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This research project was conducted at USDA , Agricultural Research Service, Fruit and Vegetable Chemistry laboratory, Pasadena, California, where Berhow was a research chemist, Tisserat was a research geneticist, Kanes was a research associate, and Vandercook, now retired, was a research chemist. Berhow and Tisserat now work at the USDA-ARS National Center for Agricultural Utilization Research, Peoria, Illinois, where Berhow is a research chemist and Tisserat is a research geneticist.

Abstract

Berhow, M., B. Tisserat, K. Kanes, and C. Vandercook. 1998. Survey of Phenolic Compounds Produced in Citrus. U.S. Department of Agriculture, Agricultural Research Service, Technical Bulletin No. 1856, 158 pp.

A survey of phenolic compounds, especially flavanones and flavone and flavonol compounds, using high pressure liquid chromatography was performed in Rutaceae, subfamily Aurantioideae, representing 5 genera, 35 species, and 114 cultivars. The average number of peaks, or phenolic compounds, occurring in citrus leaf, flavedo, albedo, and juice vesicles were 21, 17, 15, and 9.3, respectively. The overall composition of four different classes of phenolic compounds absorbing at 285 nm (flavone/ols, flavanones, coumarins/cinnamic acid derivatives, and psoralens) for the Rutaceous species and cultivars were determined in leaf, flavedo, albedo, and juice vesicle tissues. Percentages and concentrations of 11 flavanone glycosides, 3 flavone glycosides, and 1 flavonol glycoside were determined and categorized. Most taxa can be classified by their flavonoid glycosylation pattern as either predominantly neohesperidosyl or predominantly rutinosyl. The dominant neohesperidosyl flavanones were naringin, neoeriocitrin, and neohesperidin and the dominant rutinosyl flavanones were hesperidin, eriocitrin, and narirutin. Cultivars containing mainly neohesperidosyl flavanones also contained neohesperidosyl flavones. Similarly, species and cultivars containing rutinosyl flavanones contained rutinosyl flavones. The data can be used by food processors, chemists, citrus taxonomists, geneticists, and breeders.

Keywords: Aurantioideae, cinnamic acid, *Citrus,* coumarins, coumaric acid, didymin, diosmin, eriocitrin, flavanones, flavones, flavonols, hesperidin, isorhoifolin, naringin, naringin glucoside, naringin–6″–malonate, narirutin, narirutin glucoside, neoeriocitrin, neohesperidin, poncirin, psoralens, rhoifolin, rutin.

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Abbreviations

CRC# Accession number in the Citrus Variety Collection at the University of California, Riverside

HPLC High-performance liquid chromatography

NMR Nuclear magnetic resonance

Introduction

The phenolic compounds of citrus are secondary metabolic products that are believed to be produced as a result of the plant's interaction with the environment (Beier and Oertli 1983, Afek et al. 1986, Zaat et al. 1987, Laks and Pruner 1989, Snyder and Nicholson 1990). The phenolics are derived from phenylalanine and absorb light in the low ultraviolet range. In general, many absorb light around 285 nm (see figures 1 and 2). The phenolics that occur in *Citrus* include the flavonoids (flavanones, flavones, and flavonols) the anthocyanins, the coumarins, and the psorolens, among others.

Flavonoids may act as inducers (Zaat et al. 1987) and as phytoalexins (Laks and Pruner 1989, Snyder and Nicholson 1990)—that is, low-molecular-weight antimicrobial compounds that are both synthesized and accumulated in plant cells as a defense mechanism after exposure to microorganisms (Dixon 1986, Laks and Pruner 1989). Coumarins, acting as phytoalexins, are reportedly produced in response to pathogens' attacks on *Citrus* (Feldman and Hanks 1968, Afek et al. 1986, Nakatani et al. 1987).

Psoralens (linear furocoumarins) are toxic to insects, especially in the presence of ultraviolet light (Nahrstedt 1990, and references therein), and have been identified as phytoalexins in celery (Beier and Oertli 1983). Evidence indicates that some *Citrus* species may contain one or more flavedo compounds that confer insect resistance on their fruits. In particular, the Mediterranean fruit fly (*Ceratitis capitata,* a tephritid fruit fly) does not survive in lemons (Back and Pemberton 1918, Anonymous 1990). Caribbean fruit fly (*Anastrepha suspensa,* also a tephritid) pupae do not mature in lemons or limes (Nguyen and Fraser 1989, Anonymous 1990). These two observations could be related to a particular hydroxylation pattern of a flavonoid compound, the importance of which has been demonstrated for larval growth inhibition (Elliger et al. 1980).

In addition, phenolics appear to have desirable medicinal properties. Some have been reported to be antitumor agents and to exhibit antiviral and antimicrobial activities (Robbins 1980), hypotensive effects (Matsubara et al. 1985), and antioxidant properties (Robak and Gryglewski 1988). Psoralens are used in conjunction with ultraviolet light to treat psoriasis and other human skin disorders (Stolk and Siddiqui 1988). Both psoralens and coumarins are found in citrus oils (Lawrence 1982).

Recent evidence suggests that phenolics may play an important role in the regulation of plant metabolism. For example, flavonoids have been shown to be naturally occurring auxin transport regulators (Jacobs and Rubery 1988).

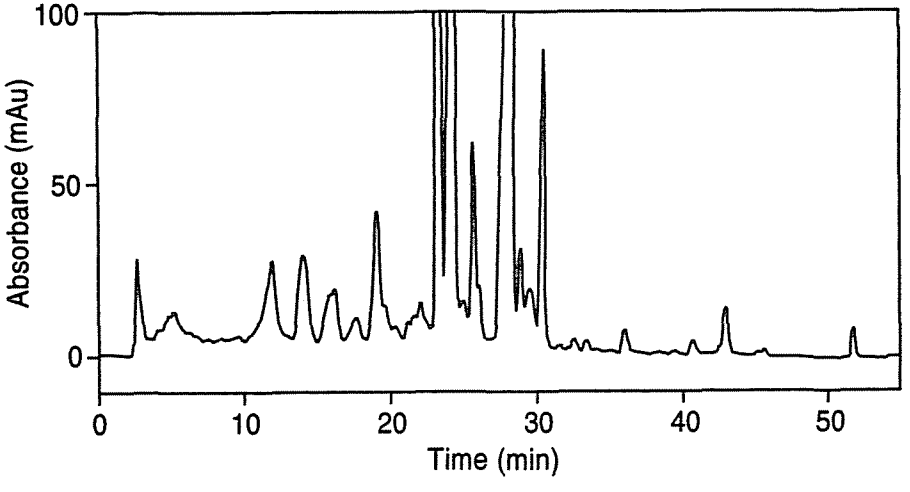


Figure 1. Typical HPLC flavonoid analysis trace at 285 nm depicting a methanol:dimethylsulfoxide extract of grapefruit leaves

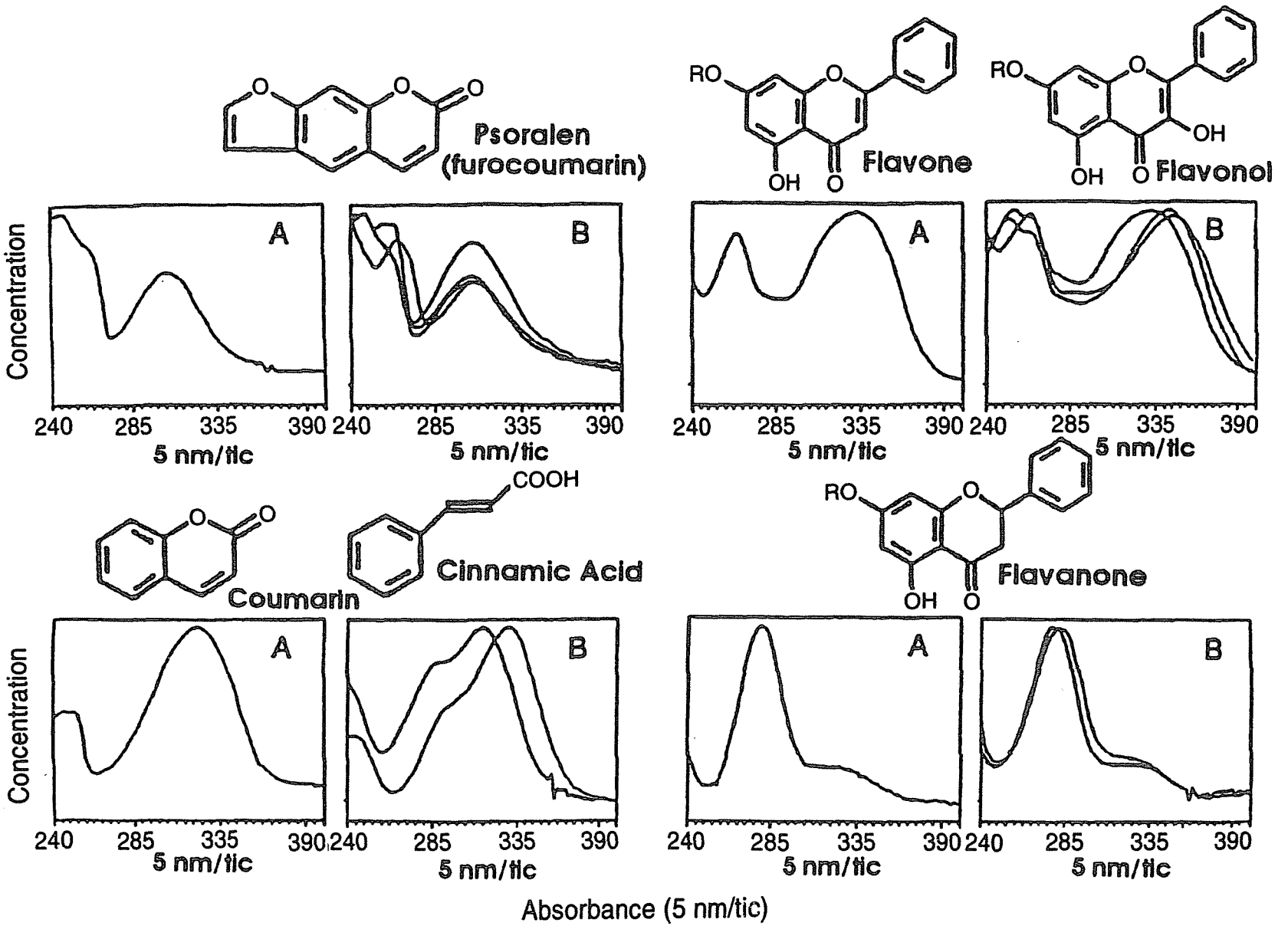


Figure 2. Structure and typical spectra of phenolic compounds found in citrus. *A*, Spectrum for a single representative compound. *B*, Range of spectra included in that particular class.

In short, the plant phenolics play a major role in both plant and animal health. Although much basic research still remains to be done, it is possible that many of these compounds, either as isolates or in conjunction with other compounds, may be used in both agricultural and pharmaceutical roles. Developing an understanding of the distribution of phenolics in *Citrus* and its related species will give an assessment of the diversity present in this important group of plants.

Citrus flavanones play an important role in citrus fruit and juice quality, contributing to juice cloud, as hesperidin does in lemons and oranges (Mizrahi and Berk 1970), and bitterness, as naringin does in grapefruits and pummelos (Horowitz and Gentili 1961, Guadagni et al. 1973, Horowitz 1986).

Different plant species, even different cultivars within a species, accumulate different flavonoids, a fact that can be of use in establishing taxonomic relationships between different citrus species and relatives. There are qualitative differences in the flavanones (and other secondary products) detected, as opposed to quantitative differences in the primary products, which are influenced by environmental stresses.

The biosynthesis of flavonoids in plant tissues has been extensively studied in many plants, and several of the biosynthetic steps have been elucidated as shown in figure 3. The control mechanisms for complex modifications in flavonoid biosynthesis (such as B–ring hydroxylations, methylation, or glycosylation) have also been studied in a small number of cultured cell suspensions from plants such as *Glycine max, Haplopappus gracilis,* and *Petroselium hortense* (Hahlbrock and Grisebach 1979, Heller and Forkmann 1988, Hahlbrock and Scheel 1989). However, these systems have not focused on flavanone modification enzymes, and many final steps are postulated only with unproven intermediates or responsible enzymes.

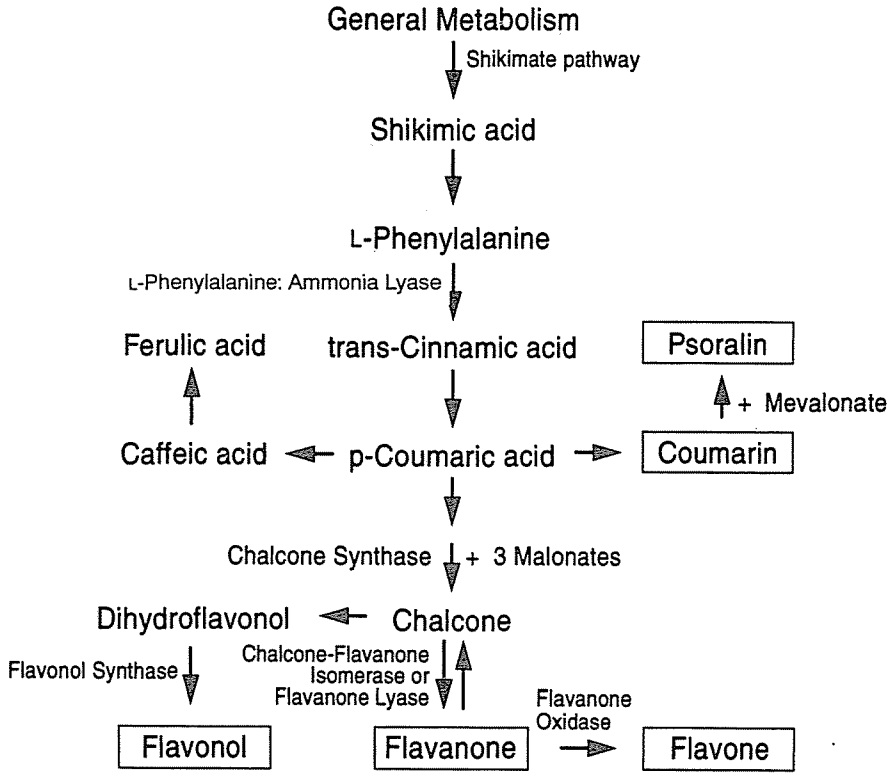


Figure 3. Biosynthetic pathways yielding the phenolic classes analyzed in this survey. Boxes represent classes. Flavonoids include flavanones, flavones, chalcones, dihydroflavonols, flavonols, and any glycosides with an aglycone based on a C6–C3–C6 structure. Dihydroflavonols are included in the flavone/ol class.

Determining the flavanone distribution in citrus tissues could point to possible tissue-specific enzymatic activity. For example, in *Haplopappus,* the enzyme flavanone synthase has a different optimal pH for naringenin production than for eriodictyol production (Hahlbrock and Grisebach 1979). Therefore, the pH at the site of the reaction (that is, in a particular tissue) could help to determine substrate specificity or the major reaction product. In addition, in some plant systems flavonoids are accumulated preferentially in the epidermis, while in others they occur in the mesophyll (Wiermann 1981). The results presented in table 1 demonstrate that in citrus species the albedo and juice vesicles generally have a greater number of flavanone peaks than the leaf tissue.

A number of surveys have identified and quantified *Citrus* flavanones based on separations performed by extractions and recrystallizations, paper chromatography and column chromatography, and preparative thin-layer chromatography (Hattori et al. 1952, Mizelle et al. 1965, Hagen et al. 1966, Maier and Metzler 1967, Mizelle et al. 1967, Fisher 1968, Albach and Redman 1969, Albach et al. 1969, Nishiura et al. 1969, Coffin 1971, Nishiura et al. 1971a,b, Tomas et al. 1978, Kamiya et al. 1979, Grieve and Scora 1980, Anis and Aminuddin 1981, Albach and Wutscher 1988). These techniques have also been used to isolate flavones, psoralens, and coumarins (Maier and Metzler 1967, Brunet and Ibrahim 1973, Dreyer and Huey 1974, Tatum and Berry 1979, Afek et al. 1986, Mizuno et al. 1987). The column chromatography and thin-layer chromatography surveys usually quantitate only one or two of the phenolics in citrus fruits. Several studies identifying naringin in grapefruit and hesperidin in lemon have been performed (Maier and Metzler 1967, Albach et al. 1969, Tomas et al. 1978, Mizuno et al. 1987, Albach and Wutscher 1988). Unfortunately, these studies are of limited quantitative value.

The influence of polyploidy on the chemical composition of leaves and fruit is unknown. The occurrence of polyploidy in *Citrus* and related genera has been reported since the 1920's (Cameron et al. 1964, Cameron and Soost 1968,1969, Soost and Cameron 1981). Tetraploidy is the most common natural polyploidy. The degree of polyploidy in *Citrus* plants is manifested with various physical effects, but no work relating the degree of polyploidy to the levels of plant phenolics has been done.

Past studies of citrus phenolics using high-performance liquid chromatography (HPLC) have been confined to a few flavonoids or to a few *Citrus* cultivars, mainly to individual species or individual phenolic compounds. Frequently this technique has been used to isolate individual compounds and not to quantitate them (Brunet and Ibrahim 1973, Dreyer and Huey 1974, Ting et al. 1979, Beier and Oertli 1983, Park et al. 1983, Jourdan et al. 1985, Gaydou et al. 1987, McHale et al. 1987, Mizuno et al. 1987, Rousseff et al. 1987, Tisserat et al. 1989, Vandercook and Tisserat 1989). Such studies are also of limited quantitative value. Investigations identifying or quantifying a few flavanones have generally been performed on lemon, orange, and grapefruit cultivars. (Hattori et al. 1952, Mizelle et al. 1965, Hagen et al. 1966, Maier and Metzler 1967, Mizelle et al. 1967, Fisher 1968, Albach et al. 1969, Nishiura et al. 1971a, Lawrence 1982, Mizuno et al. 1987, Rousseff et al. 1987, Albach and Wutscher 1988, Vandercook and Tisserat 1989). A few qualitative surveys of flavonoids in a large number of citrus cultivars have been published. The results of these studies are summarized in appendix 1.

This publication is the first to provide direct quantification of all major flavonoids in the leaves and fruit for a large number of *Citrus* species and cultivars. This information can be used to assess taxonomic classifications, evaluate potential sources of phenolic compounds for agricultural and pharmaceutical uses, and evaluate breeding program results.

Phenolic Compounds Studied

Citrus are a rich source of flavonoids (Robbins 1980). Determination of *Citrus* plant sources with high concentrations of individual flavonoids is desirable in order to study their biological properties. In this study, we determined the percentages of flavonoids, coumarins, and psoralins in different *Citrus* tissues. We have also quantified a number of specific flavonoids in these tissues. The high-pressure liquid chromatography patterns of phenolic compounds in members of the Citrus subtribe were evaluated using sensitive HPLC technology.

This survey quantitatively evaluates the following flavonoids:

flavanone glycosides
- eriocitrin (eriodictyol–7–*O*–rutinoside)
- didymin (isosakuranetin–7–*O*–rutinoside)
- hesperidin (hesperetin–7–*O*–rutinoside)
- naringin (naringenin–7–*O*–neohesperidoside)
- naringin–6″–malonate
- naringin–4′–glucoside
- narirutin (naringenin–7–*O*–rutinoside)
- narirutin–4′–glucoside
- neoeriocitrin (eriodictyol–7–*O*–neohesperidioside)
- neohesperidin (hesperetin–7–*O*–neohesperidioside)
- poncirin (isosakuranetin–7–*O*–neohesperidioside)

flavone glycosides
- diosmin (diosmetin–7–*O*–rutinoside)
- isorhoifolin (apiginin–7–*O*–rutinoside)
- rhoifolin (apiginin–7–*O*–neohesperidoside)

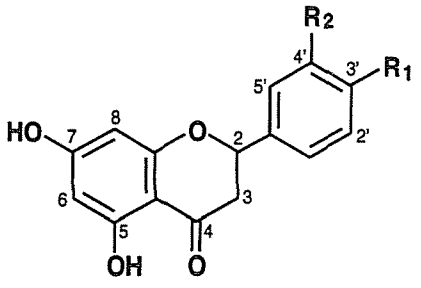
flavonol glycoside
- rutin (quercetin–3–*O*–rutinoside).

The flavonoid chemical structures are depicted in figure 4.

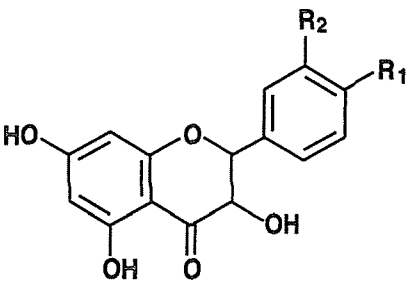
In this report, we compare the concentrations and percentages of these particular classes of phenolic compounds in various tissues for several members of the Citrus subtribe. For each cultivar studied, tables 3 and 4 provide estimates of the amounts of each phenolic compound in leaf, flavedo, albedo, and juice vesicle tissues based on identification by ultraviolet spectra. This information can be used to help differentiate citrus species, and it demonstrates that the tissues have different overall phenolic concentrations.

Plant Materials Analyzed

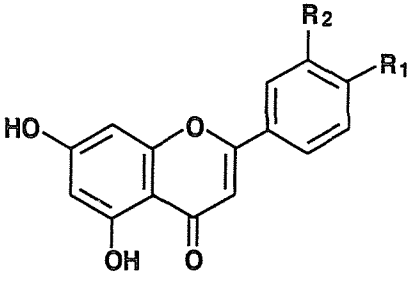
The following taxa were studied:
- *Citrus aurantifolia* (Christm.) Swing. (lime)
- *C. aurantium* L. (sour orange)
- *C. excelsa* West. (papeda)
- *C. grandis* (L.) Osb. (pummelo)
  or *C. maxima* (J. Burman) Merrill (Scora and Nicolson 1986)
- *C. grandis* × *C. limon* (lemelo)
- *C. grandis* × *C. reticulata* (pummelo-mandarin hybrid)
- *C. grandis* × *C. sinensis* (pummelo-orange hybrid)
- *C. jambhiri* Lush. (rough lemon)
- *C. hystrix* D. C. (Mauritius papeda)
- *C. limon* (L.) Burm. f. (lemon)
- *C. longispina* West. (megacarpa papeda)
- *C. macrophylla* West. (alemow)
- *C. medica* L. (citron)
- *C. microcarpa* Bunge (calamondin)
- *C. natsudaidai* Hay. (Natsudaidai orange)
- *C. paradisi* Macf. (grapefruit)
- *C. reticulata* Blanco (mandarin)
- *C. reticulata* × *C. grandis* (tangelo)
- *C. reticulata* × *C. sinensis* (tangor)



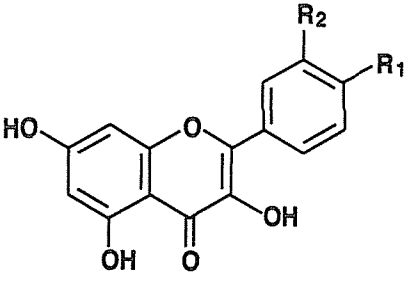
Flavanone Aglycone



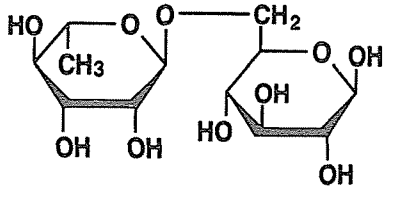
3-Hydroxyflavanone Aglycone



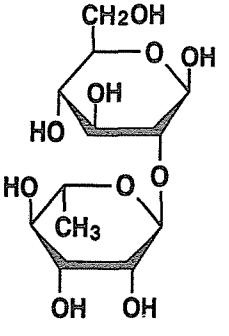
Flavone Aglycone



Flavanol Aglycone



Rutinoside (diglycoside)



Neohesperidoside (diglycoside)

Figure 4. Structure of flavanone, flavone, and flavonol compounds examined in this survey

Common name	Structural name	Ring substitution pattern R1	R2
Flavanone aglycones:			
Naringenin	5,7,3′–trihydroxyflavanone	OH	H
Isosakuranetin	5,7–dihydroxy–3′–methoxyflavanone	O–Me	H
Eriodictyol	5,7,3′,4′–tetrahydroxyflavanone	OH	OH
Hesperetin	5,7,4′,–trihydroxy–3′–methoxyflavanone	O–Me	OH
3–Hydroxyflavanone aglycone:			
Dihydrokaempferol	3,5,7,4′–tetrahydroxyflavanone	OH	H
Flavone aglycones:			
Apiginin	5,7,4′–trihydroxyflavone	OH	H
Fortuneletin	5,7–dihydroxy–3′–methoxyflavone	O–Me	H
Luteolin	5,7,3′,4′–tetrahydroxyflavone	OH	OH
Diosmetin	5,7,4′–trihydroxy–3′–methoxyflavone	O–Me	OH
Flavonol aglycones:			
Kaempferol	3,5,7,3′–tetrahydroxyflavone	OH	H
Kampferide	3,5,7–trihydroxy–3′–methoxyflavone	O–Me	H
Quercetin	3,5,7,3′,4′–pentahydroxyflavone	OH	OH
Chrysoeriol	3,5,7,4′–tetrahydroxy–3′–methoxyflavone	O–Me	OH
Isorhamnetin	3,5,7,3′–tetrahydroxy–4′–methoxyflavone	OH	O–Me
Diglycoside groups:			
Rutinoside	6–*O*–α–L–rhamnosyl–β–D–glucoside		
Neohesperidoside	2–*O*–α–L–rhamnosyl–β–D–glucoside		

C. reticulata × *Poncirus trifoliata* (citrandarin)
C. rugulosa Hort. ex Tan. (attani)
C. shunokan Hort. ex Tan. (ichang)
C. sinensis (L.) Osb. (sweet orange)
C. sinensis × *(C. sinensis* × *Poncirus trifoliata)* (citrangor)
C. sulcata Hort. ex Takahashi
C. tamurana Hort. ex Tan. (Hyuganatsu pummelo)
C. tengu Hort. ex. Tan.
C. ujukitsu Hort. ex Tan.
C. webberi West. (Webber's Philippine pummelo)
Eremocitrus glauca (Lindl.) Swing. (Australian desert lime)
Fortunella sp.? × *C. reticulata* × *(C. sinensis* × *Poncirus trifoliata)* (citrangedin)
Microcitrus australasica var. *sanguinea* (F. M. Bail.) Swing. (red pulp finger lime)
M. inodora (F. M. Bail.) Swing. (large-leaf wild lime)
M. warburgiana (F. M. Bail.) Ten. (New Guinea wild lime)
Poncirus trifoliata (L.) Raf. × *C. paradisi* (citrumelo).

Sample Preparation for Phenolic Analysis

Fresh sample preparation and extraction. Mature fruit and leaves used in this study were collected in late December at the Citrus Variety Collection at the University of California, Riverside. Fresh samples were stored frozen in sealed clear polyethylene plastic bags (168 mm × 150 mm) (Glad-Lock zipper sandwich bags, First Brands Corp., Danbury, CT) at –20 °C for up to 3 months until they could be processed for extraction. Comparison of the chromatographic profiles of extracts prepared from fresh samples and from the same samples that had been stored frozen for over 1 year showed there was little degradation of the phenolic content during freezing.

About 200 mg of thawed flavedo and albedo tissues, 100 mg of thawed leaf tissue, or 500 mg of thawed juice vesicles were ground or cut into small pieces, weighed, and placed in a 1.5-mL plastic microfuge tube. One mL of a dimethylsulfoxide:methanol solution (1:1) was added to each tube. The sample was thoroughly mashed with a spatula, then allowed to soak at 25 °C for 2 hr or longer. The sample was remashed with the spatula every 30 min during the 2-hr soaking period. The extracts were then processed for HPLC analysis as outlined below or returned to −20 °C storage until they could be processed.

Dried leaf sample preparation and extraction. Collected leaves were oven-dried at 60 °C in brown paper bags for at least 24 hr. The dried leaves were then ground into a fine powder by one of two methods. Samples of less than 10 leaves were ground to a fine powder with a mortar and pestle with the addition of a small amount of sand. Larger samples of more than 10 leaves were ground to a powder in a small, electrically driven coffee bean mill. The dried, powdered samples could be stored indefinitely in a refrigerator at 4 °C until time of extraction. Samples (approximately 250 mg) were extracted with 1 mL of a 1:1 dimethylsulfoxide:methanol mixture at 50 °C. Each extraction was allowed to soak for at least 1 hour. After centrifugation, the supernatant was decanted, the pellet re-extracted with an additional 1 mL of dimethylsulfoxide:methanol, centrifuged, decanted, and extracted a third time. The three extractions of each sample were combined and prepared for HPLC analysis.

High-Performance Liquid Chromatography Analysis

Preparation of extract for HPLC analysis. The extraction mixtures were centrifuged for 1 min in a tabletop microcentrifuge to pellet the cell debris. The resulting supernatant of each sample extract was filtered through a nonsterile 0.45-μm Nylon 66 syringe filter (Alltech Associates, Deerfield,

IL, catalog number 2047) into a 2-mL screw-capped autosampler vial that was compatible with the autosampler described below.

The chromatographic system used in this study consisted of dual Shimadzu (Kyoto, Japan) LC–6A high-pressure pumps, a Shimadzu SIL–6A automatic injector, a Shimadzu SCL–6A integrated system controller, a Licrosorb C18 reverse-phase analytical column (25 × 0.4 cm, ODS 3, 5-μm particle size) (Phenominex Corp., Torrance, CA), and a Hewlett-Packard (HP) 1040A UV diode array detector with an attached HP analysis computer and data storage system. This system consisted of a HP 85B microcomputer, HP 9133 hard disk data storage device, HP inkjet printer, and 7470A HP plotter (Hewlett-Packard, Beaverton, OR).

The gradient elution schedule consisted of an initial 2-min run of 80-percent 0.01 M phosphoric acid and 20-percent methanol followed by a linear gradient to 100-percent methanol over 55 min at a flow rate of 1 mL/min.

Usually, a trial run was performed on a new sample to determine the optimal volume of sample to be injected on the HPLC system for the best determination of the phenolic content; 25 μL of sample were routinely used for the initial run. The sample volume was then raised or lowered until the injection contained the equivalent of 5 μg of the most prevalent phenolic compound. Some samples required several HPLC runs to optimize the injection volume required to yield a good chromatographic trace. Typically, the injection volumes of leaf extract samples prepared according to this protocol were around 25 μL, while the injection volumes of extract samples prepared from fruit tissues were around 100 μL.

The injection of water as a blank failed to produce peaks in the resulting chromatogram. Furthermore, after injecting such quantities of flavonoid standards that the detector was swamped, a subsequent water blank chromatogram showed no traces of phenolic compounds. This indicates a high efficiency in flavonoid elution using this HPLC technique. It also indicates that traces of flavonoids with an unexpected glycosylation pattern did not result from contamination from previous runs. In most cases, samples from cultivars having unexpected patterns were reanalyzed to confirm the presence of unexpected or unusual flavonoids.

Peak area percentages and extinction coefficients were calculated from chromatograms of standards detected at 285 nm. This wavelength was chosen for monitoring because all phenolics examined in this study absorb at this wavelength and extinction coefficients were similar when calculated from several purified standards in the three different classes examined: flavonoids, substituted cinnamic acids, and psorolens. Peaks from chromatographic runs were then assigned to general phenolic classes or identified as specific flavonoids by the criteria given below. A typical chromatogram is shown in figure 1.

General Phenolic Analysis

The chromatographic peaks present in each sample were evaluated spectrophometrically to determine the class of phenolic compounds—flavonoid, coumarin/cinnamic acid, or psoralin—to which the peak belonged. This information was used to construct table 2, which summarizes the overall phenolic composition for each species examined.

Data Collection. For each discernible phenolic peak on the HPLC run trace at 285 nm examined, a spectrum and a relative retention time was obtained, and then it was classified as either one of the three classes of phenolics or an unknown. During the HPLC run, diode array absorption spectra were taken of each detectable peak at three points as the sample passed through

the detector: up-slope, apex, and down-slope. This information was retrieved from the computer, and the peak apex spectrum was printed out on the plotter for each peak. The up- and down-slope spectra were examined if there was any ambiguity in assigning peaks to classes.

Purified standards, either isolated in this laboratory or purchased from chemical supply companies, were used to determine both a characteristic absorbance spectrum for each of the four classes of phenolics examined and their extinction coefficients at 285 nm. The characteristic spectra of standards of these compounds are shown in figure 2. Peaks from sample runs were then assigned a classification based on the following spectral criteria:

Flavanones. Flavanones are identifiable by a characteristic absorbance maximum at 280–288 nm and a broad shoulder at about 330 nm (figure 2). These features, as well as the large number of known spectra, were used to identify this class of compounds.

Flavones and Flavonols. Flavones and flavonols exhibit high absorbances in both the 240–270 nm region and the 320–380 nm region. The flavonones and flavonols have very similar spectra and it is difficult to differentiate between the two types of compounds based on spectra alone, so they are classified together here.

Coumarins and Cinnamic Acids. As a class, coumarins are identified on the basis of their characteristically large absorbance peak occurring in the region of 310–330 nm (figure 2). Cinnamic acid derivatives (including *p*–coumaric acid, caffeic acid, and ferulic acid), although they are distinct compounds and somewhat distant biosynthetically, are included in this class because of the similarity of their absorbance spectra to that of the coumarins. Cinnamic acid derivatives are present in relatively high concentrations in mature grapefruit (Maier and Metzler 1967).

Psoralens. Psoralens (furocoumarins) have been isolated from many citrus species. They are identifiable by absorbance maxima in the region of 240–265 nm, followed by a precipitous dip in the region of 270–290 nm, and a broader, smaller peak in the region of 320–350 nm (figure 2).

Unknown. Unknowns comprised those compounds that absorbed light at 285 nm but were either obvious mixtures of compounds (as determined by the examination of the up-slope and down-slope spectra of these peaks) or had a spectrum that did not match that of the four general classes outlined above.

After the peaks in a given sample were identified, the relative concentrations of each class in the sample were determined. The concentrations were ascertained from peak areas printed out by the computer in milliabsorbance units, using the extinction coefficients determined from the standards.

Specific Flavonoid Peak Assignments and Quantification Procedures

The chromatographic peaks in each sample that were determined to be flavonoids by their spectral characteristics were then specifically identified by comparison to flavonoid standards and other information. Known flavonoid standards were chromatographed separately and as mixtures. These flavonoid standards were used to develop charts of relative retention times and to run nuclear magnetic resonance structural analysis for comparison to isolated flavonoid peaks from samples. The standards were added to tissue extracts to confirm relative retention times (Kanes et al. 1993). The identified flavonoids in each sample were then quantified on a percent weight basis and as milligrams per gram fresh weight of the sample to give a detailed flavonoid composition of the fruit and leaves for each of the cultivars examined (tables 3 and 4).

The flavanones and flavones in the sample analysis, which were previously identified by their characteristic spectral maxima under the general phenolic analysis procedure outlined above, were then specifically identified by their absolute retention times and retention times relative to other flavonoids in the same sample.

As a rule, each flavanone rutinoside eluted 0.7 to 1.1 min before its neohesperidosyl counterpart. This fact, as well as the preponderance of eriocitrin in lemons, was used to identify eriocitrin. The retention time difference relative to rhoifolin as well as its characteristic spectrum were used to identify isorhoifolin. In addition, all standards were visualized using thin-layer chromatography and their melting points were examined. Naringin–6″–malonate appears to be present in two forms in some samples, the first of which appears to be a closed lactone ring form of the malonate group (data not published). This may be an artifact of the extraction procedure and sample storage. The open ring form of naringin–6″–malonate may coelute with didymin.

Effects of polyploidy on flavonoid content. Leaf tissue from diploid and tetraploid specimens of four *Citrus paradisi* Macf. (grapefruit) cultivars were analyzed for flavonoid content and quality-related characterisitics. The cultivars examined were 'Hall', 'Imperial', 'Royal', and 'Seedy Marsh'. Plant material was obtained from the Citrus Variety Collection at the University of California, Riverside. The samples were prepared for HPLC analysis as outlined above.

Quantification of the individual flavonoid compounds was based on integrated areas. An aliquot of juice was titrated potentiometrically for total acidity (Vandercook et al. 1975). The results were calculated as milligrams of anhydrous citric acid per milliliter. The Brix values were measured by refractometer and are uncorrected for acid.

Nuclear Magnetic Resonance (NMR)

NMR was used to resolve two closely eluting flavonoids in our chromatographic profiles: didymin (isosakuranetin–7–*O*–rutinoside) and poncerin.

^{1}H NMR (270 MHz, DMSO–d_6) Didymin: d=1.15 (R–Me), 2.57 (3 eq) (3 ax is under the H–b2–eO solvent peak, as are many of the sugar H's), 3.77 (4′–OMe) 4.54 (R–1), 5.01 (G–1), 5.45 (2), 6.23 (6,8), 6.98 doublet (3′, 5′), 7.42 doublet (2′, 6′). Poncerin: d=1.15 (R–Me), 2.80 (3 eq), 3.77 (OMe) 4.48 (R–1), 5.10 (G–1), 5.6 (2), 6.12 (6′, 8′), 6.98 doublet (3′, 5′), 7.43 doublet (2′, 6′).

^{13}C NMR (270 MHz, DMSO–d_6) Didymin: didymin's spectrum is somewhat weak but resembles naringin's (Agrawal and Bensal 1989, Markham and Ternai 1976) except that it lacks a G–6 peak between 56 and 64 mg/L. This is diagnostic of rutinosides (Markham and Ternai 1976). Poncerin: poncerin contains a G–6 peak at 60.5, which is diagnostic of G–6 in neohesperidosides (Markham and Ternai 1976). The ^{13}C NMR spectrum of the phenolic portion of the two compounds resembles that of naringin with the addition of a 4′–methoxy peak at 55.1 mg/L and the following shifted peaks: 113.9 (3′, 5′) and 128.2 (2′, 6′).

Identification of Flavonoid–4′–Glucosides by β–Glucosidase Digestion

Extracts from the albedo of 'Kao Panne' pummelo had high proportions of naringin–4′–glucoside and narirutin–4′–glucoside, high overall flavanone content, and simple HPLC profiles. In order to correctly identify the flavonoid–4′–glucosides in these samples, β–glucosidase was added to prepared extracts to selectively remove the 4′–glucose groups before examination by HPLC. Samples of 'Kao Panne' albedo were ground in liquid nitrogen, after which 50 mL of a 200-mM NaOAc, pH 5 solution was

added. β–Glucosidase was added to one aliquot of this mixture to a final concentration of 1 mg/mL. A parallel sample was prepared except that β–glucosidase was not added. Both mixtures were incubated at room temperature overnight. A trichloroacetic acid (Sigma Chemical Co., St. Louis, MO) solution was added to obtain a 25-percent mixture to precipitate proteins. The resulting mixture was centrifuged and filtered as described above to prepare it for HPLC.

The percentage gain of the naringin peak and the concomitant loss of the naringin–4′–glucoside peak in the glucosidase-treated sample were compared with the total percentage of naringin and the putative naringin–4′–glucoside peak in the untreated sample. If all other percentages remained constant, the loss of the naringin–4′–glucoside peak and the gain in the naringin peak that agreed with the percentage of naringin–4′–glucoside in the untreated sample was considered as evidence for naringin–4′–glucoside. Once the identity of the 4′–glucoside peaks was confirmed in this manner, peak assignments were then made using the original methanol:dimethylsufoxide extract HPLC runs.

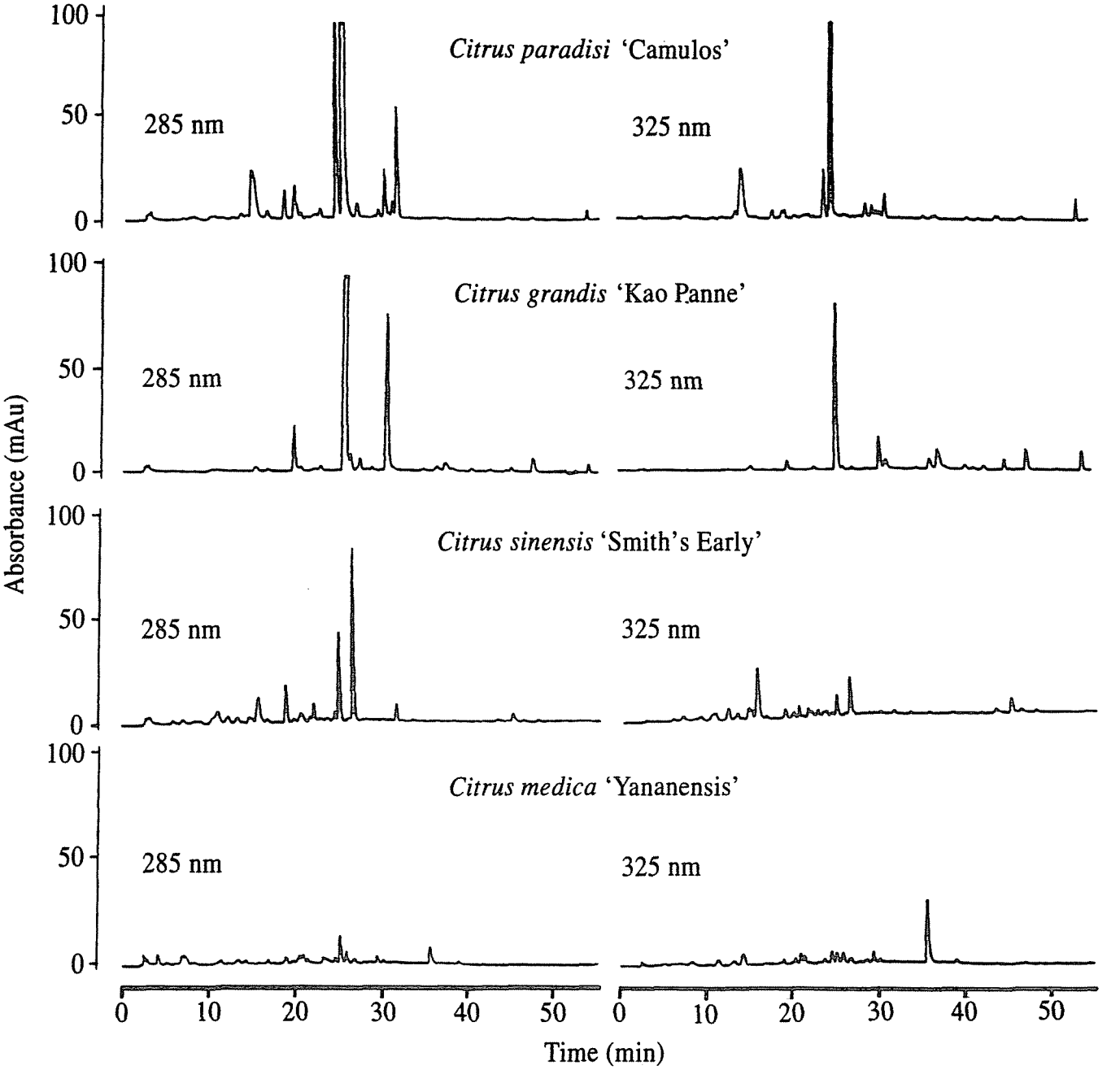
The same procedure was followed on 'Cutter' sweet orange for similar reasons in the identification of narirutin–4′–glucoside.

The overall tissue composition of phenolics has not been previously studied in the members of the Citrus subtribe. These compounds can readily be divided into classes according to their absorbance spectra (figure 2). Table 2 lists the percentages obtained for each sample of flavone/ol, flavanone, coumarin/cinnamic acid derivatives, and psoralen classes that absorb at 285 nm, as well as the concentrations (in milligrams per gram of fresh weight) of flavone/ols, flavanones, and coumarins. Void and unidentified peaks may contain chromones as well as other compounds.

Chromatograms for each sample were monitored at two wavelengths: 285 nm, which detects mainly flavanones and to a lesser extent flavones, and 325 nm, which detects coumarins and to a lesser extent psoralens and flavones. The chromatograms detected at 285 nm generally have higher total absorbances (excluding the void volume) than those detected at 325 nm. Furthermore, when the UV spectra of the peaks were examined they were readily classified, and the upslope, apex, and downslope spectra generally matched, indicating the peaks were those of a single compound (figure 2). Typical chromatograms monitored at 285 nm and 325 nm are shown in figure 5. Peaks identified at 285 nm usually also occur at 325 nm (figure 5 and tables 5 and 6). The peaks are well separated, and the peak shapes are very similar at these detection wavelengths.

For most citrus taxa, only 13 percent of the peaks detected at 325 nm, on average, were not detected at 285 nm. Exceptions occur in *C. medica* (citron) 'Citron of Commerce' and 'India Sour', *C. paradisi* (grapefruit) 'Camulos', and *C. sinensis* (orange) 'Thomson'; these cultivars had over 20 percent dissimilar total peak areas (tables 5 and 6). The citron's phenolic profiles do not resemble those of other species in tables 5 and 6 since the overall phenolic concentrations of citrons are extremely low and are dominated by coumarins. For most samples, few significant peaks (consisting of a single peak with a percentage area over 10 percent of the total area

Figure 5. Chromatographic comparisons of flavonoid patterns of albedo extracts of various *Citrus* species at 285 nm and 325 nm detection wavelengths



calculated for all peaks of a chromatogram) are detected at 325 nm. Grapefruit and orange produce larger numbers of unknown peaks with relatively high percentage areas at 285 nm. This causes a higher value for dissimilar (or unique) peaks. The average total proportional area per chromatogram of peaks detected at 285 nm but not detected at 325 nm is almost twice as high (24.5 percent versus 13.5 percent).

We believe that the number of nonvoid volume peaks can be used to describe a chromatogram's complexity and the complexity of the phenolic profile for a particular cultivar. Tables 5 and 6 summarize the average number of phenolic peaks occurring in several cultivars in various species. A wide range in the number of phenolic peaks (5 to 50 at a detection level of 0.01 mg/g fresh weight sample) occurs in *Citrus* depending on the species and the type of tissue examined.

The general trend indicates that hybrid taxa (including lemon, lime, tangelo, orange, grapefruit, and tangor) have more complicated spectra than the primary species (pummelo, citron, and mandarin). The most complicated chromatograms are found for their wild, presumably somewhat hybridized relatives: papeda, New Guinea lime, large-leaf wild lime, and red pulp finger lime. However, this observation is somewhat limited since in some cases only a small number of cultivars from a particular species were employed in this study.

Summarizing table 2, the highest concentrations and usually the highest percentages of flavone/ols occur in the leaf in citrus. The levels of flavone/ols in the flavedo are slightly lower. The concentration of flavone/ols is much less in the albedo and juice sacs of the fruit. The concentration of flavanones is greatest in the fruit albedo. The leaf or the flavedo has the highest concentrations and percentages of coumarins. It has been reported that the flavedo of 'Washington' navel orange contains about 2–4 times the concentration of flavonoids found in the albedo (Brunet and Ibrahim 1973). However, our results fail to verify this in other cultivars of orange.

In 7 of the 35 species and hybrids tested, the leaves contain the highest concentration (mg/g fresh weight) of flavanones. Some of these species may be related. Citron and a *Microcitrus* species such as Australian desert lime or the Australian large-leaf wild lime may be ancestors of lime (Swingle and Reece 1967). Rough lemon has citron and mandarin as ancestors (Hodgson 1967). Tangor seems less related, except that its flavonoid pattern resembles that of lime and rough lemon and it also has mandarin as an ancestor (Swingle and Reece 1967). Citron has only slightly higher flavanone concentrations in its leaves than in the fruit tissues; however, the overall flavanone levels in all tissues of the citron are very low, so this observation is somewhat tentative. Citron is believed to be one of the primary species and a parental source of lemon, lime, and rough lemon (Hodgson 1967, Mizelle et al. 1967, Swingle and Reece 1967).

In another nine, the flavanone concentrations were highest in the albedo (calamondin, *C. sinensis* × *(C. sinensis* × *P. trifoliata)* (citrangor), citrumelo, grapefruit, lemelo, Natsudaidai orange, pummelo, sour orange, and tangelo). Grapefruit, lemelo, Natsudaidai orange, and tangelo are believed to be pummelo hybrids (Mizelle et al. 1967, Swingle and Reece 1967); calamondin is a *Fortunella* × *C. reticulata* hybrid; and citrangor and citrumelo cultivars are believed to be *Poncirus* hybrids (Hodgson 1967, Swingle and Reece 1967, Albach and Redman 1969).

In three commercially important citrus species—lemon, mandarin, and orange—the flavanone concentrations tend to be roughly equal in leaf, flavedo, and albedo tissues. Mandarin and orange generally have slightly higher concentrations of flavanones in the leaf than in the other tissues. Lemon tends to have slightly higher flavanone concentrations in the albedo.

Juice vesicles in general contain the lowest overall concentrations of phenolics when compared to other parts of the fruit or the leaves, and their main phenolic constituents (based on phenolic percentages) are flavanones (table 2).

Fruit samples contain the same individual phenolic compounds as the leaf tissues, although the concentrations may differ dramatically. An evaluation of the leaf composition and concentration generally finds the same phenolics as in the juice vesicles, except that more flavanones are found in the fruit tissues than the leaf of many cultivars. In pummelo and grapefruit, however, the flavedo contains a larger number and higher levels of coumarins and psoralens than the other tissues. Such analyses could prove useful in genetic and taxonomic characterization of seedlings without the necessity of growing trees to fruiting age.

Tables 3 and 4 summarize our flavonoid analysis of *Citrus* species and their relatives. Additional information on flavonoid composition summarized from the literature can be found in appendix 2. Table 3 lists the 12 flavanones and table 4 lists the 4 flavones quantitated in our survey. The cultivars of the genus *Citrus* and its related species accumulate flavanone glycosides, along with some flavone and flavonol glycosides. The basic structure of these compounds in shown in figure 4. Most cultivars can be classified by the predominant glycosylation pattern on the flavonoid skeleton (Kumamoto et al. 1986, Robak and Gryglewski 1988). This glycosylation occurs at the "7" position on all compounds tested except rutin, which is glycosylated at the "3" position. Two main flavonoid glycsosylation patterns can be used to categorize *Citrus* species: the 7–*O*–neohesperidoside (2–α–L–rhamnosyl–D–glucose) pattern, which is found only in species related to the pummelo, and the 7–*O*–rutinoside (6–α–L–rhamnosyl–D–glucose) pattern, which is found in all species of citrus. The structures of these sugar groups are also shown in figure 4.

The dominant neohesperidosyl flavanones were naringin (found at high percentages in *C. rugulosa* [attani], citrangedin, grapefruit, kumquat, and pummelo), neoeriocitrin (one type of bergamot lemon and some sour orange tissues), poncerin (some *Poncirus* tissues), and neohesperidin (in *C. rugulosa* and tangelo). The dominant rutinosyl flavanones were hesperidin (*C. macrophylla* [alemow], citrangor, most citrons, *C. sulcata, C. ujukitsu,* lemon, lime, megacarpa papeda, mandarin, rough lemon, and sweet orange), eriocitrin ('Spadifora' citron, 'Seedless Lisbon' lemon), and narirutin (citrangor and some papedas).

In addition, the presence of rutin and diosmin is characteristic of cultivars related to the citron, while somewhat simple (two to five peaks) flavonoid patterns with hesperidin as a major flavonoid seem to be characteristic of the cultivars most closely related to citron and mandarin, two of the primary

citrus species. Pummelo and its close hybrids, as noted above, have a more complex flavonoid pattern dominated by the flavonoid–7–*O*–neohesperidosides.

Chromatograms obtained from extracts of mature fruits and leaves reveal that there generally are more flavanones occurring for each cultivar than has been previously reported in the literature (Hattori et al. 1952, Mizelle et al. 1965, Hagen et al. 1966, Maier and Metzler 1967, Fisher 1968, Albach and Redman 1969, Albach et al. 1969, Coffin 1971, Brunet and Ibrahim 1973, Dreyer and Huey 1974, Tomas et al. 1978, Kamiya et al. 1979, Tatum and Berry 1979, Robbins 1980, Lawrence 1982, Park et al. 1983, Matsubara et al. 1985, Kumamoto et al. 1986, Gaydou et al. 1987, Mizuno et al. 1987, Albach and Wutscher 1988, Jacobs and Rubery 1988, Robak and Gryglewski 1988, Stolk and Siddiqui 1988, Vandercook and Tisserat 1989). In general the previous publications on this subject either report only the presence or absence of flavonoids (but do not quantify them) or quantify a limited number of flavonoids (one to six) in juice or fruit. Often, only commercially important cultivars were examined, such as lemon, orange, and grapefruit. Tables 3 and 4 quantify 16 major flavonoids in fruit and leaf tissue from 107 citrus cultivars and near citrus relatives.

In addition we have found a number of cultivars that may contain malonyl esters of the flavanone glycosides. The first such compound, naringin–6″–malonate was identified in grapefruit at the Pasadena laboratory (Berhow et al. 1991). It is possible that some of the compounds we have labeled as naringin–6″–malonate may be other flavanone malonyl esters, although they appear to elute at reproducible retention times for naringin–6″–malonate. Further investigation is required on these esters.

The genetics of flavanone enzyme pattern inheritance is unknown. Also, which flavanone glycosylation pattern is dominant or recessive is not known. Although we did not analyze all cultivars available in the Citrus Variety Collection at the University of California, Riverside, our results indicate that the glycosidyl flavanone pattern is inheritable, since homozygous or heterozygous conditions are observed.

The flavone rutinosides diosmin and isorhoifolin with the flavonol rutinoside rutin are common constituents in *Citrus* species (Robak and Gryglewski 1988, Vandercook and Tisserat 1989). Figure 2 shows the spectra used in our analysis for this flavone class as well as for the neohesperidosyl flavone rhoifolin in *Citrus*. Flavones differ from flavanones by having a "2,3" double bond in the C–ring; rhoifolin corresponds to naringin, isorhoifolin corresponds to narirutin, and diosmin corresponds to hesperidin. Rutin, a prominent flavonol, is unique from the other *Citrus* flavonoids—it is the 3–*O*–rutinoside of the flavonol quercetin, and seems to be accumulated in species related to the citron.

Higher concentrations of flavones and flavonols occur in the leaves than in the flavedo, albedo, and juice vesicles. Attani, pummelo, sour orange, lemelo, Natsudaidai orange—species with mainly neohesperidosyl flavanones—also contain the neohesperidosyl flavone rhoifolin. Grapefruit, a pummelo × orange cross (Barrett and Rhodes 1976), contains rhoifolin and small amounts of isorhoifolin. Citrumelo, a *P. trifoliata* × *C. paradisi* hybrid (Hodgson 1967), contains rutin, isorhoifolin, and rhoifolin.

Citron

There have been few studies of flavonoids in citron (*C. medica*, a primary *Citrus* species [Albach and Redman 1969]). Citron cultivars have very simple flavanone patterns. Hesperidin has been reported as the main flavanone in citron (Albach and Redman 1969, Horowitz and Gentili 1977, Nishiura et al. 1971a,b). In this study, all citron cultivars (except 'India

Sour') were shown to contain exclusively rutinosyl flavanones, predominantly eriocitrin and hesperidin (except in 'Bush' citron). 'India Sour' citron contains high amounts of naringin, suggesting that it may be a hybrid.

The overall concentration of flavanones in citron is extremely low. In some samples, particularly in the leaf tissue, there are no detectable flavanones despite repeated evaluations. Citron may not contain some of the more complex enzymes necessary to produce a wide variety of flavonoid compounds, and this may reflect its "primitive" nature.

Citron contains large amounts of rutin and diosmin. Diosmin, especially, occurs in most cultivars in our study but otherwise has only been documented for 'Sarcodactylis' citron (fingered citron) (Horowitz and Gentili 1977). None of the cultivars in this study contain detectable amounts of the naringenin-like apigenin glycosides isorhoifolin or rhoifolin. This agrees with the lack of naringenin glycosides and their esters (except in 'India Sour' citron) in citron tissues. Rutin is found at relatively high levels in 'Spadifora' citron, a cultivar in which eriocitrin is the sole flavanone detected. Diosmin is also found in this cultivar, although its analogous flavanone hesperidin is not.

Citrumelo

Citrumelo (*Poncirus trifoliata* × *Citrus paradisi*), which resulted from a trifoliate orange × grapefruit hybridization, contains high levels of didymin, narirutin, and hesperidin. Poncerin, naringin (Albach and Redman 1969, Nishiura et al. 1971b, Kamiya et al. 1979, Anis and Aminuddin 1981) and neohesperidin (Horowitz and Gentili 1977) have been detected in *P. trifoliata* varieties. 'Sacaton' citrumelo contains mainly naringin and poncerin, along with narirutin, didymin, hesperidin, narirutin–4′–glucoside, neohesperidin, and naringin–4′–glucoside (Albach and Redman 1969).

Since citrumelo cultivars examined in this study do not contain the same flavanones, the parental background of each must influence the flavanone composition of this hybrid. The flavone/ols, predominantly rhoifolin, were only detected in the leaves.

Grapefruit

Grapefruit (*C. paradisi*) is a pummelo × sweet orange hybrid (Swingle and Reece 1967, Scora 1975a). Older surveys, reviews, and analyses of grapefruit mention naringin (Maier and Metzler 1967, Swingle and Reece 1967, Nishiura et al. 1969, Dreyer and Huey 1974, Metzler 1977, Kamiya et al. 1979, Anis and Aminuddin 1981, Park et al. 1983, Jourdan et al. 1985, Albach and Wutscher 1988) and poncerin (Anis and Aminuddin 1981) as well as narirutin, neohesperidin, hesperidin, didymin (Hagen et al. 1965, Mizelle et al. 1965, Hagen et al. 1966, Albach and Redman 1969, Albach et al. 1969, Coffin 1971, Horowitz and Gentili 1977, Park et al. 1983), and narirutin–4′–glucoside and naringin–4′–glucoside (Mizelle et al. 1967) with additional traces of a dihydrokaempferol glycoside (Maier and Metzler 1967) in grapefruit. Most recent flavanone research on *Citrus,* and most quantitative studies, have included different grapefruit cultivars. Nishiura et al. (1971a,b) found mainly naringin in the leaves and ripe peel, with naringin and poncerin in the juice of the ripe fruit. In part, the large variation in the results of the above studies may be due to insensitive or selective flavanone isolation or detection techniques. However, some studies of *Citrus* hybrids, including grapefruit cultivars, have noted that the hybrids can be divided into groups depending on their flavanone content or major flavanone (Tatum et al. 1978, Kamiya et al. 1979, Rousseff et al. 1987).

We can artificially divide the leaf of grapefruits and pummelo hybrid cultivars into the following four main groups depending on their major flavonoids:

- naringin/rhoifolin group ('Camulos', 'Duncan', 'Jochimsen', 'Star Ruby', 'Whitney Old Line Marsh')

- neohesperidin/neoeriocitrin/naringin group (*C. rugulosa, C. natsudaidai,* lemelo, 'Philippine' pummelo hybrid, shaddock × 'St. Michael' orange, 'Yuma Ponderosa Lemon' pummelo hybrid, 'CRC #343' grapefruit)

- hesperidin group ('Hall' grapefruit, 'Reed Seedling Marsh' grapefruit, 'Yellow Rind Mandarin' grapefruit, *C. shunokan, C. sulcata)*

- eriocitrin/narirutin/naringin group ('Red Aranyan' pummelo hybrid).

Similarly, Kamiya et al. (1979) has artificially divided pummelo and the Natsudaidai hybrids into five groups based on the flavanones in their leaves:

- naringin group
- naringin and neohesperidin group
- naringin and neoeriocitrin group
- neohesperidin and neoeriocitrin group
- naringin, neohesperidin, and neoeriocitrin group.

Consequently, any flavanone composition results for grapefruit could vary greatly depending on the cultivar chosen for study.

A few detailed quantitative studies on grapefruit flavanones have been compared with results of this survey to demonstrate the sensitivity and nonselectivity of our method (Hagen et al. 1965, 1966; Jourdan et al. 1985, Rousseff et al. 1987, Albach and Wutscher 1988). For example, using HPLC Rousseff et al. (1987) obtained the following values in 'Star Ruby' grapefruit juice: narirutin = 35 mg/L, naringin = 73 mg/L, hesperidin = 4 mg/L, and neohesperidin = 5 mg/L. Our values for juice vesicles in 'Star Ruby' grapefruit were narirutin = 210 mg/L, naringin = 1,040 mg/L, hesperidin = 0 mg/L (consistent with the fact that our method does not detect below 10 mg/L), and neohesperidin = 20 mg/L. Using a radioimmunoassay, Jourdan et al. (1985) obtained an average value of 4.64 mg naringin per gram fresh weight in mature leaves of 'Duncan' grapefruit. However, their assay simultaneously detects (and is incapable of distinguishing between) other flavanone neohesperidosides. Our analysis gives a value of 1.70 mg naringin per gram fresh weight in mature leaves of the same cultivar.

The HPLC method of this survey has been used to survey several different cultivars for four consecutive growing seasons and has always indicated that the percentages of flavanones remain fairly constant with those obtained for the 1990 season presented here, as have studies quantifying naringin concentrations for successive seasons (Albach et al. 1981).

The results of this investigation demonstrate that there is a large variety of flavanones present in grapefruit cultivars such as 'Star Ruby', 'Jochimsen', 'Camulos', 'CRC #343', and 'Duncan', all of which contain large percentages of naringin, neohesperidin, and neoeriocitrin. 'Whitney Old Line Marsh', 'Jochimsen', 'Star Ruby', and 'Duncan' resemble each other in flavanone composition and seem more typical of other grapefruit cultivars since they contain high concentrations of naringin and little hesperidin or eriocitrin. 'Camulos' and 'CRC #343' contain other flavanones not found in the more widely consumed 'Star Ruby' and 'Duncan' grapefruits.

Oddly, 'Hall', 'Reed Seedling Marsh', and 'Yellow Rind Mandarin' grapefruit contain only flavonoid rutinosides and do not accumulate naringin,

naringin–6″–malonate, naringin–4′–glucoside, or poncerin. 'Reed Seedling Marsh' should be very similar to the 'Redblush', 'Star Ruby', and other "Marsh" cultivars (Hodgson 1967) in that it should contain mainly neohesperidosyl glycosides. It is possible that the 'Reed Seedling Marsh' is not typical of the Marsh line.

Rhoifolin has been identified in grapefruit (Horowitz and Gentili 1977), and large quantities have been isolated from this species (Rowell and Beisel 1963). Some of the grapefruit cultivars examined in this study have large percentages and concentrations of rhoifolin, particularly 'Star Ruby' and 'Duncan'. However, large concentrations of diosmin and moderate concentrations of isorhoifolin were also detected in other cultivars ('Camulos' and 'Star Ruby', for example). Those grapefruit cultivars containing mostly neohesperidosyl flavanones also have high concentrations of rhoifolin and may have moderate concentrations of isorhoifolin. 'Reed Seedling Marsh' and 'Yellow Rind Mandarin' grapefruit with high concentrations of rutinosyl flavanones also contain high concentrations of diosmin. Tangelo, a mandarin × grapefruit cross (Swingle and Reece 1967, Barrett and Rhodes 1976), contains mainly rhoifolin.

Analysis of both diploid and tetraploid specimens of several grapefruit cultivars showed that flavor-related characteristics differ between fruit from the diploid plants and tetraploid plants. Other than this study, the influence of polyploidy on the chemical composition of leaves and fruits of citrus species is unknown.

Generally, tetraploid leaves are broader in proportion to their length than diploids and considerably thicker. Leaf color tends to be darker. The wings of the petioles are broader in some cultivars, and they often fuse with the leaf blade (Cameron and Soost 1968). Thorniness is more pronounced in tetraploids, vigorous shoots are less common, growth is slower, and the tree is smaller, less erect, and more compact. Tetraploids are slower in fruiting and produce less fruit. Juice vesicles are tougher and the yield of juice in proportion to the whole fruit weight is much lower.

The diploid and tetraploid forms of several cultivars of grapefruit were examined for flavonoid composition. These cultivars included examples from both neohesperidin-dominant and naringin-dominant leaf flavonoid pattern types. The naringin-dominant type, which contains naringin as the major flavanone, is characteristic of most grapefruit cultivars and was represented here by 'Seedy Marsh' and 'Hall'. The cultivars represented by the neohesperidin-dominant leaf type have neohesperidin as the major flavanone, with only some naringin present in the 'Royal' and 'Imperial' cultivars.

Diploid cultivars were found to consistently contain generally higher Brix levels, lower acid content (citric acid/mL), and higher acid/Brix ratios in the juice than their tetraploid counterparts (table 7). In contrast, higher levels of narirutin, naringin, and neohesperidin were found in the juice of tetraploid cultivars compared to diploid cultivars. These factors make the juice from diploid fruit taste better than the juice from tetraploid fruit.

Flavonoid levels in leaves varied among both the diploid and tetraploid cultivars (table 8). In naringin-dominant grapefruit leaf types such as 'Hall' and 'Seedy Marsh', naringin levels were higher in tetraploid leaves than in diploid leaves. 'Hall' leaves had less narirutin but more neohesperidin in tetraploid leaves than in diploid leaves. However in 'Seedy Marsh' leaves the opposite occurred. Neohesperidin-dominant leaf types—'Imperial' and 'Royal'—have higher neohesperidin levels but less narirutin in tetraploid leaves than in diploid leaves.

Lemon

Lemon *(Citrus limon)* is the result of a citron × lime × unidentified species cross (Malik et al. 1974) or possibly a citron × lime or rough lemon cross (Hodgson 1967). Lemon cultivars were found to contain predominantly the flavanone rutinosides eriocitrin, hesperidin, narirutin, and some didymin.

There have been a comparatively large number of chemical studies on lemon fruits (Albach and Redman 1969, Nishiura et al. 1971b, Horowitz and Gentili 1977, Tomas et al. 1978, Kamiya et al. 1979, Tatum and Berry 1979, Mizuno et al. 1987, Vandercook and Tisserat 1989, Vandercook et al. 1990) and lemon juice (Coffin 1971). Of these, only one gave quantitative values for the flavanones eriocitrin and hesperidin (Vandercook and Tisserat 1989). Park et al. (1983) and Tatum and Berry (1979) quantified the eriocitrin and hesperidin levels in lemon peel by HPLC analysis. However, their protocol involves an aqueous extraction that may lead to higher percentages of the more hydrophilic, polar flavonoids than the more nonpolar flavonoid aglycones. The cultivar employed in their study was unidentified. Most studies mention that lemons contain large quantities of eriocitrin and hesperidin (Albach and Redman 1969, Coffin 1971, Nishiura et al. 1971b, Horowitz and Gentili 1977, Tomas et al. 1978, Kamiya et al. 1979). A few studies have found narirutin in lemons (Albach and Redman 1969, Coffin 1971, Horowitz and Gentili 1977, Park et al. 1983). Two groups have found neohesperidin in 'Ponderosa' lemon, a cultivar that does not appear to be a true lemon (Albach and Redman 1969, Scora 1975b, Horowitz and Gentili 1960, 1977).

In this study, all lemons have hesperidin as their predominant flavanone, except bergamot lemon (which contains mainly neoeriocitrin) and 'Seedless Lisbon' lemon (which contains mainly eriocitrin). Bergamot lemon has few flavonoid characteristics of a true lemon, since neoeriocitrin and naringin appear to be its major flavanones. This indicates that this cultivar might be a pummelo hybrid. Scora and Kumamoto (1983) suggest that the bergamot lemon be considered a separate species: *C. bergamia.* Some lemon samples (such as 'Kaweah #1 Lisbon' lemon) contain roughly equal concentrations of eriocitrin and hesperidin. Most of the cultivars tested have narirutin, and two contain trace amounts of naringin ('Santa Theresa #1' and 'Nicaraguan').

While most lemon cultivars contain mainly rutinosyl flavanones, some cultivars have a limited ability to synthesize neohesperidosyl flavanones, a characteristic possibly obtained from hybridization with pummelo. Unlike rough lemon and citron, lemon cultivars are capable of synthesizing detectable levels of isosakuranetin glycosides (such as didymin) and flavanone glycoside ester derivatives. Some tissue samples, especially of flavedo, contain a flavanone tentatively identified as a new eriodictyol glucoside on the basis of retention time.

Unlike their primitive ancestors, some lemons seem capable of synthesizing the more hydroxylated isosakuranetin glycosides. One cultivar of lemon ('Kulu'), three cultivars of mandarin ('Robinson', 'Solid Scarlet', and 'Sunburst'), and many sweet orange cultivars (such as 'Bey', 'CPB 44944A', 'CPB 44944B', 'Fisher', 'McFadden Ribbed', 'Paradise', 'Parent Washington', 'Smith's Early', 'Thomson', and 'Cutter') contain a flavanone that elutes in the region of didymin. Lemons contain all four represented flavone/ols. The presence of rhoifolin is unexpected and occurs only in 'Kaweah #1 Lisbon' lemon.

Some of the lemon samples had high levels of rutin and diosmin (Vandercook and Tisserat 1989, Vandercook et al. 1990). Diosmin and apigenin, diosmin's aglycone, have been isolated from lemon (Horowitz and Gentili 1977). In addition, a quercetin glycoside (presumably rutin) has been obtained from lemons (Horowitz and Gentili 1977).

Lime

Lime *(Citrus aurantifolia)*, with possible citron, *Microcitrus,* and pummelo ancestors (Barrett and Rhodes 1976), contains only rutinosyl flavanones, predominantly hesperidin and either eriocitrin or narirutin. *Microcitrus* and citron, two of the potential parents of lime, also have the rutinosyl flavanone pattern. A number of papers have shown that lime can be classified as containing rutinosyl flavanones with high levels of hesperidin (Nishiura et al. 1971b, Horowitz and Gentili 1977, Kamiya et al. 1979, Anis and Aminuddin 1981). Albach and Redman (1969) reported that lime was unique among citrus taxa because it contains only hesperidin.

Our results confirm that hesperidin is a major flavanone; but consistent low levels of eriocitrin were also found in nearly all cultivars tested, as has been the case in lime juice (Coffin 1971). None of the surveyed lime cultivars contain either of the isosakuranetin glycosides or naringin–6″–malonate, possibly for the reasons discussed for *C. medica*.

Many lime samples contain appreciable amounts of the rutinosyl flavone rutin. Quercetin (presumably from deglycosylated rutin) had been isolated previously from 'Kagzi' lime (Mizelle et al. 1967). The leaf of 'Bishop Red' lime is the only sample in which isorhoifolin was detected. 'Bishop Red' lime and 'Otaheite Red Acidless' lime (both also called "Rangpur lime") are the only two lime cultivars in which any naringin is detectable, indicating the presence of some of the pummelo genome.

Mandarin

Mandarin (*Citrus reticulata,* a primary *Citrus* species) contains predominantly hesperidin, occasionally narirutin, and trace levels of didymin. Many studies note that hesperidin is a major flavanone component of mandarin (Horowitz and Gentili 1977, Metzler 1977, Kamiya et al. 1979). The simplicity of the flavanone profiles in mandarin (1–3 flavanones per tissue) is similar to that in citron, another primary species. Narirutin has been found in mandarin (Horowitz and Gentili 1977, Albach and Redman 1969). Other studies found eriocitrin in 'Ladoo' mandarin (Albach and Redman 1969, Hagen et al. 1966). All studies agree that rutinosyl flavanones predominate in mandarin and that hesperidin makes up a large part of the phenolics found in the tissues.

We did not find any eriocitrin in the mandarin cultivars we examined. There was some didymin in the 'Robinson' and 'Sunburst' mandarins. 'Robinson' is a 'Clementine' mandarin × 'Orlando' tangelo cross (Markham and Ternai 1976, Metzler 1977), which may account for the presence of a neohesperidosyl flavanone. The 'Solid Scarlet' and 'Burgess' cultivars are pure mandarins (Markham and Ternai 1976) and have no detectable levels of didymin. Mandarin, like other species containing mostly rutinosyl flavanones, contains the flavone/ols rutin and diosmin.

Natsudaidai Orange

Natsudaidai orange *(Citrus natsudaidai),* a grapefruit-like *Citrus* species, exhibits morphological characteristics of a pummelo crossed with a mandarin (Hodgson 1967) or a sour orange crossed with a mandarin (Kamiya et al. 1979). Natsudaidai orange has been reported to contain naringin (Horowitz and Gentili 1977), neohesperidin (Mizelle et al. 1965, Albach and Redman 1969, Nishiura et al. 1971b), and neoeriocitrin (Kamiya et al. 1979). The major flavanone is reportedly naringin (Horowitz and Gentili 1977), yet hesperidin has been found previously (Albach and Redman 1969).

Our analysis shows that in fruit tissues naringin is the predominant flavanone, followed by neohesperidin, while the opposite is true in leaves. Moderate amounts of narirutin, hesperidin, narirutin–4′–glucoside, and

naringin–4′–glucoside are also present. In addition, there is a small amount of neoeriocitrin in the leaves. The only flavone/ol component of Natsudaidai orange is rhoifolin.

Papeda

The papedas constitute a subgroup of species of the genus *Citrus*. Papedas have acrid oil glands in their fruit and a large winged petiole on their leaves. Most papeda cultivars (*C. hystrix, C. longispina, C. excelsa, C. macrophylla* (alemow), Mauritius papeda, and megacarpa papeda) contain predominantly hesperidin. In 'Davao Lemon' papeda, isorhoifolin predominates. Narirutin and naringin–6″–malonate are also found in all types of papeda in this survey. Poncerin, neohesperidin, naringin, and neoeriocitrin have been found in various papedas (Fisher 1968, Nishiura et al. 1971b). Only hesperidin is found in the leaf and juice vesicle tissues in *C. rugulosa* (alemow). Hesperidin, narirutin, and eriocitrin are found in the megacarpa papeda. Others have found mainly hesperidin in the leaves of Mauritius papeda and megacarpa papeda (Nishiura et al. 1971b) and hesperidin and narirutin in papeda fruit (Albach and Redman 1969).

The papedas contain predominantly rutin as the main flavone/ol constituent. Diosmin is present in some tissues, mainly the leaves of Mauritius papeda and megacarpa papeda. The papedas also contain detectable levels of the flavone/ols rutin, isorhoifolin, and diosmin in all tissues examined.

Pummelo

Pummelo *(Citrus grandis)*, a primary *Citrus* species, is reportedly one of the three species (in addition to sour orange and *Poncirus trifoliata*) that accumulate neohesperidosyl glycosides (Albach and Redman 1969). According to previous studies, naringin is the major flavanone in most pummelo cultivars (Mizelle et al. 1965, Albach and Redman 1969, Nishiura et al. 1971a, Kamiya et al. 1979, Park et al. 1983). Neohesperidin, poncerin, and naringin–4′–glucoside may also be present (Albach and Redman 1969, Nishiura et al. 1971a,b, Park et al. 1983, Kumamoto et al. 1986). Naringin is the major flavanone component in pummelo cultivars examined in this study, except in the 'Red Fleshed' pummelo, where the concentration of neoeriocitrin roughly equals that of naringin. There are also significant amounts of naringin–4′–glucoside, hesperidin, neohesperidin, and naringin–6″–malonate. The presence of small concentrations of eriocitrin and narirutin, along with hesperidin, shows that pummelo is capable of synthesizing rutinosyl glycosides.

Several hybrid cultivars of pummelo have greater amounts of rutinosyl flavanones (such as hesperidin in the 'Red Aranyan' hybrid) than pummelos themselves. Using thin-layer chromatography, Albach and Redman (1969) detected naringin and neohesperidin in pummelo and narirutin–4′–glucoside, hesperidin, naringin, poncerin, and neohesperidin in a pummelo × sweet orange cross. Rousseff et al. (1987) obtained similar results. Our results confirm the observation that, while most pummelos have neohesperidosyl flavanones, low and trace levels of rutinosyl flavanones can also occur, with larger percentages occurring in those pummelo hybrids produced from parental cultivars that accumulate rutinosyl flavanones.

Pummelo cultivars (such as 'Deep Red', 'Fleming', 'Kao Panne', 'Moanalua', 'Red Fleshed', 'Siamese Seedless', and 'Tahitian'), but not necessarily their hybrids, contain the naringin-like flavone rhoifolin. Several cultivars designated as pummelo hybrids (such as 'Philippine', 'Red Aranyan', 'Yuma Ponderosa Lemon') may also contain rutin and isorhoifolin. Other pummelo hybrids, such as the crosses between pummelo and lemon and the crosses between pummelo and orange, contain primarily rhoifolin.

Rough Lemon

All rough lemon cultivars tested contained 7–rutinosyl flavanones (usually as a mixture of hesperidin and eriocitrin). Rough lemon *(Citrus jambhiri)* is a citron or lemon × mandarin cross (Swingle and Reece 1967, Barrett and Rhodes 1976). All three possible parents contain the 7–rutinosyl glycoside flavanone pattern. The rough lemon cultivars examined in this survey have flavanone patterns similar to those of lime or lemon. They contain mostly hesperidin with small amounts of eriocitrin. There have only been a few flavanone studies on rough lemon cultivars. (Horowitz and Gentili 1977, Kumamoto et al. 1986). Hesperidin has been shown to be present in rough lemon (Horowitz and Gentili 1977), and neohesperidin has been reported to be a component of rough lemon (Albach and Redman 1969). However, no neohesperidosyl glycosides are detectable in the rough lemon cultivars in our survey, except in 'Khoubs-el-Arsa', a cultivar of unknown origin (Hodgson 1967). The leaf of 'Khoubs-el-Arsa' rough lemon contains predominantly the 7–rutinosyl glycoside flavanone hesperidin and a small amount of neoeriocitrin. This indicates that 'Khoubs-el-Arsa' is a rough lemon relative or hybrid.

Rough lemon contains the rutinosyl flavones rutin, isorhoifolin, and diosmin. No rhoifolin is detectable. Leaf tissue seems to contain the largest amounts of flavones. Rough lemon contains relatively high concentrations of isorhoifolin, unlike other rutinosyl-glycoside-containing species of this survey (lime, lemon, and especially its parental species citron, which do not contain isorhoifolin in any cultivar examined).

Sour Orange

Sour orange *(Citrus aurantium),* a pummelo × mandarin cross (Swingle and Reece 1967, Scora 1975a, Barrett and Rhodes 1976), contains neohesperidosyl flavanones. There has been some controversy over the flavanone composition of sour orange (Hattori et al. 1952, Albach and Redman 1969, Nishiura et al. 1969, Horowitz and Gentili 1977, Metzler 1977, Kamiya et al. 1979, Rousseff et al. 1987, Albach and Wutscher 1988). No hesperidin was detected in the sour orange cultivars examined in this study, although it has been reported in other studies of sour oranges (which probably examined sour orange hybrids) (Sarin and Seshadri 1960, Horowitz and Gentili 1977). There were small amounts of narirutin and eriocitrin in the cultivars examined in this study. Naringin is the predominant flavanone, followed closely by neoeriocitrin and neohesperidin. Others have found mainly neohesperidin to be the main flavanone in sour orange (Nishiura et al. 1969, 1971a,b, Metzler 1977, Albach and Wutscher 1988). Naringin–6″–malonate and poncerin are also present in some samples.

The leaf is the only sour orange tissue in which any of the four flavone/ols of this study are detectable. The neohesperidosyl flavone rhoifolin was found in the leaves of both cultivars studied. Rhoifolin has also been isolated from peel (Hattori et al. 1952) and has been reported to be a general component of sour orange (Horowitz and Gentili 1977). Other flavone glycosides, including neodiosmin, have also been isolated from sour orange (Sarin and Seshadri 1960, Horowitz and Gentili 1977).

Sweet Orange

Sweet orange *(Citrus sinensis),* a pummelo × mandarin cross (Swingle and Reece 1967, Scora 1975a, Barrett and Rhodes 1976), contains the rutinosyl glycoside flavanone pattern. There are comparatively few surveys quantifying the flavanones in sweet orange. Its flavanone profile is relatively simple and varies little among cultivars. It is generally agreed that orange fruit and juice contain hesperidin (Anis and Aminuddin 1981), narirutin (Fisher 1968, Rousseff et al. 1987), and didymin (Albach and Redman 1969,

Matsubara et al. 1985) as well as small amounts of narirutin–4′–glucoside (Albach and Redman 1969, Horowitz and Gentili 1977). According to these studies hesperidin, or a combination of hesperidin and narirutin, is the major flavanone component of orange (Hagen et al. 1966, Maier and Metzler 1967, Mizelle et al. 1967, Coffin 1971, Nishiura et al. 1971a,b, Horowitz and Gentili 1977, Kamiya et al. 1979).

Using a dried aqueous extract of orange peel called a "hesperidin complex," Park et al. (1983) detected the above flavanones as well as eriocitrin, and as can be expected, this analysis yielded much higher concentrations of all flavanones. We have found that some orange cultivars contain eriocitrin. However, with the exception of eriocitrin, which appears to be the least prevalent flavanone in oranges, the relative order of flavanone constituents agrees in both types of HPLC analysis. Rousseff et al. (1987) detected 122–254 mg/L hesperidin (0.122–0.254 mg/g fresh weight) in juice, which agrees with our average value of 0.226 mg/g hesperidin in juice vesicles (range of 0.01–0.59 mg/g). Except in 'Bey' navel (in which there appears to be a small amount of naringin), rutinosyl flavanones prevail in orange.

As in lemon and mandarin, there is a flavanone compound detectable in the orange samples that elutes at the retention time characteristic of the didymin standard. Sweet oranges contain the flavone/ols rutin, isorhoifolin, and diosmin. No rhoifolin was detectable in any sweet orange cultivar examined. Mandarin and orange have the highest concentrations of flavone/ols in their leaves.

Summary

This bulletin presents a qualitative survey of the major phenolics and quantitative survey of the major flavonoids in many species and cultivars of the Citrus subtribe. Previous studies have been of limited quantitative value and often targeted only a few key flavonoids in commercially important cultivars. We have sought to relate this flavonoid survey to the available literature as an aid in the taxonomic evaluation of the citrus cultivars—not only of the commercial cultivars but of important hybrids and rootstocks as well.

This study demonstrates two distinct ways to quantify phenolics in plant tissues: by the number of phenolic peaks per chromatogram and by the levels of phenolics based on percentage and concentration. These characteristic phenolic patterns may be used to aid in the preliminary classification and recognition of unknown cultivars endemic to the complex Aurantioideae subfamily classification schemes. Further, the knowledge of the association of phenolic patterns and concentrations can be used in biochemical studies to identify sources of tissues that have high concentrations of flavonoids and might therefore contain high concentrations of flavonoid- and phenolic-modifying enzymes.

Tables 3 and 4 can help in evaluating citrus breeding programs by contributing information toward citrus genetics and inheritance patterns (figure 6). According to several citrus taxonomic classification schemes (Swingle and Reece 1967, Scora 1975a, Barrett and Rhodes 1976), pummelo, mandarin, and citron are the likely ancestors of many present-day *Citrus* species and cultivars. Our results from both the flavanone and flavone analyses suggest that flavonoid patterns support this taxonomic chronology. Crosses of pummelo (containing predominantly neohesperidosyl flavonoids), with mandarin and citron (containing predominantly rutinosyl flavonoids), give rise to hybrid species and cultivars with mixed flavonoid glycosylation patterns. Flavonoid patterns identified in this study can be used to aid in the recognition of unknown cultivars in classification schemes. Further, these patterns can be used to identify sources of high concentrations of flavonoid-modifying enzymes (which appear to be tissue-specific).

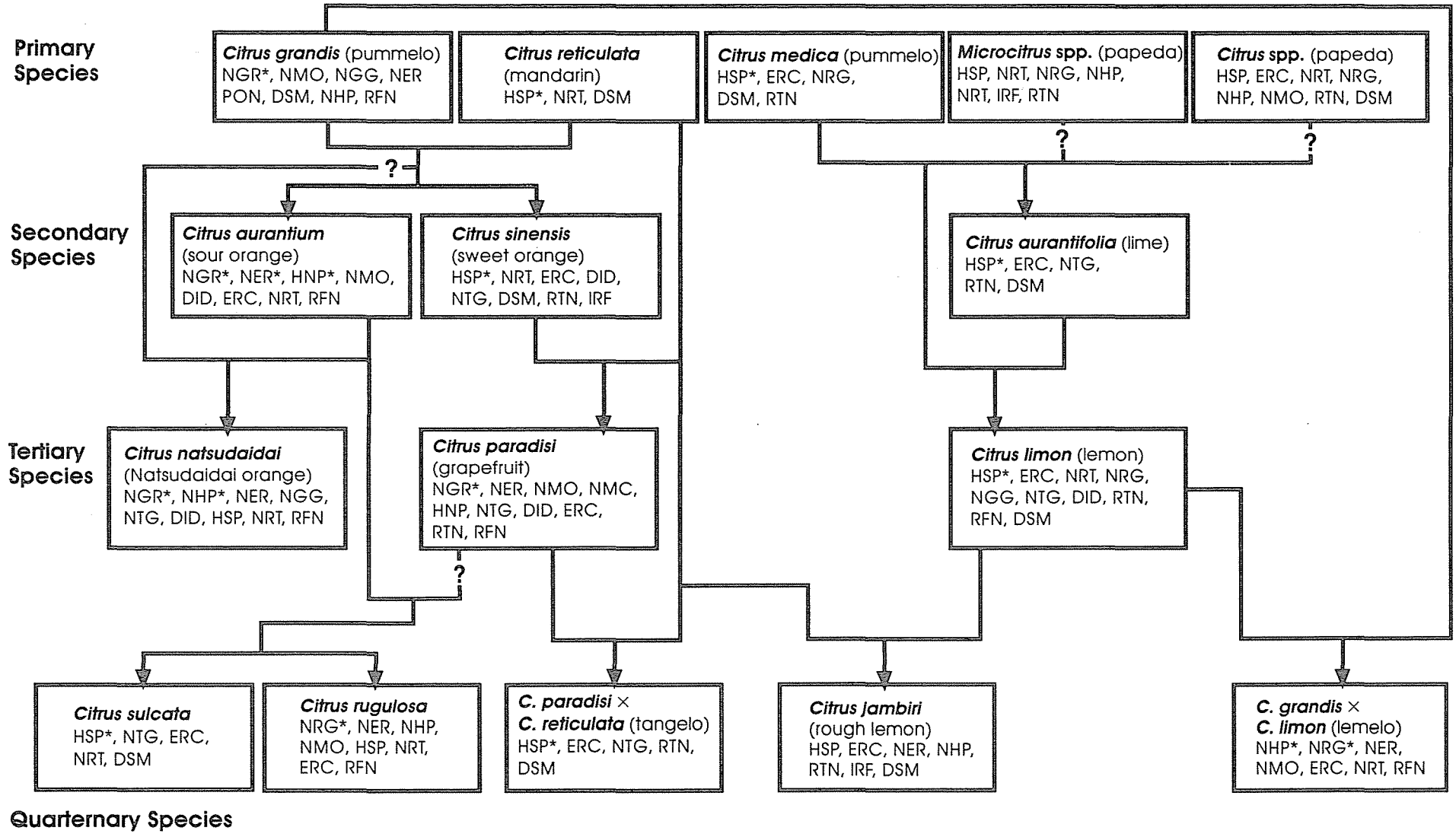


Figure 6.—Relationship between *Citrus* relatives and phenolic compounds. Prominent phenolics are indicated by asterisks. Abbreviations: DSM, diosmin; ERC, eriocitrin; HSP, hesperidin; IRF, isorhoifolin; MIX, poncerin and naringin–6″–malonate mixture; NER, neoeriocitrin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMC, narigin–6″ –malonate (closed form); NMO, naringin–6″–malonate (open form); NRG, naringin; NRT, narirutin; NTG, narirutin–4′–glucoside; PON, poncirin; RFN, rhiofolin; RTN, rutin.

Table 1. HPLC peaks in chromatograms of extracts from *Citrus* and related species at 285 nm

[Format: number of peaks ± standard deviation (number of samples in this average)]

Species	Number of peaks per tissue			
	Leaf	Flavedo	Albedo	Juice vesicles
Citrus				
aurantifolia	19.0 ± 2.8 (7)	6.8 ± 6.8 (6)	18.0 ± 5.4 (6)	9.0 ± 3.0 (7)
aurantium	17.0 ± 3.5 (2)	18.0 ± 0.0 (2)	16.0 ± 2.1 (2)	10.0 ± 0.7 (2)
excelsa	16.0 ± — (1)	28.0 ± — (1)	27.0 ± — (1)	17.0 ± — (1)
grandis	16.0 ± 4.3 (13)	20.0 ± 0.0 (4)	9.0 ± 6.8 (6)	10.0 ± 2.6 (11)
grandis × *limon*	21.4 ± 3.8 (5)	25.3 ± 1.1 (3)	14.3 ± 1.5 (3)	11.4 ± 1.5 (5)
hystrix	12.0 ± 3.4 (4)	— ± — (—)	— ± — (—)	18.0 ± 0.0 (2)
jambhiri	17.0 ± 4.9 (7)	21.0 ± 5.1 (3)	18.0 ± 7.5 (4)	5.0 ± 3.1 (8)
limon	15.4 ± 4.2 (8)	27.4 ± 10.7 (7)	19.7 ± 7.7 (7)	9.4 ± 6.9 (8)
longispina	11.0 ± — (1)	— ± — (—)	— ± — (—)	5.0 ± — (1)
medica	10.0 ± 3.8 (12)	16.0 ± 8.1 (15)	8.0 ± 4.1 (12)	4.0 ± 2.1 (11)
paradisi	15.0 ± 6.5 (9)	20.0 ± 7.0 (6)	14.0 ± 3.9 (6)	8.0 ± 4.5 (9)
reticulata	11.0 ± 5.1 (4)	12.0 ± 2.0 (2)	13.0 ± 4.2 (2)	2.0 ± 1.0 (4)
reticulata × *grandis*	15.5 ± 0.5 (2)	21.0 ± — (1)	25.0 ± — (1)	7.0 ± — (1)
reticulata × *sinensis*	14.5 ± 0.5 (2)	30.0 ± — (1)	19.5 ± 2.2 (2)	5.0 ± — (1)
rugulosa	13.0 ± — (1)	17.0 ± 7.0 (2)	17.0 ± — (1)	7.0 ± — (1)
sinensis	16.0 ± 8.0 (23)	22.0 ± 6.2 (14)	18.0 ± 9.2 (18)	6.0 ± 2.4 (24)
ujukitsu	20.0 ± 5.0 (3)	30.0 ± 4.2 (3)	14.0 ± — (1)	14.0 ± 14.0 (3)
***Citrus* average**	**15.3**	**21.0**	**16.9**	**8.7**
Eremocitrus glauca	26.0 ± — (1)	37.0 ± — (1)	31.0 ± — (1)	— ± — (—)
Microcitrus				
australasica	31.0 ± — (1)	— ± — (—)	— ± — (—)	3.0 ± — (1)
inodora	19.0 ± — (1)	33.0 ± — (1)	— ± — (—)	30.0 ± — (1)
warburgiana	20.0 ± 7.0 (2)	25.0 ± — (1)	— ± — (—)	10.0 ± — (1)
***Citrus* relatives average**	**24.0**	**31.7**	**31.0**	**15.8**

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

			Proportion						Concentration		
Species and cultivar	**CRC #**	**Plant part**	**Flav/ol**	**Flavan**	**Psor**	**Coum**	**Unkn**	**Void**	**Flav/ol**	**Flavan**	**Coum**
					(%)					(mg/g)	
Citrus aurantifolia											
Abhayapuri	3762	Leaf	34.8	36.6	3.5	8.4	14.0	2.7	3.20	2.15	0.24
		Flavedo	14.2	51.1	3.9	15.2	14.6	1.0	0.86	1.97	0.28
		Albedo	20.5	52.4	1.3	15.9	8.6	1.2	0.64	1.04	0.15
		Juice	10.2	59.9	9.0	8.1	12.7	0.0	0.07	0.25	0.02
Bishop Red	2451	Leaf	16.8	38.1	1.2	36.2	5.2	2.6	1.87	2.71	1.24
		Flavedo	6.7	57.2	0.0	16.5	16.7	2.9	0.24	1.32	0.18
		Albedo	4.7	61.0	0.0	12.7	18.8	2.9	0.18	1.47	0.15
		Juice	4.4	64.0	0.0	6.0	24.2	1.5	0.06	0.52	0.02
Borneo Rangpur	2424	Leaf	41.4	29.5	0.0	18.4	2.9	7.8	1.42	0.64	0.19
		Juice	4.6	82.0	0.0	8.6	1.6	3.2	0.04	0.44	0.02
Indian	2450	Leaf	44.3	39.7	0.0	9.7	0.0	6.3	3.35	1.92	0.23
		Flavedo	34.0	60.7	0.0	0.0	0.0	5.3	0.83	0.95	0.00
		Albedo	31.5	59.3	0.0	3.3	2.5	3.4	0.71	0.85	0.02
		Juice	3.1	84.5	0.0	0.0	9.5	2.9	0.01	0.23	0.00
Otaheite Red Acidless	2709	Leaf	51.9	24.5	0.0	5.4	14.8	3.4	3.64	1.10	0.12
		Flavedo	12.2	55.1	0.0	20.1	9.6	2.9	0.27	0.79	0.14
		Albedo	10.6	54.8	0.0	22.8	6.2	5.7	0.26	0.84	0.17
		Juice	7.6	67.5	0.0	3.9	9.6	11.4	0.06	0.35	0.01
Thornless Mexican	2683	Leaf	34.9	22.9	19.8	5.6	10.8	5.8	1.97	0.82	0.10
		Flavedo	15.1	12.4	15.4	44.4	11.5	1.3	1.03	0.54	0.93
		Albedo	10.6	30.1	11.3	35.5	11.4	1.1	0.17	0.31	0.18
		Juice	7.0	53.1	23.6	0.0	13.1	3.4	0.03	0.12	0.00

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

Species and cultivar	CRC #	Plant part	Proportion (%)						Concentration (mg/g)		
			Flav/ol	Flavan	Psor	Coum	Unkn	Void	Flav/ol	Flavan	Coum
Citrus aurantifolia (cont.)											
West Indian	1813	Leaf	15.1	23.2	21.4	26.8	13.4	0.1	1.89	1.86	1.03
		Flavedo	12.3	23.5	11.8	38.3	12.8	1.3	1.24	1.52	1.19
		Albedo	13.8	27.4	6.3	39.3	11.8	1.4	0.91	1.15	0.80
		Juice	8.8	43.6	0.0	38.6	9.1	0.0	0.10	0.30	0.13
C. aurantium											
Granitos	2715	Leaf	34.5	55.4	0.0	0.0	9.4	0.7	2.34	2.40	0.00
		Flavedo	44.9	12.1	0.0	25.4	9.1	8.5	1.34	0.23	0.23
		Albedo	2.7	92.3	0.0	0.0	3.7	1.3	0.27	5.85	0.00
		Juice	7.4	89.8	0.0	0.0	1.0	1.9	0.20	1.59	0.00
Keen # 1–10	2624	Leaf	40.2	49.5	0.0	0.0	4.8	5.5	5.51	4.33	0.00
		Flavedo	8.4	83.0	1.9	2.5	2.3	2.0	0.78	4.90	0.07
		Albedo	8.0	80.1	0.4	7.8	1.8	1.9	0.85	5.43	0.26
		Juice	4.2	86.0	0.0	3.3	1.2	5.2	0.08	1.01	0.02
C. excelsa											
Unknown	2316	Leaf	16.9	38.7	2.6	25.1	12.5	4.1	0.99	1.45	0.45
		Flavedo	19.3	35.0	25.3	6.0	13.2	1.1	2.55	2.96	0.24
		Albedo	17.4	47.0	12.2	15.9	5.7	1.8	1.33	2.30	0.38
		Juice	12.2	55.1	8.3	20.6	2.2	1.5	0.17	0.50	0.09
C. grandis											
African	2346	Leaf	40.7	52.4	0.0	0.0	3.2	3.7	1.87	1.54	0.00
		Flavedo	1.7	46.0	5.1	15.4	1.4	30.4	0.05	0.85	0.14
		Albedo	1.3	86.1	1.3	0.0	8.9	2.3	0.05	2.11	0.00
		Juice	5.7	78.3	0.0	6.7	7.7	1.6	0.06	0.51	0.02

Continued

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

			Proportion						Concentration		
Species and cultivar	**CRC #**	**Plant part**	**Flav/ol**	**Flavan**	**Psor**	**Coum**	**Unkn**	**Void**	**Flav/ol**	**Flavan**	**Coum**
					(%)					(mg/g)	
C. grandis (cont.)											
Deep Red	2347	Leaf	32.2	53.0	0.0	6.4	7.3	1.1	1.61	1.69	0.10
		Flavedo	3.1	61.3	0.0	24.2	8.9	2.6	0.08	0.95	0.18
		Albedo	0.0	88.3	0.0	5.8	4.2	1.6	0.00	2.93	0.09
		Juice	0.0	73.9	6.5	9.9	7.0	2.7	0.00	0.34	0.02
Fleming	578	Leaf	37.3	56.5	0.0	1.8	1.4	3.0	4.69	4.54	0.07
		Juice	0.0	74.5	2.3	10.4	10.1	2.6	0.00	0.73	0.05
Kao Panne	2355	Albedo	0.0	99.0	0.0	0.0	0.0	1.0	0.00	1.73	0.00
Kao Panne	2356	Leaf	11.3	83.2	0.0	3.3	1.2	1.0	1.08	5.06	0.10
		Flavedo	1.4	47.6	19.0	26.4	4.1	1.5	0.08	1.66	0.45
		Albedo	0.0	94.4	1.6	1.7	1.2	1.1	0.00	5.67	0.05
		Juice	0.0	95.5	0.6	3.5	0.0	0.4	0.00	3.03	0.05
Moanalua	448	Leaf	33.9	46.6	0.0	0.0	12.4	7.1	1.73	1.52	0.00
		Juice	15.1	36.7	7.0	35.3	0.0	5.8	0.07	0.12	0.05
Philippine hybrid	2343	Leaf	24.2	43.1	0.0	0.0	22.9	9.9	0.49	0.56	0.00
		Juice	7.9	79.4	0.0	0.0	6.6	6.1	0.07	0.44	0.00
Red Aranyan hybrid	2605	Leaf	42.2	19.3	2.7	0.0	30.8	4.9	1.23	0.36	0.00
		Juice	6.5	39.2	9.7	34.9	3.1	6.6	0.04	0.16	0.07
Red Fleshed	2338	Leaf	34.5	52.7	2.4	6.3	2.1	2.0	2.01	1.96	0.11
		Flavedo	7.0	75.9	2.8	9.3	4.3	0.7	1.10	7.59	0.45
		Albedo	0.0	93.3	0.8	4.6	0.7	0.6	0.00	10.32	0.25
		Juice	1.5	85.5	3.7	7.7	1.4	0.1	0.03	1.27	0.06
Siamese Seedless	640	Leaf	35.4	51.2	0.0	0.0	7.4	6.0	3.29	3.03	0.00
		Juice	0.0	64.7	2.2	21.3	9.7	2.1	0.00	0.33	0.05

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

Species and cultivar	CRC #	Plant part	Proportion (%)						Concentration (mg/g)		
			Flav/ol	Flavan	Psor	Coum	Unkn	Void	Flav/ol	Flavan	Coum
C. grandis (cont.)											
Tahitian	3806	Leaf	28.1	61.9	0.0	4.6	0.6	4.8	1.51	2.13	0.08
		Juice	0.0	64.3	3.3	22.8	3.9	5.7	0.00	0.27	0.05
Yuma Ponderosa Lemon	3488	Leaf	48.1	22.5	0.0	14.0	9.9	5.4	3.49	1.04	0.31
		Juice	0.0	80.5	0.0	0.0	15.3	4.2	0.00	0.23	0.00
C. grandis* × *C. limon											
Unknown	1481	Leaf	39.0	30.8	0.0	4.4	18.1	7.7	2.45	1.24	0.09
		Flavedo	18.4	53.7	7.5	10.1	9.0	1.2	0.98	1.83	0.17
		Albedo	5.9	84.9	0.0	0.0	7.9	1.4	0.21	1.96	0.00
		Juice	13.1	77.2	0.0	0.0	8.4	1.4	0.15	0.55	0.00
Unknown	1775	Leaf	44.1	34.3	0.0	11.9	5.2	4.5	4.53	2.25	0.38
		Juice	7.1	46.0	0.0	12.0	29.2	5.8	0.06	0.26	0.03
C. grandis* × *C. reticulata											
Frua Mandarin ×	3555	Leaf	17.8	72.5	0.0	0.0	5.2	4.4	0.64	1.67	0.00
Cocktail Grapefruit		Juice	5.8	91.5	0.0	0.0	0.0	2.7	0.04	0.35	0.00
C. grandis* × *C. sinensis											
Shaddock × St. Michael	42–1	Leaf	6.3	77.5	0.0	4.9	9.0	2.3	0.38	2.99	0.09
		Juice	3.2	74.8	1.9	8.2	9.8	2.2	0.05	0.75	0.04
Tahitian × Star Ruby	3781	Leaf	21.8	52.7	1.5	0.0	17.6	6.4	1.18	1.83	0.00
		Juice	0.0	100.0	0.0	0.0	0.0	0.0	0.00	0.07	0.00
C. hystrix											
Davao Lemon	2427	Leaf	25.8	27.0	8.7	20.2	15.9	2.5	1.22	0.81	0.29
		Juice	6.3	63.5	0.0	25.2	5.0	0.0	0.01	0.10	0.02

Continued

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

			Proportion						Concentration		
Species and cultivar	CRC #	Plant part	Flav/ol	Flavan	Psor	Coum	Unkn	Void	Flav/ol	Flavan	Coum
			(%)						(mg/g)		
C. hystrix (cont.)											
Kulubot	3612	Leaf	23.6	71.1	0.0	0.0	0.0	5.3	0.58	1.12	0.00
		Juice	0.0	100.0	0.0	0.0	0.0	0.0	0.00	0.01	0.00
Limon Real	2317	Leaf	64.6	23.8	0.0	0.0	5.3	6.3	2.45	0.58	0.00
		Juice	0.0	93.0	0.0	0.0	5.5	1.5	0.00	0.12	0.00
Philippines	2892	Leaf	37.2	0.0	6.6	7.6	42.3	6.3	1.22	0.00	0.08
		Juice	0.0	0.0	0.0	96.7	0.0	3.3	0.00	0.00	0.02
Unknown—Morocco	3174	Leaf	40.3	16.8	11.8	15.8	8.1	7.3	0.98	0.26	0.12
		Juice	0.0	74.6	0.0	0.0	25.4	0.0	0.00	0.03	0.00
C. jambhiri											
Khoubs-el-Arsa	2489	Leaf	69.4	18.4	1.4	0.0	3.1	7.7	6.45	1.09	0.00
		Juice	14.8	80.4	0.0	0.0	0.0	4.8	0.05	0.19	0.00
Limoneira	3834	Leaf	64.0	30.1	0.0	2.7	1.6	1.6	5.43	1.63	0.07
		Flavedo	45.0	38.0	0.0	4.8	7.3	4.9	1.54	0.83	0.05
		Albedo	30.6	45.4	0.0	7.9	12.0	3.9	1.00	0.95	0.08
		Juice	24.5	62.4	0.0	3.7	2.8	6.6	0.21	0.34	0.01
Milam	3396	Leaf	26.9	63.7	0.0	0.0	6.3	3.0	2.14	3.23	0.00
		Juice	0.0	83.8	0.0	7.3	2.1	6.7	0.00	0.26	0.01
Stowe Red	3185	Leaf	64.5	27.2	0.0	0.0	0.0	8.3	3.28	0.88	0.00
		Juice	0.0	93.1	0.0	0.0	0.0	6.9	0.00	0.17	0.00
Unknown	3060	Leaf	52.8	40.7	0.0	0.0	0.0	6.6	4.09	2.01	0.00
		Flavedo	23.4	54.3	4.6	2.7	9.5	5.4	0.71	1.06	0.03
		Albedo	11.5	57.6	0.0	16.0	8.4	6.6	0.22	0.69	0.09
		Juice	12.3	79.1	0.0	0.0	3.9	4.6	0.07	0.30	0.00

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

Species and cultivar	CRC #	Plant part	Proportion (%)						Concentration (mg/g)		
			Flav/ol	Flavan	Psor	Coum	Unkn	Void	Flav/ol	Flavan	Coum
C. limon											
Bergamot	2881	Leaf	50.2	38.8	0.6	5.1	1.6	3.7	3.90	1.92	0.12
		Flavedo	51.0	16.4	8.8	10.2	12.8	0.8	5.17	1.06	0.32
		Albedo	34.8	46.0	7.3	3.1	7.7	1.0	1.83	1.55	0.05
		Juice	19.9	67.7	3.3	0.0	7.9	1.2	0.27	0.59	0.00
Corona Foothill Eureka	3043	Leaf	68.9	18.6	1.8	2.7	0.0	7.9	3.00	0.52	0.04
		Flavedo	5.8	47.5	13.6	30.9	0.0	2.2	0.18	0.92	0.29
		Albedo	11.6	67.9	1.8	10.0	6.1	2.6	0.34	1.26	0.09
		Juice	4.6	80.2	0.0	11.3	3.9	0.0	0.02	0.24	0.02
Kaweah #1 Lisbon	3010	Leaf	48.4	32.6	0.0	7.4	6.2	5.3	3.34	1.44	0.16
		Flavedo	21.4	62.8	2.2	6.4	6.2	1.0	1.83	3.42	0.17
		Albedo	17.3	64.3	0.6	10.2	6.4	1.2	0.89	2.11	0.16
		Juice	7.0	83.2	0.0	9.6	0.0	0.3	0.05	0.37	0.02
Kulu	3045	Leaf	47.7	23.5	0.0	12.0	7.5	9.3	2.41	0.76	0.19
		Flavedo	36.5	35.1	0.0	16.7	8.6	3.2	0.67	0.41	0.09
		Albedo	19.4	68.1	0.0	10.7	1.8	0.0	0.29	0.64	0.05
		Juice	5.4	89.0	0.0	5.0	0.0	0.7	0.04	0.45	0.01
Kulu	3487	Leaf	57.3	20.6	0.0	14.5	0.0	7.6	0.95	0.22	0.07
		Juice	35.1	41.0	0.0	13.8	0.0	10.1	0.08	0.06	0.01
Nicaraguan	3841	Leaf	23.0	11.1	14.4	32.5	13.0	6.0	1.58	0.49	0.69
		Flavedo	17.3	12.0	23.4	31.2	14.6	1.5	1.29	0.57	0.71
		Albedo	12.0	24.0	16.6	36.6	10.5	0.4	0.27	0.35	0.26
		Juice	0.0	41.2	5.9	24.6	20.0	8.4	0.00	0.13	0.04

Continued

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

Species and cultivar	CRC #	Plant part	Proportion (%)						Concentration (mg/g)		
			Flav/ol	Flavan	Psor	Coum	Unkn	Void	Flav/ol	Flavan	Coum
C. limon (cont.)											
Santa Teresa #1	3894	Leaf	30.2	40.6	0.0	21.2	5.7	2.3	5.58	4.79	1.21
		Flavedo	29.6	51.8	2.0	5.6	10.2	0.8	5.99	6.69	0.35
		Albedo	16.1	65.3	2.4	11.6	3.4	1.1	3.22	8.33	0.71
		Juice	19.7	67.9	1.9	7.0	2.5	1.0	1.53	3.38	0.17
Seedless Lisbon	3001	Leaf	68.5	21.8	0.0	0.0	7.1	2.6	4.34	0.88	0.00
		Flavedo	13.0	72.9	0.8	0.0	9.4	4.0	0.65	2.34	0.00
		Albedo	9.9	77.7	0.0	0.0	10.5	1.8	0.46	2.32	0.00
		Juice	0.0	93.0	0.0	0.0	0.0	7.0	0.00	0.31	0.00
Unknown—Borneo	3765	Leaf	43.6	11.8	3.8	12.0	23.9	4.9	3.53	0.61	0.30
		Juice	12.1	60.4	0.0	14.2	5.3	8.0	0.05	0.15	0.02
Unknown—Morocco	3155–A	Leaf	33.2	43.9	0.0	12.7	8.2	2.1	2.92	2.47	0.34
		Juice	4.5	90.2	0.0	0.0	3.7	1.7	0.04	0.51	0.00
C. longispina											
Unknown	2320	Leaf	35.1	56.5	0.0	0.0	3.5	4.9	1.87	1.92	0.00
		Juice	0.0	60.8	36.1	0.0	0.0	3.1	0.00	0.17	0.00
C. macrophylla											
Unknown	3842	Leaf	14.0	46.8	5.6	15.7	15.1	2.9	0.71	1.51	0.24
		Juice	14.9	65.8	0.0	0.0	14.1	5.2	0.06	0.16	0.00
C. medica											
Bush	—	Flavedo	10.5	13.2	26.2	31.0	16.9	2.1	0.81	0.65	0.73
		Albedo	4.7	65.1	10.7	9.5	9.7	0.3	0.21	1.84	0.13
		Juice	4.7	82.2	3.0	3.0	5.5	1.6	0.05	0.52	0.01

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

Species and cultivar	CRC #	Plant part	Proportion (%)						Concentration (mg/g)		
			Flav/ol	Flavan	Psor	Coum	Unkn	Void	Flav/ol	Flavan	Coum
C. medica (cont.)											
Citron of Commerce	3518	Leaf	24.8	0.0	0.0	58.3	0.0	16.9	0.26	0.00	0.19
		Flavedo	5.7	16.8	0.0	77.5	0.0	0.0	0.03	0.06	0.13
		Albedo	0.0	38.9	0.0	61.1	0.0	0.0	0.00	0.03	0.02
		Juice	0.0	40.1	0.0	0.0	0.0	59.9	0.00	0.02	0.00
		Medulla	27.1	70.1	0.0	0.0	0.0	2.8	0.03	0.06	0.00
		Septa membrane	12.0	76.0	0.0	0.0	0.0	12.0	0.02	0.07	0.00
Dulcia	3654	Leaf	43.3	0.0	4.2	27.6	8.4	16.6	1.28	0.00	0.25
		Flavedo	15.8	14.5	5.4	41.7	14.2	8.5	0.08	0.05	0.06
		Albedo	0.0	0.0	31.2	22.6	35.7	10.5	0.00	0.00	0.02
		Juice	0.0	34.6	23.3	13.8	21.1	7.2	0.00	0.04	0.01
Fingered	3768	Leaf	61.9	0.0	3.4	21.5	4.7	8.5	3.58	0.00	0.38
		Flavedo	9.8	11.3	7.9	64.8	1.8	4.3	0.18	0.13	0.36
		Albedo	0.0	23.6	0.0	61.9	14.5	0.0	0.00	0.04	0.05
India Sour	661	Leaf	16.6	41.0	0.0	0.0	33.3	9.1	0.36	0.56	0.00
		Flavedo	16.2	50.9	20.8	10.4	1.7	0.0	0.31	0.63	0.06
		Albedo	15.7	55.9	9.9	12.4	4.0	2.1	0.27	0.62	0.07
		Juice	17.0	70.8	0.0	5.2	7.1	0.0	0.10	0.27	0.01
Mexican	3531	Leaf	44.2	10.9	0.0	14.7	14.4	15.7	0.81	0.13	0.08
		Flavedo	33.7	0.0	0.0	0.0	52.3	14.0	0.41	0.00	0.00
		Albedo	21.1	20.1	0.0	0.0	21.5	37.4	0.03	0.02	0.00
		Juice	0.0	23.1	0.0	0.0	19.3	57.6	0.00	0.01	0.00

Continued

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

			Proportion						Concentration		
Species and cultivar	CRC #	Plant part	Flav/ol	Flavan	Psor	Coum	Unkn	Void	Flav/ol	Flavan	Coum
			(%)						(mg/g)		
C. medica (cont.)											
South Coast Field Station	3546	Leaf	67.6	0.0	0.0	6.2	7.5	18.8	1.32	0.00	0.04
		Flavedo	7.3	6.3	0.0	11.6	71.4	3.4	0.17	0.09	0.08
		Albedo	0.0	16.8	0.0	18.6	50.7	14.0	0.00	0.03	0.01
		Juice	57.4	32.0	0.0	0.0	0.0	10.6	0.05	0.02	0.00
Spadifora	3535	Leaf	79.7	0.0	0.0	0.0	5.0	15.3	1.44	0.00	0.00
		Flavedo	32.5	2.0	5.2	9.8	46.1	4.4	0.33	0.01	0.03
		Albedo	23.2	16.7	0.0	11.0	43.5	5.5	0.04	0.02	0.01
		Juice	29.0	10.5	0.0	0.0	0.0	60.5	0.08	0.02	0.00
Yunanensis	3798	Leaf	58.4	0.0	0.0	14.4	11.6	15.6	1.42	0.00	0.11
		Flavedo	10.5	0.0	3.1	41.9	40.5	4.0	0.31	0.00	0.38
		Albedo	4.2	4.2	0.0	23.7	57.5	10.5	0.03	0.02	0.05
		Juice	30.0	44.9	0.0	0.0	19.3	5.7	0.05	0.04	0.00
C. microcarpa											
Calasnu	2867	Leaf	21.2	71.3	0.0	0.0	3.5	4.0	1.10	2.35	0.00
		Flavedo	36.1	36.4	0.0	16.8	8.9	1.7	1.99	1.28	0.28
		Albedo	2.5	87.0	0.0	2.2	6.4	1.9	0.28	6.15	0.08
		Juice	9.5	77.4	0.0	3.7	5.2	4.2	0.23	1.19	0.03
Samuyao	3605	Leaf	17.2	44.0	21.2	7.3	6.7	3.6	0.95	1.55	0.12
		Juice	0.0	25.7	52.5	2.8	15.8	3.2	0.00	0.14	0.01
C. natsudaidai											
Unknown	3235	Leaf	57.7	37.4	0.0	2.0	0.0	2.8	5.36	2.22	0.06
		Flavedo	23.6	16.2	14.2	38.3	5.3	2.4	0.93	0.41	0.46
		Albedo	1.9	76.8	4.7	12.7	3.3	0.6	0.10	2.54	0.20
		Juice	6.7	68.4	2.6	12.1	4.6	5.6	0.04	0.27	0.02

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

Species and cultivar	CRC #	Plant part	Proportion (%)						Concentration (mg/g)		
			Flav/ol	Flavan	Psor	Coum	Unkn	Void	Flav/ol	Flavan	Coum
C. paradisi											
Camulos	3139	Leaf	37.7	56.7	0.0	2.7	1.3	1.5	4.15	3.99	0.09
		Flavedo	12.2	43.4	6.2	26.8	10.8	0.6	0.51	1.16	0.35
		Albedo	0.4	92.9	0.0	5.5	0.6	0.6	0.05	7.69	0.22
		Juice	0.9	92.2	0.0	0.0	6.9	0.0	0.02	1.28	0.00
CRC #343	343	Leaf	38.6	51.8	2.5	0.9	4.4	1.7	3.88	3.32	0.03
		Flavedo	8.7	27.3	15.0	32.4	13.0	3.5	0.37	0.74	0.43
		Albedo	0.0	96.9	0.6	2.4	0.0	0.0	0.00	9.53	0.11
		Juice	0.0	82.1	5.2	9.6	2.7	0.3	0.00	1.47	0.08
Duncan	3832	Leaf	6.4	88.7	0.0	0.0	0.0	4.8	0.25	2.24	0.00
		Flavedo	0.0	58.0	6.6	16.1	9.0	10.4	0.00	0.64	0.09
		Albedo	0.0	94.6	0.0	3.5	0.9	1.1	0.00	5.65	0.10
		Juice	0.0	86.4	0.0	9.1	0.0	4.5	0.00	0.63	0.03
Hall	3068	Leaf	46.8	42.3	0.0	0.0	4.9	6.0	2.45	1.41	0.00
		Juice	4.5	85.1	0.0	3.1	0.0	7.3	0.03	0.38	0.01
Jochimsen	2784	Leaf	21.7	68.1	0.0	0.0	8.1	2.2	0.72	1.44	0.00
		Flavedo	14.4	53.6	5.0	5.3	18.6	3.1	0.46	1.09	0.05
		Albedo	0.7	90.4	0.0	5.8	0.7	2.4	0.05	3.95	0.12
		Juice	4.7	69.8	0.0	13.9	6.3	5.2	0.04	0.39	0.04
Reed Seedling Marsh	3128	Leaf	51.8	37.7	0.0	0.0	6.0	4.5	1.38	0.64	0.00
		Juice	3.7	85.0	0.0	0.0	0.5	10.9	0.02	0.31	0.00
Star Ruby	3770	Leaf	34.2	57.3	0.0	0.0	3.1	5.4	1.95	2.09	0.00
		Flavedo	6.9	59.6	5.9	19.3	5.5	2.8	0.22	1.21	0.19
		Albedo	0.4	93.9	0.0	3.4	1.3	0.9	0.10	15.03	0.26
		Juice	2.0	83.8	1.3	9.5	2.3	1.0	0.05	1.39	0.08

Continued

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

Species and cultivar	CRC #	Plant part	Proportion (%)						Concentration (mg/g)		
			Flav/ol	Flavan	Psor	Coum	Unkn	Void	Flav/ol	Flavan	Coum
C. paradisi (cont.)											
Whitney Old Line Marsh	3804	Leaf	43.5	41.5	0.0	0.0	9.0	6.0	2.72	1.66	0.00
		Juice	3.1	68.1	6.4	18.3	3.0	1.1	0.05	0.73	0.09
Yellow Rind Mandarin	3895	Leaf	55.4	29.2	0.0	0.0	10.3	5.2	2.91	0.98	0.00
		Flavedo	27.6	50.4	0.0	9.8	7.1	5.1	0.82	0.96	0.09
		Albedo	18.2	53.0	0.0	17.4	2.4	9.0	0.57	1.07	0.17
		Juice	9.3	73.4	0.0	0.0	7.4	10.0	0.06	0.30	0.00
C. reticulata											
Robinson	3850	Leaf	30.6	55.8	0.0	7.2	1.6	4.9	4.30	5.00	0.31
		Flavedo	13.2	70.3	0.0	7.3	3.1	6.1	0.46	1.55	0.08
		Albedo	4.1	77.0	0.0	5.9	7.3	5.6	0.11	1.37	0.05
		Juice	0.0	84.8	0.0	0.0	0.0	15.2	0.00	0.16	0.00
Scarlet Emperor	3326	Leaf	28.4	62.7	0.0	0.0	3.2	5.6	0.43	0.61	0.00
		Juice	3.6	84.5	0.0	0.0	3.8	8.0	0.02	0.27	0.00
Solid Scarlet	3328	Leaf	52.7	36.4	0.0	0.0	4.7	6.1	2.34	1.03	0.00
		Juice	0.0	90.8	0.0	0.0	0.0	9.2	0.00	0.28	0.00
Sunburst	3809	Leaf	23.5	54.6	0.0	0.0	7.9	14.1	1.04	1.54	0.00
		Flavedo	24.0	41.7	0.0	10.9	18.4	5.1	1.30	1.44	0.18
		Albedo	16.2	52.2	0.0	14.8	11.8	5.0	0.98	2.01	0.27
		Juice	8.2	68.3	0.0	0.0	8.1	15.4	0.03	0.18	0.00
C. reticulata* × *C. grandis											
Sacaton	3331	Leaf	7.0	81.9	0.0	2.7	4.9	3.6	0.41	3.06	0.05
		Flavedo	21.4	65.2	0.0	5.9	3.7	3.8	0.96	1.87	0.08
		Albedo	2.5	94.0	0.0	1.5	0.7	1.3	0.23	5.52	0.04
		Juice	1.7	92.5	0.0	3.0	1.3	1.4	0.07	2.48	0.04

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

Species and cultivar	CRC #	Plant part	Proportion (%)						Concentration (mg/g)		
			Flav/ol	Flavan	Psor	Coum	Unkn	Void	Flav/ol	Flavan	Coum
C. reticulata* × *C. sinensis											
Sue Linda Temple	3810	Leaf	22.9	62.8	0.0	2.0	8.0	4.3	1.41	2.47	0.04
		Flavedo	2.7	61.1	0.0	25.9	7.0	3.3	0.13	1.93	0.39
		Albedo	9.8	70.6	0.0	13.4	3.9	2.3	0.47	2.16	0.20
		Juice	2.7	84.6	0.0	7.0	0.0	5.7	0.02	0.42	0.02
C. reticulata* × *Poncirus trifoliata											
Unknown	2619	Leaf	7.9	57.0	7.1	13.5	14.1	0.4	1.62	7.45	0.85
		Flavedo	53.4	39.3	0.0	1.3	3.8	2.2	2.32	1.09	0.02
		Albedo	10.9	50.5	9.1	15.0	14.2	0.3	6.01	17.77	2.55
		Juice	1.0	94.3	0.5	1.7	1.9	0.6	0.14	8.54	0.07
C. rugulosa											
Unknown	3556	Leaf	21.7	65.5	0.0	0.0	8.9	4.0	0.42	0.82	0.00
		Flavedo	1.8	96.3	0.0	1.2	0.0	0.8	0.18	6.32	0.04
		Albedo	7.4	79.1	0.0	5.5	6.4	1.6	0.42	2.86	0.10
		Juice	4.3	82.8	0.0	10.5	0.0	2.4	0.03	0.35	0.02
C. shunokan											
Unknown	3476	Leaf	47.5	26.3	0.0	0.0	22.6	3.6	1.61	0.57	0.00
		Juice	12.4	81.4	0.0	0.0	0.0	6.2	0.11	0.48	0.00
C. sinensis											
Blood orange cultivars											
Cipo	3896	Leaf	22.6	63.8	0.0	0.0	6.3	7.2	0.52	0.95	0.00
Rotuma Island	3867	Leaf	46.8	43.9	0.0	1.5	2.2	5.7	3.73	2.23	0.04
		Juice	5.6	80.9	0.0	2.4	4.1	7.0	0.04	0.41	0.01
Vainiglia Pink Fleshed	3801	Juice	2.4	78.2	0.0	0.0	0.0	19.4	0.02	0.33	0.00

Continued

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

			Proportion						Concentration		
Species and cultivar	CRC #	Plant part	Flav/ol	Flavan	Psor	Coum	Unkn	Void	Flav/ol	Flavan	Coum
			(%)						(mg/g)		
C. sinensis (cont.)											
Navel cultivars											
Bey	3406	Leaf	42.9	45.4	0.0	4.2	4.6	2.9	5.17	3.49	0.16
		Flavedo	9.5	61.6	0.0	14.0	11.9	2.9	0.40	1.67	0.18
		Albedo	8.3	67.6	0.0	7.1	14.1	3.0	0.48	2.49	0.13
		Juice	5.7	86.7	0.0	1.4	1.6	4.7	0.08	0.78	0.01
CPB #44944A Seedling	3305	Leaf	39.4	26.7	0.0	16.9	14.0	3.0	8.06	3.49	1.06
		Flavedo	16.7	28.8	0.0	23.7	28.7	2.2	1.34	1.47	0.58
		Albedo	5.1	66.7	0.0	10.2	14.7	3.4	0.16	1.31	0.10
		Juice	1.4	19.1	0.0	0.0	78.0	1.5	0.01	0.12	0.00
CPB #44944B Seedling	3306–A	Leaf	34.4	25.0	0.0	14.7	22.9	3.0	4.95	2.30	0.65
		Flavedo	4.1	24.1	0.0	32.4	38.5	0.8	0.20	0.75	0.49
		Albedo	0.0	52.9	0.0	5.4	41.7	0.0	0.00	0.50	0.02
		Juice	1.8	21.6	0.0	0.0	74.8	1.8	0.02	0.12	0.00
Fisher	3645	Leaf	43.0	48.3	0.0	0.0	4.8	3.9	6.53	4.68	0.00
		Flavedo	12.1	75.4	0.0	3.1	6.9	2.5	0.55	2.20	0.04
		Albedo	10.4	73.1	0.0	9.3	5.3	1.9	0.96	4.31	0.26
		Juice	4.1	86.0	1.6	0.0	4.8	3.6	0.05	0.73	0.00
Golden Buckeye	588	Leaf	28.1	65.1	0.0	0.0	2.2	4.6	0.27	0.40	0.00
		Juice	5.3	79.5	0.0	1.1	11.5	2.6	0.04	0.38	0.00
McFadden Ribbed	609	Leaf	29.7	58.8	0.0	3.1	5.3	3.0	0.95	1.21	0.03
		Flavedo	14.3	54.5	0.0	15.1	13.2	2.9	0.76	1.84	0.25
		Albedo	9.3	58.6	0.0	18.1	11.2	2.8	0.45	1.81	0.27
		Juice	7.2	76.3	0.0	8.0	3.6	4.9	0.08	0.51	0.03

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

Species and cultivar	CRC #	Plant part	Proportion (%)						Concentration (mg/g)		
			Flav/ol	Flavan	Psor	Coum	Unkn	Void	Flav/ol	Flavan	Coum
C. sinensis (cont.)											
Navel cultivars (cont.)											
Paradise	2853	Leaf	35.7	28.7	0.0	16.8	15.2	3.6	4.54	2.33	0.66
		Flavedo	23.6	61.3	0.0	0.0	12.5	2.6	1.89	3.13	0.00
		Albedo	8.5	68.9	0.0	10.1	8.7	3.7	0.47	2.42	0.17
		Juice	5.2	81.4	0.0	1.1	6.2	6.2	0.07	0.67	0.00
Parent Wahington	1241–B	Leaf	37.2	54.6	0.0	0.0	4.6	3.6	2.00	1.87	0.00
		Juice	5.3	87.5	0.0	0.0	0.0	7.2	0.03	0.36	0.00
Ruvel	3181	Leaf	63.6	30.0	0.0	0.0	2.7	3.7	2.27	0.68	0.00
		Juice	0.0	73.1	0.0	0.0	21.2	5.7	0.00	0.15	0.00
Smith's Early	574	Leaf	22.3	75.1	0.0	0.0	0.0	2.6	3.51	7.56	0.00
		Flavedo	12.2	70.1	0.0	0.8	9.4	7.5	0.62	2.26	0.01
		Albedo	3.1	85.6	0.0	0.6	7.6	3.0	0.07	1.18	0.00
		Juice	3.5	86.8	0.0	0.0	5.3	4.4	0.04	0.63	0.00
Thomson	983	Leaf	21.9	70.8	0.0	0.0	2.4	4.9	0.62	1.29	0.00
		Flavedo	35.7	39.9	0.0	6.8	12.8	4.7	1.40	1.00	0.08
		Albedo	8.3	68.3	0.0	10.2	8.6	4.6	0.12	0.62	0.04
		Juice	5.4	87.3	0.0	1.4	3.2	2.7	0.05	0.47	0.00
Sweet orange cultivars											
Catlin	3860	Leaf	29.2	57.1	0.0	5.8	3.4	4.4	0.80	1.00	0.05
		Juice	6.1	79.3	0.0	0.0	10.2	4.4	0.04	0.32	0.00
Espagnole sans Pepins	3249	Leaf	23.9	64.3	0.0	0.0	6.6	5.2	1.05	1.81	0.00
		Juice	5.2	77.9	0.0	8.1	0.3	8.5	0.03	0.33	0.02
Finike	3870	Leaf	48.1	44.7	0.0	0.0	6.6	0.7	0.92	0.55	0.00
		Juice	7.6	84.0	0.0	7.2	0.0	1.1	0.09	0.64	0.03

Continued

Table 2. Percentage and total concentrations of phenolics in *Citrus* and related species (cont.)

[The CRC # represents accession number in the Citrus Variety Collection, University of California, Riverside. Abbreviations used in table: Flav/ol, flavone/flavonol; Flavan, flavanone; Psor, psoralen; Coum, coumarin/cinnamic acid; Unkn, unknown]

Species and cultivar	CRC #	Plant part	Proportion (%)						Concentration (mg/g)		
			Flav/ol	Flavan	Psor	Coum	Unkn	Void	Flav/ol	Flavan	Coum
Fortunella japonica (cont.)											
Unknown	—	Leaf	36.2	37.6	0.0	9.9	14.5	1.7	6.62	4.39	0.56
		Peel	13.5	73.1	0.0	3.6	4.9	4.9	1.17	4.06	0.10
		Juice	10.8	85.1	0.0	0.0	0.0	4.2	0.08	0.40	0.00
Unknown	—	Leaf	7.3	26.2	23.8	23.0	17.1	2.7	1.24	2.84	1.20
		Flavedo	7.5	8.1	12.2	55.4	16.2	0.6	1.03	0.71	2.34
		Albedo	3.8	48.3	1.0	38.1	8.0	0.8	0.25	2.02	0.77
		Juice	6.8	63.2	6.7	21.2	0.0	2.1	0.10	0.58	0.09
Microcitrus australasica											
Sanguinea	1484	Flavedo	40.9	0.0	2.5	22.1	32.3	2.2	2.38	0.00	0.40
		Juice	11.2	0.0	0.0	74.1	0.0	14.8	0.02	0.00	0.04
M. indora											
Unknown	3785–A	Leaf	12.5	67.2	11.9	0.0	7.0	1.5	1.16	3.96	0.00
		Flavedo	81.0	5.7	0.0	0.7	11.5	1.1	8.75	0.39	0.02
		Juice	66.0	5.7	1.5	3.5	22.6	0.7	3.28	0.18	0.05
M. warburgiana											
Unknown	3782–D	Leaf	61.4	11.4	5.0	13.3	6.0	2.9	4.47	0.53	0.30
		Flavedo	9.5	5.8	67.1	4.9	11.1	1.7	0.63	0.24	0.10
		Juice	0.0	11.6	73.5	0.0	10.7	4.3	0.00	0.07	0.00
Poncirus trifoliata* × *Citrus paradisi											
Swingle	3767	Leaf	52.9	23.4	0.0	15.9	6.0	1.8	5.49	1.55	0.51
		Flavedo	0.0	18.0	0.0	72.3	7.9	1.8	0.00	0.78	1.51
		Albedo	0.3	78.6	0.0	17.7	2.9	0.4	0.03	5.62	0.61
		Juice	0.0	75.4	0.0	16.8	7.4	0.4	0.00	1.30	0.14
Unknown	1452	Leaf	12.3	62.6	0.0	7.6	15.1	2.5	0.56	1.82	0.11
		Juice	2.3	44.4	3.8	36.9	9.2	3.4	0.03	0.42	0.17

Table 3. Flavanone composition in genus *Citrus* and its near relatives

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. *Concentrations are average of two to four runs ±0.05 mg/g fresh weight*]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
Citrus aurantifolia																
Abhayapuri	3762	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	2.1	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	2	98	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	1.9	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.0	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.3	0	0	0	0	0	0	0	0	—
Bishop Red Rangpur	2451	Leaf	%	5	0	16	79	0	0	0	0	0	0	0	0	0
			mg/g	0.1	0	0.4	2.1	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	13	87	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.2	1.2	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	13	82	0	0	0	0	0	0	0	0	5
			mg/g	0	0	0.2	1.2	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	14	83	3	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	0.4	tr	0	0	0	0	0	0	0	—
Borneo Rangpur	2424	Leaf	%	0	0	19	81	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	0.5	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	6	94	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.4	0	0	0	0	0	0	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
Citrus aurantifolia (cont.)																
Indian	2450	Leaf	%	4	0	22	74	0	0	0	0	0	0	0	0	0
			mg/g	0.1	0	0.4	1.4	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	16	84	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.2	0.8	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	15	85	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	0.7	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	11	89	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.2	0	0	0	0	0	0	0	0	—
Otaheite Red Acidless Rangpur	2709	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.1	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	0	89	11	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.7	0.1	0	0	0	0	0	0	0	—
		Albedo	%	0	0	0	92	8	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.8	0.1	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	94	6	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.3	tr	0	0	0	0	0	0	0	—
Thornless Mexican	2683	Leaf	%	0	0	11	89	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	0.7	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	9	91	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.5	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	4	96	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.3	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	6	94	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.1	0	0	0	0	0	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, naringin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, naringin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
Citrus aurantifolia (cont.)																
West Indian	1813	Leaf	%	0	0	5	95	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	1.8	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	4	96	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	1.4	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	4	96	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	1.1	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	6	94	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.1	0	0	0	0	0	0	0	0	—
C. aurantium																
Granitos	2715	Leaf	%	0	14	0	0	0	25	33	0	16	0	0	0	12
			mg/g	0	0.3	0	0	0	0.6	0.8	0	0.4	0	0	0	—
		Flavedo	%	0	0	26	0	0	45	0	0	29	0	0	0	0
			mg/g	0	0	0.1	0	0	0.1	0	0	0.1	0	0	0	—
		Albedo	%	0	4	2	0	0	22	39	6	24	3	0	0	0
			mg/g	0	0.2	0.1	0	0	1.3	2.3	0.3	1.4	0.2	0	0	—
		Juice	%	0	5	0	0	0	24	40	0	23	5	0	0	3
			mg/g	0	0.1	0	0	0	0.4	0.6	0	0.4	0.1	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. aurantium (cont.)																
Keen #1–10	2624	Leaf	%	0	24	0	0	0	25	20	0	17	0	0	0	14
			mg/g	0	1.0	0	0	0	1.1	0.9	0	0.7	0	0	0	—
		Flavedo	%	0	9	1	0	1	17	35	0	30	5	0	0	2
			mg/g	0	0.5	0.1	0	tr	0.8	1.7	0	1.5	0.2	0	0	—
		Albedo	%	0	0	1	0	1	17	42	0	33	5	0	0	0
			mg/g	0	0	0.1	0	tr	0.9	2.3	0	1.8	0.3	0	0	—
		Juice	%	0	4	2	0	0	18	35	0	3	5	0	0	33
			mg/g	0	tr	tr	0	0	0.2	0.3	0	tr	tr	0	0	—
C. excelsa																
Unknown	2316	Leaf	%	0	0	0	57	10	0	0	0	0	0	0	33	0
			mg/g	0	0	0	0.8	0.1	0	0	0	0	0	0	0.5	—
		Flavedo	%	0	0	0	48	5	0	0	0	0	0	0	46	1
			mg/g	0	0	0	1.4	0.1	0	0	0	0	0	0	1.4	—
		Albedo	%	0	0	0	50	6	0	0	0	0	0	0	44	0
			mg/g	0	0	0	1.1	0.1	0	0	0	0	0	0	1.0	—
		Juice	%	0	0	0	54	6	0	0	0	0	0	0	40	0
			mg/g	0	0	0	0.3	tr	0	0	0	0	0	0	0.2	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON; poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavanones												
				7–Rutinosides					7–Neohesperidosides							
				NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. grandis																
African	2346	Leaf	%	0	0	0	0	0	11	64	5	0	20	0	0	0
			mg/g	0	0	0	0	0	0.2	0.1	0.1	0	0.3	0	0	—
		Flavedo	%	0	0	12	3	3	0	56	16	0	10	0	0	0
			mg/g	0	0	0.1	tr	tr	0	0.5	0.1	0	0.1	0	0	—
		Albedo	%	0	0	0	1	0	0	78	11	0	10	0	0	0
			mg/g	0	0	0	tr	0	0	1.6	0.2	0	0.2	0	0	—
		Juice	%	0	0	0	0	0	0	80	11	0	10	0	0	0
			mg/g	0	0	0	0	0	0	0.4	0.1	0	tr	0	0	—
Deep Red	2347	Leaf	%	0	0	0	8	0	0	25	0	0	66	0	0	0
			mg/g	0	0	0	0.1	0	0	0.4	0	0	1.1	0	0	—
		Flavedo	%	0	0	0	5	0	0	53	15	0	27	0	0	0
			mg/g	0	0	0	tr	0	0	0.5	0.1	0	0.3	0	0	—
		Albedo	%	0	0	0	3	0	0	68	9	0	21	0	0	0
			mg/g	0	0	0	0.1	0	0	2.0	0.3	0	0.6	0	0	—
		Juice	%	0	0	0	5	0	0	64	6	0	25	0	0	0
			mg/g	0	0	0	tr	0	0	0.2	tr	0	0.1	0	0	—
Fleming	578	Leaf	%	0	0	0	2	0	2	15	0	0	65	5	0	0
			mg/g	0	0	0	0.1	0	0.1	0.7	0	0	2.3	0.2	0	—
		Juice	%	0	0	0	0	0	0	39	5	0	54	0	0	11
			mg/g	0	0	0	0	0	0	0.3	tr	0	0.4	0	0	0
Kao Panne	2355	Albedo	%	0	2	0	0	0	1	91	3	0	4	0	0	2
			mg/g	0	tr	0	0	0	tr	1.6	tr	0	0.1	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. grandis (cont.)																
Kao Panne	2356	Leaf	%	0	0	0	3	0	0	65	1	2	29	0	0	0
			mg/g	0	0	0	0.2	0	0	3.3	tr	0.1	1.4	0	0	—
		Flavedo	%	0	0	0	7	0	0	51	12	1	28	0	0	0
			mg/g	0	0	0	0.1	0	0	0.8	0.2	tr	0.5	0	0	—
		Albedo	%	0	0	0	2	0	0	76	4	1	17	0	0	0
			mg/g	0	0	0	0.1	0	0	4.3	0.2	0.1	1.0	0	0	—
		Juice	%	0	0	0	1	1	1	77	2	1	16	0	0	0
			mg/g	0	0	0	0.1	tr	tr	2.3	tr	tr	0.5	0	0	—
Moanalua	448	Leaf	%	0	0	0	0	0	0	52	0	0	48	0	0	0
			mg/g	0	0	0	0	0	0	0.4	0	0	0.4	0	0	—
		Juice	%	0	0	0	0	0	52	32	0	0	16	0	0	0
			mg/g	0	0	0	0	0	0.1	tr	0	0	tr	0	0	—
Philippine hybrid	2343	Leaf	%	0	0	0	20	0	0	15	0	65	0	0	0	0
			mg/g	0	0	0	0.1	0	0	0.1	0	0.4	0	0	0	—
		Juice	%	0	0	0	12	16	0	36	0	31	4	0	0	0
			mg/g	0	0	0	tr	0.1	0	0.2	0	0.1	tr	0	0	—
Red Aranyan hybrid	2605	Leaf	%	0	0	0	0	44	56	0	0	0	0	0	0	0
			mg/g	0	0	0	0	0.2	0.2	0	0	0	0	0	0	—
		Juice	%	13	0	12	0	40	18	18	0	0	0	0	0	0
			mg/g	tr	0	tr	0	0.1	tr	tr	0	0	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavanones												
				7–Rutinosides					7–Neohesperidosides							
				NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. grandis (cont.)																
Red Fleshed	2338	Leaf	%	0	0	4	0	12	41	27	1	0	0	14	0	1
			mg/g	0	0	0.1	0	0.2	0.8	0.5	tr	0	0	0.3	0	—
		Flavedo	%	3	0	4	1	10	33	34	4	1	6	3	0	1
			mg/g	0.2	0	0.3	0.1	0.8	2.5	2.6	0.3	0.1	0.5	0.2	0	—
		Albedo	%	2	3	3	0	9	34	42	3	1	0	1	0	2
			mg/g	0.2	0.4	0.3	0	0.9	3.5	4.4	0.3	tr	0	0.1	0	—
		Juice	%	3	4	4	0	11	34	40	3	0	0	1	0	0
			mg/g	tr	tr	tr	0	0.1	0.4	0.5	tr	0	0	tr	0	—
Siamese Seedless	640	Leaf	%	0	0	0	3	0	3	32	7	10	45	0	0	0
			mg/g	0	0	0	0.1	0	0.1	1.0	0.2	0.3	1.4	0	0	—
		Juice	%	0	0	0	0	8	0	72	10	0	10	0	0	0
			mg/g	0	0	0	0	tr	0	0.2	tr	0	tr	0	0	—
Tahitian	3806	Leaf	%	0	0	1	1	0	0	26	0	12	60	0	0	0
			mg/g	0	0	tr	tr	0	0	0.5	0	0.2	1.3	0	0	—
		Juice	%	0	0	0	5	0	0	66	13	0	16	0	0	0
			mg/g	0	0	0	tr	0	0	0.2	tr	0	tr	0	0	—
Yuma Ponderosa Lemon	3488	Leaf	%	0	0	0	21	0	24	22	0	32	0	0	0	0
			mg/g	0	0	0	0.2	0	0.2	0.2	0	0.3	0	0	0	—
		Juice	%	0	0	0	17	6	29	12	0	36	0	0	0	0
			mg/g	0	0	0	tr	tr	0.1	tr	0	0.1	0	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. grandis* × *C. limon																
Unknown	1481	Leaf	%	0	0	0	0	0	20	25	0	54	0	0	0	0
			mg/g	0	0	0	0	0	0.2	0.3	0	0.6	0	0	0	—
		Flavedo	%	0	0	1	0	5	12	55	0	16	12	0	0	0
			mg/g	0	0	tr	0	0.1	0.2	0.9	0	0.2	0.2	0	0	—
		Albedo	%	0	0	1	0	2	6	68	0	18	4	0	1	0
			mg/g	0	0	tr	0	tr	0.1	1.5	0	0.4	0.1	0	tr	—
		Juice	%	0	0	2	0	3	12	40	0	41	3	0	0	0
			mg/g	0	0	tr	0	tr	0.1	0.3	0	0.3	tr	0	0	—
Unknown	1775	Leaf	%	0	0	2	0	0	0	51	0	0	47	0	0	0
			mg/g	0	0	tr	0	0	0	1.1	0	0	1.0	0	0	—
		Juice	%	0	0	0	0	0	0	100	0	0	0	0	0	0
			mg/g	0	0	0	0	0	0	0.3	0	0	0	0	0	—
C. grandis* × *C. reticulata																
Frua Mandarin × pummelo	3555	Leaf	%	6	5	9	7	13	19	6	0	36	0	0	0	0
			mg/g	0.1	0.1	0.2	0.1	0.2	0.3	0.1	0	0.6	0	0	0	—
		Juice	%	6	0	20	6	17	6	15	0	22	9	0	0	0
			mg/g	tr	0	0.1	tr	0.1	tr	tr	0	0.1	tr	0	0	—
C. grandis* × *C. sinensis																
Shaddock × St. Michael	42–1	Leaf	%	2	6	0	22	6	3	8	0	53	0	0	0	0
			mg/g	0.1	0.2	0	0.7	0.2	0.1	0.2	0	1.6	0	0	0	—
		Juice	%	3	0	0	18	13	0	23	0	41	0	0	2	0
			mg/g	tr	0	0	0.1	0.1	0	0.2	0	0.3	0	0	tr	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavanones												
				7–Rutinosides					7–Neohesperidosides							
				NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
***C. grandis* × *C. sinensis* (cont.)**																
Tahitian ×	3781	Leaf	%	0	0	2	2	0	0	32	0	0	58	5	0	1
Star Ruby			mg/g	0	0	tr	tr	0	0	0.6	0	0	1.1	0.1	0	—
		Juice	%	0	0	0	0	0	0	100	0	0	0	0	0	0
			mg/g	0	0	0	0	0	0	0.1	0	0	0	0	0	—
C. hystrix																
Davao Lemon	2427	Leaf	%	0	50	0	50	0	0	0	0	0	0	0	0	0
			mg/g	0	0.4	0	0.4	0	0	0	0	0	0	0	0	—
		Juice	%	0	28	0	72	0	0	0	0	0	0	0	0	0
			mg/g	0	tr	0	0.1	0	0	0	0	0	0	0	0	—
Kulubot	3612	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.1	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	tr	0	0	0	0	0	0	0	0	—
Limon Real	2317	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.6	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.1	0	0	0	0	0	0	0	0	—
Philippines	2892	Leaf	%	0	0	0	0	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	0	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0	0	0	0	0	0	0	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. hystrix (cont.)																
Unknown—	3174	Leaf	%	0	43	0	56	0	0	0	0	0	0	0	0	0
Morocco			mg/g	0	0.1	0	0.1	0	0	0	0	0	0	0	0	—
		Juice	%	0	70	0	30	0	0	0	0	0	0	0	0	0
			mg/g	0	tr	0	tr	0	0	0	0	0	0	0	0	—
C. jambhiri																
Khoubs-el-Arsa	2489	Leaf	%	0	0	0	87	0	3	0	0	0	0	0	9	0
			mg/g	0	0	0	1.0	0	tr	0	0	0	0	0	0.1	—
		Juice	%	0	0	0	19	0	24	10	0	32	0	0	15	0
			mg/g	0	0	0	tr	0	tr	tr	0	0.1	0	0	tr	—
Limoneira	3834	Leaf	%	0	0	40	60	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.6	1.0	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	20	74	0	0	0	0	0	0	0	0	6
			mg/g	0	0	0.2	0.6	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	14	84	0	0	0	0	0	0	0	0	2
			mg/g	0	0	0.1	0.8	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	12	88	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.3	0	0	0	0	0	0	0	0	—
Milam	3396	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	3.2	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.3	0	0	0	0	0	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. jambhiri (cont.)																
Stowe Red	3185	Leaf	%	0	0	50	50	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.4	0.4	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	6	94	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.2	0	0	0	0	0	0	0	0	—
Unknown	3060	Leaf	%	0	0	23	77	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.4	1.3	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	14	86	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	0.7	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	10	90	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	0.7	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	14	86	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.3	0	0	0	0	0	0	0	0	—
C. limon																
Bergamot	2881	Leaf	%	0	0	0	13	0	27	6	0	0	0	0	17	37
			mg/g	0	0	0	0.2	0	0.5	0.1	0	0	0	0	0.3	—
		Flavedo	%	0	0	0	0	0	46	25	0	0	0	0	0	29
			mg/g	0	0	0	0	0	0.5	0.3	0	0	0	0	0	—
		Albedo	%	0	0	0	6	0	57	20	0	0	0	0	10	7
			mg/g	0	0	0	0.1	0	0.9	0.3	0	0	0	0	0.2	—
		Juice	%	0	16	0	0	0	37	3	0	9	10	0	0	25
			mg/g	0	0.1	0	0	0	0.2	tr	0	tr	0.1	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. limon (cont.)																
Corona Foothill	3043	Leaf	%	0	0	31	69	0	0	0	0	0	0	0	0	0
Eureka			mg/g	0	0	0.2	0.4	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	26	67	5	0	2	0	0	0	0	0	0
			mg/g	0	0	0.2	0.6	tr	0	tr	0	0	0	0	0	—
		Albedo	%	2	0	26	66	5	0	2	0	0	0	0	0	0
			mg/g	tr	0	0.3	0.8	0.1	0	tr	0	0	0	0	0	—
		Juice	%	0	0	29	66	5	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	0.2	tr	0	0	0	0	0	0	0	—
Kaweah #1 Lisbon	3010	Leaf	%	20	0	44	36	0	0	0	0	0	0	0	0	0
			mg/g	0.3	0	0.6	0.5	0	0	0	0	0	0	0	0	—
		Flavedo	%	3	0	42	52	0	0	0	0	0	0	0	0	3
			mg/g	0.1	0	1.4	1.8	0	0	0	0	0	0	0	0	—
		Albedo	%	4	0	46	50	0	0	0	0	0	0	0	0	0
			mg/g	0.1	0	1.0	1.1	0	0	0	0	0	0	0	0	—
		Juice	%	5	0	48	47	0	0	0	0	0	0	0	0	0
			mg/g	tr	0	0.2	0.2	0	0	0	0	0	0	0	0	—
Kulu	3045	Leaf	%	0	0	20	80	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.2	0.6	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	11	17	50	21	0	0	0	0	0	0	0	0
			mg/g	0	tr	0.1	0.2	0.1	0	0	0	0	0	0	0	—
		Albedo	%	0	17	8	74	0	0	0	0	0	0	0	0	0
			mg/g	0	0.1	tr	0.5	0	0	0	0	0	0	0	0	—
		Juice	%	0	7	10	78	4	0	0	0	0	0	0	0	0
			mg/g	0	tr	tr	0.3	tr	0	0	0	0	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. limon (cont.)																
Kulu	3487	Leaf	%	0	0	38	61	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	0.1	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	36	64	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	tr	0	0	0	0	0	0	0	0	—
Nicaraguan	3841	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.5	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	0	93	0	0	0	7	0	0	0	0	0
			mg/g	0	0	0	0.5	0	0	0	tr	0	0	0	0	—
		Albedo	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.3	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	11	89	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.1	0	0	0	0	0	0	0	0	—
Santa Teresa #1	3894	Leaf	%	0	0	17	78	0	0	0	0	0	0	0	0	4
			mg/g	0	0	0.8	4.0	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	8	77	4	0	0	7	0	0	0	0	4
			mg/g	0	0	0.6	5.1	0.3	0	0	0.5	0	0	0	0	—
		Albedo	%	0	0	11	79	4	0	2	2	0	0	0	0	2
			mg/g	0	0	0.9	6.6	0.3	0	0.2	0.1	0	0	0	0	—
		Juice	%	0	0	9	85	2	0	1	0	0	0	0	0	3
			mg/g	0	0	0.3	2.9	0.1	0	tr	0	0	0	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4'–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4'–glucoside; NHP, neohesperidin; NMO, naringin–6"–malonate (open form); PON, poncirin; NMC, naringin–6"–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. limon (cont.)																
Seedless Lisbon	3001	Leaf	%	0	0	100	0	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.9	0	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	69	22	7	0	0	0	0	0	0	0	2
			mg/g	0	0	1.6	0.5	0.1	0	0	0	0	0	0	0	—
		Albedo	%	0	0	67	33	0	0	0	0	0	0	0	0	0
			mg/g	0	0	1.5	0.8	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	72	28	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.2	0.1	0	0	0	0	0	0	0	0	—
Unknown—Borneo	3765	Leaf	%	0	0	0	0	35	0	0	0	0	0	0	0	65
			mg/g	0	0	0	0	0.2	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	89	0	0	0	0	0	0	0	0	11
			mg/g	0	0	0	0.1	0	0	0	0	0	0	0	0	—
Unknown—Morocco	3155–A	Leaf	%	6	0	7	42	26	0	0	0	0	19	0	0	0
			mg/g	0.1	0	0.2	1.0	0.6	0	0	0	0	0.5	0	0	—
		Juice	%	0	0	3	53	11	0	0	0	0	33	0	0	0
			mg/g	0	0	tr	0.3	0.1	0	0	0	0	0.2	0	0	—
C. longispina																
Unknown	2320	Leaf	%	0	0	31	34	24	6	0	0	0	0	0	0	5
			mg/g	0	0	0.6	0.6	0.5	0.1	0	0	0	0	0	0	—
		Juice	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.2	0	0	0	0	0	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4'–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4'–glucoside; NHP, neohesperidin; NMO, naringin–6"–malonate (open form); PON, poncirin; NMC, naringin–6"–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. macrophylla																
Unknown	3842	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.5	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.2	0	0	0	0	0	0	0	0	—
C. medica																
Bush	—	Flavedo	%	0	0	11	89	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	0.6	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	5	91	0	0	4	0	0	0	0	0	0
			mg/g	0	0	0.1	1.7	0	0	0.1	0	0	0	0	0	—
		Juice	%	0	0	12	88	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.2	0	0	0	0	0	0	0	0	—
Citron of Commerce	3518	Leaf	%	0	0	0	0	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	33	67	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	tr	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	32	68	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	tr	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	tr	0	0	0	0	0	0	0	0	—
		Medulla	%	0	0	76	25	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	tr	0	0	0	0	0	0	0	0	—
		Septa membrane	%	0	0	64	36	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	tr	0	0	0	0	0	0	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON; poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. medica (cont.)																
Dulcia	3654	Leaf	%	0	0	0	0	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	tr	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	tr	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	45	55	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	tr	0	0	0	0	0	0	0	0	—
Fingered	3768	Leaf	%	0	0	0	0	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	35	65	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	tr	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	tr	0	0	0	0	0	0	0	0	—
India Sour	661	Leaf	%	0	0	0	67	0	0	33	0	0	0	0	0	0
			mg/g	0	0	0	0.4	0	0	0.2	0	0	0	0	0	—
		Flavedo	%	0	0	0	85	0	0	15	0	0	0	0	0	0
			mg/g	0	0	0	0.5	0	0	0.1	0	0	0	0	0	—
		Albedo	%	0	0	0	84	0	0	16	0	0	0	0	0	0
			mg/g	0	0	0	0.5	0	0	0.1	0	0	0	0	0	—
		Juice	%	0	0	0	68	0	0	29	0	0	0	0	0	3
			mg/g	0	0	0	0.2	0	0	0.1	0	0	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. medica (cont.)																
Mexican	3531	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.1	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	tr	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	tr	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	tr	0	0	0	0	0	0	0	0	—
South Coast Field Station	3546	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	tr	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.2	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	47	53	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	tr	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	50	50	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	tr	0	0	0	0	0	0	0	0	—
Spadifora	3535	Leaf	%	0	0	100	0	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	100	0	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	100	0	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	100	0	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0	0	0	0	0	0	0	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. medica (cont.)																
Yunanensis	3798	Leaf	%	0	0	0	0	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	0	0	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0	0	0	0	0	0	0	0	0	—
		Albedo	%	0	0	40	60	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	tr	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	tr	0	0	0	0	0	0	0	0	—
C. microcarpa																
Calasnu	2867	Leaf	%	0	0	3	32	7	0	48	0	0	5	0	5	0
			mg/g	0	0	0.1	0.7	0.2	0	1.1	0	0	0.1	0	0.1	—
		Flavedo	%	0	0	0	89	0	0	0	0	0	0	0	0	11
			mg/g	0	0	0	1.1	0	0	0	0	0	0	0	0	—
		Albedo	%	0	2	3	25	1	1	55	0	1	1	0	0	11
			mg/g	0	0.1	0.2	1.6	0.1	0.1	3	0	0.1	0.1	0	0	—
		Juice	%	0	3	3	40	0	0	50	0	0	4	0	0	0
			mg/g	0	tr	tr	0.5	0	0	0.6	0	0	tr	0	0	—
Samuyao	3605	Leaf	%	0	0	0	39	0	0	0	0	61	0	0	0	0
			mg/g	0	0	0	0.6	0	0	0	0	0.1	0	0	0	—
		Juice	%	0	0	0	64	0	0	0	0	36	0	0	0	0
			mg/g	0	0	0	0.1	0	0	0	0	tr	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides						7–Neohesperidosides						
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. natsudaidai																
Unknown	3235	Leaf	%	0	7	0	0	0	13	25	0	54	0	0	0	1
			mg/g	0	0.2	0	0	0	0.3	0.6	0	1.2	0	0	0	—
		Flavedo	%	0	0	0	0	0	0	33	15	52	0	0	0	0
			mg/g	0	0	0	0	0	0	0.1	0.1	0.2	0	0	0	—
		Albedo	%	1	0	0	2	3	0	55	10	25	4	0	0	1
			mg/g	tr	0	0	0.1	0.1	0	1.4	0.2	0.6	0.1	0	0	—
		Juice	%	6	8	0	0	11	0	56	8	11	0	0	0	0
			mg/g	tr	tr	0	0	tr	0	0.1	tr	tr	0	0	0	—
C. paradisi																
Camulos	3139	Leaf	%	0	0	0	15	10	2	47	1	0	19	0	5	1
			mg/g	0	0	0	0.6	0.4	0.1	1.9	tr	0	0.8	0	0.2	—
		Flavedo	%	0	0	0	0	15	0	75	0	7	0	0	3	0
			mg/g	0	0	0	0	0.2	0	0.8	0	0.1	0	0	tr	—
		Albedo	%	1	1	0	0	11	1	75	2	1	2	0	5	2
			mg/g	0.1	0.1	0	0	0.8	tr	5.8	0.2	0.1	0.2	0	0.4	—
		Juice	%	2	1	0	0	17	0	72	1	1	2	0	4	0
			mg/g	tr	tr	0	0	0.2	0	0.9	tr	tr	tr	0	0.1	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. paradisi (cont.)																
CRC #343	343	Leaf	%	12	0	0	0	0	18	17	1	39	0	0	2	11
			mg/g	0.4	0	0	0	0	0.6	0.5	tr	1.3	0	0	0.1	—
		Flavedo	%	4	0	15	0	11	24	19	0	26	0	0	0	1
			mg/g	tr	0	0.1	0	0.1	0.2	0.1	0	0.2	0	0	0	—
		Albedo	%	1	0	5	5	4	9	28	2	44	1	0	1	0
			mg/g	0.1	0	0.5	0.4	0.4	0.9	2.7	0.2	4.2	0.1	0	0.1	—
		Juice	%	1	0	7	5	6	9	26	2	43	1	0	0	0
			mg/g	tr	0	0.1	0.1	0.1	0.1	0.4	tr	0.6	tr	0	0	—
Duncan	3832	Leaf	%	0	0	0	0	11	0	76	0	4	0	0	0	9
			mg/g	0	0	0	0	0.2	0	1.7	0	0.1	0	0	0	—
		Flavedo	%	0	0	0	0	11	0	75	0	3	5	0	0	6
			mg/g	0	0	0	0	0.1	0	0.5	0	tr	tr	0	0	—
		Albedo	%	0	0	0	0	8	0	87	1	0	1	0	3	0
			mg/g	0	0	0	0	0.4	0	4.9	tr	0	0.1	0	0.2	—
		Juice	%	0	0	0	0	12	0	85	0	0	0	0	3	0
			mg/g	0	0	0	0	0.1	0	0.5	0	0	0	0	tr	—
Hall	3068	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.4	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	96	4	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.4	tr	0	0	0	0	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. paradisi (cont.)																
Jochimsen	2784	Leaf	%	0	0	0	9	15	0	46	0	8	22	0	0	0
			mg/g	0	0	0	0.1	0.2	0	0.7	0	0.1	0.3	0	0	—
		Flavedo	%	0	0	0	7	19	0	74	0	0	0	0	0	0
			mg/g	0	0	0	0.1	0.2	0	0.8	0	0	0	0	0	—
		Albedo	%	1	0	0	0	9	0	82	1	0	3	0	3	1
			mg/g	tr	0	0	0	0.4	0	3.2	0.1	0	0.1	0	0.1	—
		Juice	%	0	0	0	28	27	0	45	0	0	0	0	0	0
			mg/g	0	0	0	0.1	0.1	0	0.2	0	0	0	0	0	—
Reed Seedling Marsh	3128	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.6	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	97	3	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.3	tr	0	0	0	0	0	0	0	—
Star Ruby	3770	Leaf	%	0	0	0	0	15	0	43	0	15	26	0	0	1
			mg/g	0	0	0	0	0.3	0	0.9	0	0.3	0.5	0	0	—
		Flavedo	%	0	0	0	0	6	0	82	0	5	7	0	0	0
			mg/g	0	0	0	0	0.1	0	1.0	0	tr	0.1	0	0	—
		Albedo	%	0	1	0	0	9	1	75	2	1	4	0	5	3
			mg/g	0	0.1	0	0	1.4	0.1	11.3	0.3	0.2	0.7	0	0.7	—
		Juice	%	2	0	0	0	15	0	75	0	2	2	0	3	1
			mg/g	tr	0	0	0	0.2	0	1.0	0	tr	tr	0	tr	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4'–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4'–glucoside; NHP, neohesperidin; NMO, naringin–6"–malonate (open form); PON, poncirin; NMC, naringin–6"–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. paradisi (cont.)																
Whitney Old	3804	Leaf	%	0	0	0	0	0	0	45	0	22	27	0	5	1
Line Marsh			mg/g	0	0	0	0	0	0	0.7	0	0.4	0.4	0	0.1	—
		Juice	%	2	0	0	3	35	0	57	0	0	0	0	3	0
			mg/g	tr	0	0	tr	0.3	0	0.4	0	0	0	0	tr	—
Yellow Rind	3895	Leaf	%	0	0	58	42	0	0	0	0	0	0	0	0	0
Mandarin			mg/g	0	0	0.6	0.4	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	13	85	2	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	0.8	tr	0	0	0	0	0	0	0	—
		Albedo	%	0	0	14	81	3	0	0	0	0	0	0	0	2
			mg/g	0	0	0.1	0.9	tr	0	0	0	0	0	0	0	—
		Juice	%	0	0	9	91	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.3	0	0	0	0	0	0	0	0	—
C. reticulata																
Robinson	3850	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	5.0	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	0	92	8	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.4	0.1	0	0	0	0	0	0	0	—
		Albedo	%	0	2	0	93	5	0	0	0	0	0	0	0	0
			mg/g	0	tr	0	1.3	0.1	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.2	0	0	0	0	0	0	0	0	—
Scarlet Emperor	3326	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.6	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.3	0	0	0	0	0	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavanones												
				7–Rutinosides					7–Neohesperidosides							
				NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. reticulata (cont.)																
Solid Scarlet	3328	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.0	0	0	0	0	0	0	0	0	—
		Juice	%	0	4	0	96	0	0	0	0	0	0	0	0	0
			mg/g	0	tr	0	0.3	0	0	0	0	0	0	0	0	—
Sunburst	3809	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.5	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	0	97	3	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.4	tr	0	0	0	0	0	0	0	—
		Albedo	%	0	3	0	93	4	0	0	0	0	0	0	0	0
			mg/g	0	0.1	0	1.9	0.1	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.2	0	0	0	0	0	0	0	0	—
C. reticulata* × *C. paradisi																
Sacaton	3331	Leaf	%	0	0	0	8	6	2	13	0	61	0	0	0	10
			mg/g	0	0	0	0.2	0.2	0.1	0.5	0	1.9	0	0	0	—
		Flavedo	%	0	0	0	13	4	2	17	2	61	0	0	1	0
			mg/g	0	0	0	0.2	0.1	tr	0.3	tr	1.1	0	0	tr	—
		Albedo	%	0	0	0	5	3	1	35	2	52	1	0	1	0
			mg/g	0	0	0	0.3	0.2	0.1	2.2	0.1	2.7	tr	0	0.1	—
		Juice	%	0	1	0	8	5	1	29	1	53	1	0	1	0
			mg/g	0	tr	0	0.1	0.1	tr	0.2	tr	1.2	tr	0	tr	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4'–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4'–glucoside; NHP, neohesperidin; NMO, naringin–6"–malonate (open form); PON, poncirin; NMC, naringin–6"–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. reticulata* × *C. sinensis																
Sue Linda Temple	3810	Leaf	%	0	0	6	85	9	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	2.1	0.2	0	0	0	0	0	0	0	—
		Flavedo	%	4	3	0	75	17	0	0	0	0	0	0	0	1
			mg/g	0.1	tr	0	1.4	0.3	0	0	0	0	0	0	0	—
		Albedo	%	4	2	5	70	12	0	0	0	0	0	0	0	7
			mg/g	0.1	tr	0.1	1.6	0.3	0	0	0	0	0	0	0	—
		Juice	%	4	0	5	75	16	0	0	0	0	0	0	0	0
			mg/g	tr	0	tr	0.3	0.1	0	0	0	0	0	0	0	—
C. reticulata* × *Poncirus trifoliata																
Unknown	2619	Leaf	%	0	16	3	22	9	0	46	0	0	0	0	0	4
			mg/g	0	1.2	0.2	1.7	0.7	0	3.4	0	0	0	0	0	—
		Flavedo	%	0	0	0	0	0	0	100	0	0	0	0	0	0
			mg/g	0	0	0	0	0	0	1.1	0	0	0	0	0	—
		Albedo	%	1	15	3	29	7	0	44	0	0	0	0	0	1
			mg/g	0.1	2.7	0.6	5.1	1.3	0	7.8	0	0	0	0	0	—
		Juice	%	1	16	2	28	8	0	41	0	2	1	0	0	1
			mg/g	tr	1.3	0.2	2.4	0.7	0	3.5	0	0.2	tr	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4'–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4'–glucoside; NHP, neohesperidin; NMO, naringin–6"–malonate (open form); PON, poncirin; NMC, naringin–6"–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. rugulosa																
Unknown	3556	Leaf	%	0	0	0	4	11	18	31	0	36	0	0	0	0
			mg/g	0	0	0	tr	0.1	0.1	0.2	0	0.3	0	0	0	—
		Flavedo	%	0	0	1	2	2	6	44	3	40	1	0	1	0
			mg/g	0	0	tr	0.1	0.1	0.4	1.9	0.1	1.7	0.1	0	tr	—
		Albedo	%	0	0	2	3	3	12	35	3	42	0	0	0	0
			mg/g	0	0	tr	0.1	0.1	0.3	1.0	0.1	1.2	0	0	0	—
		Juice	%	0	0	0	0	18	11	56	5	10	0	0	0	0
			mg/g	0	0	0	0	0.1	tr	0.2	tr	tr	0	0	0	—
C. shunokan																
Unknown	3476	Leaf	%	0	0	8	55	37	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.3	0.2	0	0	0	0	0	0	0	—
		Juice	%	21	0	2	36	41	0	0	0	0	0	0	0	0
			mg/g	0.1	0	tr	0.2	0.2	0	0	0	0	0	0	0	—
C. sinensis																
Blood orange cultivars																
Cipo	3896	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.9	0	0	0	0	0	0	0	0	—
Rotuma Island	3867	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	2.2	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	80	11	0	9	0	0	0	0	0	0
			mg/g	0	0	0	0.3	tr	0	tr	0	0	0	0	0	—
Vainiglia Pink	3801	Juice	%	0	4	0	83	12	0	0	0	0	0	0	0	1
Fleshed			mg/g	0	tr	0	0.3	tr	0	0	0	0	0	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. sinensis (cont.)																
Navel cultivars																
Bey	3406	Leaf	%	0	1	1	95	3	0	0	0	0	0	0	0	0
			mg/g	0	tr	0.1	2.3	0.2	0	0	0	0	0	0	0	—
		Flavedo	%	2	2	4	75	5	4	4	4	0	0	0	0	0
			mg/g	tr	tr	0.1	1.2	0.1	0.1	0.1	0.1	0	0	0	0	—
		Albedo	%	3	2	3	77	10	1	1	3	0	0	0	0	0
			mg/g	0.1	tr	0.1	1.4	0.3	tr	tr	0.1	0	0	0	0	—
		Juice	%	5	3	3	75	12	2	0	0	0	0	0	0	0
			mg/g	0.1	tr	tr	0.4	0.1	tr	0	0	0	0	0	0	—
CPB #44944A	3305	Leaf	%	0	0	4	96	0	0	0	0	0	0	0	0	0
Seedling			mg/g	0	0	0.1	3.3	0	0	0	0	0	0	0	0	—
		Flavedo	%	1	0	1	91	7	0	0	0	0	0	0	0	0
			mg/g	tr	0	tr	1.1	0.1	0	0	0	0	0	0	0	—
		Albedo	%	5	2	5	74	5	0	0	0	0	0	0	0	8
			mg/g	0.1	tr	0.1	1.0	0.1	0	0	0	0	0	0	0	—
		Juice	%	1	1	0	92	6	0	0	0	0	0	0	0	0
			mg/g	0.1	tr	0	0.2	tr	0	0	0	0	0	0	0	—
CPB #44944B	3306–A	Leaf	%	0	0	3	90	7	0	0	0	0	0	0	0	0
Seedling			mg/g	0	0	0.1	2.1	0.2	0	0	0	0	0	0	0	—
		Flavedo	%	4	4	0	79	13	0	0	0	0	0	0	0	0
			mg/g	tr	tr	0	0.6	0.1	0	0	0	0	0	0	0	—
		Albedo	%	15	5	5	34	36	0	0	0	0	0	0	0	5
			mg/g	0.1	tr	tr	0.2	0.2	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	88	12	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.1	tr	0	0	0	0	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4'–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4'–glucoside; NHP, neohesperidin; NMO, naringin–6"–malonate (open form); PON; poncirin; NMC, naringin–6"–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. sinensis (cont.)																
Navel cultivars (cont.)																
Fisher	3645	Leaf	%	0	0	2	98	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	4.6	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	3	0	86	11	0	0	0	0	0	0	0	0
			mg/g	0	0.1	0	1.9	0.2	0	0	0	0	0	0	0	—
		Albedo	%	5	5	2	74	13	0	0	0	0	0	0	0	0
			mg/g	0.2	0.2	0.1	3.2	0.6	0	0	0	0	0	0	0	—
		Juice	%	3	3	3	75	15	0	0	1	0	0	0	0	0
			mg/g	tr	tr	tr	0.5	0.1	0	0	tr	0	0	0	0	—
Golden Buckeye	588	Leaf	%	0	0	5	95	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.9	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	92	8	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.3	tr	0	0	0	0	0	0	0	—
McFadden Ribbed	609	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.2	0	0	0	0	0	0	0	0	—
		Flavedo	%	3	4	0	83	10	0	0	0	0	0	0	0	0
			mg/g	tr	0.1	0	1.5	0.2	0	0	0	0	0	0	0	—
		Albedo	%	5	3	5	77	10	0	0	0	0	0	0	0	0
			mg/g	0.1	tr	0.1	1.4	0.2	0	0	0	0	0	0	0	—
		Juice	%	4	3	0	78	13	0	0	0	0	0	0	0	2
			mg/g	tr	tr	0	0.4	0.1	0	0	0	0	0	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4'–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4'–glucoside; NHP, neohesperidin; NMO, naringin–6"–malonate (open form); PON, poncirin; NMC, naringin–6"–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. sinensis (cont.)																
Navel cultivars (cont.)																
Paradise	2853	Leaf	%	0	0	2	96	0	0	0	0	0	0	0	0	2
			mg/g	0	0	tr	2.7	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	2	1	92	5	0	0	0	0	0	0	0	0
			mg/g	0	tr	tr	1.8	0.1	0	0	0	0	0	0	0	—
		Albedo	%	3	3	2	84	7	0	0	0	0	0	0	0	1
			mg/g	0.1	tr	tr	1.1	0.1	0	0	0	0	0	0	0	—
		Juice	%	3	2	2	83	9	0	0	0	0	0	0	0	0
			mg/g	tr	tr	tr	0.3	tr	0	0	0	0	0	0	0	—
Parent Washington	1241–B	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.9	0	0	0	0	0	0	0	0	—
		Juice	%	4	3	0	72	21	0	0	0	0	0	0	0	0
			mg/g	tr	tr	0	0.3	0.1	0	0	0	0	0	0	0	—
Ruvel	3181	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.7	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	10	90	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.1	0	0	0	0	0	0	0	0	—
Smith's Early	574	Leaf	%	0	0	1	91	5	0	0	0	0	0	0	0	3
			mg/g	0	0	0.1	6.9	0.4	0	0	0	0	0	0	0	—
		Flavedo	%	0	3	1	88	8	0	0	0	0	0	0	0	0
			mg/g	0	0.1	tr	2.0	0.2	0	0	0	0	0	0	0	—
		Albedo	%	3	4	2	81	10	0	0	0	0	0	0	0	0
			mg/g	0.1	tr	tr	0.8	0.2	0	0	0	0	0	0	0	—
		Juice	%	5	3	1	75	15	0	0	0	0	0	0	0	1
			mg/g	tr	tr	tr	0.4	0.1	0	0	0	0	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. sinensis (cont.)																
Navel cultivars (cont.)																
Thomson	983	Leaf	%	0	0	4	88	8	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	1.5	0.1	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	8	88	0	0	0	0	0	0	0	0	4
			mg/g	0	0	tr	1.0	0	0	0	0	0	0	0	0	—
		Albedo	%	1	2	2	90	5	0	0	0	0	0	0	0	0
			mg/g	tr	tr	tr	0.4	0.1	0	0	0	0	0	0	0	—
		Juice	%	5	0	1	80	14	0	0	0	0	0	0	0	0
			mg/g	tr	0	tr	0.3	tr	0	0	0	0	0	0	0	—
Sweet orange cultivars																
Catlin	3860	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.0	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	92	8	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.3	tr	0	0	0	0	0	0	0	—
Espagnole sans Pepins	3249	Leaf	%	0	0	0	93	0	0	0	0	0	0	0	0	7
			mg/g	0	0	0	1.7	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	92	8	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.3	tr	0	0	0	0	0	0	0	—
Finike	3870	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.5	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	4	91	5	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.6	tr	0	0	0	0	0	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4'–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4'–glucoside; NHP, neohesperidin; NMO, naringin–6"–malonate (open form); PON, poncirin; NMC, naringin–6"–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. sinensis (cont.)																
Sweet orange cultivars (cont.)																
Homosassa	1696	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.2	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	87	13	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.4	tr	0	0	0	0	0	0	0	—
Valencia cultivars																
Cutter	3030	Leaf	%	0	0	1	95	4	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	1.5	0.1	0	0	0	0	0	0	0	—
		Flavedo	%	3	4	3	77	12	0	0	0	0	0	0	0	1
			mg/g	tr	0.1	0.1	1.9	0.3	0	0	0	0	0	0	0	—
		Albedo	%	6	5	3	65	20	0	0	0	0	0	0	0	1
			mg/g	0.1	0.1	0.1	1.8	0.5	0	0	0	0	0	0	0	—
		Juice	%	4	4	3	73	15	0	0	0	0	0	0	0	1
			mg/g	tr	tr	tr	0.5	0.1	0	0	0	0	0	0	0	—
Hart's Late	314	Leaf	%	0	0	4	96	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0.1	2.5	0	0	0	0	0	0	0	0	—
		Flavedo	%	1	4	1	85	9	0	0	0	0	0	0	0	0
			mg/g	tr	tr	tr	0.9	0.2	0	0	0	0	0	0	0	—
		Albedo	%	1	4	7	78	10	0	0	0	0	0	0	0	0
			mg/g	0.1	tr	tr	1.0	0.2	0	0	0	0	0	0	0	—
		Juice	%	0	4	0	84	12	0	0	0	0	0	0	0	0
			mg/g	0	tr	0	0.3	tr	0	0	0	0	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4'–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4'–glucoside; NHP, neohesperidin; NMO, naringin–6"–malonate (open form); PON, poncirin; NMC, naringin–6"–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivars	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. sinensis (cont.)																
Valencia cultivars (cont.)																
Seedless	2776	Leaf	%	0	0	1	97	2	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	1.7	tr	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	93	6	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.3	tr	0	0	0	0	0	0	0	—
***C. sinensis* × (*C. sinensis* × *Poncirus trifoliata*)**																
Unknown	1447	Leaf	%	0	0	19	25	23	0	0	0	0	0	0	33	1
			mg/g	0	0	0.3	0.4	0.3	0	0	0	0	0	0	0.5	—
		Flavedo	%	9	0	20	28	18	0	5	0	0	0	0	19	1
			mg/g	0.2	0	0.5	0.6	0.4	0	0.1	0	0	0	0	0.4	—
		Albedo	%	6	0	12	27	15	0	0	0	0	0	0	40	0
			mg/g	0.4	0	0.8	2.0	1.0	0	0	0	0	0	0	3.0	—
		Juice	%	7	0	12	21	17	0	0	0	0	0	0	43	0
			mg/g	tr	0	0.1	0.1	0.1	0	0	0	0	0	0	0.3	—
C. sulcata																
Unknown	3257	Leaf	%	16	0	31	42	11	0	0	0	0	0	0	0	0
			mg/g	0.2	0	0.4	0.6	0.1	0	0	0	0	0	0	0	—
		Juice	%	18	0	13	18	51	0	0	0	0	0	0	0	0
			mg/g	tr	0	tr	tr	0.1	0	0	0	0	0	0	0	—
C. tamurana																
Unknown	3092	Leaf	%	0	0	0	5	0	0	15	8	67	5	0	0	0
			mg/g	0	0	0	0.1	0	0	0.4	0.2	1.9	0.1	0	0	—
		Juice	%	0	0	0	0	7	0	44	17	24	8	0	0	0
			mg/g	0	0	0	0	tr	0	0.1	tr	tr	tr	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
C. tengu																
Unknown	3461	Leaf	%	0	8	0	0	92	0	0	0	0	0	0	0	0
			mg/g	0	tr	0	0	0.4	0	0	0	0	0	0	0	—
		Juice	%	21	0	0	0	79	0	0	0	0	0	0	0	0
			mg/g	tr	0	0	0	0.1	0	0	0	0	0	0	0	—
C. ujukitsu																
Unknown	3467	Leaf	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	1.0	0	0	0	0	0	0	0	0	—
		Juice	%	10	0	0	52	31	0	0	0	0	0	0	5	2
			mg/g	tr	0	0	0.2	0.1	0	0	0	0	0	0	tr	—
C. webberi																
Montana	767	Leaf	%	0	15	0	85	0	0	0	0	0	0	0	0	0
			mg/g	0	0.3	0	1.6	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	100	0	0	0	0	0	0	0	0	0
			mg/g	0	0	0	0.2	0	0	0	0	0	0	0	0	—
Unknown	1455	Leaf	%	0	79	0	21	0	0	0	0	0	0	0	0	0
			mg/g	0	2.7	0	0.7	0	0	0	0	0	0	0	0	—
		Juice	%	0	58	0	40	1	0	0	0	0	0	0	0	1
			mg/g	0	1.1	0	0.6	tr	0	0	0	0	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. *Concentrations are average of two to four runs ±0.05 mg/g fresh weight*]

Species and cultivar	CRC #	Plant part		Flavanones												
				7–Rutinosides					7–Neohesperidosides							
				NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
Eremocitrus glauca																
Unknown hybrid	2439	Leaf	%	0	0	0	92	0	0	0	0	0	0	0	0	8
			mg/g	0	0	0	8.6	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	0	75	0	0	4	21	0	0	0	0	0
			mg/g	0	0	0	1.7	0	0	0.1	0.5	0	0	0	0	—
		Albedo	%	0	0	0	73	10	0	0	14	0	0	0	0	2
			mg/g	0	0	0	1.8	0.2	0	0	0.3	0	0	0	0	—
		Juice	%	5	0	5	79	8	0	0	0	0	0	0	0	3
			mg/g	tr	0	tr	0.9	0.1	0	0	0	0	0	0	0	—
Fortunella japonica																
Unknown	—	Leaf	%	0	0	0	0	0	0	90	0	10	0	0	0	0
			mg/g	0	0	0	0	0	0	1.2	0	0.2	0	0	0	—
		Flavedo	%	0	0	0	0	0	0	96	0	2	0	0	2	0
			mg/g	0	0	0	0	0	0	1.2	0	tr	0	0	tr	—
		Albedo	%	0	0	0	0	0	0	98	0	0	0	0	2	0
			mg/g	0	0	0	0	0	0	0.9	0	0	0	0	tr	—
Unknown	—	Leaf	%	0	0	0	0	0	0	100	0	0	0	0	0	0
			mg/g	0	0	0	0	0	0	4.4	0	0	0	0	0	—
		Peel	%	0	0	3	0	0	1	97	0	0	0	0	0	0
			mg/g	0	0	0.1	0	0	tr	3.9	0	0	0	0	0	—
		Juice	%	0	0	0	0	0	0	100	0	0	0	0	0	0
			mg/g	0	0	0	0	0	0	0.4	0	0	0	0	0	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, narirutin–4'–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4'–glucoside; NHP, neohesperidin; NMO, naringin–6"–malonate (open form); PON, poncirin; NMC, naringin–6"–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
Fortunella japonica (cont.)																
Unknown	—	Leaf	%	0	0	12	75	0	0	13	0	0	0	0	0	0
			mg/g	0	0	0.4	2.2	0	0	0.4	0	0	0	0	0	—
		Flavedo	%	0	0	15	58	0	0	25	0	0	0	0	0	2
			mg/g	0	0	0.1	0.4	0	0	0.2	0	0	0	0	0	—
		Albedo	%	0	0	3	92	2	0	4	0	0	0	0	0	0
			mg/g	0	0	0.1	1.8	tr	0	0.1	0	0	0	0	0	—
		Juice	%	0	0	6	94	0	0	0	0	0	0	0	0	0
			mg/g	0	0	tr	0.6	0	0	0	0	0	0	0	0	—
Fortunella* sp. × *Citrus reticulata* × *(C. sinensis* × *Poncirus trifoliata)																
Unknown	3573	Leaf	%	0	0	12	0	0	0	71	17	0	0	0	0	0
			mg/g	0	0	tr	0	0	0	0.2	0.1	0	0	0	0	—
		Juice	%	0	0	19	0	10	0	53	18	0	0	0	0	0
			mg/g	0	0	tr	0	tr	0	0.1	tr	0	0	0	0	—
Microcitrus australasica																
Sanguinea	1484	Flavedo	%	0	0	0	0	0	0	0	0	0	0	0	0	100
			mg/g	0	0	0	0	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	0	0	0	0	0	0	0	0	0	100
			mg/g	0	0	0	0	0	0	0	0	0	0	0	0	—

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[[Abbreviations: NTG, narirutin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]]

Species and cultivar	CRC #	Plant part		Flavanones												
				7–Rutinosides					7–Neohesperidosides							
				NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
M. inodora																
Unknown	3785–A	Leaf	%	0	0	0	3	16	0	3	0	16	0	0	0	62
			mg/g	0	0	0	0.1	0.6	0	0.1	0	0.7	0	0	0	—
		Flavedo	%	0	0	0	0	0	0	0	0	0	0	0	100	0
			mg/g	0	0	0	0	0	0	0	0	0	0	0	0.4	—
		Juice	%	0	0	0	0	0	0	0	0	0	0	0	100	0
			mg/g	0	0	0	0	0	0	0	0	0	0	0	0.2	—
M. warburgiana																
Unknown	3782–D	Leaf	%	0	0	0	0	0	0	0	0	0	0	0	0	100
			mg/g	0	0	0	0	0	0	0	0	0	0	0	0	—
		Flavedo	%	0	0	0	0	0	0	0	0	0	0	0	0	100
			mg/g	0	0	0	0	0	0	0	0	0	0	0	0	—
		Juice	%	0	0	0	0	22	0	0	0	0	0	0	0	78
			mg/g	0	0	0	0	tr	0	0	0	0	0	0	0	—
Poncirus trifoliata* × *C. paradisi																
Swingle	3767	Leaf	%	0	0	0	0	74	0	0	0	0	0	0	26	0
			mg/g	0	0	0	0	1.1	0	0	0	0	0	0	0.4	—
		Flavedo	%	0	0	0	0	60	0	5	20	0	0	0	15	0
			mg/g	0	0	0	0	0.5	0	tr	0.2	0	0	0	0.1	—
		Albedo	%	0	0	0	0	35	0	0	5	0	0	0	60	0
			mg/g	0	0	0	0	2.0	0	0	0.3	0	0	0	3.4	—
		Juice	%	0	0	0	0	31	0	0	5	0	0	0	64	0
			mg/g	0	0	0	0	0.4	0	0	0.1	0	0	0	0.8	—

Continued

Table 3. Flavanone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: NTG, naringin–4′–glucoside; DID, didymin; ERC, eriocitrin; HSP, hesperidin; NRT, narirutin; NER, neoeriocitrin; NRG, naringin; NGG, naringin–4′–glucoside; NHP, neohesperidin; NMO, naringin–6″–malonate (open form); PON, poncirin; NMC, naringin–6″–malonate (closed form); tr, trace. Concentrations are average of two to four runs ±0.05 mg/g fresh weight]

				Flavanones												
				7–Rutinosides					7–Neohesperidosides							
Species and cultivar	CRC #	Plant part		NTG	DID	ERC	HSP	NRT	NER	NRG	NGG	NHP	NMO	PON	NMC	Other
***Poncirus trifoliata* × *C. paradisi* (cont).**																
Unknown	1452	Leaf	%	0	7	0	70	0	0	11	0	0	0	0	11	1
			mg/g	0	0.1	0	1.3	0	0	0.2	0	0	0	0	0.2	—
		Juice	%	0	29	0	12	0	0	21	0	0	0	0	21	17
			mg/g	0	0.1	0	tr	0	0	0.1	0	0	0	0	0.1	—

Table 4. Flavone composition in genus *Citrus* and its near relatives

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivars	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
Citrus aurantifolia								
Abhayapuri	3762	Leaf	%	17	0	0	15	68
			mg/g	0.5	0	0	0.5	—
		Flavedo	%	0	0	0	20	80
			mg/g	0	0	0	0.2	—
		Albedo	%	13	0	0	9	79
			mg/g	0.1	0	0	tr	—
		Juice	%	37	0	0	21	42
			mg/g	tr	0	0	tr	—
Bishop Red Rangpur	2451	Leaf	%	53	6	0	41	0
			mg/g	1.0	0.1	0	0.8	—
		Flavedo	%	0	0	0	40	60
			mg/g	0	0	0	0.1	—
		Albedo	%	0	0	0	45	55
			mg/g	0	0	0	0.1	—
		Juice	%	0	0	0	39	61
			mg/g	0	0	0	tr	—
Borneo Rangpur	2424	Leaf	%	24	0	0	23	53
			mg/g	0.3	0	0	0.3	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
Citrus aurantifolia (cont.)								
Indian	2450	Leaf	%	0	0	0	12	88
			mg/g	0	0	0	0.4	—
		Flavedo	%	15	0	0	8	77
			mg/g	0.1	0	0	0.1	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Otaheite Red Acidless Rangpur	2709	Leaf	%	0	0	0	3	97
			mg/g	0	0	0	0.1	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Thornless Mexican	2683	Leaf	%	13	0	0	13	74
			mg/g	0.3	0	0	0.3	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
Citrus aurantifolia (cont.)								
West Indian	1813	Leaf	%	32	0	0	28	40
			mg/g	0.6	0	0	0.5	—
		Flavedo	%	11	0	0	0	89
			mg/g	0.1	0	0	0	—
		Albedo	%	10	0	0	19	71
			mg/g	0.1	0	0	0.2	—
		Juice	%	36	0	0	0	64
			mg/g	tr	0	0	0	—
C. aurantium								
Granitos	2715	Leaf	%	0	0	11	0	89
			mg/g	0	0	0.1	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Keen #1–10	2624	Leaf	%	0	0	9	0	91
			mg/g	0	0	0.5	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. excelsa								
Unknown	2316	Leaf	%	49	7	0	27	17
			mg/g	0.5	0.1	0	0.3	—
		Flavedo	%	19	0	0	17	64
			mg/g	0.5	0	0	0.4	—
		Albedo	%	20	4	0	18	58
			mg/g	0.3	0.1	0	0.3	—
		Juice	%	23	0	0	27	50
			mg/g	tr	0	0	tr	—
C. grandis								
African	2346	Leaf	%	0	7	0	0	93
			mg/g	0	0.1	0	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	100	0	0
			mg/g	0	0	tr	0	—
		Juice	%	0	0	100	0	0
			mg/g	0	0	0.1	0	—
Deep Red	2347	Leaf	%	0	0	59	0	41
			mg/g	0	0	0.9	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. grandis (cont.)								
Fleming	578	Leaf	%	0	0	19	0	81
			mg/g	0	0	0.9	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Kao Panne	2355	Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Kao Panne	2356	Leaf	%	0	0	56	0	44
			mg/g	0	0	0.6	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Moanalua	448	Leaf	%	0	0	32	0	68
			mg/g	0	0	0.3	0	—
		Juice	%	0	0	45	0	55
			mg/g	0	0	tr	0	—
Philippine hybrid	2343	Leaf	%	0	13	0	0	87
			mg/g	0	0.1	0	0	—
		Juice	%	0	0	28	0	72
			mg/g	0	0	tr	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. grandis (cont.)								
Red Aranyan hybrid	2605	Leaf	%	0	0	0	34	66
			mg/g	0	0	0	0.4	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Red Fleshed	2338	Leaf	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Siamese Seedless	640	Leaf	%	0	0	41	0	59
			mg/g	0	0	1.4	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Tahitian	3806	Leaf	%	0	0	33	0	57
			mg/g	0	0	0.5	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Yuma Ponderosa Lemon	3488	Leaf	%	21	0	8	0	71
			mg/g	0.7	0	0.3	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. grandis* × *C. limon								
Unknown	1481	Leaf	%	0	0	10	0	90
			mg/g	0	0	0.2	0	—
		Flavedo	%	0	0	33	0	67
			mg/g	0	0	0.3	0	—
		Albedo	%	0	0	75	0	25
			mg/g	0	0	0.2	0	—
		Juice	%	0	0	44	0	56
			mg/g	0	0	tr	0	—
Unknown	1775	Leaf	%	0	0	28	0	72
			mg/g	0	0	1.3	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
C. grandis* × *C. reticulata								
Frua Mandarin × pummelo	3555	Leaf	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
C. grandis* × *C. sinensis								
Shaddock × St. Michael	42–1	Leaf	%	0	0	29	0	71
			mg/g	0	0	0.1	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
***C. grandis* × *C. sinensis* (cont.)**								
Tahitian × Star Ruby	3781	Leaf	%	0	0	25	0	75
			mg/g	0	0	0.3	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
C. hystrix								
Davao Lemon	2427	Leaf	%	65	0	0	0	35
			mg/g	0.8	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Kulubot	3612	Leaf	%	17	0	0	18	65
			mg/g	0.1	0	0	0.1	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Limon Real	2317	Leaf	%	25	0	0	15	60
			mg/g	0.6	0	0	0.4	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Philippines	2892	Leaf	%	33	0	0	16	51
			mg/g	0.4	0	0	0.2	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Unknown—Morocco	3174	Leaf	%	50	0	0	0	50
			mg/g	0.5	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. jambhiri								
Khoubs-el-Arsa	2489	Leaf	%	0	2	0	4	94
			mg/g	0	0.2	0	0.2	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Limoneira	3834	Leaf	%	0	3	0	10	87
			mg/g	0	0.2	0	0.5	—
		Flavedo	%	6	0	0	5	89
			mg/g	0.1	0	0	0.1	—
		Albedo	%	0	0	0	4	96
			mg/g	0	0	0	tr	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Milam	3396	Leaf	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Stowe Red	3185	Leaf	%	10	4	0	0	86
			mg/g	0.3	0.1	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. jambhiri (cont.)								
Unknown	3060	Leaf	%	7	4	0	16	73
			mg/g	0.1	0.1	0	0.5	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	6	94
			mg/g	0	0	0	tr	—
		Juice	%	0	0	0	29	71
			mg/g	0	0	0	tr	—
C. limon								
Bergamot	2881	Leaf	%	0	0	9	16	75
			mg/g	0	0	0.4	0.6	—
		Flavedo	%	0	0	0	16	84
			mg/g	0	0	0	0.8	—
		Albedo	%	0	0	11	0	89
			mg/g	0	0	0.2	0	—
		Juice	%	0	0	23	0	77
			mg/g	0	0	0.1	0	—
Corona Foothill Eureka	3043	Leaf	%	0	0	0	7	93
			mg/g	0	0	0	0.2	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. limon (cont.)								
Kaweah #1 Lisbon	3010	Leaf	%	0	22	0	13	65
			mg/g	0	0.7	0	0.4	—
		Flavedo	%	0	0	11	13	76
			mg/g	0	0	0.2	0.2	—
		Albedo	%	0	0	14	16	70
			mg/g	0	0	0.1	0.1	—
		Juice	%	0	0	0	37	63
			mg/g	0	0	0	tr	—
Kulu	3045	Leaf	%	21	0	0	0	79
			mg/g	0.5	0	0	0	—
		Flavedo	%	4	0	0	0	96
			mg/g	tr	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Kulu	3487	Leaf	%	25	0	0	0	75
			mg/g	0.2	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. limon (cont.)								
Nicaraguan	3841	Leaf	%	82	0	0	0	18
			mg/g	1.3	0	0	0	—
		Flavedo	%	37	0	0	0	63
			mg/g	0.5	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Santa Teresa #1	3894	Leaf	%	20	0	0	0	80
			mg/g	0.9	0	0	0	—
		Flavedo	%	0	0	0	12	88
			mg/g	0	0	0	0.7	—
		Albedo	%	0	0	0	16	84
			mg/g	0	0	0	0.5	—
		Juice	%	12	0	0	13	75
			mg/g	0.2	0	0	0.2	—
Seedless Lisbon	3001	Leaf	%	11	3	0	14	72
			mg/g	0.5	0.1	0	0.6	—
		Flavedo	%	13	0	0	11	76
			mg/g	0.1	0	0	0.1	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. limon (cont.)								
Unknown—Borneo	3765	Leaf	%	20	3	0	11	66
			mg/g	0.7	0.1	0	0.4	—
		Juice	%	73	0	0	0	27
			mg/g	tr	0	0	0	—
Unknown—Morocco	3155–A	Leaf	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
C. longispina								
Unknown	2320	Leaf	%	0	0	17	49	34
			mg/g	0	0	0.3	0.9	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
C. macrophylla								
Unknown	3842	Leaf	%	86	0	0	0	14
			mg/g	0.6	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
C. medica								
Bush	—	Flavedo	%	0	0	0	40	60
			mg/g	0	0	0	0.3	—
		Albedo	%	0	0	0	66	34
			mg/g	0	0	0	0.1	—
		Juice	%	0	0	0	58	42
			mg/g	0	0	0	tr	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. medica (cont.)								
Citron of Commerce	3518	Leaf	%	100	0	0	0	0
			mg/g	0.1	0	0	0	—
		Flavedo	%	0	0	0	99	1
			mg/g	0	0	0	tr	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Medulla	%	0	0	0	49	51
			mg/g	0	0	0	tr	—
		Septa	%	0	0	0	0	100
		membrane	mg/g	0	0	0	0	—
Dulcia	3654	Leaf	%	53	0	0	0	47
			mg/g	0.4	0	0	0	—
		Flavedo	%	27	0	0	35	38
			mg/g	tr	0	0	tr	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Fingered	3768	Leaf	%	30	0	0	8	62
			mg/g	1.1	0	0	0.3	—
		Flavedo	%	0	0	0	42	58
			mg/g	0	0	0	tr	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. medica (cont.)								
India Sour	661	Leaf	%	0	0	0	38	62
			mg/g	0	0	0	0.1	—
		Flavedo	%	0	0	0	44	56
			mg/g	0	0	0	0.1	—
		Albedo	%	0	0	0	57	43
			mg/g	0	0	0	0.2	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Mexican	3531	Leaf	%	56	0	0	4	40
			mg/g	0.6	0	0	tr	—
		Flavedo	%	38	0	0	0	62
			mg/g	0.1	0	0	0	—
		Albedo	%	100	0	0	0	0
			mg/g	tr	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
South Coast Field Station	3546	Leaf	%	27	0	0	0	72
			mg/g	0.3	0	0	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	40	60
			mg/g	0	0	0	tr	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. medica (cont.)								
Spadifora	3535	Leaf	%	40	0	0	0	60
			mg/g	0.6	0	0	0	—
		Flavedo	%	31	0	0	0	69
			mg/g	0.1	0	0	0	—
		Albedo	%	33	0	0	34	33
			mg/g	tr	0	0	tr	—
		Juice	%	18	0	0	34	48
			mg/g	tr	0	0	tr	—
Yunanensis	3798	Leaf	%	40	0	0	4	56
			mg/g	0.6	0	0	0.1	—
		Flavedo	%	0	0	0	31	69
			mg/g	0	0	0	tr	—
		Albedo	%	0	0	0	99	1
			mg/g	0	0	0	tr	—
		Juice	%	25	0	0	30	45
			mg/g	tr	0	0	tr	—
C. microcarpa								
Calasnu	2867	Leaf	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Flavedo	%	0	0	0	6	94
			mg/g	0	0	0	0.1	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	14	86
			mg/g	0	0	0	tr	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. microcarpa (cont.)								
Samuyao	3605	Leaf	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
C. natsudaidai								
Unknown	3235	Leaf	%	0	0	9	0	91
			mg/g	0	0	0.5	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	99	0	1
			mg/g	0	0	0.1	0	—
		Juice	%	0	0	31	0	69
			mg/g	0	0	tr	0	—
C. paradisi								
Camulos	3139	Leaf	%	3	14	0	51	32
			mg/g	0.1	0.6	0	2.1	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	92	0	8
			mg/g	0	0	tr	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. paradisi (cont.)								
CRC #343	343	Leaf	%	12	0	0	0	88
			mg/g	0.5	0	0	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Duncan	3832	Leaf	%	0	0	100	0	0
			mg/g	0	0	0.2	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Hall	3068	Leaf	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. paradisi (cont.)								
Jochimsen	2784	Leaf	%	0	18	64	0	18
			mg/g	0	-	-	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Reed Seedling Marsh	3128	Leaf	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Star Ruby	3770	Leaf	%	0	22	51	0	27
			mg/g	0	0.4	1.0	0	—
		Flavedo	%	0	0	44	0	56
			mg/g	0	0	0.1	0	—
		Albedo	%	0	0	100	0	0
			mg/g	0	0	0.1	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Whitney Old Line Marsh	3804	Leaf	%	0	13	48	0	39
			mg/g	0	0.3	1.3	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. paradisi (cont.)								
Yellow Rind Mandarin	3895	Leaf	%	0	0	0	9	91
			mg/g	0	0	0	0.2	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
C. reticulata								
Robinson	3850	Leaf	%	6	5	0	19	70
			mg/g	0.3	0.2	0	0.8	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Scarlet Emperor	3326	Leaf	%	0	0	0	20	80
			mg/g	0	0	0	0.1	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Solid Scarlet	3328	Leaf	%	0	0	0	9	91
			mg/g	0	0	0	0.2	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. reticulata (cont.)								
Sunburst	3809	Leaf	%	0	0	0	37	63
			mg/g	0	0	0	0.4	—
		Flavedo	%	8	0	0	0	92
			mg/g	0.1	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
C. reticulata* × *C. paradisi								
Sacaton	3331	Leaf	%	0	0	0	11	89
			mg/g	0	0	0	0.1	—
		Flavedo	%	3	0	0	0	97
			mg/g	tr	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. reticulata* × *C. sinensis								
Sue Linda Temple	3810	Leaf	%	8	0	0	11	81
			mg/g	0.1	0	0	0.1	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
C. reticulata* × *Poncirus trifoliata								
Unknown	2619	Leaf	%	0	0	0	25	75
			mg/g	0	0	0	0.4	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	98	2
			mg/g	0	0	0	0.1	—
C. rugulosa								
Unknown	3556	Leaf	%	0	0	23	0	77
			mg/g	0	0	0.1	0	—
		Flavedo	%	0	0	54	0	46
			mg/g	0	0	0.1	0	—
		Albedo	%	0	0	21	0	79
			mg/g	0	0	0.1	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. shunokan								
Unknown	3476	Leaf	%	9	11	0	9	71
			mg/g	0.1	0.2	0	0.1	—
		Juice	%	0	27	0	0	73
			mg/g	0	tr	0	0	—
C. sinensis								
Blood orange cultivars								
Cipo	3896	Leaf	%	0	0	0	20	80
			mg/g	0	0	0	0.1	—
Rotuma Island	3867	Leaf	%	3	8	0	14	75
			mg/g	0.1	0.3	0	0.5	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Vainiglia Pink Fleshed	3801	Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Navel cultivars								
Bey	3406	Leaf	%	2	12	0	7	79
			mg/g	0.2	0.3	0	0.2	—
		Flavedo	%	0	0	0	5	95
			mg/g	0	0	0	tr	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. sinensis (cont.)								
Navel cultivars (cont.)								
CPB #44944A Seedling	3305	Leaf	%	2	9	0	5	84
			mg/g	0.2	0.7	0	0.4	—
		Flavedo	%	5	0	0	5	90
			mg/g	tr	0	0	tr	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
CPB #44944B Seedling	3306–A	Leaf	%	0	8	0	8	84
			mg/g	0	0.4	0	0.4	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Fisher	3645	Leaf	%	3	8	0	10	79
			mg/g	0.2	0.5	0	0.6	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. sinensis (cont.)								
Navel cultivars (cont.)								
Golden Buckeye	588	Leaf	%	0	18	0	11	70
			mg/g	0	tr	0	tr	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
McFadden Ribbed	609	Leaf	%	0	0	0	7	93
			mg/g	0	0	0	0.1	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Paradise	2853	Leaf	%	2	8	0	5	85
			mg/g	0.1	0.4	0	0.1	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	36	64
			mg/g	0	0	0	0.1	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. sinensis (cont.)								
Navel cultivars (cont.)								
Parent Washington	1241–B	Leaf	%	0	0	0	12	88
			mg/g	0	0	0	0.2	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Ruvel	3181	Leaf	%	0	9	0	5	86
			mg/g	0	0.2	0	0.1	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Smith's Early	574	Leaf	%	0	0	0	21	79
			mg/g	0	0	0	0.7	—
		Flavedo	%	0	0	0	7	93
			mg/g	0	0	0	tr	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Thomson	983	Leaf	%	0	16	0	14	70
			mg/g	0	0.2	0	tr	—
		Flavedo	%	5	16	0	5	74
			mg/g	tr	0.1	0	tr	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. sinensis (cont.)								
Sweet orange cultivars								
Catlin	3860	Leaf	%	0	13	0	19	68
			mg/g	0	0.1	0	0.1	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Espagnole sans Pepins	3249	Leaf	%	0	18	0	0	82
			mg/g	0	0.2	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Finike	3870	Leaf	%	0	25	0	15	60
			mg/g	0	0.3	0	0.1	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Homosassa	1696	Leaf	%	0	13	0	11	76
			mg/g	0	0.2	0	0.1	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. sinensis (cont.)								
Valencia cultivars								
Cutter	3030	Leaf	%	0	16	0	23	61
			mg/g	0	0.1	0	0.2	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Hart's Late	314	Leaf	%	6	0	0	7	87
			mg/g	0.2	0	0	0.3	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Seedless	2776	Leaf	%	0	16	0	25	59
			mg/g	0	0.1	0	0.2	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
***C. sinensis* × (*C. sinensis* × *Poncirus trifoliata*)**								
Unknown	1447	Leaf	%	0	19	0	0	81
			mg/g	0	0.4	0	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	45	0	55
			mg/g	0	0	tr	0	—
C. sulcata								
Unknown	3257	Leaf	%	0	0	0	25	75
			mg/g	0	0	0	0.6	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
C. tamurana								
Unknown	3092	Leaf	%	0	0	0	45	55
			mg/g	0	0	0	0.2	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
C. tengu								
Unknown	3461	Leaf	%	0	64	0	0	36
			mg/g	0	0.4	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
C. ujukitsu								
Unknown	3467	Leaf	%	8	6	0	6	80
			mg/g	0.3	0.3	0	0.2	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
C. webberi								
Montana	767	Leaf	%	24	0	0	37	39
			mg/g	0.4	0	0	0.6	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Unknown	1455	Leaf	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Eremocitrus glauca								
Unknown hybrid	2439	Leaf	%	0	0	0	13	87
			mg/g	0	0	0	0.7	—
		Flavedo	%	15	0	0	5	80
			mg/g	0.7	0	0	0.3	—
		Albedo	%	10	0	0	0	90
			mg/g	0.1	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
Fortunella japonica								
Unknown	—	Leaf	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Unknown	—	Leaf	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Peel	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Unknown	—	Leaf	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	45	55
			mg/g	0	0	0	0.1	—
		Juice	%	0	0	0	35	65
			mg/g	0	0	0	tr	—
***Fortunella* sp. × *Citrus reticulata* × (*C. sinensis* × *Poncirus trifoliata*)**								
Unknown	3573	Leaf	%	0	0	0	12	88
			mg/g	0	0	0	0.1	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Continued

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
Microcitrus australasica								
Sanguinea	1484	Flavedo	%	35	0	0	0	65
			mg/g	0.8	0	0	0	—
		Juice	%	99	0	0	0	1
			mg/g	tr	0	0	0	—
M. inodora								
Unknown	3785–A	Leaf	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
M. warburgiana								
Unknown	3782–D	Leaf	%	0	43	0	0	57
			mg/g	0	1.8	0	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 4. Flavone composition in genus *Citrus* and its near relatives (cont.)

[Abbreviations: RTN, rutin; IRF, isorhoifolin; RFN, rhoifolin; DSM, diosmin; tr, trace. Concentrations are averages of two to four runs ±0.05 mg/g fresh weight]

Species and cultivar	CRC #	Plant part		Flavones				
				RTN	IRF	RFN	DSM	Other
Poncirus trifoliata* × *C. paradisi								
Swingle	3767	Leaf	%	0	0	40	0	60
			mg/g	0	0	2.2	0	—
		Flavedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Albedo	%	0	0	0	0	100
			mg/g	0	0	0	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—
Unknown	1452	Leaf	%	23	14	63	0	0
			mg/g	0.1	0.1	0.3	0	—
		Juice	%	0	0	0	0	100
			mg/g	0	0	0	0	—

Table 5. Comparison of similar (shared) and dissimilar (unique) peaks observed at 285 nm (to those observed at 325 nm) in various *Citrus* species and cultivars

Species and cultivar	CRC#	Plant part	Peaks at 285 nm					Absorbance difference 285/325
			Shared peaks	Unique peaks	% Area major	Unique total	% Area shared	
Citrus grandis								
Deep Red	2347	Leaf	12	2	9.0	14.6	82.9	1.0
C. limon								
Kaweah #1 Lisbon	3010	Leaf	13	1	6.6	6.6	88.0	0.7
C. medica								
Citron of Commerce	3518	Leaf	5	0	0.0	0.0	83.1	0.6
Fingered	3768	Leaf	12	3	2.6	6.8	84.6	0.6
		Flavedo	1	1	16.1	16.1	83.9	0.3
India Sour	661	Leaf	10	1	13.6	13.6	77.2	0.8
C. natsudaidai								
Unknown	3235	Flavedo	13	4	2.1	6.3	93.0	0.6
		Albedo	19	7	5.4	16.0	82.4	1.5
C. paradisi								
Camulos	3139	Leaf	14	6	8.7	20.2	78.3	1.1
		Flavedo	21	4	2.9	7.7	91.7	0.9
		Albedo	8	7	1.3	4.5	94.9	3.9
		Juice	4	6	6.9	17.8	82.2	3.4
CRC #343	343	Leaf	15	7	20.2	33.7	64.5	0.9
C. sinensis								
Bey	3406	Flavedo	24	3	1.2	3.2	92.7	0.9
		Albedo	18	3	3.1	7.6	89.9	1.2
CPB #44944A Seedling	3305	Leaf	6	3	35.5	42.4	57.0	3.4
		Flavedo	29	3	23.7	27.4	71.2	1.3
		Albedo	29	5	12.2	15.4	81.7	1.0
		Juice	2	2	78.0	79.5	19.0	3.5
CPB #44944B Seedling	3306	Leaf	23	7	17.7	25.0	71.9	1.1
		Flavedo	14	6	35.9	43.3	56.1	1.5
		Albedo	4	3	41.7	41.1	50.2	2.7

Table 5. Comparison of similar (shared) and dissimilar (unique) peaks observed at 285 nm (to those observed at 325 nm) in various *Citrus* species and cultivars (cont.)

Species and cultivar	CRC#	Plant part	Peaks at 285 nm					Absorbance difference 285/325
			Shared peaks	Unique peaks	% Area major	Unique total	% Area shared	
C. sinensis (cont.)								
Paradise	2853	Leaf	24	6	11.1	15.5	80.9	1.1
		Flavedo	15	1	41.9	42.0	56.1	1.5
		Albedo	2	5	67.7	67.7	32.3	1.7
		Juice	1	2	83.9	86.2	13.8	5.1
Thomson	983	Leaf	16	4	2.2	6.5	93.4	0.8
		Flavedo	15	6	4.3	18.2	77.1	1.0
		Albedo	5	1	7.7	7.7	88.9	0.9
		Albedo	4	2	6.0	9.6	75.6	1.0
		Juice	3	1	5.9	5.9	89.7	2.4
Average			**12**	**3.6**	**20.3**	**24.5**	**72.1**	**1.6**

Table 6. Comparison of similar (shared) and dissimilar (unique) peaks observed at 325 nm (to those observed at 285 nm) in various *Citrus* species and cultivars

Species and cultivar	CRC#	Plant part	Peaks at 325 nm					Absorbance difference 285/325
			Shared peaks	Unique peaks	% Area major	Unique total	% Area shared	
Citrus grandis								
Deep Red	2347	Leaf	12	5	6.2	12.4	87.6	1.0
C. limon								
Kaweah #1 Lisbon	3010	Leaf	13	6	2.7	12.7	87.3	0.7
C. medica								
Citron of Commerce	3518	Leaf	5	4	8.1	24.2	75.8	-0.6
Fingered	3768	Leaf	12	5	3.7	9.6	89.6	0.6
		Flavedo	1	3	6.8	15.4	84.6	0.3
India Sour	661	Leaf	10	5	5.9	23.8	76.2	0.8
C. natsudaidai								
Unknown	3235	Flavedo	13	5	3.9	10.7	89.3	0.6
		Albedo	19	8	2.1	9.4	90.6	1.5
C. paradisi								
Camulos	3139	Leaf	14	12	6.1	20.7	79.3	1.1
		Flavedo	21	6	4.1	12.4	87.6	0.9
		Albedo	8	4	1.4	5.1	94.9	3.9
		Juice	4	4	21.3	33.8	66.2	3.4
CRC #343	343	Leaf	15	7	8.6	19.1	80.6	0.9
C. sinensis								
Bey	3406	Flavedo	24	4	2.5	6.2	93.8	0.9
		Albedo	18	4	3.1	8.7	91.3	1.2
CPB #44944A Seedling	3305	Leaf	6	2	6.0	11.5	88.5	3.4
		Flavedo	29	5	3.1	8.4	91.1	1.3
		Albedo	29	6	2.3	4.7	95.3	1.0
		Juice	2	0	0.0	0.0	100.0	3.5
CPB #44944B Seedling	3306	Leaf	23	6	2.6	7.7	91.8	1.1
		Flavedo	14	6	3.4	11.8	88.3	1.5
		Albedo	4	0	0.0	0.0	100.0	2.7

Table 6. Comparison of similar (shared) and dissimilar (unique) peaks observed at 325 nm (to those observed at 285 nm) in various *Citrus* species and cultivars (cont.)

Species and cultivar	CRC#	Plant part	Peaks at 325 nm					Absorbance difference 285/325
			Shared peaks	Unique peaks	% Area major	Unique total	% Area shared	
C. sinensis (cont.)								
Paradise	2853	Leaf	24	5	2.1	5.2	94.2	1.1
		Flavedo	15	10	3.1	17.2	82.8	1.5
		Albedo	2	1	13.9	13.9	86.1	1.7
		Juice	1	0	0.0	0.0	100.0	5.1
Thomson	983	Leaf	16	10	6.2	20.9	78.6	0.8
		Flavedo	15	9	4.0	17.0	82.1	1.0
		Albedo	5	4	10.0	29.7	70.3	0.9
		Albedo	4	5	10.1	36.8	63.2	1.0
		Juice	3	2	12.0	21.2	78.8	2.4
Average			**12**	**4.8**	**5.2**	**13.4**	**86.4**	**1.6**

Table 7. Flavonoid contents of the juice from diploid and tetraploid grapefruit cultivars

[Abbreviations: NRT, narirutin; NRG, naringin; NHP, neohesperidin]

Cultivar	Ploidy	Brix (%)	Acid (mg/mL)	Acid/Brix	Flavonoids NRT	NRG (mg/mL)	NHP
Naringin-dominant types							
Seedy Marsh	2N	12.5	18.4	6.8	0.07	0.11	—
Seedy Marsh	4N	11.8	21.6	5.4	0.08	0.15	—
Hall	2N	11.1	17.0	6.5	0.10	0.24	—
Hall	4N	11.6	20.5	5.6	0.16	0.43	—
Neohesperdin-dominant types							
Imperial	2N	12.9	16.0	8.0	0.10	0.13	0.03
Imperial	4N	12.6	26.1	4.8	0.19	0.35	0.07
Royal	2N	13.1	17.3	7.6	0.05	0.08	0.03
Royal	4N	12.8	19.4	6.6	0.07	0.15	0.05

Table 8. Flavonoids in leaves from several grapefruit cultivars

[Abbreviations: NRT, narirutin; NRG, naringin; NHP, neohesperidin]

Cultivar	Ploidy	Flavonoids NRT (mg/g)	NRG (mg/g)	NHP (mg/g)
Narinigin-dominant types				
Seedy Marsh	2N	0.68	2.38	3.14
Seedy Marsh	4N	0.73	3.45	2.71
Hall	2N	0.67	2.09	2.93
Hall	4N	0.60	3.96	3.15
Neohesperin-dominant types				
Imperial	2N	0.71	0.95	1.66
Imperial	4N	0.59	1.36	6.51
Royal	2N	0.91	1.12	2.43
Royal	4N	0.79	1.10	3.33

Appendix 1
Rutaceae Members' Geographic and Genetic Origin

This appendix is a summary of the relevant literature on this subject. Numbers in parentheses indicate the publication(s) that provided the information. Species and varietal names are as given in the original publication.

1. Swingle and Reece 1967
2. Singh and Nath 1969
3. Hodgson 1967
4. Scora 1988
5. Barrett and Rhodes 1976
6. Stone et al. 1973
7. Scora et al. 1976
8. Ray and Walheim 1980

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Citrus			
amblycarpa Ochse	Djerook leemo	Java (3)	Mandarinlike (3)
asahikan Hort. ex Tan.	Asahikan	Japan (3)	Pummelolike fruit (3)
aurantifolia (Christm.) Swing.	Lime	East India archipelago (1)	Citron × *Microcitrus* (4)
aurantifolia	Lime		Citron × Pummelo × *Microcitrus* (5)
aurantifolia	Lime		Papeda × citron-lemon complex (7)
aurantifolia	Lime		Citron × Papeda (7)
Bearss	Persian	California (3)	Chance seedling from a Tahitian lime (3)
Indian	Palestine	India (3)	Unknown origin (3)
Mexican	Bartenders lime	(8)	Unknown origin? (8)
Otaheite Orange			Acidless dwarf form of 'Rangpur' (8)
Rangpur	Acid type	(8)	Unknown origin? (8)
West Indian	Mexican/Key lime	India and Egypt (3)	Unknown origin? (3)
aurantifolia × *C. limon*	Lemonime	(1)	Lemon × lime (4)
aurantifolia × *Fortunella japonica* or *F. margarita*	Limequat	Florida (1)	Lime × round kumquat (4)
aurantium L.	Sour orange	China (3, 4)	Pummelo × mandarin (3, 4)

Continued

Appendix 1
Rutaceae Members' Geographic and Genetic Origin (cont.)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Citrus (cont.)			
aurantium	Sour orange	Southeast Asia (1)	
aurantium	Sour orange	Assam (7)	Pummelo × mandarin (5, 7)
Bouquet		(8)	Unknown origin, dwarf variety (8)
Chinotto		Italy (8)	Unknown? (8)
Myrtifolia	Myrtle-leaf orange	China (1)	One of the oldest cultivars known (1)
Seville		Spain (8)	Unknown origin, ornamental? (8)
aurantium × *Poncirus trifoliata*	Citradia	(1)	Sour orange × trifoliate orange (1)
bergamia Risso and Poit.	Bergamot		Lime × citron (4)
bergamia	Bergamot sour orange		Sour orange × citron (7)
bigaradia	Sour orange	(1)	Actually *C. aurantium* (1)
canaliculata Hort. ex Y. Tan.	Sour orange type	(3)	Sour orange type? (3)
depressa Hayata	Â	Okinawa and Formosa (3)	Mandarinlike (3)
excelsa West.	Papeda	(3)	Papeda, wild citrus type (3)
glaberrima Hort. ex Tan.	Kinukawa	(3)	Pummelolike fruit, unknown? (3)
grandis (L.) Osb.	Pummelo	Southeast India, East India archipelago (1)	Primary citrus species (4)
Amilbed	Pummelo	Lower Himalayas (2)	*C. megaloxycarpa?* (2)
Bhogatey	Pummelo	Lower Himalayas (2)	*C. megaloxycarpa?* (2)
Chandler	Pummelo	California (8)	'Siamese Pink' × 'Chandler'? (3)
Managua	(See Tahitian)		
Reinking	Pummelo	(8)	Unknown origin? (8)
Siamese Pink	Siam pummelo	Thailand (3)	Unknown origin (3)
Tahitian	Pummelo	Tahitian origin (3)	Chance seedling (3)
grandis × *C. limon*	Lemelo	(3)	Pummelo × lime (3)
grandis × *C. reticulata*	Grapefruit hybrid	(3)	Pummelo × mandarin (3)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Citrus (cont.)			
grandis × *C. sinensis*	Grapefruit hybrid	(3)	Pummelo × sweet orange (3)
halimii Stone		Thailand and Malaysia (4)	Primary citrus species (4, 6)
halimii			Resembles mountain lemon or citron (7)
hassaku Hort. ex Tan.	Hassaku mikan or zabon	(3)	Pummelo × sweet orange hybrid? (3)
hystrix DC.	Mauritius papeda	East India archipelago, Ceylon, Philippines (1)	Papeda, wild citrus type (1)
ichangensis Swing.	Ichang papeda	China (1)	Papeda, wild citrus type (1)
ichangensis × *C. grandis*	Ichang lemon or shangyuan	China (1)	Ichang × pummelo (1)
ichangensis × *C. reticulata* 'Satsuma'	Ichandarin	(1)	Ichang × mandarin (1)
indica Tan.	Indian wild orange	East Himalayan region (1)	Somewhat mandarinlike, origin unknown? (1)
indica	Indian wild orange		Somewhat mandarinlike, origin unknown? (6)
indica	Indian wild orange	Assam (7)	Primitive mandarin (7)
jambhiri Lush.	Rough lemon	Northeast India (2, 3)	Mandarin × (citron × lemon) (2, 3, 4, 7)
Chrysocarpa	Soh-jhalia	Assam, India (2)	*Citrus jambhiri* Lush 'Chrysocarpa' (2)
Italian 76		India (2)	*Citrus jambhiri* 'Laevis' (2)
Kata Jamir		India (2)	*Citrus jambhiri* 'Laevis' (2)
junos Sieb. ex Tan.			Papeda × mandarin (4)
junos	Yuzu	Japan	*Citrus nobilis?* (2)
junos	Jeneru	Northeast India	*Citrus nobilis?* (2)
karna Raf.	Karna, karna katta	India (3)	Lemon fruit of unknown origin (3)
kinokuni Hort. ex Tan.	Kishu mikan, hirakishu, mukakukishu	China, Japan (3)	Mandarinlike (3)
latifolia Tan.	Lime-type	(3)	Large fruit acid lime, origin unknown (3)

Continued

Appendix 1
Rutaceae Members' Geographic and Genetic Origin (cont.)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Citrus (cont.)			
latifolia	Meyer lemon	India (2)	India or Palestine sweet lime (2)
latifolia	Tahiti or persian	India (2)	India or Palestine sweet lime (2)
latifolia	Soh-synteng	Assam (2)	India or Palestine sweet lime (2)
latipes Tan.	Khasi papeda	Northeast India (1)	Papeda, wild citrus type (1)
latipes	Khasi papeda		Hybrid papeda (7)
limetta Risso	Limetta	Mediterranean (3)	Unknown? (3)
limettoides Tan.	Sweet lime	(3)	Mandarin × lime? (3)
limon (L.) Burm. f.	Lemon	Southeast Asia (1)	Mandarin × (lemon × citron) (4)
limon	Lemon		Citron × lime × unidentified? (5)
limon	Lemon		Citron × lime (7)
limon	Gulgul or hill lemon	India (2)	True lemon, *C. limon* 'Decumana' (2)
limon	Lemon		Citron/lime × rough lemon or pummelo (4)
Bergamot	(See *Citrus bergamia*)		
Corona Foothill Eureka	(See 'Villafranca')	California (3)	Selection of 'Villafranca' (3)
Eureka	Lemon	California (8)	Selection of 'Villafranca' (3)
Improved Meyer		China (8)	Unknown origin? (8)
Kaweah #1 Lisbon	(See Lisbon)		
Lisbon	Lemon	Portugal (8)	Unknown origin? (8)
Ponderosa	Lemon	Italy (8)	Natural hybrid, lemon × citron? (8)
Villafranca		Sicily (3)	Unknown origin? (3)
limon × *C. aurantifolia*	Lemonimes, perrine lemon	United States	'Genoa' lemon × 'Mexican' lime (2)
limon × *C. reticulata*	Lemandarins, otaheite orange, or red lemon	United States	Lemon × mandarin? (2)
limon × *C. reticulata*	Lemandarins, pak ning-mong, or white lemon	United States	Lemon × mandarin? (2)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Citrus (cont.)			
limon × *C. sinensis*	Lemonange, Meyer lemon	United States (1)	Lemon × sweet orange (2)
limonia Osbeck	Rangpur lime		Mandarin × sour orange (4)
limonia	Rangpur lime		Mandarin × rough lemon (6)
limonum	Citron lemon	India (2)	Lemonlike citron bushes (2)
limonum	Citròn lemon	India (2)	*Citrus medica* var. *limonum* (Lush.). (2)
longispina West.	Megacarpa papeda	(1)	Papeda, wild citrus type (1)
lycopersicaeformis Hort. ex Tan.	Kokni, kodakithuli	Southern India (3)	Mandarinlike (3)
macrophylla West.	Alemow	Cebu? (1)	*Citrus celebica* × papeda × pummelo (4)
macrophylla		Cebu, Philippines (3)	Lemon or lime × pummelo (3)
macroptera Montr.	Annam papeda	Southeast India (1)	Papeda, wild citrus type (1)
maderaspatana Hort. ex Tan.	Kichili	South India (2)	Resembles sour orange (2)
madurensis Lour.	Calamondin	(4)	Kumquat × mandarin (2)
Depressa	Calamondin or hazara	India (2)	(2)
maxima (Burm.) Merril	(See *Citrus grandis*)		
medica L.	Citron	(1)	Primary citrus species (4)
Citron of Commerce	(See Corsican)		
Corsican		Corsica (3)	Indistinguishable from 'Citron of Commerce' (3)
Etrog	Atrog/ethrog	Middle East (3)	Unknown origin? (8)
Fingered Citron	Buddha's hand	(8)	Unknown origin? (8)
Kagzi Kalan		India (2)	Sour lime × citron (2)
Nepali Kagzi		India (2)	Sour lime × citron (2)
Sacrodactylis	Fingered citron	(2)	*Citrus medica* var. sacrodactylis Swing. (2)

Continued

Appendix 1
Rutaceae Members' Geographic and Genetic Origin (cont.)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Citrus (cont.)			
megaloxycarpa Lush.			
Bhogatey	Bhogatey	Lower Himalayas (2)	*Citrus grandis* var. megaloxycarpa (2)
Holong-Tenga	Holong-tenga	India (2)	*Citrus grandis* 'Rugosa' (2)
Keem	Keem	India (2)	*Citrus grandis* 'Keem' (2)
Lemon Thumb	Lemon thumb	India (2)	*Citrus grandis* 'Rugosa' (2)
Mehalung	Mahalung	India (2)	*Citrus grandis* 'Rugosa' (2)
meyerii Y. Tan.	Meyer lemon	China (3)	Unknown origin? (3)
micrantha West.	Small-flowered papeda	Philippines (1)	Papeda, wild citrus type (1)
microcarpa Bunge	Calamondin	(1)	Mandarin × kumquat (1)
nana Tan.	Citron	(7)	Primitive citron (7)
natsudaidai	Natsudaidai orange (orangelo)	Japan (3)	(3)
nobilis	Mandarin or king orange	Indochina (3)	Tangor?, mandarin × sweet orange? (1, 3)
King Orange	Kunenbo mandarin	India (2)	Natural tangor (2)
obovoidea Hort.	Kinkoji	(3)	Pummelo × mandarin hybrid (3)
oleocarpa Hort. ex Tan.	Timkat, yuhikitsu	China, Japan (3)	Mandarinlike
paradisi Macf.	Grapefruit	West Indies (1)	Pummelo × sweet orange (4, 5)
Marsh Seedless	Marsh	Florida (8)	Unknown origin? (8)
Redblush		Florida (8)	Unknown origin? (8)
paradisi × *C. reticulata*	Tangelo		Grapefruit × mandarin (3)
K Early/Sunrise	Tangelo—K early/Sunrise	Florida (3)	Grapefruit × mandarin (3)
Minneola	Tangelo—Minneola	Florida (3)	'Duncan' grapefruit × 'Dancy' mandarin (3)
Pearl	Tangelo—Pearl	Florida (3)	Grapefruit × mandarin (3)
Pina	Tangelo—Pina	Florida (3)	'Duncan' grapefruit × 'Dancy' mandarin (3)
Orlando	Tangelo	California (3)	'Duncan' grapefruit × 'Dancy' mandarin (3)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Citrus (cont.)			
paradisi × *C. reticulata (cont.)*			
Sampson	Tangelo	California (3)	'Duncan' grapefruit × 'Dancy' mandarin (3)
Seminole	Tangelo	California (3)	'Duncan' grapefruit × 'Dancy' mandarin (3)
Sunshine	Tangelo—Sunshine	Florida (3)	Grapefruit × 'Dancy' mandarin (3)
Wekiwa	Tangelo—Wekiwa	(3)	Grapefruit × 'Sampson' tangelo (3)
pennivesiculata Tan.		India (4)	Resembles satkara of Assam, papeda? (4)
Attara	Attara	India (4)	Resembles satkara of Assam, papeda? (4)
Baduapulli	Baduapulli	India (4)	Resembles satkara of Assam, papeda? (4)
Gunjanimma	Gunjanimma	India (4)	Resembles satkara of Assam, papeda? (4)
pseudolimon Tan.	Galgal or gulgul	India (3)	Lemon cultivar (3)
reshni Hort. ex Tan.	Chota, billi kichili, cleopatra	India (3)	Mandarinlike (3)
reticulata Blanco	Mandarin	Philippines, southeast India (1)	Primary species (1, 4)
reticulata	Mandarin/tangerine	China (7)	Primary species (7)
Austera	Sour mandarin	China (1)	Also identified as *Citrus sunki* (1)
Beauty	Beauty of glen retreat, glen	Australia (3)	'Dancy' seedling (3)
Burgess	Solid scarlet	Australia (3)	Chance 'Ellendale' seedling (3)
Campeona		Argentina (3)	Similar to *Citrus nobilis* (3)
Capurro		Argentina (3)	Chance seedling (3)
Carvalhais	Tangera	Portugal (3)	Mediterranean mandarin hybrid (3)
Clementine	Algeria, clementino de nules, monreal	North Africa (3)	Chance seedling (3)
Cravo	Laranja cravo	Brazil (3)	Unknown origin (3)
Crenatifolia	Kaula mandarin	India (2)	(2)
Dancy	Frost dancy, trimble, weshart	Morocco (8)	Unknown origin (8)

Continued

Appendix 1
Rutaceae Members' Geographic and Genetic Origin (cont.)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Citrus (cont.)			
reticulata (cont.)			
Deliciosa	Mediterranean or willow leaf	(2)	(2)
Ellendale	Ellendale beauty, fagan, grant, hearne	Australia (3)	Natural tangor? (3)
Emperor	Emperor of Canton	Australia (3)	Chance seedling (3)
Empress		South Africa (3)	Chance seedling (3)
Encore		California (3, 8)	'King' × Mediterranean mandarin (3, 8)
Fairchild		California (3, 8)	Tangelo 'Fairchild' × 'Clementine' mandarin (3, 8)
Fewtrell	Fewtrell's early	Australia (3)	Willow leaf or Mediterranean mandarin origin? (3)
Fortune		California (8)	'King' × Mediterranean mandarin (8)
Fortune		California (3)	'Clementine' × 'Dancy' mandarin (3)
Fremont		California (8)	'King' × Mediterranean mandarin (8)
Fremont		California (3)	'Clementine' × 'Ponkan' mandarin (3)
Frua		California (3)	'King' mandarin hybrid (3)
Imperial	Early imperial	Australia (3)	Chance hybrid of Mediterranean or willow leaf mandarin (3)
Hansen		Australia (3)	Tangor? (3)
Heen Naran	Heen naran	Ceylon (2)	Like 'Cleopatra' mandarin (2)
Hickson		Australia (3)	Tangor? (3)
Honey		California (3, 8)	'King' × Mediterranean mandarin (3, 8)
Kapura-Tenga	Kapura-tenga	Assam (2)	Like 'Cleopatra' mandarin (2)
Kara		California (3, 8)	'King' × 'Satsuma' mandarin (3, 8)
Kat	Sour mandarin	China (1)	'Austera' × sweet mandarin or sweet orange? (1)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Citrus (cont.)			
reticulata (cont.)			
Kaula	Keonla	India (3)	Unknown (3)
Kinnow		California (3, 8)	'King' × Mediterranean mandarin (3, 8)
Kodangkithuli	Kodangkithuli	South India (2)	Like 'Cleopatra' mandarin (2)
Kokni	Kokni	North India (2)	Like 'Cleopatra' mandarin (2)
Ladu	Ladoo	India (3)	Unknown origin (3)
Late Emperor		Australia (3)	Limb sport of 'Emperor' (3)
Lee		Florida (3)	'Clementine' mandarin × 'Orlando' tangelo (3)
Malvasio		Argentina (3)	Chance seedling? (3)
Mandalina		Lebanon (3)	Unknown origin (3)
Mediterranean	Willow leaf	Spain, Italy? (8)	Widely grown in Spain and Italy (8)
Murcott	Murcott honey, Smith	California (3)	Chance mutation/tangor origin? (3)
Muscio		Australia (3)	Unknown (3)
Naatje	Natal tightskin, redskin	Asia (3)	Unknown (3)
Nova		Florida (3)	'Clementine' mandarin × 'Orlando' tangelo (3)
Ortanique		Jamaica (3)	Chance seedling (3)
Osceola		Florida (3)	'Clementine' mandarin × 'Orlando' tangelo (3)
Page		Florida (3, 8)	'Minneola' tangelo × 'Clementine' mandarin (3, 8)
Parker	Parker special	Australia (3)	Unknown (3)
Pixie		California (8)	'King' × 'Dancy' mandarins (Kincy) (8)
Ponkan	Cravo tardia, nagpur, oneco, warnurco	China, Formosa (3)	Ancient origin (3)
Robinson		Florida (3)	'Clementine' mandarin × 'Orlando' tangelo (3)

Continued

Appendix 1
Rutaceae Members' Geographic and Genetic Origin (cont.)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Citrus (cont.)			
reticulata (cont.)			
Sanguigno	Sanguine	Italy (3)	Unknown (3)
Satsuma		Japan? (8)	Unknown origin? (8)
Scarlet		Australia (3)	Unknown (3)
Som-Chuk	Somjook, necked orange	Thailand (3)	Natural tangor? (3)
Stemp		Australia (3)	Tangor? (3)
Tankan	Kosho tankan	Formosa (3)	Natural tangor? (3)
Wallent		Australia (3)	Chance seedling (3)
Wilking		California (8)	'King' × 'Dancy' mandarin (8)
Wilking		California (3)	'King' × willow leaf (Mediterranean) mandarin (3)
reticulata × *C. paradisi*	Tangelo	(1)	Mandarin × grapefruit (3)
reticulata × *C. sinensis*	Tangor	(3)	Mandarin × sweet orange (3)
Dweet	Tangor	Florida (3, 8)	Mediterranean sweet orange × 'Dancy' mandarin (3, 8)
Mency	Tangor	(3)	Mediterranean sweet orange × 'Dancy' mandarin (3)
Temple	Tangor	Florida (8)	Florida seedling (8)
Temple	Tangor	Jamaica (3)	Also called *Citrus temple* (3)
Umatilla	Tangor	Florida (3)	'Satsuma' mandarin × 'Ruby' orange (3)
reticulata × *Poncirus trifoliata*	Citrandarin	(1)	(1)
reticulata var. Austera? × *C. ichangensis*	Yuzu	(1)	Mandarin × ichang (1)
reticulata var. Austera? × *Fortunella* sp.	Calamondin		Mandarin × kumquat (1)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Citrus (cont.)			
reticulata 'Calamondin' × *Fortunella* sp. × *Microcitrus australasica*	Faustrimedin	(1)	Calamondin × kumquat × *Microcitrus* (1)
rugulosa Hort ex. Tan.	Attani	India (2)	Pummelo × sweet orange? (2)
semperflorens Lush.	Sadaphal	India (4)	Pummelo or citron or *C. pennivesiculata?* (4)
semperflorens	Nardaba	India (4)	Pummelo or citron or *C. pennivericulata?* (4)
shunokan Hort ex. Tan.	Sour orange?	(1)	Pummelo × sweet orange (1)
sinensis (L.) Osbeck	Sweet orange	(1)	Pummelo × mandarin (1)
sinensis	Sweet orange	Assam (7)	Pummelo × mandarin (7)
Barrio	Sweet orange	Brazil (3)	Chance seedling? (3)
Bedmar	Bern		
Belladonna	Sweet orange	Italy (3)	Established Italian cultivar (3)
Berna	Bernia, verna, vernia, verda, bedmar	Spain (3)	Established Spanish cultivar (3)
Biondo Comune	Nostrale liscio	Italy (3)	Established Italian cultivar (3)
Cadenera	Cadena fina, cadena sin jueso, orero, valence san pepins	Spain (3)	Chance seedling? (3)
Calabrese	Ovale	Italy (3)	Unknown origin, established cultivar (3)
Diller	Sweet orange	Arizonia (8)	Originated from a seedling (8)
Hamlin	Sweet orange	Florida (8)	Florida seedling (8)
Marrs	Sweet orange	Texas (8)	Bud sport of 'Washington Navel' sweet orange (8)
Moro	Blood orange	Italy (8)	Fruit in clusters; unknown origin (8)

Continued

Appendix 1
Rutaceae Members' Geographic and Genetic Origin (cont.)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Citrus (cont.)			
sinensis (cont.)			
Pineapple		Florida (8)	Unknown? (8)
Robertson Navel	Navel orange	California (8)	Bud sport of 'Washington Navel' sweet orange (8)
Sanguinelli	Blood orange	Spain (8)	Unknown origin? (8)
Shamouti	Sweet orange	Israel (8)	Unknown? (8)
Skaggs Bonanza Navel	Navel orange	California (8)	Bud sport of 'Washington navel' (8)
Summernavel	Navel orange	California (8)	Bud sport of 'Washington navel' (8)
Tarocco	Blood orange	Italy (8)	Unknown origin? (8)
Trovita Navel	Navel orange	California (8)	Seedling of 'Washington navel'? (8)
Valencia	Sweet orange	Spain or Portugal (8)	(8)
Washington Navel	Navel orange	California (8)	(8)
sinensis × *C. paradisi*			
Chironja	Chironja orangelo	(3)	Sweet orange × grapefruit (3)
Hassaku	Hassaku orangelo	(3)	Sweet orange × grapefruit (3)
Imperial	Imperial orangelo	(3)	Sweet orange × grapefruit (3)
Kawano	Kawano orangelo	(3)	Sweet orange × grapefruit (3)
Royal	Royal orangelo	(3)	Sweet orange × grapefruit (3)
Triumph	Triumph orangelo	(3)	Sweet orange × grapefruit (3)
sinensis × *C. reticulata*	Tangor	(1)	Sweet orange × mandarin (4)
sinensis × (*C. sinensis* × *P. trifoliata*)	Citangor	(3)	Sweet orange × trifoliate orange (3)
(*sinensis* × *Poncirus* sp.) × *C. reticulata* 'Austera' × *Fortunella* sp.	Citrangedin	(3)	Sweet orange × *Poncirus* sp. × Mandarin × *Fortunella* sp. (3)
sinensis × *P. trifoliata*	Citrange	(1)	Sweet orange × trifoliate sweet orange (1)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Citrus (cont.)			
(*sinensis* × *P. trifoliata*) × *Eremocitrus glauca*	Citrangeremo	(1)	Sweet orange × Trifoliata orange × wild lime (1)
(*sinensis* × *P. trifoliata*) × *Fortunella japonica* or *F. margarita*	Citrangequat	(3)	Citrange × kumquat (3)
sulcata Hort. ex Takahashi	Grapefruit type	(1)	Pummelo × sweet orange (1)
sunki Hort ex Tan.	Sunki, suenkat, sunkat	South China (3)	Also called *Citrus sunki* 'Austera' (3)
tachibana (Mak.) Tan.	Tachibana orange	Japan (1)	(1)
tamurana Hort. ex Tan.	Hyuganatsu pummelo	(1)	Pummelo type (1)
tamurana	Hyuganatsu pummelo	(3)	Pummelo type (3)
tengu Hort ex Tan.	Grapefruit type	(1)	Pummelo × sweet orange? (1)
ujukitsu Hort. ex Tan.	Sour orange type	(1)	Pummelo × sweet orange? (1)
unshiu Marc.	Satsuma mandarin	(3)	Mandarin type? (3)
volckameriana	Rough lemon type	Italy (3)	Lemon × Rangpur lime/mandarin? (3)
webberi West.	Webber's Philippine pummelo	(1)	Mandarin? × *Citrus macroptera* (4)
Eremocitrus			
glauca (Lind.) Swing.	Australian desert lime	Australia (1)	Eremocitrus, wild type (1)
glauca	Australian desert lime	Australia (7)	Evolved from *Microcitrus?* (7)
Fortunella	Kumquat		
sp.	Kumquat		Possibly kumquat × mandarin? (5)
sp.	Kumquat		Not a true distinct group (6)
sp.	Kumquat	China (7)	Related to mandarin? (7)
crassifolia Swing.	Meiwa kumquat	(3)	Kumquat wild type? (3)
hindsii (Champ.) Swing.	Hong Kong kumquat	China (3)	Ancient origin? (3)

Continued

Appendix 1
Rutaceae Members' Geographic and Genetic Origin (cont.)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Fortunella (cont.)			
hindsii		Mountains of southern China and Hong Kong (1)	Unknown origin, grows wild (1)
japonica (Thumb) Swing.	Marumi kumquat	(3)	Kumquat wild type? (3)
japonica	Round kumquat	Japan (1)	Unknown origin (1)
margarita (Lour.) Swing.	Nagami or oval kumquat	(3)	Kumquat wild type? (3)
margarita	Oval kumquat	China (1)	Origin unknown; found in subtropical regions (1)
maragarita × *F. japonica*	Meiwa kumquat	China and Japan (1)	Oval kumquat × Round kumquat (1)
maragarita × *F. japonica*	*F. ovata?*	China and Japan (1)	Kumquat cross hybrid (1)
polyandra (Ridl.) Tan.	Malayan kumquat	Malaya (3)	Hybrid origin? (3)
polyandra	Malayan kumquat	Malay peninsula (1)	Unknown origin, tropical type (1)
sp. × *Citrus limon*	Limequat	United States (1)	Kumquat × lime (1)
sp. × *Citrus reticulata*	Orangequat	United States (3)	Kumquat × sweet orange (3)
sp. × *Citrus reticulata* × *(C. sinensis* × *Poncirus trifoliata)* (citrangedin)	Citrangedin	(1)	Kumquat × mandarin × citrange (1)
sp. × *(Poncirus trifoliata* × *Citrus sinensis)*	Citrangequat	United States (3)	Kumquat × citrange (3)
Microcitrus			
sp.		Australia (7)	Ancient *Microcitrus* origin (7)
australasica (F. Muell.) Swing.	Australian finger lime	New Guinea (1)	*Microcitrus* wild type (1)
inodora (F. M. Bail.) Swing.	Large-leaf Australian lime	New Guinea (1)	*Microcitrus* wild type (1)
warburgiana (F. M. Bail.) Tan.	New Guinea wild lime	New Guinea (1)	*Microcitrus* wild type (1)

Species and cultivar	Common name	Geographic origin (Ref.)	Genetic origin (Ref.)
Poncirus			
sp.	Trifoliate orange	China (7)	Related to Mandarin (7)
trifoliata (L.) Raf.	Trifoliate orange	China (1, 3)	Trifoliate orange × sweet orange (1)
trifoliata	Trifoliate orange		Trifoliate orange × sweet orange (4)
trifoliata × *C. aurantium*	Citradia	(3)	Trifoliate orange × sour orange (3)
trifoliata × *C. limon*	Citremon	(3)	Trifoliate orange × lemon (1, 3)
trifoliata × *C. paradisi*	Citrumelo	(3)	Trifoliate orange × grapefruit (1, 3)
trifoliata × *C. reticulata*	Citrandarin	(3)	Trifoliate orange × mandarin (1, 3)
trifoliata × *C. sinensis*	Citrange	(3)	Trifoliate orange × sweet orange (1, 3)
(trifoliata × *C. sinensis)*	Segentranges	(1)	(1)
(*trifoliata* × *C. sinensis*) × *C. sinensis*	Citrangor	(1)	Citrange × sweet orange (1)
(*trifoliata* × *C. sinensis*) × *Eremocitrus glauca*	Citrangeremo	(1)	Citrange × *Eremocitrus glauca* (1)
(*trifoliata* × *C. sinensis*) × *Fortunella* sp.	Citrangequats	(1)	Citrange × *Fortunella* sp. (1)
(*trifoliata* × *C. sinensis*) × *Poncirus trifoliata*	Cicitrange	(1)	Citrange × Trifoliate orange (1)
trifoliata × *Fortunella japonica*	Citrumquats	(3)	Trifoliate orange × kumquat (1)
trifoliata × *Fortunella margarita*	Citrumquats	(3)	Trifoliate orange × kumquat (1)

Appendix 2
Taxonomic Literature Review of Flavonoids Found in Citrus

For each citrus species, the flavonoids that have been reported in the literature are listed below. Numbers in parentheses indicate the publication(s) which have reported the presence of that flavonoid in the species. The species name given is that listed in the publication.

1. Horowitz and Gentili 1977
2. Albach and Redman 1969
3. Kanes et al. 1993
4. Berhow and Vandercook 1989
5. Nishiura et al. 1971a
6. Berhow et al. 1996

Citrus amblycarpa
Flavanone glycosides
- Didymin (2)
- Hesperidin (1, 2, 5)
- Naringin (2)
- Narirutin (2)
- Neohesperidin (2)
- Poncerin (1, 2)

C. ampullacea
Flavanone glycosides
- Naringin (5)

C. asahikan
Flavanone glycosides
- Naringin (5)
- Neoeriocitrin (5)
- Neohesperidin (5)

C. assamensis
Flavanone glycosides
- Naringin (5)

C. aurantiacia
Flavanone glycosides
- Naringin (5)

C. aurantifolia
Flavanone glycosides
- Eriocitrin (3)
- Hesperidin (1, 2, 3)

C. aurantium
Flavanone glycosides
- Didymin (3)
- Eriocitrin (3)
- Hesperidin (1, 2)
- Naringin (1, 2, 3, 5)
- Naringin–6″–malonate (3)
- Neoeriocitrin (1, 3, 5)
- Neodiosmin (6)
- Neohesperidin (1, 2, 3, 5)

Flavone aglycones
- 5–*O*–Desmethyl–nobiletin (1)
- Isosinensetin (1)
- Luteolin–7–*O*–neohesperidoside (1)
- Neodiosmin (1)
- Nobiletin (1)
- Rhoifolin (1, 3)
- Sinensetin (1)
- Tangeritin (1)
- Tetra–*O*–methyl–isoscutellarein (1)

Appendix 2
Taxonomic Literature Review of Flavonoids Found in Citrus (cont.)

C. aurea
Flavanone glycosides
Hesperidin (5)
Narirutin (5)

C. balotina
Flavanone glycosides
Naringin (5)

C. bergamia
Flavanone glycosides
Didymin (3)
Hesperidin (3)
Naringin (3, 5)
Naringin–6″–malonate (3)
Neoeriocitrin (1, 3, 5)
Neohesperidin (3, 5)

C. canaliculata
Flavanone glycosides
Eriocitrin (5)
Hesperidin (5)
Narirutin (5)
Flavone aglycones
5–Hydroxy–7,8,3′,4′–pentamethoxyflavone (1)

C. clementina
Flavanone glycosides
Hesperidin (5)

C. cleopatra
Flavanone glycosides
Hesperidin (5)
Narirutin (5)

C. deliciosa
Flavanone glycosides
Didymin (5)
Eriocitrin (5)
Hesperidin (5)
Narirutin (5)

C. depressa
Flavanone glycosides
Hesperidin (5)

C. erythrosa
Flavanone glycosides
Hesperidin (5)
Prunin (5)

C. excelsa

Flavanone glycosides

- Didymin (2)
- Hesperidin (1, 2, 3)
- Naringin (5)
- Narirutin (2 ,3)
- Narirutin–4′–glucoside (2)
- Neoeriocitrin (5)
- Neohesperidin (5)

Flavone glycosides

- Diosmin (3)
- Isorhoifolin (3)
- Rutin (3)

C. funadoko

Flavanone glycosides

- Naringin (5)
- Neohesperidin (5)
- Poncerin (5)

C. genshokan

Flavanone glycosides

- Hesperidin (5)

C. glaberrima

Flavanone glycosides

- Naringin (5)
- Neoeriocitrin (5)
- Neohesperidin (5)

C. grandis

Flavanone glycosides

- Hesperidin (3)
- Naringin (1, 2, 3, 5)
- Naringin–4′–glucoside (1, 2, 3)
- Naringin–6″–malonate (3)
- Neoeriocitrin (5)
- Neohesperidin (2, 3, 5)
- Poncerin (1, 2, 3, 5)

Flavone glycosides

- Luteolin–7–*O*–neohesperidoside (1)
- Rhoifolin (1, 3)

C. halimii

Flavanone glycosides

- Hesperidin (1)

C. hanaju

Flavanone glycosides

- Eriocitrin (5)
- Hesperidin (5)
- Narirutin (5)

C. hassaku

Flavanone glycosides

- Hesperidin (2)
- Naringin (1, 2, 5)
- Neoeriocitrin (5)
- Neohesperidin (2, 5)

Appendix 2
Taxonomic Literature Review of Flavonoids Found in Citrus (cont.)

C. hystrix
Flavanone glycosides
Didymin (3, 6)
Eriocitrin (6)
Hesperidin (3, 5, 6)
Narirutin (6)
Neoeriocitrin (6)
Neohesperidin (6)
Flavone glycosides
Diosmin (3)
Rutin (3, 6)

C. ichangensis
Flavanone glycosides
Didymin (6)
Hesperidin (6)
Naringin (5)
Flavone glycosides
Diosmin (6)
Rutin (6)

C. inflata
Flavanone glycosides
Hesperidin (5)
Narirutin (5)

C. intermedia
Flavanone glycosides
Naringin (5)

C. iwaikan
Flavanone glycosides
Eriocitrin (5)
Hesperidin (5)
Narirutin (5)

C. iyo
Flavanone glycosides
Eriocitrin (5)
Hesperidin (2, 5)
Narirutin (5)

C. junos
Flavanone glycosides
Eriocitrin (5, 6)
Hesperidin (2, 5, 6)
Naringin (6)
Narirutin (5, 6)
Neoeriocitrin (6)
Neohesperidin (6)
Flavone glycosides
Diosmin (6)
Neodiosmin (6)
Rutin (6)

C. karna
Flavanone glycosides
Hesperidin (1, 2, 5)
Narirutin (2, 5)
Narirutin–4′–glucoside (1, 2)

C. keraji
Flavanone glycosides
Eriocitrin (5)
Hesperidin (5)

C. kinokuni
Flavanone glycosides
Hesperidin (5)

C. kotokan
Flavanone glycosides
Eriocitrin (5)
Hesperidin (2, 5)
Narirutin (5)

C. latifolia
Flavanone glycosides
Hesperidin (5)

C. latipes
Flavanone glycosides
Didymin (6)
Eriocitrin (6)
Hesperidin (6)
Naringin (6)
Naringin–4′–glucoside (6)
Narirutin (6)
Neohesperidin (6)
Poncerin (6)
Flavone glycosides
Diosmin (6)
Rutin (6)

C. limettoides
Flavanone glycosides
Hesperidin (1, 2)

C. limon
Flavanone glycosides
Didymin (3)
Eriocitrin (1, 2, 3, 5)
Hesperidin (1, 2, 3, 5)
Naringin–4′–glucoside (2, 3)
Narirutin (1, 2, 3)
Narirutin-4′–glucoside (3)
Neoeriocitrin (2)
Neohesperidin (1)
Flavone glycosides
Chrysoeriol–glycoside (1)
Diosmin (1, 3)
Isolimocitrol–3–glucoside (1)
Isorhamnetin–glycoside (1)
Isorhoifolin (1, 3)
Limocitol–3–glucoside (1)
Limocitrin–3–glucoside (1)
Luteolin–7–*O*–rutinoside (1)
Rutin (1)
C–glycosylflavones
Apiginin–6,8–diglucoside (1)
Diosmetin–6,8–diglucoside (1)
Diosmetin–6–glucoside (1)
Diosmetin–8–glucoside (1)
Vitexin–2″–xyloside (1)

Appendix 2
Taxonomic Literature Review of Flavonoids Found in Citrus (cont.)

C. limonia
Flavanone glycosides
Eriocitrin (5)
Hesperidin (5)

C. limonimedica
Flavanone glycosides
Hesperidin (5)

C. longispina
Flavanone glycosides
Eriocitrin (3)
Hesperidin (3)
Narirutin (3)
Neoeriocitrin (3)
Flavone glycosides
Diosmin (3)
Rhoifolin (3)

C. lumia
Flavanone glycosides
Eriocitrin (5)
Hesperidin (5)

C. luminciana
Flavanone glycosides
Naringin (2)

C. luteo-turgida
Flavanone glycosides
Eriocitrin (5)
Hesperidin (5)
Narirutin (5)

C. macrophylla
Flavanone glycosides
Eriocitrin (6)
Hesperidin (3, 6)
Naringin–4′–glucoside (6)
Naringin–6″–malonate (6)
Flavone glycosides
Diosmin (6)
Isorhoifolin (6)
Rutin (3, 6)

C. madurensis
Flavanone glycosides
Hesperidin (5)

C. medica
Flavanone glycosides
Eriocitrin (3)
Hesperidin (1, 2, 3, 5)
Naringin–4′–glucoside (3)
Flavone aglycones
Tangeritin (1)
Flavone glycosides
Diosmin (1, 3)
Rutin (3)

C. medioglobosa
Flavanone glycosides
Hesperidin (2)
Naringin (2, 5)

C. megaloxycarpa
Flavanone glycosides
Hesperidin (5)

C. meyerii
Flavanone glycosides
Hesperidin (5)

C. microcarpa
Flavanone glycosides
Didymin (3)
Eriocitrin (3)
Hesperidin (3)
Naringin (3)
Naringin–6″–malonate (3)
Narirutin (3)
Neoeriocitrin (3)
Neohesperidin (3)
Flavone glycosides
Diosmin (3)

C. mitis
Flavanone aglycones
Citromitin (1, 2)
5–*O*–Desmethyl–citromitin (1, 2)
Flavanone glycosides
Hesperidin (1, 2)

C. mitsuharu
Flavanone glycosides
Naringin (5)

C. montana
Flavanone glycosides
Hesperidin (5)

C. natsudaidai
Flavanone glycosides
Didymin (3)
Hesperidin (2, 3)
Naringin (1, 2, 3, 5)
Naringin–4′–glucoside (3)
Naringin–6″–malonate (3)
Narirutin (3)
Narirutin–4′–glucoside (3)
Neoeriocitrin (3, 5)
Neohesperidin (2, 3, 5)
Flavone aglycones
Natsudaidain (1)
Flavone glycosides
Rhoifolin (3)

C. nippokoreana
Flavanone glycosides
Hesperidin (5)

Appendix 2
Taxonomic Literature Review of Flavonoids Found in Citrus (cont.)

C. nobilis
Flavanone glycosides
- Didymin (5)
- Eriocitrin (5)
- Hesperidin (5)
- Narirutin (5)

C. obovoidea
Flavanone glycosides
- Naringin (5)
- Neoeriocitrin (5)
- Neohesperidin (5)

C. oleocarpa
Flavanone glycosides
- Hesperidin (5)

C. otachibana
Flavanone glycosides
- Naringin (5)

C. papillaris
Flavanone glycosides
- Didymin (5)
- Hesperidin (5)
- Narirutin (5)

C. paradisi
Flavanone glycosides
- Didymin (2, 3)
- Dihydrokaempferol glycoside (1)
- Eriocitrin (3)
- Hesperidin (1, 2, 3)
- Naringin (1, 2, 3, 5)
- Naringin–4′–glucoside (1, 2, 3)
- Naringin–6″–malonate (3)
- Narirutin (1, 2, 3)
- Narirutin–4′–glucoside (1, 2, 3)
- Neoeriocitrin (1, 3)
- Neohesperidin (1, 2, 3)
- Poncerin (1, 2, 3, 5)
- Prunin (4)

Flavone aglycones
- 3,5,6,7,8,3′,4′–Heptamethoxyflavone (1)
- Nobiletin (1)
- Tangeritin (1)

Flavone glycosides
- Diosmin (3)
- Isorhoifolin (1, 3)
- Kaempferol–glycoside (1)
- Rhoifolin (1, 3)
- Rutin (1, 3)

C. platymamma
Flavanone glycosides
- Eriocitrin (5)
- Hesperidin (5)
- Narirutin (5)

C. ponki
Flavanone glycosides
Hesperidin (5)
Narirutin (5)

C. pseudo-aurantium
Flavanone glycosides
Hesperidin (5)
Narirutin (5)

C. pseudogulgul
Flavanone glycosides
Narirutin (5)

C. pyriformis
Flavanone glycosides
Naringin (5)
Neoeriocitrin (5)
Neohesperidin (5)

C. reshni
Flavanone glycosides
Hesperidin (5)
Narirutin (5)

C. reticulata
Flavanone aglycones
Citromitin (1, 2)
5–*O*–Desmethyl–citromitin (1, 2)
Flavanone glycosides
Didymin (2, 3)
Hesperidin (1, 2, 5)
Narirutin (2, 3)
Neoeriocitrin (2)
Neohesperidin (2, 3)
Flavone aglycones
Auranetin (1)
5–*O*–Desmethyl–nobiletin (1)
5,4′–Dihydroxy–6,7,8,3′–tetramethoxyflavone (1)
3,5,6,7,8,3′,4′–Heptamethoxyflavone (1)
5–Hydroxy–auranetin (1)
Nobiletin (1)
Tangeritin (1)
Xanthomicrol (1)
Flavone glycosides
Diosmin (3)
Isorhoifolin (3)
Rhoifolin (3)

Appendix 2
Taxonomic Literature Review of Flavonoids Found in Citrus (cont.)

C. rokugatsu
Flavanone glycosides
Hesperidin (5)

C. rugulosa
Flavanone glycosides
Eriocitrin (3)
Hesperidin (3)
Naringin (3, 5)
Naringin–4′–glucoside (3)
Naringin–6″–malonate (3)
Narirutin (3)
Neoeriocitrin (3, 5)
Neohesperidin (3, 5)
Flavone glycosides
Rhoifolin (3)

C. shunokan
Flavanone glycosides
Didymin (5)
Eriocitrin (3, 5)
Hesperidin (3, 5)
Narirutin (3, 5)
Narirutin–4′–glucoside (3)
Flavone glycosides
Diosmin (3)
Isorhoifolin (3)
Rutin (3)

C. sinensis
Anthocyanins
Cyanidin–3,5–diglucoside (1)
Cyanidin–3–glucoside (1)
Delphinidin–3–glucoside (1)
Peonidin–5–glucoside (1)
Petunidin–3–glucoside (1)
Flavanone glycosides
Didymin (1, 2, 3)
Eriocitrin (3)
Hesperidin (1, 2, 3, 5)
Narirutin (1, 2, 3, 5)
Flavone aglycones
5–*O*–Desmethyl–nobiletin (1)
3,5,6,7,8,3′,4′–Heptamethoxyflavone (1)
Nobiletin (1)
Tangeritin (1)
Flavone glycosides
Diosmin (3)
Isorhoifolin (3)
Rutin (3)
C–glycosylflavones
Diosmetin–8–glucoside (1)
Vitexin–2″–xyloside (1)

C. sinograndis
Flavanone glycosides
Naringin (5)
Neohesperidin (5)

C. sphaerocarpa
Flavanone glycosides
Eriocitrin (5)
Hesperidin (5)
Narirutin (5)

C. succosa
Flavanone glycosides
Hesperidin (5)

C. sudachi
Flavanone glycosides
Eriocitrin (5)
Hesperidin (5)
Narirutin (5)
Flavone aglycones
3′–Demethoxy–sudachitin (1)
Sudachitin (1)

C. suhuiensis
Flavanone glycosides
Hesperidin (5)

C. sulcata
Flavanone glycosides
Eriocitrin (3, 5)
Hesperidin (3, 5)
Narirutin (3, 5)
Narirutin–4′–glucoside (3)

C. tachibana
Flavanone glycosides
Didymin (2)
Eriocitrin (5)
Hesperidin (1, 2, 5)
Narirutin (2, 5)
Poncerin (2)

C. taiwanica
Flavanone glycosides
Didymin (2)
Hesperidin (1, 2)
Naringin (2, 5)
Narirutin (2)
Neoeriocitrin (5)
Neohesperidin (2, 5)
Poncerin (1, 2)

C. takuma-sudachi
Flavanone glycosides
Hesperidin (5)
Narirutin (5)

Appendix 2
Taxonomic Literature Review of Flavonoids Found in Citrus (cont.)

C. tamurana
Flavanone glycosides
- Didymin (5)
- Eriocitrin (5)
- Hesperidin (3, 5)
- Naringin (3)
- Naringin–4′–glucoside (3)
- Naringin–6″–malonate (3)
- Narirutin (3,5)
- Neohesperidin (3)

Flavone glycosides
- Diosmin (3)

C. tangerina
Flavanone glycosides
- Hesperidin (5)

C. tankan
Flavanone glycosides
- Didymin (5)
- Hesperidin (2, 5)
- Narirutin (5)

C. temple
Flavanone glycosides
- Hesperidin (5)

C. tengu
Flavanone glycosides
- Didymin (3, 5)
- Narirutin (3, 5)
- Narirutin–4′–glucoside (3)

Flavone glycosides
- Isorhoifolin (3)

C. truncata
Flavanone glycosides
- Naringin (5)
- Neoeriocitrin (5)
- Neohesperidin (5)

C. tumida
Flavanone glycosides
- Eriocitrin (5)
- Hesperidin (5)
- Narirutin (5)

C. ujukitsu
Flavanone glycosides
- Eriocitrin (5)
- Hesperidin (3, 5)
- Narirutin (3, 5)
- Narirutin–4′–glucoside (3)

Flavone glycosides
- Diosmin (3)
- Isorhoifolin (3)
- Rutin (3)

C. unshiu
Flavanone glycosides
Hesperidin (1, 5)
Narirutin (1, 5)

C. webberi
Flavanone glycosides
Didymin (3, 6)
Hesperidin (3, 6)
Narirutin (3, 6)
Flavone glycosides
Diosmin (3)
Isorhoifolin (3)
Rutin (6)

C. wilsonii
Flavanone glycosides
Didymin (6)
Hesperidin (6)
Naringin (5)
Flavone glycosides
Rutin (6)

C. yamabuki
Flavanone glycosides
Eriocitrin (5)
Hesperidin (5)
Narirutin (5)

C. yanbaruensis
Flavanone glycosides
Naringin (5)
Neohesperidin (5)

C. yatsushiro
Flavanone glycosides
Hesperidin (5)
Narirutin (5)

C. yuko
Flavanone glycosides
Eriocitrin (5)
Hesperidin (5)
Narirutin (5)

Fortunella crassifolia
Flavanone glycosides
Eriocitrin (1, 2)
Hesperidin (1, 2)
Naringin (2)
Narirutin (2)
Neoeriocitrin (1, 2)
Poncerin (1, 2)
Flavone glycosides
Fortunellin (1)

F. hindsii
Flavanone glycosides
Eriocitrin (1, 2)
Hesperidin (2)
Naringin (2)
Narirutin (2)

Appendix 2
Taxonomic Literature Review of Flavonoids Found in Citrus (cont.)

F. japonica
Flavone aglycones
Isosinensetin (1)
Nobiletin (1)
Tangeritin (1)
Flavone glycosides
Fortunellin (1)

F. margarita
Flavanone glycosides
Naringin (1)
Poncerin (1)
Flavone aglycones
3–Hydroxy–5,6,7,3′,4′–pentamethoxyflavone (1)
Flavone glycosides
Fortunellin (1)
C–glycosylflavones
Isomargaretin (1)
Margaretin (1)

F. ovovata
Flavone glycosides
Fortunellin (1)

Microcitrus australasica
Flavone glycosides
Isorhoifolin (3)

M. warburgiana
Flavanone glycosides
Narirutin (3)
Flavone glycosides
Isorhoifolin (3)
Rutin (3)

Poncirus trifoliata
Flavanone glycosides
Hesperidin (2)
Naringin (1, 2, 5)
Neohesperidin (1, 2)
Poncerin (1, 2)

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