

of the original juice concentrate should be such that it provides at least 46 mg/100 mL in the dilution at the time of preparation. If this criterion is met, the expected shelf-life to an expiration date value of 28 mg/100 mL is about 20 days.

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Pigmentation and Color Comparison of Ruby Red and Star Ruby Grapefruit Juice

Juice of the Star Ruby grapefruit (*Citrus paradisi Macfad*) extracted by commercial machinery and canned during the regular harvest season contained from 0.34 to 0.56 mg/100 g of β -carotene and 0.57 to 0.72 mg/100 g of lycopene, as compared to the corresponding respective value ranges of 0.09–0.14 mg/100 g of β -carotene and 0.04–0.08 mg/100 g of lycopene for the Texas Ruby Red variety. Blending with Star Ruby juice at about a 30% level in the early processing season and 40% in the late processing season is proposed as a means of maintaining a desired level of pink color in canned Texas grapefruit juice. In Texas, the processing of pink grapefruit juice is emphasized as contrasted to white grapefruit juice in Florida and California.

The Texas Ruby Red grapefruit (*Citrus paradisi*), the major commercial citrus produced in the Lower Rio Grande Valley of Texas, poses a problem for processors since, as the fruit advance in maturity, their color fades from pink to a nondescript pinkish-brown or off-yellow. This problem was studied in detail by Lime et al. (1954, 1956, 1959), who found that adding back pulp pigment to juice would improve the color.

The Star Ruby (*Citrus paradisi Macfad*), developed by Hensz (1971) at the Texas A & I University Citrus Center, Weslaco, TX, is a seedless, dark-red-fleshed grapefruit, originating from Hudson grapefruit seed irradiated at Brookhaven National Laboratory, Long Island, NY. The deep color of the Star Ruby suggests that the juice might be blended with that of Ruby Red grapefruit such that the canned juices produced over the entire processing season and the reconstituted products would be uniform in color and of an attractive degree of pinkness. This study, a part of a larger investigation, was initiated to ascertain the differences of lycopene and carotene contents in these two grapefruit varieties with advancing maturity as well as to determine the color changes occurring in pure juices and juice blends.

MATERIALS AND METHODS

Field run fruit of both Ruby Red and Star Ruby varieties were obtained over three harvest seasons by arrangement with the Texas A & I University Citrus Center

at Weslaco, TX. Samples were taken early in the season (first or second week in December), in midseason (about the last week in January), and late in the season (about the middle or latter part of March). The fruit were washed on a set of brush rolls, and the juice was extracted in an FMC Model 091B in-line Test Extractor fitted with 0.735-mm screens. The pure juices of the two varieties and blends containing 10, 20, and 30% Star Ruby juice were canned hot in 6-oz cans. In mid- and late-season packs, a 40% blend was added.

Pigment was analyzed by method B of the procedure of Lime et al. (1957). Initially, a B and L Spectronic 20 spectrophotometer with a 0.5 in. (1.27 cm) square cuvette was used; and subsequently, in the 1976–1977 season, a Carey 15 instrument with a 1-cm cell was used. Color was determined on a Gardner color difference meter with an LR-1 standard. Values for R_d , a , and b were determined and the a/b ratio calculated.

RESULTS AND DISCUSSION

Table I shows that the color of both grapefruit varieties tended to fade with advancing maturity, although both carotene and lycopene contents as well as the resulting color varied somewhat. Both spectrophotometers gave comparable results; but to adhere more closely to the original procedure of Lime et al. (1957), we changed to the 1-cm Carey cell. In the 1976–1977 season, climate may have had some effect on juice color. Rainfall was almost

Table I. Color and Pigmentation Ruby and Star Ruby Juice Blends

sample	date	gardner color a/b	mg % caro- tene	mg % lyco- pene
Ruby	12/11/74	0.10	0.11	0.08
10% Star		0.30	0.16	0.15
20% Star		0.46	0.19	0.22
30% Star		0.63	0.24	0.28
Star Ruby		1.21	0.34	0.69
Ruby	1/21/75	0.14	0.13	0.06
10% Star		0.41	0.15	0.16
20% Star		0.48	0.21	0.18
30% Star		0.66	0.24	0.28
40% Star		0.77	0.27	0.32
Star Ruby		1.41	0.53	0.68
Ruby	3/18/75	0.13	0.14	0.05
10% Star		0.26	0.16	0.09
20% Star		0.38	0.20	0.15
30% Star		0.51	0.23	0.21
40% Star		0.63	0.29	0.28
Star Ruby		1.04	0.49	0.60
Ruby	12/8/75	0.18	0.11	0.06
10% Star		0.38	0.16	0.16
20% Star		0.47	0.19	0.22
30% Star		0.61	0.27	0.33
Star Ruby		1.21	0.54	0.74
Ruby	1/30/76	0.03	0.13	0.05
10% Star		0.20	0.16	0.13
20% Star		0.41	0.18	0.19
30% Star		0.46	0.22	0.28
40% Star		0.57	0.29	0.31
Star Ruby		1.07	0.56	0.63
Ruby	3/25/76	0.03	0.10	0.04
10% Star		0.17	0.11	0.07
20% Star		0.28	0.14	0.14
30% Star		0.39	0.17	0.17
40% Star		0.49	0.18	0.28
Star Ruby		0.89	0.31	0.57
Ruby	12/14/76	0.04	0.14	0.05
10% Star		0.26	0.18	0.17
20% Star		0.36	0.21	0.20
30% Star		0.53	0.23	0.24
Star Ruby		1.40	0.54	0.70
Ruby	2/22/77	0.07	0.13	0.05
10% Star		0.32	0.16	0.17
20% Star		0.49	0.18	0.21
30% Star		0.64	0.23	0.24
40% Star		0.75	0.34	0.25
Star Ruby		1.60	0.45	0.72
Ruby	3/23/77	0.03	0.09	0.04
10% Star		0.20	0.13	0.15
20% Star		0.38	0.22	0.19
30% Star		0.43	0.26	0.23
40% Star		0.55	0.29	0.30
Star Ruby		1.01	0.39	0.70

continuous from early October, 1976, until about February 2, 1977; and as a result, the second sample of the 1976-1977 season was harvested over 1 month later than usual.

Previous work on Ruby Red grapefruit pigmentation (Lime et al., 1957) was based on the entire fleshy section. As compared with the juice, the fleshy section has perhaps three times as much pulp (minus the rag) and five times as much pigment since much pigment remains in the reject pulp when juice is machine extracted. Pulp content, to be reported in more detail later, varied from 6-16% in the Ruby Red juice and from 5-12% in the Star Ruby. During the extraction, we noted that the juice sacs of the Star Ruby were significantly thicker than those of the Ruby Red; consequently, more pulp was rejected during juicing of the Star Ruby.

For the three seasons, the color of the Ruby Red grapefruit juice alone was satisfactory, as judged from the readings of the color difference meter [positive *a/b* ratio, with the LR-1 standard; Lime et al. (1958)]. However, the Texas citrus industry would like a deeper-pink product. Their representatives visually examined the juice blends and indicated that a level of 30% Star Ruby in early season blends were sufficiently colored to be recognized as pink. For comparable color, a 40% level would be necessary in late season blends.

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Essential Leaf Oils of *Parthenium argentatum* A. Gray

The major monoterpenes in the leaf oil of *Parthenium argentatum* A. Gray have been identified by gas chromatography-mass spectroscopy to be α -pinene, camphene, β -pinene, sabinene, β -myrcene, limonene, terpinolene, β -ocimene, and ocimene.

In the foreseeable future, the direct production of hydrocarbons by cultivated plants will become one of the important substitutes for our limited supply of fossil fuel. This development of our agricultural industry would also alleviate our dependence on nondomestic sources of these strategic commodities. The rubber producing potential

of guayule has long been known. The early commercial development of guayule began around 1904 with the invention of a practicable extraction process for guayule rubber. The Continental-Mexican Rubber Co. began experiments for growing the shrub under cultivation and initiated a study of the plant (Lloyd, 1911).