tangeretin content can be removed from the peel if the flavedo is removed, with only a 37.5% loss in peel weight. The Duncan grapefruit is somewhat of an exception, however. Even though about 90% of the tangeretin is located in the flavedo and can be removed if the flavedo is removed, as much as 62.8% of the peel will be lost if this is done. This is because the flavedo constitutes the major portion of the peel in some varieties (see Table 2).

Table 2. Relative distribution of tangeretin in Florida citrus peel.

Variety	Flavedo Wt. %	Flavedo % Total tang.	Albedo Wt. %	Albedo % Total tang.
Duncan grapefruit	37.5	95.7	62.5	4.3
Mott grapefruit	18.8	80.8	81.2	19.1
Thompson grapefruit	26.1	62.7	73.9	37.3
Valencia orange	55.5	94.8	44.5	5.2
Pineapple orange	46.9	89.0	53.1	11.0
Parson Brown orange	34.9	90.7	65.1	9.3
Temple orange	62.8	93.5	37.1	6.4
King mandarin	46.9	86.9	53.1	13.1
Sweet lime	53.5	93.6	46.5	6.4
Average	42.5	87.5	57.5	12.5

The differences between flavedo and albedo tangeretin concentrations varies considerably among varieties. Using just grapefruit as an example, Duncan flavedo tangeretin levels are almost forty times greater than the corresponding albedo levels. Thompson grapefruit flavedo is only 4.7 times more concentrated than is albedo. The source of this eight fold difference is found by comparing the flavedo and albedo concentrations found in Table 1. While the flavedo layers have similar tangeretin concentrations, there is ten times more tangeretin in Thompson albedo than Duncan albedo. Thus, tangeretin levels can be further reduced if a variety with low albedo tangeretin level is used.

Conclusion

Tangeretin is found in all portions of citrus peel but is primarily concentrated in the flavedo. If it is desirable to reduce final tangeretin from citrus peel based dietary fiber, it can be readily accomplished by either of two ways. Tangeretin content may be lowered as much as 98% by using albedo alone instead of whole peel. While some extra cost would be incurred in removing the flavedo, some of this cost could be recouped by recovery of the commercially valuable oil. The second approach to reduce tangeretin (with little or no added expense) would be to avoid the use of varieties that are particularly high in tangeretin content such as the mandarins, preferably using varieties that have low albedo tangeretin content.

Literature Cited

1. Jones, R. W., G. S. Mason, H. Reich, and M. N. Huffman. 1964 Cytotoxic activities of certain flavonoids against zebra-fish embryos. *Cancer Chemother Rep.* 34:19-20.
2. Nelson, E. K. 1934. The occurrence of a pentamethyl flavonol in tangerine peel. *J. Am. Chem. Soc.* 56:1312-1392.
3. Robbins, R. C. 1976. Regulatory action of phenylbenzo- -pyrone (PBP) derivatives on blood constituents affecting rheology in patients with coronary heart disease (CHD). *Internat. J. Vit. Nutr. Res.* 46:338-347.
4. Rouseff, R. L. and S. V. Ting. 1979. Analysis of polymethoxylated flavones in orange juice and fruit parts. In Liquid Chromatographic Analysis of Foods and Beverages, G. Charalambois, ed., Academic Press. New York and London, p. 537-558.
5. ————, ————. 1979. Quantitation of polymethoxylated flavones in orange juice by high-performance liquid chromatography. *J. Chromatog.* 176:75-87.
6. Schwartz, A. G. and W. R. Rate. 1979. Inhibition of aflatoxin B_1-induced cytotoxicity and binding to DNA in cultured rat liver cells by naturally occurring flavones. *J. of Environmental Pathology and Toxicology* 2:1021-1028.
7. Stout, M. G., H. Reich, and M. N. Huffman. 1964. Neonatal lethality of offspring of tangeretin-treated rats. *Cancer Chemother. Rep.* 36:23-24.

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THE INFLUENCE OF COLOR ON CONSUMER PREFERENCES FOR FLORIDA FROZEN CONCENTRATED GRAPEFRUIT JUICES[1]

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Abstract. **During the 1978-79 citrus season, 5 frozen concentrated grapefruit juices were prepared for a consumer test, the only variable being different levels of visual colors. *Taste tests were* conducted to determine the effect of color on acceptance, preference and flavor ratings of the juices as individual juices or when juices were compared with other juices. Color was found to have a significant effect in acceptance of paired juices. In general, yellowish-white to brownish-yellow (chamois) juices were preferred over either white or pink juices. A bias was found between male and female consumers.**

Pink grapefruit sell very well in the fresh fruit markets. The 'Star Ruby', a newly introduced deep red variety is reported in the "Citrograph" (1) to have become the number two grapefruit in Texas production ahead of the 'Marsh Pink' and the 'Marsh White'. The success of pink fruit in Texas has not gone unnoticed in Florida. Florida is now reported to have some 28% of its grapefruit in pinks (2). With pink fruit production come the problems that have been reported in Texas. Mature pink grapefruit juice has a tendency to develop a distinct "muddy brown" color when processed. Reuther, et al. (9) reported that until processing methods are perfected to retain the natural color of the lycopene pigments which are responsible for the red color in pink fruit, utilization of the pigmented varieties would be largely restricted to fresh fruit outlets.

[1]Florida Agricultural Experiment Stations Journal Series No. 2062. Cooperative research by the Florida Department of Citrus and AREC, University of Florida.

The processors of pink fruit feel that they are in a "no win" position with the USDA. When the pink fruit has good color early in the season, the USDA tends to downgrade the juice for "immature flavor" and when the flavor is good later in the season, the USDA grades the juice down again—this time for "poor color".

Under proposed revisions for grapefruit juice quality standards being considered at this time the USDA (3) has suggested that juice color be eliminated as a quality factor in determining grade. The proposal for eliminating juice color as a quality factor is opposed by processors who want to know the color of grapefruit juice before it is poured out of the can. They especially want color to be controlled in glass bottle packs so that only the best appearing juice will carry a Florida label. To resolve the differences of opinion as to what constitutes a good grapefruit juice color, the Florida Citrus Processors Association requested that the Florida Department of Citrus (FDOC) conduct a survey to determine what juice color(s) would be desired by the consumer, if indeed, color influenced the consumer at all (4).

Consumer tests and sensory panels are generally useful in determining two things: does a difference exist between samples, and is there a preference for certain samples. Differences between paired samples can be determined with relatively small panels. Reliable consumer preference estimates require fairly large numbers of people, and even then, there is no assurance that results will apply to the entire population. This is pointed out in discussion of methods of conducting tests and evaluating data which are presented in Kramer and Twigg (7) and Larmond (8). The purpose of this paper is to evaluate and present the results of a consumer preference test for grapefruit juice colors.

Materials and Methods

To avoid the effects of difference in variety, maturity and other factors that would influence flavor judgment, samples of different colors were prepared from a common white grapefruit concentrate selected by experienced personnel for its good flavor and color quality. In addition to the white juice, four selected juice colors were prepared by adding very small amounts of Food, Drug and Cosmetic grade color additives to the base concentrate. Colors were adjusted with these additives so that the prepared samples were visual matches of juices selected for their representative color. Hunter Citrus Colorimeter D45D2 Citrus Red (CR) and Citrus Yellow (CY) readings were used as an aid in adjusting the juices to match selected colors.

Juice colors selected for the preference tests were judged to be representative of those normally found during a citrus processing season based upon a study by Huggart *et al.* (5, 6) of the distribution of CR values obtained from commercial samples. The selected colors were spaced to fall in with the normal frequency pattern, starting with a white juice. Juices presented in the preference tests ranged in color levels from white to yellowish white, brownish-yellow (chamois), light pink and pink. Code letters, CR and CY readings for the samples are listed in Table 1. The lots of concentrate were packed in 6-ounce enamel-lined cans and held at −8°F (−22°C) until shipped. Samples were packed in dry ice and shipped by air express to the cities selected for the consumer preference tests.

Table 1. Description of the test juices.

Test juice code	Visual color	Hunter Citrus Colorimeter	
		Citrus Red	Citrus Yellow
H	White	7.9	33.7
J	Yellowish white	13.3	42.6
K	Brownish yellow (chamois)	23.8	46.7
M	Light pink	26.9	42.1
L	Pink	32.5	44.9

The consumer preference test for grapefruit juice color was completed for the FDOC by Market Facts, Inc., (MFI), Chicago, Ill., under the supervision of the FDOC Market Research staff. The consumer tests were conducted in supermarkets March 21 through 23 in four cities—Charlotte, N.C., Chicago, Ill., Denver, Colo. and New York, N.Y. Respondents numbered 125 in each city for a total of 500 people. Each juice was sampled 200 times, 100 times in the first position and 100 times in the second position. Each juice was tasted with every other juice 25 times as first sample and 25 times as second sample to give a total of 200 trials. Each juice was sampled 50 times in each city: in the first position 25 times; second position 25 times.

The study, in essence, was in two parts: a) monadic hedonic preference evaluation of the characteristics of the five juices as individual juices, and b) a paired comparison in which the consumer expressed a preference or no preference for one juice of a pair. In each part of the test, juices were rated for flavor, color and acidity. The participant was also asked if the juice was, "just right" or how it might be improved. Results of the monadic tests were obtained from 200 consumers. Results for the paired comparison are shown for 50 trials. Each juice was tasted 100 times on a monadic basis and 100 times following another product. This gave an evaluation of the juice by itself then an evaluation of the juice compared with all other juices. Only users of grapefruit juice within the past year or so participated in the taste test.

Results are shown for the juices considered alone, juices preferred to all other test juices and for one test juice compared to one other test juice. Juices were scored on a scale from poor (score 1) through fair, good, very good, extremely good to excellent (score 6).

Results and Discussion

Mean flavor scores. Overall opinion of the 5 juices was obtained both before and immediately after tasting. There was no particular preference as shown by the mean flavor scores for any one of the samples over the others, however, it is interesting to note that all juices improved from a good plus (score 3.3) for the group to a very good rating (score 3.6) after they had been tasted, Table 2. Results of this part of the test indicated that the juices, on averages tasted slightly better than they looked. There was no preference or pattern and all juices rated between good and very good. This would indicate that if the consumer had the juice in the home, one at a time, the color appearance of the individual juice considered alone would not materially affect the perceived sweetness, acidity or overall opinion of the product.

Table 2. Average overall opinion of grapefruit juice samples.[z]

Evaluation	Test product				
	H	J	K	M	L
Before tasting	3.2	3.4	3.3	3.1	3.3
After tasting	3.6	3.5	3.6	3.5	3.6

[z]Rating: 1 = poor, 2 = fair, 3 = good, 4 = very good, 5 = extremely good and 6 = excellent.

The juices were then scored for three characteristics, overall taste, color and acidity. Again there was no preference shown for any of the juices although overall taste for

all juices on average was rated good to very good (score 3.6). *Acidity and color* of the samples averaged about 3.3, a good plus.

Could juice be improved? An opinion was then obtained from the participants as to whether a juice could be improved by adjusting sweetness, acidity or color. Results showed that over 50% of the respondents considered the juices to be, "just right" for sweetness and acidity. As many as a third of the respondents wanted the juices to be sweeter with less acid.

With the exception of color, there was no pattern of preference for any of the juices. The respondents showed a very definite awareness of juice color with 67% voting for yellowish-white sample J. A significant pattern was shown for color (Table 3). The significant trend shown in Table 3 is the shift in opinion from sample to sample as to how juice color could be improved. As the color in the samples increased from white to pink, the percentage of replies for improving color increased stepwise. The pink juice was found by 35% of the respondents to be "too dark" while only 9% considered the pink juice to be "too light". Conversely going from the pink juice to the lighter juices, the percentage of responses increased stepwise ending with 45% considering the white juice as being, "too light". There should be a point where the minority of dissidents are equally divided. If a curve were drawn to fit the data shown in Table 3, this point should fall between a yellowish-white (J) and a brownish-yellow juice (K).

Table 3. Evaluation of color quality of juice samples.

	Test product[z]				
	H	J	K	M	L
Too dark	4	7	26	30	35
Just right	51	67	59	53	56
Too light	45	26	15	17	9

[z]Percentage of respondents considering the samples to be: Too dark; just right or too light.

Sample preference. A definite pattern of preference for the yellowish-white juice J was found in the comparison tests (Table 4). The participant was asked to indicate a preference for the first or second juice tasted. As shown in Table 4, 52% of the respondents preferred J, 44% preferred all other juices and 4% showed no preference.

Table 4. Overall sample preference.

Preference	Test product[z]				
	H	J	K	M	L
Test product	45	52	45	48	45
All others	49	44	49	45	48
None	6	4	6	7	7

[z]Percentage of respondents preferring products.

The percentage of individuals preferring J was not much greater than those preferring the other four juices. The thread running through the fabric of this test that gave J a significant edge over the other juices was the fact that J was selected over the other juices, whether served first or served second, for overall taste, color and acidity, as shown in Table 5.

Paired comparisons. Keeping in mind that all of the samples came out of the same drum of concentrate, it was significant to note how much color alone affected the consumer when two juices were compared. This was shown in terms of overall juice preference, taste, color, sweetness and acidity. The greatest effect was found when yellowish-white juice J was paired with the pink juice L as shown in Table 6. About 70% of the participants preferred the overall taste of J to 28% for L, with 2% expressing no preference. Additional overall paired comparisons of note included: white H over brownish-yellow K (58% to 37%); white H over light pink M (58% to 37%) and brownish-yellow K over light pink M (51% to 36%). Preferences were not as pronounced in other pairs.

Table 5. Overall product preference for selected attributes.

Attribute	Test product[z]				
	H	J	K	M	L
Preference	45	52	45	48	45
Taste	46	63	46	48	45
Color	42	48	42	42	42
Sweetness	47	47	42	44	45
Acidity	48	52	44	47	41

[z]Percentage of respondents preferring product.

Table 6. Respondent's preference for a test product in a paired comparison.

Attribute	Test product[z]		
	J	L	No preference
Juice preference	63.0	34.8	2.2
Overall taste	69.6	28.3	2.2
" color	56.5	39.1	4.3
" sweetness	58.7	26.1	15.2
" acidity	65.2	28.3	6.5

[z]Percentage.

Demographics. Current users and heavy users preferred sample J. Past users preferred H while light users were equal in their preference for H and J. Percentagewise, females preferred white juice H at 51% over all others while males preferred yellowish-white juice J at 53%.

Summary and conclusions. Results of the survey indicated that people were significantly aware of grapefruit juice color when certain pairs of juice colors were compared, especially in their preference for a yellowish-white juice when compared to a pink juice. A pattern of preference for yellowish-white juice over white, yellowish-brown, light pink or pink was shown in all characteristics scored: overall taste, color, sweetness and acidity.

When average preference scores from the monadic (hedonic) test for juices (one at a time) were considered, there was no significant pattern or preference found for any of the five color levels. These results indicated that juice color would have little or no effect on the consumer if the juices were used in the home one by one. However, if the juices were packed in glass and stacked side by side in the supermarket with other products, the percentages shown in the paired comparisons indicate that one color quality juice of a pair may get into the home at a rate 2 to 1 faster than the other juice.

Literature Cited

1. Anon. 1978. Star Ruby finding its niche in Texas citrus. *Citrograph*, 64:1 11-12.
2. Conner, Doyle. (Commissioner) 1978. 1977-78 Season annual report, Division of Fruit and Vegetable Inspection, State of Florida, Florida Department of Agriculture and Consumer Services.
3. Food Safety and Quality Service, USDA. 1978. Grapefruit juice. Federal Register. 43(127):28511-28516.

4. ————. 1978. Grapefruit juice. Federal Register. 43(232):56245.
5. Huggart, R. L. and D. R. Petrus. 1976. Color in canned commercial grapefruit juice. *Proc. Fla. State Hort. Soc.* 89:194-196.
6. ————, ———— and B. S. Buslig. 1977. Color aspects of Florida commercial grapefruit juices, 1976-77. *Proc. Fla. State Hort. Soc.* 90:173-175.
7. Kramer, Amihud and Bernard A. Twigg. 1970. Quality control for the food industry. 3rd Ed. The Avi Publishing Co., Inc., Westport, Conn, p. 120-154.
8. Larmond, Elizabeth. 1977. Laboratory methods for sensory evaluation of food. Publication 1637. Research Branch, Canada Department of Agriculture, Ottawa, Ont.
9. Reuther, Walter, H. J. Webber and L. D. Bachelor. 1967. The Citrus Industry. Vol. I. Revised ed. University of California. p. 543.

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EVALUATION OF A BEVERAGE CLOUDING AGENT FROM ORANGE PECTIN POMACE LEACH WATER[1]

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Abstract. **A beverage clouding agent was manufactured from orange pectin pomace leach water prepared from Valencia and Hamlin oranges. A commercial pectinase was used to hydrolyze pectin in the leach water. Clouding agent solids recovered (as % of peel solids) were 29% for Valencia orange peel and 27% for Hamlin orange peel. The stability of the prepared cloud was evaluated at a solids level of 1%. The initial cloud value was 410 NTU and after 30 days storage the drink retained 90% of the initial cloud. Sensory evaluation of the clouding agent indicated no bitterness when 0.25, 0.50, or 1.0% of the clouding agent was added to citrus drinks. Browning of the cloud concentrate during storage was prevented by freezing or by treatment with sulfur dioxide.**

Various material are used in most fruit-base drinks to provide an opaque or cloudy appearance. These materials are referred to as "clouding agents". The major use of these agents is in beverages to which citrus oil-flavoring materials have been added. The citrus oil is emulsified in the aqueous phase with the aid of emulsifiers and stabilizers, however, the oil phase, because of its low specific gravity, tends to separate from the aqueous phase. To increase the specific gravity of the oil phase, oil soluble materials such as brominated vegetable oil (BVO, sp. gr. 1.2 to 1.3) and (glycerol ester of wood rosin (EWR), sp. gr. 1.1)) are added to the citrus oils. The specific gravity of citrus drinks is 1.04–1.05. These materials are approved for use by the Food and Drug Administration at a maximum level of 15 ppm for BVO and a maximum of 100 ppm for EWR. Both of the materials have negative factors regarding their use.

A naturally occurring clouding agent for citrus drinks is highly desirable. Kesterson et al. (9) prepared a clouding agent from citrus seed meal. Several researchers (2, 3) have investigated the use of citrus pulp wash solids as a beverage clouding agent. Tateo (14) reported on the manufacture of a clouding agent from citrus pectin pomace aqueous waste. Douglas (8) patented a process to prepare a cloud fortified citrus fruit juice by the addition of finely divided albedo to juice. Villadsen (16) patented a process for the preparation of a clouding and coloring agent for soft drinks from citrus peel and/or citrus fruit rag.

The production of this new specialty is also desirable because it helps eliminate one source of water pollution during pectin manufacturing. Citrus peel must be leached with water to remove some of the sugars prior to drying the peel or extracting the pectin. Additional information on pectin manufacturing can be found in (1 & 4). Water from the peel leaching operation is concentrated so both the volume and pollution load can be reduced.

The purpose of this study was to evaluate the preparation of a beverage clouding agent prepared from the peel of Florida grown oranges. Emphasis was on the determination of product yield, product composition and physical characteristics of the clouding agent.

Materials and Methods

Clouding Agent Preparation. Orange peel used to prepare the clouding agent was from Valencia oranges picked July 25, 1978 and from Hamlin oranges that were picked November 29, 1978. The fruit was obtained and clouding agents were prepared at the University of Florida Agricultural Research and Education Center at Lake Alfred, Florida. The preparation of the orange peel clouding agent followed the outline presented in Figure 1.

Oranges were washed the day before the clouding agent preparation and stored at ambient temperature overnight. The following morning, the juice was extracted at 2.1 kg/cm^2 (30 psi) in a FMC (Food Machinery Corporation) in-line juice extractor. Peel was comminuted in a Fitzmill disintegrator type D using 3.8 cm (1½″) and a 1.75 cm (11/16″) screen for Hamlin and Valencia orange peel, respectively.

Up to this point the peel has been handled as it would be in a pectin operation. Normally room temperature water is used to remove the soluble solids prior to drying the peel or for extracting the pectin. See (4) for further details.

Ground peel was then added into water which had been preheated to 70°C in a steam jacketed kettle (2.5 kg of water to 1 kg of ground peel). After heating for 5 minutes at 60°C, the mixture was pumped through an FMC finisher model 35 with 2.9 kg/cm^2 (42 psi) air pressure, and a .05 cm (.020″) screen.

Peel that has been leached with hot water has been previously examined and found suitable for extracting pectin (5, 6, 7, 8).

Liquid recovered from the finisher was pumped through a SA 7-06-076 Centrico continuous centrifuge which removed large sludge particles from the liquid extract. The centrifuged extract was enzyme treated with a pectinase (Irgazyme 100, CIBA Geigy Labs) for 30 minutes at 52-54°C. Enzyme concentration was 100 ppm (by weight) for Valencia orange

[1]Florida Agricultural Experiment Station—Journal Series No. 2037.
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