct and exotic flavors (7), and many also have excellent nutritional qualities (8). Some of the lesser known tropical fruit flavors not produced in any commercial quantities are still beyond the reach of ice cream manufacturers purely on the basis of excessive cost. This situation can be remedied; one of the aims of the present work has been to create interest in new fruit flavor possibilities.

During the past four years the University of Hawaii Food Processing Laboratory has been studying and developing new and better uses for the many tropical fruits which grow in Hawaii. The Hawaii pineapple is well known to every one. Other fruits such as the banana, avocado, coconut, and papaya have been introduced to the mainland consumer. There are a number of lesser known fruits which have far greater commercial possibilities than they now enjoy; among these are passion fruit, mango, guava, lychee, and soursop.

One of the possible commercial uses of these fruits is as flavors in ice creams, sherbets, and ices. The purpose of this circular is to present the results of our survey work in this field. Our primary object was to determine whether or not these fruits are suitable as a flavoring for frozen desserts. Our approach was quite general and did not deal with the problem of body and texture defects that might be associated with each fruit flavor. In all cases, the fruit was used as a puree, usually in the frozen state. Since solid chunks or pieces of fruit were not used, there was no texture problem involving ice crystal formation. Pertinent information is given about the characteristics of the puree when stored below freezing. All the basic ice cream and sherbet mixes were obtained without modification from local commercial ice cream manufacturers.

The regulations of the Territory concerning such products are patterned after mainland standards. In brief, for ice cream the minimum milk fat and non-fat milk solids contents are 12 percent and 5 percent, respectively. The finished ice cream must not weigh less than 4.5 pounds per gallon. In sherbets, the weight of milk fats is not less than

1 percent nor more than 3 percent, and the total milk solids is not less than 2 percent and not more than 5 percent. The finished sherbet should have a titratable acidity, calculated as lactic acid, of not less than 0.35 percent and should not weigh less than 6 pounds per gallon. In all of our work, a small, commercial ice cream batch freezer was used.

PASSION FRUIT

Passiflora edulis f. flavicarpa

Passion fruit juice in frozen desserts has received more attention than any of the other Hawaii tropical fruits. Passion fruit is rapidly becoming an important commercial crop due to development through technological research of a frozen juice product which retains the fruit's refreshing natural flavor. In all cases, the juice used was the frozen pure juice that had been processed without heat according to the process described by Boyle, *et al.* (2). Passion fruit flavor is easily damaged by ordinary heating techniques; consequently, the only product which can be recommended is the frozen juice. This frozen product will be available from Hawaii in 1955 in sufficient commercial quantities to supply a growing market in the ice cream trade.

The physical appearance of passion fruit juice is very much like that of orange juice. Its bright orange color is due to carotenoid pigments carried by the pulpy material in the juice. It is very tart with a pH of approximately 3.0 and a titratable acidity of approximately 4 percent as citric acid. In this respect, it is very much like lemon juice and, thus, it must be diluted with water and sugar when used as a beverage. The ascorbic acid content ranges from 10 to 20 milligrams per 100 grams. The juice's most interesting and valuable characteristic is its distinctive and pleasant aroma. Tests have shown that the juice contains catalase enzymes, but peroxidase or pectinesterase enzymes are absent. However, peroxidase and pectinesterase enzymes are found in the rind tissue. During the extraction of the juice these two enzymes may contaminate the juice and cause undesirable changes during frozen storage.

ICE CREAM

The results of many test trials using mixes proved that passion fruit was only a fair flavor for ice cream. Ice cream made with 5 and 10 percent additions of the juice to the basic mix was quite strong in fruit flavor, but most tasters felt that the aroma of the fruit was largely repressed, apparently by the butter fat. The dominant quality seemed to be the undesirable sourness of the ice cream. The titratable acidity of the 10 percent addition of passion fruit juice was about 0.40 percent as lactic acid.

Passion fruit juice as a possible fortifier of such bland flavors as

peach and apricot has been suggested. Preliminary work along this line indicates that passion fruit does help to enhance peach flavor in ice cream. Peach ice creams were prepared by mixing 20 percent frozen and canned Elberta freestone peaches, respectively, into the basic ice cream mix. The peach flavor was not identified by any of 15 taste testers. Even after the flavor ingredient was revealed, the tasters had difficulty in identifying the flavor. When passion fruit juice and 2 percent of the ice cream mix were added to the peach flavored mix there was a definite difference in flavor. All the tasters considered it an improvement. Some felt that the peach flavor may have been enhanced. When passion fruit juice was doubled to 4 percent there was a noticeable tartness to the ice cream which many of the tasters did not like. The control (ice cream) to which 2 percent passion fruit juice alone was added was rather weak in passion fruit flavor and not nearly as flavorful as the peach and passion fruit combination. The titratable acidities of the 2 and 4 percent passion fruit mixes in 20 percent peach were 0.26 and 0.35 percent, respectively.

In the case of ice creams having frozen strawberry as the flavoring (20 percent of the ice cream mix), most of the tasters could identify the flavor of the fruit. Although the flavor was somewhat delicate, it was judged good. The addition of passion fruit juice in amounts of 2 and 4 percent did not help the strawberry flavor. Even at the 2 percent level, the flavor of strawberry was largely masked by that of the passion fruit. The combined flavor was rather pleasant, but was not judged particularly helpful in identifying either flavor.

Canned apricots in heavy syrup were blended and added in the amount of 20 percent of the ice cream mix. The flavor of the fruit was more readily identified than that of peach and less readily than that of strawberry. The addition of 2 percent passion fruit juice to the ice cream mix made an interesting blend. A few tasters thought passion fruit enhanced the apricot flavor, but most of them did not think so.

Frozen orange juice concentrate was used to flavor ice cream in the amount of 7.5 percent of the weight of the ice cream mix. Orange flavor was easily recognizable, but the ice cream was a little too tart in the opinion of the judges. Addition of passion fruit juice made the ice cream too sour. The blend of flavors, however, was judged good, but, as in the case with apricots, there was no feeling that passion fruit enhanced the orange flavor.

SHERBET

Passion fruit juice by itself appears to be more suitable as a flavoring for sherbet than for ice cream. The high acidity of the juice is not a disadvantage in sherbets. Passion fruit juice in the amount of 10 and 15 percent of the basic sherbet mix was used. The titratable acidities as lactic acid were 0.40 and 0.52 percent, respectively. Most tasters considered the flavor very good. There is some suppression of the fruit's

aroma but not nearly as much as in ice cream. The product is now on the local market and has rapidly become the leading seller among all sherbets. Among the staff and taste panels of the Laboratory who have had the opportunity to compare the sherbet with the ices, the consensus is that passion fruit flavor is stronger and more refreshing when used in ices.

ICE

It is generally true that frozen ices are not very popular with ice cream manufacturers, who are usually associated with the dairy industry. But purely from the taste point of view, we find passion fruit juice is at its best as a flavoring for ices. The distinctive aroma of the juice is retained very well without any suppression from the milk products. The formula developed by the Laboratory is as follows:

Water	66 pounds
Sugar (cane)	27 pounds
Corn syrup (42° B.)	6 pounds
Gelatin (Knox, household)	9 ounces
Passion fruit juice	10 pounds

(The juice is added to the chilled mix.)

The titratable acidity of the passion fruit flavored mix is about 0.50 percent as lactic acid, and its soluble solids by refractometer are approximately 30 percent. Higher percentages of passion fruit juice are not considered necessary; in fact, many complained of tartness at the 15 percent level. The overrun in this fruit mix when processed in a batch freezer was generally high, about 50 to 80 percent.

COMMON GUAVA

Psidium guajava

The processing of this fruit into a puree and various other products is described by Boyle, *et al.* (1). One essential feature in processing the puree is the removal of a large portion of the fine stone cells that ordinarily impart a gritty texture to the product. This removal is accomplished by fine screens in the paddle finisher.

The frozen puree, with or without added sugar, keeps well under storage except for traces of enzyme activity which occasionally show up as light clotting in the puree after a long period of storage. Inactivating the enzymes by heating does greater damage to flavor than does the limited enzyme activity. Guava puree is available in commercial quantities from several fruit processors in Hawaii.

Guava puree is pink in color and is quite acid to taste, having a pH of 3.4 with a titratable acidity of approximately 1.0 percent. The ascorbic acid content of guava purees prepared from the wild fruit runs from 60 to 100 milligrams per 100 grams. A guava selection program is underway to find guavas having a high ascorbic acid content. As a result

of this selection program, guava fruits with an ascorbic acid content ranging from 300 to 500 milligrams per 100 grams have been found; orchards are being planted to these selected varieties.

The aroma of guava fruit is rather subdued, and there is a trace of what Popenoe (10) described as a "musky" flavor. The fruit is used in jam and jelly making, where its high pectin content is of advantage. In Hawaii its use as a nectar is increasingly popular.

ICE CREAM

In ice cream, guava proved to be only a fair flavor. With guava puree added at the 15 percent level to the ice cream mix, the fruit flavor was very weak. There is very little improvement in the flavor when puree is added at the 25 percent level. The flavor cannot be recognized and the product is tart.

SHERBET

Guava has proved to be a good flavor for sherbet. With 20 percent guava puree added to the basic mix, a flavorful product was obtained; a small amount of citric acid helped to improve the flavor. Without adding any acid, the level of titratable acidity was about 0.25 percent as lactic acid, which is too low for sherbet standards. Most tasters preferred the sherbet with titratable acidity between 0.5 and 0.6 percent—this applied to sherbet mix with a 20 percent addition of unsweetened guava puree. Guava sherbet is being produced commercially and is enjoying very favorable consumer acceptance.

ICE

Ices prepared with guava puree had an excellent guava fruit flavor. The high pectin content in the guava fruit produced a high overrun, particularly when the addition of guava puree was high (about 30 percent). Guava ice showed a slight change of color after storage for one month at freezing temperatures. The original light pink color of the guava was lost and was replaced with a trace of brown. This type of color change has been reported by Cruess (4), and he claims that anthocyanin pigments in the fruit react with any gelatin in the mix. To mask this undesirable color—it does not have an adverse effect on the flavor of the guava ice—the addition of a small amount of artificial coloring is recommended.

PAPAYA

Carica papaya

Papaya enjoys great popularity in Hawaii as a fresh breakfast fruit. In addition, it has been processed in several forms: chunks packed in syrup, frozen puree, canned nectar, refrigerated nectar, and jams. It is a very nutritious fruit with high ascorbic acid and Vitamin A con-

tents. The flavor is very bland, but there is a slight offensive odor which is most noticeable to those who have not cultivated a taste for the fruit.

Processing of papaya puree has been described partially by Seagrave-Smith and Sherman (12) and will be described in detail in a future publication. One of the essential points in processing the fruit is inactivating the pectinesterase enzyme by flash pasteurizing the puree at about 200° F. for 50 to 60 seconds, followed by rapid cooling. Without such enzyme inactivation, the frozen papaya puree gels and develops very strong off-flavors. Papaya puree with the inactivated enzyme has been stored in a frozen condition for almost a year before being used in some of our preparations.

When fresh papaya puree is prepared with no enzyme inactivation and is used in making a frozen dessert, very undesirable changes will occur in the product; an occasional biting flavor was noted in the sherbets and ices. A local manufacturer has complained that unpleasant flavors may develop within a week after mixing. We wish to emphasize that in papaya puree with the inactivated enzyme none of these undesirable effects occurred. Thus, for frozen dessert work we recommend only this type of puree.

ICE CREAM

When papaya puree is added at a 25 percent level to a basic ice cream mix, the resulting ice cream has a very weak papaya flavor which most tasters could not identify. When a small amount of passion fruit juice, about 3 percent of the mix weight, was added to the above ice cream formula, the blend of flavors was a decided improvement. Many tasters felt that passion fruit helped to bring out the papaya flavor. In this respect, papaya is similar to peach.

SHERBET

In sherbets made with papaya puree, the addition of citric acid is necessary to help improve the bland papaya flavor. However, the use of juices such as lemon, lime, or passion fruit produced better tasting sherbets than when citric acid was used as the acidifying agent. Even in canned papaya nectar some lemon juice helps to improve the overall flavor. About 3 percent of lemon, lime, or passion fruit juice produced sherbet with a good flavor. With more than this amount these flavors become dominant over the papaya flavor. Additional citric acid may be used to bring up the titratable acidity levels.

ICE

The same general considerations cited for papaya sherbet apply to papaya ice. On the whole, papaya ice cream and sherbet were preferred over the ices.

STRAWBERRY GUAVA

Psidium cattleianum

While this fruit is not commercially processed, it has an attractive flavor suitable for sherbets or ices. Although it is not used in manufacturing jam and jelly or in making nectar as is the common guava, if a demand for the puree were created it would be available, since the fruit grows abundantly in the forests of the Hawaiian Islands. Experimental packs of the puree have been kept frozen for over a year with very good retention of color and flavor. It has a very deep red color and a flavor somewhat similar to that of the common guava, but with less of the musky flavor and a much stronger aroma. There is a trace of an astringent quality even in the very ripe fruit.

ICE CREAM

Strawberry guava makes only fair ice creams, as is the case with the common guava. When strawberry guava puree is added at the 20 percent level the flavor in ice cream is very weak and difficult to recognize.

SHERBET

Strawberry guava is an excellent flavor for sherbets. At the 20 percent level the characteristic flavor of the fruit was readily identifiable. The color of the puree gave a deep pink color to the sherbet. Some citric acid is necessary since the titratable acidity as lactic acid of the finished product without the addition of any acid was only 0.30 percent.

ICE

Strawberry guava is a delightful flavor for ices. At the 20 percent level with the addition of citric acid the product was considered very pleasant tasting. No special overrun problem was encountered with this fruit; the pectin content of this fruit is less than that of the common guava. Oddly, no adverse color reaction was noted in storage. Its deep red color, which shows the usual anthocyanin reaction with changes in pH, did not bleach out or turn brown due to reaction with the gelatin in the ice mix.

BANANA

Musa sapientum

Three varieties of bananas commercially grown in Hawaii were tested: (1) Gros Michel variety, (called Bluefield in Hawaii), which is the banana found in the retail trade of the continental United States; (2) Cavendish; (3) Brazilian. Banana puree is not available commercially; therefore, we began with the fresh fruit, which was peeled and immersed in an acidified syrup (3 parts banana to 1 part 50 percent syrup containing 2 percent citric acid). The whole mix was run through a pulper; for small batches, a blender was used. In the short

time of handling, enzymatic darkening was not noted but caution must be taken to work carefully and to use only sound, firm fruit. Commercial pulping would probably use ascorbic acid as an antioxidant. Another method of preparing the puree has been described by Mustard and Stahl (9) in which the whole fruit is blanched prior to peeling and pulping.

ICE CREAM

In ice creams, bananas were considered excellent. The aroma of the fruit came through very well at the 20 percent level calculated as the banana portion in the syrup preparation. Fortification with synthetic banana flavors can be done easily, but in these experiments it was not added. The Gros Michel was definitely the best for flavor, followed by the Cavendish. The Brazilian variety is somewhat acid in taste and was found to be undesirable in ice creams.

SHERBET

Bananas were also considered an excellent flavoring for sherbets. As in ice creams, the Gros Michel was definitely the best. The Brazilian variety, which has an acid reaction, was considered the poorest for flavor. In general, the overrun tended to be low with all banana formulations. A 20 percent addition of banana puree was considered adequate for a good sherbet flavor.

ICE

Ices containing banana were rated good, but most tasters felt that milk solids blended well with banana flavor and that sherbets and ice creams were more desirable. Again a 20 percent addition was considered adequate.

Darkening in any of the frozen banana dessert products as a result of storage was not observed, but, as mentioned earlier, if sound firm fruit is not used and if the puree is allowed to stand for a while, browning may occur which will be noticeable in the finished product. A small quantity of artificial yellow color would probably mask this discoloration.

COCONUT

Cocos nucifera

Coconuts are processed on a very small scale as frozen milk, frozen shred, toasted chips, and syrup. In our work we used frozen milk derived by pressing the grated flesh of fresh coconut. This milk has about 25 percent fat and practically all of the characteristic flavor of the nut. We also used a finely ground preparation of the whole flesh; this material resembled the milk except for its slightly sandy texture which was not very desirable in the finished product.

ICE CREAM

The coconut flavor of the milk is somewhat bland, and since good synthetic coconut flavors are available it is possible to enhance the flavor

with them. Therefore, in our ice cream we used approximately 10 percent of milk and fortified the flavor with artificial coconut flavor. The resulting mixture was excellent, provided an excess of synthetic flavoring was not used. Even a 5 percent addition of coconut milk with synthetic flavoring was considered very good. The use of solid pieces of flesh, such as shredded coconut, was not tried although it is used by manufacturers. There is much room for experimental work to develop a good coconut flavoring which does not rely too heavily on the synthetic flavor. In general, coconut is an excellent flavor for ice creams.

SHERBET

With coconut milk in sherbets, we encountered a problem in acidity. In order to conform to sherbet standards, acid has to be added. When citric acid was added to give a titratable acidity of the minimum level required, the tasters did not like the sourness. The general impression was that sour milk had been used in the formulation.

ICE

Coconut milk in ices gave the same difficulties encountered in sherbets. An acidified coconut flavor was not quite palatable to the tasters. Moreover, the texture of the products tended to be hard and crumbly.

AVOCADO

Persea americana

The avocado puree used in all of our work was freshly prepared from whole fruit. Processed puree is not available commercially. The problems of heat and freeze processing of avocados have been discussed by Cruess, *et al.* (3). The frozen product called "guacamole" has been tested by the Laboratory and is quite stable under prolonged storage conditions, but it is unsuitable for ice cream flavoring because of its high acidity, salt, and spice contents.

There are wide variations in the quality of avocados available in Hawaii. Good avocado varieties with a smooth texture and having a fat content ranging from 12 to 18 percent should be used for making ice cream. The flesh can be run through a pulper to remove fibers and to make a smooth homogeneous puree. Rapid handling of the pulped material is important to minimize the enzymatic reactions that may occur. Prolonged storage tests were not conducted on whether such changes occur in the frozen ice cream, but on short tests of about a month there were no undesirable changes in color or flavor.

ICE CREAM

Avocado puree was considered an excellent flavoring for ice creams. When added in the amount of 20 percent of the mix it imparted a definite, recognizable flavor which may be described as pleasant and nut-like. With some varieties, a trace of bitterness was detected, especially when slightly underripe fruit was used. In general, avocado

ice cream was considered one of the best of all the ice cream tested. Some tasters considered it too rich in fat, with the addition of the avocado fat to that of the mix itself. There was also a slight tendency toward poor texture in the finished product.

SHERBET AND ICE

The use of avocado in sherbets and ices gave poor products, similar to those of coconut. It was not considered an outstanding flavoring material, although it was more adaptable to these forms since the addition of acid did not interfere with the fruit flavor. The texture problems encountered with avocado ice cream were not evident in the sherbets and ices.

MANGO

Mangifera indica

Mango puree is not available commercially in Hawaii but may be in the future. In our work we have used either fresh puree or frozen puree that had been stored for as long as a year. Hayden and Pirie were the two varieties tested. The frozen puree of both varieties had undergone only slight flavor deterioration and no color change during this long storage period. Frozen slices packed in syrup showed some undesirable enzymatic changes in flavor and in color. Canned puree, packed with and without sugar, was of excellent quality after six months of shelf storage. Canned slices packed in syrup are also of excellent quality. Although much of the fresh fruit aroma is lost in these canned products, experiments have shown that canned mangos are adaptable as ice cream flavoring. Many tasters of canned mangos have described the flavor as being similar to canned peaches, but actually mangos have a much stronger flavor which should make this fruit more suitable than peaches for ice creams.

ICE CREAM

Ice cream flavored with mango was considered excellent. At the 20 percent level the flavor of the fruit was rather delicate but recognizable. It definitely was more flavorful than any peach ice cream (5, 6) we have made. Injection methods for mango ice cream described by Krienke (5, 6) should definitely help toward producing a better flavor. This method should be applicable for most of the fruit flavors under study, even for such tart fruit as passion fruit.

SHERBET AND ICE

Mango was also considered an excellent flavor for sherbet and ice. A 20 percent addition of mango puree gave sufficient flavor to these products. The mango flavor was especially strong in ices. Some acid will have to be added to meet standards and to actually enhance the fruit flavor. Taste testers showed a slight preference for mango flavor in ice creams, with sherbets and ices following in that order.

LYCHEE

Litchi chinensis

The undependable fruiting habit of the lychee has been a deterrent to the commercial production of this fruit. Much work is being done by the Station and with promising results which may stimulate orchard expansion. The fruit commands a very high price on the fresh fruit market and its cost in frozen desserts would be almost prohibitive. However, with the thought that sizeable orchards may be started soon and that surplus and cull fruits will eventually be available for processing, we have used it in this work.

Storage tests with the frozen whole fruit (Brewster variety) and with the peeled and pitted fruit packed with and without sugar have shown that this fruit can be easily kept for over a year with no noticeable unfavorable changes. For ice cream work, the frozen packs can be blended to break up the flesh. The fruit should be blended just before use, because after standing for several hours the blended fruit begins to turn brown. Large pieces of fruit were not desirable from the flavor standpoint. The lychee has a strong aroma which is dispersed throughout the frozen dessert product when finely chopped up fruit is used.

ICE CREAM

Because of its high cost, several levels of the fruit ingredient were used in all of our work. In ice cream a 10 percent addition of lychee was considered adequate to give a very distinctive product. The addition of 20 percent lychee did not increase the flavor enough to merit the additional cost.

SHERBET AND ICE

In sherbets and ices, lychee was used at the 5 percent level. Even at this level the flavor was definitely pleasing and readily identifiable. But most tasters felt that the 10 percent level was the better one. The aroma of the fruit is, of course, best preserved in the ices.

SOURSOP

Anona muricata

The soursop is even less of a commercial fruit than the lychee; there is not a single known commercial planting. This is somewhat surprising in view of the fact that many people know its merits both as a nectar and as a frozen dessert flavoring. A recent publication (11) from Puerto Rico described a method of processing the fruit into a nectar. In our work the fruit was hand peeled, seeded, and pulped in a conical screw type juice expresser in contrast to the paddle pulper used for most of the other fruit. This puree was packed with and without sugar and used after frozen storage for over a year. The stored puree was in excellent condition with no noticeable color or flavor deterioration.

ICE CREAM

Soursop at the 20 percent level will produce an excellent ice cream. The fruit's natural acidity, about 0.9 percent titratable acidity as citric acid, was not too high to interfere with the milk solids. The high perfume-like aroma of the fruit came through very well in this product.

SHERBET

Soursop in sherbets was considered an excellent flavor. The pleasant and refreshing aroma was most noticeable. A 15 percent addition to the sherbet mix gave excellent flavor. Even as a sherbet prepared in the refrigerator, soursop has long been considered by local housewives an exceptionally good flavoring.

ICE

Ices made with soursop puree were definitely considered some of the best. The high aroma of the fruit is not repressed in any way by the ice mix ingredients.

DISCUSSION AND SUMMARY

In general, the tropical fruit flavors are repressed in ice creams. Fruits with high acid content are not as suitable as those with low acid. Fruit with high fat content, such as avocado and coconut, appear to be eminently suitable. The consensus of taste testers is that ice cream tastes "good," whatever its flavor. But for fruit-flavored ice cream they feel that the flavor should be at least recognizable. No one expects to get the full impact of the pure fruit itself. A flavor which is too strong would not be desirable, but the value of the fruit ingredient is lost if one cannot recognize it.

In sherbets, the fruit flavors come through more readily than in ice creams. The tolerance of sherbets to higher amounts of acid is definitely in favor of the use of these flavors. The criterion for judging the fruit flavors has been more than that the fruit flavors should be recognizable—the product must actually have the characteristic flavor of the fruit. In this respect, almost all the fruits tested have been entirely satisfactory for sherbets, with the exception of fruits, such as avocado and coconut, having high oil content.

The acid fruits are particularly suitable for ices, while those with high oil contents are definitely not suitable. It is in ices that the fruit flavor, as such, is at its best because there is no repression of the flavor by any of the ingredients of the basic ice mix. The overall effect is a very pleasant, refreshing, frozen fruit dessert whose main flavor characteristic is that of the fruit itself. In this respect it is quite different from ice creams, whose main feature is the rich flavor of the milk ingredients.

In table 1, the fruit flavors are rated for the various frozen desserts. The ratings given in the table indicate that most of these fruit flavors make excellent ice creams, sherbets, and ices, and, therefore, their use

TABLE 1. Ratings of the fruit flavors in order of preference, beginning with the best.

	ICE CREAM	SHERBET	ICE
Excellent	Avocado Coconut Banana Mango Lychee Soursop	Soursop Lychee Banana Mango Strawberry guava Common guava Passion Fruit	Soursop Lychee Passion Fruit Strawberry guava Common guava Mango Banana
Good	Strawberry guava Common guava Papaya	Papaya Avocado	Papaya
Fair	Passion Fruit	Coconut	Avocado Coconut

should be increased. Many of these flavors are so attractive and unique that favorable public acceptance can be assured.

As will be noticed in table 2, the fruits have a wide range of acidity, soluble solids, and ascorbic acid content. Coconut and avocado have a high content of oil which probably is not desirable in frozen desserts. The guava has a high ascorbic acid content. A high vitamin C guava sherbet will be possible with the development of guava varieties having an ascorbic acid content ranging from 300 to 500 milligrams per 100 grams of edible portion. A sherbet could contain from 30 to 50 milligrams per 100 grams.

CONCLUSION

A survey was made to ascertain the feasibility of using Hawaii tropical fruits for flavoring ice creams, sherbets, and ices. The survey results indicate that many of the tropical fruits should be recommended to the ice cream manufacturers as flavoring for their products.

The survey showed that excellent ice creams can be manufactured using avocado, coconut, banana, mango, lychee, and soursop as the flavoring. Excellent sherbets can be produced using soursop, lychee, banana, mango, strawberry guava, common guava, and passion fruit. Soursop, lychee, passion fruit, strawberry guava, common guava, mango, and banana were found to be excellent flavors for ices.

The generalized formulas for using tropical fruits are given for each of these frozen desserts. It will be possible to obtain all of these tropical fruits as frozen or processed purees when a demand is developed for their use in the ice cream industry.

TABLE 2. Selected average chemical values of the fruits.

FRUIT	COLOR AND TEXTURE OF JUICE OR PUREE	pH	TITRATABLE ACID AS CITRIC ACID	SOLUBLE SOLIDS AS SUCROSE	ASCORBIC ACID
Passion fruit	bright orange juice	3.0	% 4.0	% 16	mg/100g 15
Common guava	pink, very heavy puree	3.3	1.0	8	100
Papaya	bright orange, heavy puree	5.2	0.1	12	90
Strawberry guava	deep red, very heavy puree	3.3	2.0	12	66
Banana (Gros Michel)	creamy, very heavy puree	4.8	0.5	23	6
Coconut	white, light emulsion	6.2	0.1	fat=25	3
Avocado (West Indian)	yellow-green, very heavy puree	6.5	0.2	fat=12	10
Mango (Hayden)	yellow-orange, heavy puree	4.4	0.3	13	15
Lychee (Brewster)	white, heavy puree	4.3	0.3	18	64
Soursop	white, heavy puree	3.7	0.9	10	20

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