The above data show that limonin does occur in all important varieties of Florida citrus, but that only a very few contained sufficient quantities to cause problems in processing of mature fruit. High concentrations in the rag emphasize the necessity for careful and gentle juice extraction and finishing procedures in the commercial processing of grapefruit juices.

LITERATURE REFERENCES


COLOR STANDARDIZATION OF PIGMENTED GRAPEFRUIT JUICES

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ABSTRACT

Florida pigmented grapefruit, consisting largely of ‘Ruby’ and similar varieties have been planted extensively because of their ready acceptance on the fresh fruit market. Of the December 1969 total of 98,665 acres of bearing grapefruit, 26,396 acres or 26.8 percent are of the variety listed as ‘Pink Seedless’.

During the 1968-69 season, processors used 65 percent of the 40 million box grapefruit crop and pink grapefruit accounted for 19 percent of the grapefruit going to the canners. The Florida Department of Citrus estimates grapefruit bearing acreage could increase by as much as 37 percent by 1972.

Due to the excellent consumer demand for processed grapefruit juices, canners are utilizing all available fruit. Especially prepared select packs of pink grapefruit juice are processed by plants using a large volume of pink grapefruit during optimum color maturity. Small volumes of pink grapefruit create a problem in the cannery because the addition of pink juice to normally white grapefruit juice results in a canned product that has a muddy, nondescriptive color.

Methods of standardizing pink grapefruit juice colors are discussed. Data are presented to show seasonal change of juice colors of three varieties of pink grapefruit. Packs were prepared in tin and enamel lined cans with standardized juice colors using FD&C certified pure food colors and synthetic carotenoids. Color and flavor changes were determined in the juices which had been stored at 80°F.

INTRODUCTION

Pigmented grapefruit (‘Pink Seeded’ and ‘Pink Seedless’), consisting largely of ‘Ruby’ and similar varieties have been planted extensively in Florida because of their ready acceptance in the fresh fruit market. Of the total 98,665 acres of bearing grapefruit (2), 26,396 acres or 26.8 percent are of the variety listed as ‘Pink Seedless’.

During the 1969 season, processors used 65 percent of the 40 million box crop (3). Pigmented grapefruit accounted for 19 percent of the total grapefruit going to the canners. The Department of Citrus estimates grapefruit bear-
ing acreage may increase by as much as 37 percent by 1972.

The percentage of the total grapefruit crop used by processors has increased from an average of 47.6 percent during the 15 seasons from 1950-51 through 1964-65; to 65 percent during the last two seasons ending with the 1969-70 harvest. The recent excellent consumer demand for canned grapefruit juice is thought to be related to the weight-watching, diet-conscious consumer who thinks that a glass of grapefruit juice for breakfast will "burn off the calories" so that anything can be eaten during the rest of the day. Regardless of the reason, this substantial demand by the consumer for grapefruit juice is encouraging the canner to utilize pink as well as white fruit.

Especially prepared select packs of pink grapefruit juice are processed by plants using a large volume of pink grapefruit. Lime, Stephens and Griffiths (8), reported that best color occurred in Texas during a short period when the fruit first passed maturity. This also occurs in Florida fruit. Later in the season, the pink color of the early fruit fades to a yellow or yellowish-pink which Ting and others (9, 10, 11) associated with the change in the ratio of lycopene to beta carotene, the red and yellow carotenoids which are predominant in pigmented grapefruit. Juice from well mature fruit has a faded color, and when packed alone or mixed with white grapefruit juice in quantities greater than 10 percent, results in a canned product that has a muddy, nondescript color which falls below U. S. Grade A specifications (12).

Boyd and Peterson (1) reported that plain cans cause some bleaching of color in orange juice with a resulting characteristic flavor which is undesirable. However, they found that the use of enameled cans prevents the loss of color.

The problem of preparing and storing an attractive canned red grapefruit juice is not new to the citrus industry. Lime et al. (8) reported that studies attempting to find a practical method of processing Texas red and pink grapefruit juices were initiated as early as January 1951, at the U. S. Fruit and Vegetable Products Laboratory, Weslaco, Texas. Lime and Griffiths (7) were able to fortify poorly colored juices by the addition of highly colored red grapefruit pulp recovered early in the season. It might be noted, however, that the amount of pulp required to produce a good color in the April juice, also was reported to have a suspended solids content of 12.5 percent which exceeds the 10 percent maximum pulp limit for U. S. Grade A grapefruit juice. Hunter (4) proposed a pulp-fortified red grapefruit juice and a pack was prepared for a consumer preference test in 1960. In the summary of Hunter's report, it was stated that a slight preference was found for white, rather than red juice. About one-fourth of the homemakers liked the test juices, but about half felt that the juices were too tart.

During the 1969-70 citrus season, the Florida Canners Association requested that the Florida Department of Citrus Research Department conduct a study of the problem of canning pink/red grapefruit juice.

The purpose of this paper is to present data showing color and flavor changes occurring in 'Ruby' grapefruit juices packed with and without color additives in tin or enamel lined cans and held at a storage temperature of 80°F. Data are also presented to show the characteristic colors of juices hand-reamed from small samples of 'Ruby' and 'Thompson Pink' seedless ('Thompson') grapefruit and 'Foster Pink' seeded ('Foster') grapefruit at periodic intervals during one season.

**Experimental Procedures**

**Canned Packs.**—Approximately 20 boxes of 'Ruby' grapefruit were obtained from a local packinghouse December 19, 1969. Juice was extracted on an FMC Corporation "In-Line Juice Extractor" using 0.040 inch extractor tubes. The extracted juice was finished with a screw type finisher using an 0.020 inch screen, de-aerated and pasteurized at 185°F. in a Walker Wallace plate pasteurizer. The juice was hot-filled into alternate 12 ounce tin and enamel-lined cans, closed, inverted, spray cooled to 90°F., cased and placed in 80°F. storage. Control samples were placed in 32°F. storage. A second lot of 'Ruby' grapefruit were obtained in March to pack a colored juice with sugar added. Acceptable food colors were added to juices for each respective pack while the freshly finished de-aerated juice was being stirred in a small holding tank just prior to pasturization. U. S. Food and Drug Administration certified pure food colors used were FD&C Red No. 2 and Yellow No. 5 in both the soluble and insoluble forms (lakes). Hoffman-LaRoche Roxanthin
HUGGART AND TING: GRAPEFRUIT JUICES

(R), which is the registered trade name of a carotenoid closely related to beta carotene, was also used.

Hand-reamed juices.—Two trees each of the varieties 'Ruby', 'Thompson' and 'Foster' were reserved for this study. Each week, six fruit of each variety were picked at random from around the periphery of a tree. The fruit were halved and hand-extracted using a Sunkist electric reamer. Pulp and seeds were separated from the juice using a large tea strainer of about 18 mesh. The juice was de-aerated and placed in a 1-inch screw cap culture tube for color measurements.

Color measurements.—Citrus Red (CR) and Citrus Yellow (CY) color measurements were obtained using a Hunterlab Citrus Colorimeter (HCC) (5).

Plastic comparator tubes such as are used for determining orange juice color scores by the USDA method (13) are not available for grapefruit juice, therefore, color descriptions are used to give a visual evaluation for some of the HCC measurements. In general, higher CR values indicate more redness while higher CY values indicate more yellowness. A desirable pink color is found in juices with high CR and low CY. Juices having an equal ratio of CR to CY in the higher ranges, tend to be brown or muddy. In the variety juices, Table 2 a low ratio of CR to CY was found in the samples having a yellowish or chamois color.

Flavor Evaluation.—Samples were presented to the Citrus Experiment Station Taste Panel for evaluation. Test procedures employed were the Hedonic Rating System and the Triangle Test. Significant differences among samples were determined using a modification of Kramer's Rapid Method (6).

RESULTS AND DISCUSSION
Coloration of Cut Fruit and Extracted Juices.

- When juice was extracted by hand-reaming grapefruit in the laboratory, it was noted that the deep pink color that was apparent in the flesh and membrane of the fruit did not come out with the juice. Extracted juice was practically devoid of pink color except for the color carried in the juice sacs (pulp). A large amount of the red color was left in the rag membrane of the fruit. HCC measurements of the screened pulp from a sample of 'Ruby' juice during optimum red color intensity had a CR value of 83.5 and a CY value of 40.8 and was almost salmon pink in color, whereas the juice had a CR of 38.1 and CY of 29.1. The color of the juice might be described as being pale, but distinctly pink. The characteristic of retaining the red-colored carotenoid in the rag and pulp rather than washing out with the juice, appears to be peculiar to pigmented grapefruit during the life of the fruit.

Maximum CR values and the most intense pink visual color, in fresh fruit of all three varieties studied, were found for a period of about one month, from September 22 to October 20, as shown in Table 1. The juice of the 'Thompson' and the 'Foster' were almost white with a pink tinge of visually equal color. CR values of these two juices were 20.7 and 20.4 respectively. The 'Ruby' juice was a bright pink and had a relatively high CR of 36.8.

Pink color developed in the 'Ruby' juice starting in August, Table 2, with a CR of 31.8 and CY of 28.5. The color became a bright pink in September and October then changed to a yellowish-pink in November and December. In January, the yellow chamois color of the mature fruit juice appeared as shown by the increase in the CY values which leveled off at 40 in February. Colorimeter measurements and the visual colors of the 'Thompson' and the 'Foster' juices parallel those of the 'Ruby', but their juices, at best, were weak in color and showed only the slightest pink tinge which rapidly changed to

<table>
<thead>
<tr>
<th>Fruit variety</th>
<th>Citric acid percent</th>
<th>°Brix hydrometer</th>
<th>Brix/acid ratio</th>
<th>Hunterlab Citrus Colorimeter CR</th>
<th>Hunterlab Citrus Colorimeter CY</th>
<th>Visual color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ruby</td>
<td>1.11</td>
<td>8.16</td>
<td>7.4</td>
<td>36.8</td>
<td>28.9</td>
<td>Bright pink</td>
</tr>
<tr>
<td>Thompson</td>
<td>1.36</td>
<td>7.95</td>
<td>5.9</td>
<td>20.7</td>
<td>24.6</td>
<td>Pink-tinged</td>
</tr>
<tr>
<td>Foster</td>
<td>1.71</td>
<td>8.79</td>
<td>5.1</td>
<td>20.4</td>
<td>25.0</td>
<td>Pink-tinged</td>
</tr>
</tbody>
</table>

Table 1. Average Citrus Red (CR) and Citrus Yellow (CY) values for pigmented grapefruit at optimum pink color level from September 22 to October 20, 1969.
Table 2. Average Citrus Red (CR) and Citrus Yellow (CY) values of pigmented grapefruit juice samples extracted each month of the 1969-70 growing season.

<table>
<thead>
<tr>
<th>Date of samples</th>
<th>Ruby Red CR</th>
<th>Ruby Red CY</th>
<th>Foster Seeded Hunterlab Citrus Colorimeter CR</th>
<th>Foster Seeded Hunterlab Citrus Colorimeter CY</th>
<th>Thompson Seedless CR</th>
<th>Thompson Seedless CY</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>24.2</td>
<td>33.0</td>
<td>13.2</td>
<td>35.2</td>
<td>11.7</td>
<td>34.2</td>
</tr>
<tr>
<td>August</td>
<td>31.8</td>
<td>28.5</td>
<td>14.9</td>
<td>31.1</td>
<td>13.3</td>
<td>30.8</td>
</tr>
<tr>
<td>September</td>
<td>33.9</td>
<td>28.2</td>
<td>18.9</td>
<td>25.7</td>
<td>18.9</td>
<td>24.0</td>
</tr>
<tr>
<td>October</td>
<td>35.4</td>
<td>29.1</td>
<td>20.2</td>
<td>24.1</td>
<td>20.4</td>
<td>24.1</td>
</tr>
<tr>
<td>November</td>
<td>31.0</td>
<td>31.7</td>
<td>19.0</td>
<td>25.9</td>
<td>18.1</td>
<td>26.2</td>
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<tr>
<td>December</td>
<td>29.5</td>
<td>36.2</td>
<td>17.0</td>
<td>30.0</td>
<td>19.6</td>
<td>31.3</td>
</tr>
<tr>
<td>January</td>
<td>29.6</td>
<td>38.7</td>
<td>19.0</td>
<td>33.4</td>
<td>18.2</td>
<td>32.2</td>
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<tr>
<td>February</td>
<td>31.2</td>
<td>40.4</td>
<td>18.4</td>
<td>34.8</td>
<td>18.6</td>
<td>33.6</td>
</tr>
<tr>
<td>March</td>
<td>30.1</td>
<td>40.7</td>
<td>17.9</td>
<td>34.3</td>
<td>17.6</td>
<td>33.4</td>
</tr>
<tr>
<td>April</td>
<td>29.9</td>
<td>40.4</td>
<td>17.9</td>
<td>33.4</td>
<td>16.6</td>
<td>34.2</td>
</tr>
<tr>
<td>May</td>
<td>31.3</td>
<td>40.9</td>
<td>17.7</td>
<td>34.2</td>
<td>16.8</td>
<td>34.5</td>
</tr>
<tr>
<td>June</td>
<td>33.1</td>
<td>41.5</td>
<td>20.5</td>
<td>37.3</td>
<td>18.9</td>
<td>36.9</td>
</tr>
</tbody>
</table>

The chamois yellow color of the mature fruit juice.

Standardization of Juice Colors.—The authors felt that the homemaker who uses Florida 'Ruby' grapefruit from the fresh fruit market in the preparation of fruit salads, might expect to find the standardized color of Florida canned 'Ruby' grapefruit juice equal in color to that of the edible portion of the fresh fruit.

Coloring materials used as standardizing agents in the preparation of these packs were lycopene extracts, synthetic carotenoids and FD&C certified pure food colors. Lycopene, the red carotenoid in the extract from 'Ruby' grapefruit pulp and rag, degraded rapidly leaving mostly beta carotene with its yellow color. When this extract was added, the juice became orange colored, thus the use of pulp and rag extract awaits upon a method of extracting and stabilizing the lycopene. It was noted that juice sacs stored at 5°F. for 1 year shifted to a yellower color, dropping from a CR of 84 to 79 while increasing in yellow from a CY of 41 to 46.

Use of Roxanthin (R) produced a juice color which was acceptable, although of a yellowish tomato red hue. A coloration more closely resembling that of 'Ruby' grapefruit juice sacs was attained using mixtures of the soluble or insoluble forms of pure food colors Red No. 2 and Yellow No. 5.

Storage.—When stored at 80°F., juices packed in enamel cans with FD&C insoluble food colors retained a good appearance for three months before browning, while those with soluble food colors, had a muddy appearance after 30 days. These changes in visual appearance were accompanied by a decrease in CR and an increase in CY values. Samples standardized with Roxanthin (R) showed slight browning when packed in enamel for six months.

Samples standardized with Roxanthin (R) faded slightly in six months when packed in tin. The samples standardized with either FD&C soluble or insoluble food colors packed in tin lined cans, lost their color within one week at 80°F. storage.

A pack of juice containing added sugar and standardized with Roxanthin (R), showed the same pattern of color changes found in juices packed without the addition of sugar, indicating little if any sugar effect on the color.

One case of each of the above mentioned packs was held at 32°F. storage as a control. When these samples were examined for color appearances after seven months storage, the standardized juices packed with the insoluble food colors in enamel cans and the juices standardized with Roxanthin (R) packed in either tin or enamel lined cans, were found to have retained most of their original color. The juices
standardized with soluble color and packed in enamel had faded slightly. The color was lost in juices standardized with either soluble or insoluble colors packed in tin lined cans. This was unexpected as orange juices held at 32°F show little change in either color or flavor.

Flavor.—The Citrus Experiment Station Taste Panel expressed a preference for sweetened grapefruit juice. A significant difference at the 1 percent level was found by the panel between juices packed in either tin lined or enamel lined cans after three months storage at 80°F. A preference was expressed for juices in tin lined cans, although one panel member who was able to separate the juices consistently, expressed a preference for juices packed in enameled cans.

ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance rendered by Dr. Paul J. Fellers in setting up flavor evaluation studies and interpretation of data, and to the individual members of the taste panel for their scores and comments.

LITERATURE CITED


EVALUATION OF PECTINS FROM FLORIDA LEMONS HARVESTED FROM YOUNG TREES

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ABSTRACT

Extracted pectins from peel and pulp of lemon selections (Bearss No. 1, Bearss (Nucellar), Italian, and Villafrance) were evaluated during the 1968 growing season for jelly grade, methoxyl content, and anhydrogalacturonic acid. Yields of pectin were usually greater from pulp than from peel and the yields increased in both components with maturity until December, at which time there was a decrease of pectin in these components. Jelly grades of the pectins increased in both components with increased maturity of the lemons. Pectins extracted from peel ranged from 225 to 272 grade while pectins from the pulp ranged from 166 to 285 grade. Anhydrogalacturonic acid of pectins extracted from the peel ranged from 75 to 87%, while those of pectins from the pulp ranged from 65 to 92%. The higher values generally occurred in the pectins of both components after September. Data are also presented showing the relation of peel, pulp, juice, and seeds in the 4 lemon selections during the growing season.

INTRODUCTION

The citrus processor in Florida, who is processing lemon juice and frozen concentrate for lemonade, has lemon peel and pulp which is a rich source for the manufacture of high quality pectin. Processing lemons during the fall months...