

---

# Safety Assessment of Citrus Peel-Derived Ingredients as Used in Cosmetics

---

Status: Draft Report for Panel Review  
Release Date: November 20, 2015  
Panel Meeting Date: December 14-15, 2015

The 2015 Cosmetic Ingredient Review Expert Panel members are: Chairman, Wilma F. Bergfeld, M.D., F.A.C.P.; Donald V. Belsito, M.D.; Ronald A. Hill, Ph.D.; Curtis D. Klaassen, Ph.D.; Daniel C. Liebler, Ph.D.; James G. Marks, Jr., M.D., Ronald C. Shank, Ph.D.; Thomas J. Slaga, Ph.D.; and Paul W. Snyder, D.V.M., Ph.D. The CIR Director is Lillian J. Gill, D.P.A. This report was prepared by Christina Burnett, Senior Scientific Analyst/Writer.

---

## Cosmetic Ingredient Review

1620 L Street NW, Suite 1200 ◊ Washington, DC 20036-4702 ◊ ph 202.331.0651 ◊ fax 202.331.0088 ◊  
[cirinfo@cir-safety.org](mailto:cirinfo@cir-safety.org)



Commitment & Credibility since 1976

Memorandum

To: CIR Expert Panel Members and Liaisons  
From: Christina Burnett, Senior Scientific Writer/Analyst  
Date: November 20, 2015  
Subject: Draft Report of the Safety Assessment of *Citrus* Peel-Derived Ingredients

Enclosed is the draft Report of the Safety Assessment of *Citrus* Peel-Derived Ingredients as Used in Cosmetics. (It is identified as *cpeel122015rep* in the pdf document.)

At the March 2014 meeting, the Panel tabled further discussion of 198 *Citrus*-derived ingredients to allow CIR staff to reorganize the report and to obtain clarification from the Research Institute for Fragrance Materials (RIFM) on the functions of some of the ingredients. Based on the Panel's recommendation of grouping the ingredients by plant parts according to greatest number of uses, the first two assessments reviewed by the Panel were *Citrus*-derived peel oils (14 ingredients; final report issued September 2014) and *Citrus* fruit-derived ingredients (80 ingredients; draft final report currently under Panel consideration). As it stands, the Panel has concluded that the ingredients in these two safety assessments are safe for use in both rinse-off and leave-on cosmetic products when formulated to be non-sensitizing and non-irritating, provided that leave-on products do not contain more than 0.0015% (15 ppm) 5-methoxypsonal (5-MOP).

At the September 2015 meeting, the Panel finalized the groupings of the remaining ingredients. The Panel will be reviewing the safety of *Citrus* plant- and seed-derived ingredients (33 ingredients), *Citrus* flower- and leaf-derived ingredients (32 ingredients), and *Citrus* peel-derived ingredients (47 ingredients) in three separate, concurrent reports. The minutes from the September Panel meeting and the initial meeting on the full *Citrus* family of ingredients from 2014 can be found in the *Citrus* fruit-derived ingredients package (*cfruit122015min* under the bookmark tabs "Citrus Remainders Strategy September 21-22, 2015" and "Citrus-Derived Ingredients March 2014").

Since March 2014, no new unpublished data on *Citrus* peel-derived ingredients have been received. The Council is currently performing a new concentration of use survey to update the data that was originally collected in 2013. An updated search of the published literature has found no relevant safety test data concerning the ingredients found in this report.

The *Citrus* peel-derived ingredients described in this report function primarily as skin conditioning agents. *Citrus limon* (lemon) peel extract has the most reported uses of the ingredients in this report in cosmetic products, with a total of 171; the majority of the uses are in rinse-off preparations (e.g. non-coloring hair conditioners, hair shampoos, and skin cleansing preparations). *Citrus aurantium dulcis* (orange) peel extract has the second greatest number of overall uses reported, with a total of 54; a good number of uses are in non-coloring hair preparations. The results of the concentration of use survey indicate *citrus aurantium amara* (bitter orange) peel powder and *citrus aurantium dulcis* (orange) peel powder have the highest reported maximum concentration of use; they are both used at up to 6% in skin cleansing preparations. The highest reported maximum concentration of use in a leave-on product is 1.9% in a lipstick for *citrus aurantium dulcis* (orange) peel extract.

Discrepancies were found between the INCI Dictionary and the VCRP database during the creation of the Use Table. The VCRP included ingredients using old botanical nomenclature (e.g. *citrus sinensis* instead of *citrus aurantium dulcis* for sweet orange) and ingredients that do not have entries in the INCI Dictionary (e.g. *citrus tachibana* (tachibana) peel extract). These discrepancies have been footnoted in the Use Table.

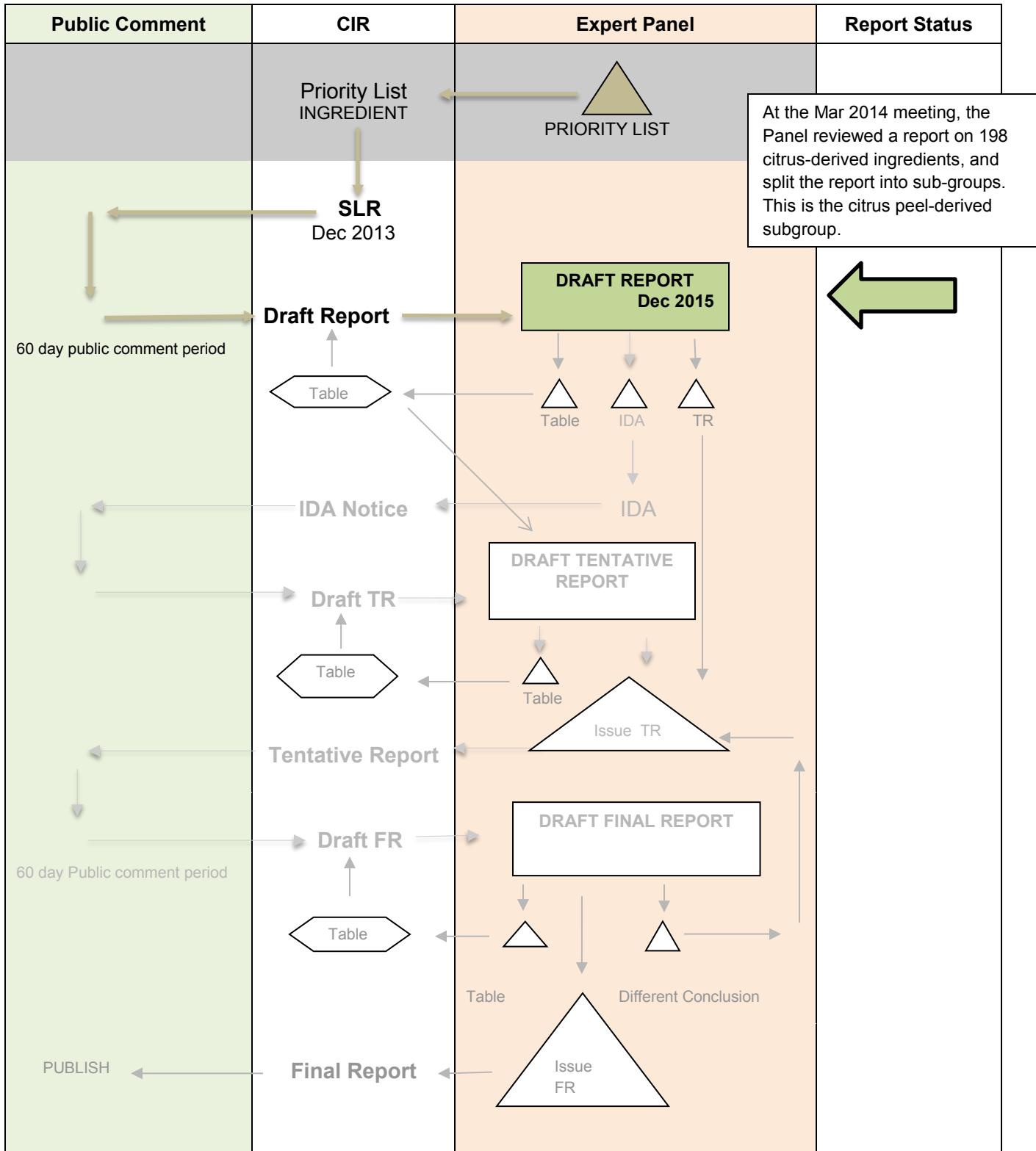
Included in this report package is the Final Safety Assessment on Citrus-Derived Peel Oils. The current report on the Citrus peel-derived ingredients includes ingredients that are intact and powdered peels, which likely contain peel oils. Staff would like guidance from the Panel on how to approach inclusion of any overlapping data from the peel oils report into the peel report.

If no further data are needed, the Panel should issue a Tentative Report. If data are needed, an Insufficient Data Announcement should be issued, and the data needs listed.

# SAFETY ASSESSMENT FLOW CHART

**INGREDIENT/FAMILY** Citrus Peel-Derived Ingredients

**MEETING** Dec 2015



### **Citrus Peel-Derived Ingredients History**

**December 2013** – Scientific Literature Review announced.

**March 2014** - The Panel tabled further discussion of 198 citrus-derived ingredients to allow CIR staff to reorganize the report and to obtain clarification from RIFM on the functions of some of the ingredients. These ingredients were presented in a single safety assessment report addressing ingredients from all of the citrus plant species currently reported to be used in cosmetics in the International Cosmetic Ingredient Dictionary and Handbook. The Panel felt revising this report into smaller subgroups would be a manageable and meaningful alternative approach to assessing the safety of these ingredients. Based on the Panel's recommendation of grouping the ingredients by plant parts according to greatest number of uses, the first assessment reviewed by the Panel was citrus-derived peel oils, followed by citrus fruit-derived ingredients.

**September 2015** – The Panel reviewed the report strategy for the remaining citrus ingredients. The Panel agreed that the remaining ingredients could be divided into 3 reports: citrus flower- and leaf-derived ingredients, citrus peel-derived ingredients, and citrus plant- and seed-derived ingredients. These reports can be reviewed concurrently.

| Citrus Peel-Derived Ingredients Data Profile – December 2015 – Writer, Christina Burnett |        |                              |                         |             |                 |                                     |                                     |                |               |              |
|--|--------|------------------------------|-------------------------|-------------|-----------------|-------------------------------------|-------------------------------------|----------------|---------------|--------------|
|  | In-Use | Physical/Chemical Properties | Method of Manufacturing | Composition | Carcinogenicity | Irritation/Sensitization - Nonhuman | Irritation/Sensitization - Clinical | Ocular/Mucosal | Phototoxicity | Case Studies |
| citrus aurantifolia (lime) peel  | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus aurantifolia (lime) peel extract  | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus aurantifolia (lime) peel powder   | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus aurantium amara (bitter orange) peel extract                                      | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus aurantium amara (bitter orange) peel powder                                       | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus aurantium dulcis (orange) peel extract  | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus aurantium dulcis (orange) peel powder   | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus aurantium dulcis (orange) peel wax  | X      | X                            | X                       | X           |                 | X                                   | X                                   |                | X             |              |
| citrus aurantium tachibana peel extract  | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus depressa peel extract   | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus grandis (grapefruit) peel extract   | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus junos peel extract  | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus limon (lemon) peel extract  | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus limon (lemon) peel powder   | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus nobilis (mandarin orange) peel extract  | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus paradisi (grapefruit) peel extract  | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus reticulata (tangerine) peel extract   | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus unshiu peel extract   | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
|  |        |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus aurantium amara (bitter orange) peel wax (not INCI ingredient)                    | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus medica limonum (lemon) peel wax   | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| citrus tachibana (tachibana) peel extract  | X      |                              |                         |             |                 |                                     |                                     |                |               |              |
| lemon peel juice   |        |                              |                         |             |                 |                                     |                                     | X              |               |              |
| NO USES OR DATA WERE AVAILABLE FOR THE REMAINING CITRUS INGREDIENTS LISTED IN TABLE 1.   |        |                              |                         |             |                 |                                     |                                     |                |               |              |

“X” indicates that data were available in the category for that ingredient.

### Search Strategy for Citrus Peel-Derived Ingredients

- August 2014 – miscellaneous searches for additional data on constituents
- Scifinder – February 26, 2013
  - Search for INCI citrus ingredients w/ CAS No. – 99 hits, 10 ordered
- PubMed – March 5, 2013
  - Search for “citrus cosmetics” – 65 hits, 1 ordered
  - Search for “citrus sensitization” – 36 hits, 8 ordered
  - Search for “citrus dermal” – 12 hits, 0 ordered
  - Search for “citrus phototoxicity” – 24 hits, 10 ordered
- SciFinder – Aug 19 2013
  - toxicity of citrus ingredients – 11 hits; 1 ordered
  - carcinogenicity of citrus – 466 hits; 8 ordered
- SciFinder – Aug 20, 2013
  - Phototoxicity of citrus – 47 hits; 21 ordered
  - Dermal effects of citrus – 51 hits; 1 new ref found
  - Dermal absorption of citrus – 1 hit; not useful
  - Constituents of citrus – 116 hits;
  - Citrus – Belsito, Marks, Bergfeld, Api, RIFM– 2 found

Ordered a few others; printed some directly

Updated searches in November, 2013 – ordered an additional 4 references

Updated searches July 2015 with the term “citrus” – 1 new relevant reference found.

**Updated searches October 2015 with the term “citrus AND peel NOT oil”– 0 new relevant references found.**

#### Online Info

- FDA
  - GRAS definitions
- Dr. Duke's Phytochemical and Ethnobotanical Databases
  - Due to volume of data, limited search to Citrus limon (Lemon), Citrus aurantifolia (Lime), Citrus paradisi (Grapefruit), Citrus sinensis (Sweet Orange), and Citrus aurantium (Bitter Orange)
- National Toxicology Program (NTP)
  - Bitter Orange Extract (mixture)
- SCCS/SCCP
  - Opinion on fragrance allergens in cosmetic products
  - Opinion on Furocoumarins in cosmetic products
- Sigma Aldrich
  - Citrus aurantiifolia (lime)
  - Citrus aurantium (bitter orange)
  - Citrus paradisi (grapefruit)
  - Citrus reticulata (tangerine)
- IFRA
  - 7-methoxycoumarin
  - Standard for citrus oils and other furocoumarins containing essential oils. Ingredients include:

---

## Safety Assessment of Citrus Peel-Derived Ingredients as Used in Cosmetics

---

Status: Draft Report for Panel Review  
Release Date: November 20, 2015  
Panel Meeting Date: December 14-15, 2015

The 2015 Cosmetic Ingredient Review Expert Panel members are: Chairman, Wilma F. Bergfeld, M.D., F.A.C.P.; Donald V. Belsito, M.D.; Ronald A. Hill, Ph.D.; Curtis D. Klaassen, Ph.D.; Daniel C. Liebler, Ph.D.; James G. Marks, Jr., M.D., Ronald C. Shank, Ph.D.; Thomas J. Slaga, Ph.D.; and Paul W. Snyder, D.V.M., Ph.D. The CIR Director is Lillian J. Gill, D.P.A. This report was prepared by Christina Burnett, Senior Scientific Analyst/Writer.

---

### Cosmetic Ingredient Review

1620 L Street NW, Suite 1200 ◊ Washington, DC 20036-4702 ◊ ph 202.331.0651 ◊ fax 202.331.0088 ◊  
[cirinfo@cir-safety.org](mailto:cirinfo@cir-safety.org)

## INTRODUCTION

*Citrus* peel-derived ingredients are widely used in cosmetics, and are most frequently reported to function in cosmetics as skin conditioning agents (Table 1).<sup>1</sup> This report assesses the safety of the following 47 ingredients:

|   |   |
|---|---|
| citrus aurantifolia (lime) peel                     | citrus junos peel extract                     |
| citrus aurantifolia (lime) peel extract             | citrus junos peel powder                      |
| citrus aurantifolia (lime) peel powder              | citrus junos peel water                       |
| citrus aurantifolia (lime) peel water               | citrus limon (lemon) peel                     |
| citrus aurantium amara (bitter orange) peel         | citrus limon (lemon) peel extract             |
| citrus aurantium amara (bitter orange) peel extract | citrus limon (lemon) peel powder              |
| citrus aurantium amara (bitter orange) peel powder  | citrus limon (lemon) peel water               |
| citrus aurantium bergamia (bergamot) peel water     | citrus limon (lemon) peel wax                 |
| citrus aurantium dulcis (orange) peel extract       | citrus natsudaidai peel extract               |
| citrus aurantium dulcis (orange) peel powder        | citrus nobilis (mandarin orange) peel extract |
| citrus aurantium dulcis (orange) peel wax           | citrus nobilis (mandarin orange) peel powder  |
| citrus aurantium sinensis peel extract              | citrus paradisi (grapefruit) peel extract     |
| citrus aurantium tachibana peel extract             | citrus reticulata (tangerine) peel extract    |
| citrus depressa peel extract                        | citrus reticulata (tangerine) peel powder     |
| citrus depressa peel powder                         | citrus shunkokan peel extract                 |
| citrus grandis (grapefruit) peel                    | citrus sunki peel extract                     |
| citrus grandis (grapefruit) peel extract            | citrus tachibana/reticulata peel powder       |
| citrus grandis (grapefruit) peel powder             | citrus tangelo peel powder                    |
| citrus hassaku/natsudaidai peel powder              | citrus tangerina (tangerine) peel             |
| citrus iyo peel extract                             | citrus tangerina (tangerine) peel extract     |
| citrus iyo peel water                               | citrus unshiu peel extract                    |
| citrus jabara peel extract                          | citrus unshiu peel powder                     |
| citrus jabara peel powder                           | citrus unshiu peel water                      |
| citrus jabara peel water                            |   |

The Panel has reviewed previously the safety of *Citrus*-derived peel oils and concluded that 14 *Citrus*-derived peel oil ingredients are safe for use in both rinse-off and leave-on cosmetic products when formulated to be non-sensitizing and non-irritating, provided that leave-on products do not contain more than 0.0015% (15 ppm) 5-methoxysoralen (5-MOP).<sup>2</sup> The Panel is concurrently reviewing the safety of *Citrus* fruit-derived ingredients, *Citrus* flower- and leaf-derived ingredients, and *Citrus* plant- and seed-derived ingredients.

Some of the *Citrus* peels that are used to derive the ingredients described in this safety assessment are used as food. The U.S. Food and Drug Administration (FDA) determined that the use of some *Citrus* peels as direct food substances is generally recognized as safe (GRAS). Additionally, essential oils, oleoresins (solvent-free), and natural extracts (including distillates) derived from some *Citrus* peels are GRAS for their intended use in foods for human and animal consumption. Daily consumption of these GRAS foods would result in much larger systemic exposures than what is expected from use in cosmetic products, even if there was 100% absorption. Thus, the systemic toxicity potential of *Citrus* peel-derived ingredients via oral exposure is not addressed further in this report. The primary focus of the safety assessment is the review of safety based on topical exposure.

The CIR does not review ingredients that function only as fragrance ingredients because, as fragrances, the safety of these ingredients is evaluated by the Research Institute for Fragrance Materials (RIFM). Four of the *Citrus* peel-derived ingredients in this report function only as fragrance ingredients, according to the *International Cosmetic Ingredient Dictionary and Handbook* (see Table 2).<sup>1</sup> However, according to personal communications with RIFM in March 2015, these ingredients were not included in their review process, thus CIR is reviewing the safety of these ingredients.

Botanical ingredients such as those derived from *Citrus* are comprised of hundreds of constituents, some of which have the potential to cause toxic effects; for example, bergapten (aka 5-methoxysoralen or 5-MOP) is a naturally-occurring phototoxic furanocoumarin (psoralen) in some *Citrus* ingredients. In this assessment, CIR is reviewing the potential toxicity of each *Citrus* peel-derived ingredient as a whole, complex substance. Except for specific constituents of concern that the Panel has identified, CIR is not reviewing the potential toxicity of the individual constituents of the *Citrus* peels from which the ingredients in this report are derived.

Note: In many of the published studies included in this assessment, the information provided is not sufficient to determine how well the substance being tested represents the cosmetic ingredient. In this safety assessment, if a substance tested in a study is not clearly a cosmetic ingredient, because of lack of information on the genus and species from which the substance was derived and/or the method of extraction used, the test substance will be referred to by a common name (e.g. sweet orange peel extract). If the substance is clearly a cosmetic ingredient, the International Nomenclature of Cosmetic Ingredients (INCI) name will be used (e.g. "citrus aurantium dulcis (orange) peel extract"). Additionally, some inconsistencies were noted in both taxonomic and INCI naming conventions. For example, this report includes the sweet orange ingredient described as citrus aurantium dulcis (orange) in the *International Cosmetic Ingredient Dictionary and*

*Handbook.*<sup>1</sup> In contrast, most of the published literature and FDA Voluntary Cosmetic Registration Program (VCRP) refer to this ingredient as citrus sinensis (sweet orange). Another example of a naming inconsistency is citrus grandis (grapefruit); *Citrus grandis* is generally considered a name for a pummelo, which may also be referred to as *Citrus maxima*. *Citrus paradisi* appears to be the more widely accepted nomenclature for grapefruit. The INCI Committee of the Personal Care Products Council (Council) is working to correct some of these inconsistencies. The genus and species names associated with the ingredient names designated by the INCI Committee are listed in Table 3.<sup>3</sup>

## **CHEMISTRY**

The definitions and functions of the citrus-derived ingredients included in this report are provided in Table 1. The definition indicates what part(s) of the plant from which an ingredient is obtained. In some cases, the definition provides insight on the method(s) of manufacture

### **Physical and Chemical Properties**

Physical and chemical properties of citrus aurantium dulcis (orange) peel wax are provided in Table 4.

### **Method of Manufacturing**

#### Citrus Aurantium Dulcis (Orange) Peel Wax

According to data provided by a supplier, citrus aurantium dulcis (orange) peel wax is a by-product from the manufacturing of orange essential oil and from orange fruit peels following orange juice production.<sup>4</sup> Citrus aurantium dulcis (orange) peel wax is obtained from residues of citrus terpenes and orange essential oil distillation. The crude wax is processed by physical methods only and is further refined with various absorbents and filtrated. The deodorization process removes all terpenes and most of the essential oil components.

### **Constituents/Composition**

The *Citrus* ingredients are complex botanicals made up of numerous constituents. Table 5 lists *Citrus* constituents that are established contact allergens, according the European Commission's Scientific Committee on Consumer Safety (SCCS).<sup>5</sup>

#### Citrus Aurantium Dulcis (Orange) Peel Wax

Based on data provided by a supplier, citrus aurantium dulcis (orange) peel wax is a water-free substance not likely to be contaminated by microorganisms (bacteria, yeast, or fungi) because of the high temperature, filtration, and absorbents used during processing.<sup>4</sup> 1,4-Dioxane, ethylene oxide, solvents (e.g., benzol), nitrosamines and free amines were not present in the supplier's product. Heavy metals, pesticides, and polycyclic aromatic hydrocarbons were absent or present at very low concentrations (detail not provided). Low concentrations of fragrance allergens were present (detail not provided).

The supplier stated that citrus aurantium dulcis (orange) peel wax consists of approximately 60% esters (C42-C60), 18% phytosterols (beta-sitosterol, stigmasterol), 3% sterol esters, 8% free fatty acids, 5% hydrocarbons, and 4% free fatty alcohols.<sup>4</sup> Further information states that approximately 50% of citrus aurantium dulcis (orange) peel wax consists of unsaturated monoesters of unsaturated fatty acids and long-chain alcohols, with the fatty acids consisting mostly of linoleic, oleic, linolenic, arachidic, and erucic acids.<sup>6</sup> The fatty alcohol portion of the ester is mostly dotriacontanol (C32) and tetratricontanol (C34).

Tables 6 and 7 present additional chemical composition data on citrus aurantium dulcis (orange) peel wax.

## **USE**

### **Cosmetic**

The safety of these cosmetic ingredients is evaluated on the basis of the expected use in cosmetics. The Panel utilizes data received from the FDA and the cosmetics industry in determining safety. The data received from the FDA are those it collects from manufacturers on the use of individual ingredients in cosmetics by cosmetic product category in its Voluntary Cosmetic Registration Program (VCRP), and those from the cosmetic industry are submitted in response to a survey of the maximum reported use concentrations by category conducted by the Personal Care Products Council (Council).

According to the 2015 VCRP data, citrus limon (lemon) peel extract has the most reported uses of the ingredients in this report in cosmetic products, with a total of 171; the majority of the uses are in rinse-off preparations (e.g. non-coloring hair conditioners, hair shampoos, and skin cleansing preparations; Table 8).<sup>7</sup> Citrus aurantium dulcis (orange) peel extract has the second greatest number of overall uses reported, with a total of 54; many of the uses are in non-coloring hair preparations. The results of the concentration of use survey conducted in 2013 by the Council indicate citrus aurantium amara (bitter orange) peel powder and citrus aurantium dulcis (orange) peel powder have the highest reported maximum concentration of use; they are both used at up to 6% in skin cleansing preparations.<sup>8</sup> The highest reported maximum concentration of use in a leave-on product is 1.9% in a lipstick for citrus aurantium dulcis (orange) peel extract.

Table 9 lists all *Citrus* peel-derived ingredients not indicated to be in use based on the VCRP data or the results of the Council concentration of use survey.

In some cases, reports of uses were received from the VCRP, but no concentration of use data were provided. For example, citrus reticulata (mandarin orange) peel extract is reported to be used in 30 formulations, but no use concentration data were available. In other cases, no reported uses were reported to the VCRP, but a maximum use concentration was provided in the industry survey. For example, citrus aurantifolia (lime) peel was not reported in the VCRP database to be in use, but the industry survey indicated that it is used in paste masks (mud packs) at up to 1.5%. It should be presumed that citrus aurantifolia (lime) peel is used in at least one cosmetic formulation.

Some of these ingredients may be used in products that can be incidentally ingested or come into contact with mucous membranes. For example, citrus aurantium dulcis (orange) peel extract is used at 1.9% in lipstick and citrus limon (lemon) peel extract is used at 0.51% in personal cleanliness products. Additionally, some of these ingredients were reported to be used in fragrance preparations and could possibly be inhaled. For example, citrus aurantium dulcis (orange) peel extract was reported to be used in fragrance preparations at a maximum concentration of 0.001%. In practice, 95% to 99% of the droplets/particles released from cosmetic sprays have aerodynamic equivalent diameters >10 µm, with propellant sprays yielding a greater fraction of droplets/particles below 10 µm compared with pump sprays.<sup>9-12</sup> Therefore, most droplets/particles incidentally inhaled from cosmetic sprays would be deposited in the nasopharyngeal and bronchial regions and would not be respirable (i.e., they would not enter the lungs) to any appreciable amount.<sup>10,11</sup>

Under the rules governing cosmetic products in the European Union, *Citrus*-derived ingredients must have a furocoumarin content below 1 mg/kg in sun-protection products and in bronzing products.<sup>13</sup> The International Fragrance Association (IFRA) has issued standards for *Citrus* oils and other furocoumarin-containing essential oils.<sup>14</sup> Finished products that are applied to the skin, excluding rinse-off products like bath preparations and soaps, must not contain more than 0.0015% or 15 ppm 5-MOP. This equates to a level of 0.0075% or 75 ppm in a fragrance compound when used at 20% in a consumer product that is applied to the skin. If the level of 5-MOP has not been determined, limits specified for individual oils should be observed, and when such oils are used in combination with other phototoxic constituent containing ingredients, the potential for an additive effect should be considered and use levels should be reduced accordingly.

An IFRA standard also has been issued for 7-methoxycoumarin, which is prohibited for use in fragrance compounds.<sup>15</sup> Based on established maximum levels of this substance from commercially-available natural sources (like essential oils, extracts and absolutes), IFRA has determined that exposure to 7-methoxycoumarin from the use of these oils and extracts is acceptable if the level of 7-methoxycoumarin in the finished product does not exceed 100 ppm.

### **Non-Cosmetic**

The essential oils, oleoresins (solvent-free), and natural extractives (including distillates) derived from the following *Citrus* plant sources are generally recognized as safe (GRAS) for their intended use in foods for human consumption: *Citrus aurantifolia* (lime); *Citrus aurantium* (bergamot); *Citrus aurantium* (bitter orange; the flowers and peel); *Citrus limon* (lemon); *Citrus paradisi* (grapefruit); *Citrus reticulata* (tangerine); *Citrus reticulata blanco* (mandarin); *Citrus sinensis* (orange; the leaf, flowers, and peel) and citrus peels (species not specified) (21CFR182.20). These essential oils, oleoresins (solvent-free), and natural extractives (including distillates) of these *Citrus* plant sources are GRAS for their intended use in animal drugs, feeds, and related products (21CFR582.20).

*Citrus aurantium* amara (bitter orange) and extracts of its dried fruit and peel have been used in traditional Western medicines and in Chinese and Japanese herbal medicines.<sup>16</sup>

### **TOXICOKINETICS**

No relevant published toxicokinetics studies on *Citrus* peel-derived ingredients were identified in a literature search for these ingredients and no unpublished data were submitted; these type of data are not expected since these botanical ingredients are mixtures of hundreds of constituents.

### **TOXICOLOGICAL STUDIES**

#### **Acute Toxicity**

Some of the *Citrus* ingredients in this assessment are foods, and the daily exposure from consumption would result in a much larger systemic dose than that resulting from use in cosmetic products. Also, as noted earlier, essential oils, oleoresins (solvent-free), and natural extractives (including distillates) derived from some *Citrus* peels are GRAS for their intended use in foods for human and animal consumption according to the FDA. Consequently, the systemic toxicity potential is not addressed further in this report. The safety focus of use of these *Citrus* ingredients as cosmetic ingredients is on the potential for irritation and sensitization from topical exposure.

### **Repeated Dose Toxicity**

No relevant published repeated dose toxicity studies on *Citrus* peel-derived ingredients were identified in a literature search and no unpublished data were submitted.

### **REPRODUCTIVE AND DEVELOPMENTAL TOXICITY**

No relevant published reproductive and developmental studies on *Citrus* peel-derived ingredients were identified in a literature search and no unpublished data were submitted.

### **GENOTOXICITY**

No relevant published genotoxicity studies on *Citrus* peel-derived ingredients were identified in a literature search and no unpublished data were submitted.

### **CARCINOGENICITY**

No relevant published carcinogenicity studies on *Citrus* peel-derived ingredients were identified in a literature search and no unpublished data were submitted.

### **IRRITATION AND SENSITIZATION**

#### **Dermal Irritation**

Dermal irritation studies are summarized in Table 10.<sup>4,6</sup> In an in vitro test, no irritation potential was observed for citrus aurantium dulcis (orange) peel wax tested at 100%. In human subjects, no irritation was observed after topical exposure to citrus aurantium dulcis (orange) peel wax (100%).

#### **Sensitization**

No relevant published sensitization studies on *Citrus* peel-derived ingredients were identified in a literature search and no unpublished data were submitted.

#### **Phototoxicity and Photosensitization**

Phototoxicity and photosensitization studies are presented in Table 11.<sup>17-21</sup> Undiluted lemon peel juice produced phototoxic reactions in several rat studies. In humans, citrus aurantium dulcis (orange) peel wax (100%) was not phototoxic, but undiluted sweet orange peel produced phototoxic reactions.

#### **Occupational Exposure**

In a retrospective study (2001-2010) of professional food handlers in Denmark, 8.5% (16/188) of the patients had positive reactions to orange peel and 7.9% (15/191) of the patients had positive reactions to lemon peel.<sup>22</sup>

### **SUMMARY**

The 47 *Citrus* peel-derived ingredients described in this report are reported to function in cosmetics primarily as skin conditioning agents. Botanical ingredients such as those derived from the genus *Citrus* are composed of hundreds of constituents, some of which have the potential to cause toxic effects; for example, bergapten (aka 5-methoxysoralen or 5-MOP) is a naturally-occurring, phototoxic furanocoumarin (psoralen) in *Citrus*. CIR reviewed the information available on the potential toxicity of each *Citrus* peel-derived ingredient as a whole, complex substance; CIR did not review the potential toxicity information on the individual constituents of which the *Citrus* peel-derived ingredients are comprised.

*Citrus limon* (lemon) peel extract has the most reported uses of the ingredients in this report in cosmetic products, with a total of 171; the majority of the uses are in rinse-off preparations (e.g. non-coloring hair conditioners, hair shampoos, and skin cleansing preparations). *Citrus aurantium dulcis* (orange) peel extract has the second greatest number of overall uses reported, with a total of 54; a good number of uses are in non-coloring hair preparations. The results of the concentration of use survey indicate citrus aurantium amara (bitter orange) peel powder and citrus aurantium dulcis (orange) peel powder have the highest reported maximum concentration of use; they are both used at up to 6% in skin cleansing preparations. The highest reported maximum concentration of use in a leave-on product is 1.9% in a lipstick for *citrus aurantium dulcis* (orange) peel extract.

Under the rules governing cosmetic products in the European Union, *Citrus*-derived ingredients must have furocoumarin content below 1 mg/kg in sun-protection and bronzing products. IFRA also has issued standards for *Citrus* oils and other furocoumarin-containing essential oils. Finished products that are applied to the skin, excluding rinse-off products

like bath preparations and soaps, must not contain more than 0.0015% or 15 ppm 5-MOP. If the level of 5-MOP has not been determined, limits specified for individual oils should be observed, and when such oils are used in combination with other phototoxic ingredients, the potential additive effect should be taken into consideration and use levels should be reduced accordingly.

Some of the *Citrus* ingredients in this assessment are found in foods, and the daily exposure from food use would result in a much larger systemic dose than that resulting from use in cosmetic products. Essential oils, oleoresins (solvent-free), and natural extractives (including distillates) derived from some citrus fruits are GRAS for their intended use in foods for human and animal consumption according to the FDA.

In an in vitro test, no dermal irritation potential was observed for citrus aurantium dulcis (orange) peel wax tested at 100%. In human subjects, no irritation was observed after topical exposure to citrus aurantium dulcis (orange) peel wax (100%).

Undiluted lemon peel juice produced phototoxic reactions in several rat studies and sweet orange peel inhibited growth of *Candida albicans* following UV-irradiation. In humans, citrus aurantium dulcis (orange) peel wax (100%) was not photosensitizing, but undiluted sweet orange peel produced phototoxic reactions.

In a retrospective study of professional food handlers in Denmark, 8.5% (16/188) of the patients had positive reactions to orange peel and 7.9% (15/191) of the patients had positive reactions to lemon peel.

No relevant published studies on the toxicokinetics, repeated dose toxicity, reproductive and development toxicity, genotoxicity, carcinogenicity, or dermal sensitization of citrus-derived ingredients were discovered and no unpublished data were submitted to address these topics.

**TABLES****Table 1.** Definitions and functions of *Citrus* peel-derived ingredients.<sup>1</sup>

| Ingredient  | Definition  | Function  |
|---|---|---|
| Citrus Aurantifolia (Lime) Peel   | Citrus Aurantifolia (Lime) Peel is the peel obtained from <i>Citrus aurantifolia</i> .  | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Aurantifolia (Lime) Peel Extract<br>CAS No. 90063-52-8             | Citrus Aurantifolia (Lime) Peel Extract is the extract of the peel of <i>Citrus aurantifolia</i> .  | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Aurantifolia (Lime) Peel Powder                                    | Citrus Aurantifolia (Lime) Peel Powder is the powder obtained from the dried, ground peel of <i>Citrus aurantifolia</i> .   | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Aurantifolia (Lime) Peel Water                                     | Citrus Aurantifolia (Lime) Peel Water is the aqueous solution of the Fragrance Ingredients steam distillates obtained from the peel of <i>Citrus aurantifolia</i> . |   |
| Citrus Aurantium Amara (Bitter Orange) Peel                               | Citrus Aurantium Amara (Bitter Orange) Peel is the peel of <i>Citrus aurantium amara</i> .  | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Aurantium Amara (Bitter Orange) Peel Extract<br>CAS No. 72968-50-4 | Citrus Aurantium Amara (Bitter Orange) Peel Extract is the extract of the peel of <i>Citrus aurantium amara</i> .   | Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous   |
| Citrus Aurantium Amara (Bitter Orange) Peel Powder                        | Citrus Aurantium Amara (Bitter Orange) Peel Powder is the powder obtained from the dried, ground peel of <i>Citrus aurantium amara</i> .                            | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Aurantium Bergamia (Bergamot) Peel Water                           | Citrus Aurantium Bergamia (Bergamot) Peel Water is an aqueous solution of the steam distillate obtained from the peel of <i>Citrus aurantium bergamia</i> .         | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Aurantium Dulcis (Orange) Peel Extract                             | Citrus Aurantium Dulcis (Orange) Peel Extract is the extract of the peel of <i>Citrus aurantium dulcis</i> .  | Binders; Emulsion Stabilizers; Skin-Conditioning Agents - Miscellaneous; Viscosity Increasing Agents - Aqueous Absorbents |
| Citrus Aurantium Dulcis (Orange) Peel Powder                              | Citrus Aurantium Dulcis (Orange) Peel Powder is the powder obtained from the dried, ground peel of <i>Citrus aurantium dulcis</i> .                                 |   |
| Citrus Aurantium Dulcis (Orange) Peel Wax                                 | Citrus Aurantium Dulcis (Orange) Peel Wax is a wax obtained from the peel of the orange, <i>Citrus aurantium dulcis</i> .   | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Aurantium Sinensis Peel Extract                                    | Citrus Aurantium Sinensis Peel Extract is the extract of the peel of <i>Citrus aurantium sinensis</i> .   | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Aurantium Tachibana Peel Extract                                   | Citrus Aurantium Tachibana Peel Extract is the extract of the peel of <i>Citrus aurantium tachibana</i> .   | Skin-Conditioning Agents - Humectant  |
| Citrus Depressa Peel Extract  | Citrus Depressa Peel Extract is the extract of the peel of <i>Citrus depressa</i> .   | Skin-Conditioning Agents - Humectant  |
| Citrus Depressa Peel Powder   | Citrus Depressa Peel Powder is the powder obtained from the dried, ground peel of <i>Citrus depressa</i> .  | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Grandis (Grapefruit) Peel  | Citrus Grandis (Grapefruit) Peel is the peel of <i>Citrus grandis</i> .   | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Grandis (Grapefruit) Peel Extract                                  | Citrus Grandis (Grapefruit) Peel Extract is the extract of the peel of <i>Citrus grandis</i> .  | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Grandis (Grapefruit) Peel Powder                                   | Citrus Grandis (Grapefruit) Peel Powder is the powder obtained from the dried, ground peel of <i>Citrus grandis</i> .   | Absorbents  |
| Citrus Hassaku/Natsudaidai Peel Powder                                    | Citrus Hassaku/Natsudaidai Peel Powder is the powder obtained from the dried, ground peel of a hybrid of <i>Citrus hassaku</i> and <i>Citrus natsudaidai</i> .      | Flavoring Agents  |
| Citrus Iyo Peel Extract   | Citrus Iyo Peel Extract is the extract of the peel of <i>Citrus iyo</i> .   | Skin-Conditioning Agents - Humectant  |
| Citrus Iyo Peel Water   | Citrus Iyo Peel Water is an aqueous solution of the steam distillate obtained from the peel of <i>Citrus iyo</i> .  | Skin-Conditioning Agents - Humectant  |
| Citrus Jabara Peel Extract  | Citrus Jabara Peel Extract is the extract of the peel of <i>Citrus jabara</i> .   | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Jabara Peel Powder   | Citrus Jabara Peel Powder is the powder obtained from the dried, ground peels of <i>Citrus jabara</i> .   | Fragrance Ingredients   |
| Citrus Jabara Peel Water  | Citrus Jabara Peel Water is an aqueous solution of the steam distillate obtained from the peel of <i>Citrus jabara</i> .  | Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous   |
| Citrus Junos Peel Extract   | Citrus Junos Peel Extract is the extract of the peel of <i>Citrus junos</i> .   | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Junos Peel Powder  | Citrus Junos Peel Powder is the dried, ground powder obtained from the peels of <i>Citrus junos</i> .   | Fragrance Ingredients   |
| Citrus Junos Peel Water   | Citrus Junos Peel Water is an aqueous solution of the steam distillate obtained from the peel of <i>Citrus junos</i> .  | Skin-Conditioning Agents - Miscellaneous  |
| Citrus Limon (Lemon) Peel<br>CAS No. 84929-31-7; 85085-28-5; 92346-89-9   | Citrus Limon (Lemon) Peel is the peel of <i>Citrus limon</i> .  | Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous   |
| Citrus Limon (Lemon) Peel Extract<br>CAS No. 84929-31-7; 85085-28-5       | Citrus Limon (Lemon) Peel Extract is the extract of the peel of <i>Citrus limon</i> .   | Skin Protectants; Skin-Conditioning Agents - Emollient  |
| Citrus Limon (Lemon) Peel Powder<br>CAS No. 84929-31-7; 85085-28-5        | Citrus Limon (Lemon) Peel Powder is the powder obtained from the dried, ground peel of <i>Citrus limon</i> .  | Absorbents  |

**Table 1.** Definitions and functions of *Citrus* peel-derived ingredients.<sup>1</sup>

| <b>Ingredient</b>   | <b>Definition</b>  | <b>Function</b>  |
|---|--|--|
| Citrus Limon (Lemon) Peel Water<br>CAS No. 84929-31-7; 85085-28-5         | Citrus Limon (Lemon) Peel Water is an aqueous solution of the steam distillate obtained from the peel of <i>Citrus limon</i> .                                   | Skin-Conditioning Agents - Miscellaneous                           |
| Citrus Limon (Lemon) Peel Wax<br>CAS No. 84929-31-7; 85085-28-5           | Citrus Limon (Lemon) Peel Wax is the wax obtained from the peel of <i>Citrus limon</i> .   | Skin-Conditioning Agents - Occlusive                               |
| Citrus Natsudaidai Peel Extract<br><br>CAS No. 90063-83-5                 | Citrus Natsudaidai Peel Extract is the extract of the peel of <i>Citrus natsudaidai</i> .<br><br>Citrus Nobilis (Mandarin Orange) Peel Extract                   | Skin-Conditioning Agents - Humectant                               |
| Citrus Nobilis (Mandarin Orange) Peel Extract<br>CAS No. 90063-83-5       | Citrus Nobilis (Mandarin Orange) Peel Extract is the extract of the peel of <i>Citrus nobilis</i> .  | Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous    |
| Citrus Nobilis (Mandarin Orange) Peel Powder                              | Citrus Nobilis (Mandarin Orange) Peel Powder is the powder obtained from the dried, ground peel of <i>Citrus nobilis</i> .                                       | Abrasives  |
| Citrus Paradisi (Grapefruit) Peel Extract<br>CAS No. 90045-43-5 (generic) | Citrus Paradisi (Grapefruit) Peel Extract is the extract obtained from the peel of <i>Citrus paradisi</i> .  | Skin-Conditioning Agents - Miscellaneous                           |
| Citrus Reticulata (Tangerine) Peel Extract                                | Citrus Reticulata (Tangerine) Peel Extract is the extract of the peel of <i>Citrus reticulata</i> .  | Skin-Conditioning Agents - Miscellaneous                           |
| Citrus Reticulata (Tangerine) Peel Powder                                 | Citrus Reticulata (Tangerine) Peel Powder is the powder obtained from the dried, ground peel of <i>Citrus reticulata</i> .                                       | Skin-Conditioning Agents - Miscellaneous                           |
| Citrus Shunkokan Peel Extract   | Citrus Shunkokan Peel Extract is the extract of the peel of <i>Citrus shunkokan</i> .  | Antioxidants   |
| Citrus Sunki Peel Extract   | Citrus Sunki Peel Extract is the extract of the peel of <i>Citrus sunki</i> .  | Humectants; Skin Protectants; Skin-Conditioning Agents - Humectant |
| Citrus Tachibana/Reticulata Peel Powder                                   | Citrus Tachibana/Reticulata Peel Powder is the powder obtained from the finely ground peel of a hybrid of <i>Citrus tachibana</i> and <i>Citrus reticulata</i> . | Skin-Conditioning Agents - Miscellaneous                           |
| Citrus Tangelo Peel Powder  | Citrus Tangelo Peel Powder is the powder obtained from the dried, ground peel of <i>Citrus tangelo</i> .   | Flavoring Agents   |
| Citrus Tangerina (Tangerine) Peel   | Citrus Tangerina (Tangerine) Peel is the peel of the tangerine, <i>Citrus tangerina</i> .  | Abrasives  |
| Citrus Tangerina (Tangerine) Peel Extract                                 | Citrus Tangerina (Tangerine) Peel Extract is the extract of the peel of <i>Citrus tangerina</i> .  | Cosmetic Astringents   |
| Citrus Unshiu Peel Extract  | Citrus Unshiu Peel Extract is the extract of the peel of <i>Citrus unshiu</i> .  | Skin-Conditioning Agents - Miscellaneous                           |
| Citrus Unshiu Peel Powder   | Citrus Unshiu Peel Powder is the powder of the dried, ground peel of <i>Citrus unshiu</i> .  | Fragrance Ingredients  |
| Citrus Unshiu Peel Water  | Citrus Unshiu Peel Water is the aqueous solution of the steam distillates obtained from the peel of <i>Citrus unshiu</i> .                                       | Skin Protectants   |

**Table 2.** Citrus-ingredients that potentially function solely as fragrance ingredients.Citrus Aurantifolia (Lime) Peel Water  
Citrus Jabara Peel PowderCitrus Junos Peel Powder  
Citrus Unshiu Peel Powder

**Table 3.** Review of *Citrus* genus species names<sup>3</sup>

| <b>Genus Species Name Used in INCI Names (common name)</b> | <b>Accepted Genus Species Name</b>                |
|--|---|
| <i>Citrus aurantifolia</i> (lime)                          | <i>Citrus x aurantifolia</i>                      |
| <i>Citrus aurantium amara</i> (bitter orange)              | <i>Citrus x aurantium</i>                         |
| <i>Citrus aurantium bergamia</i> (bergamot)                | <i>Citrus x limon</i>                             |
| <i>Citrus aurantium dulcis</i> (orange)                    | <i>Citrus x aurantium</i>                         |
| <i>Citrus clementina</i> (clementine)                      | <i>Citrus x aurantium</i>                         |
| <i>Citrus depressa</i>                                     | <i>Citrus reticulata</i>                          |
| <i>Citrus glauca</i>                                       | <i>Citrus glauca</i>                              |
| <i>Citrus grandis</i> (grapefruit or pomelo)               | <i>Citrus maxima</i> or <i>Citrus x aurantium</i> |
| <i>Citrus hassaku</i>                                      | <i>Citrus medica x Citrus x aurantium</i>         |
| <i>Citrus iyo</i>  | <i>Citrus x aurantium</i>                         |
| <i>Citrus jabara</i>                                       | Not known   |
| <i>Citrus japonica</i> (kumquat)                           | <i>Citrus japonica</i>                            |
| <i>Citrus junos</i>  | <i>Citrus x junos</i>                             |
| <i>Citrus limon</i> (lemon)                                | <i>Citrus x limon</i>                             |
| <i>Citrus madurensis</i>                                   | <i>Citrus x microcarpa</i>                        |
| <i>Citrus medica vulgaris</i>                              | <i>Citrus reticulata</i>                          |
| <i>Citrus natsudaidai</i>                                  | <i>Citrus x aurantium</i>                         |
| <i>Citrus nobilis</i> (mandarin orange)                    | <i>Citrus reticulata</i>                          |
| <i>Citrus paradisi</i> (grapefruit)                        | <i>Citrus x aurantium</i>                         |
| <i>Citrus reticulata</i> (tangerine)                       | <i>Citrus reticulata</i>                          |
| <i>Citrus shunkokan</i>                                    | Cultivated hybrid                                 |
| <i>Citrus sinensis</i> (orange)                            | <i>Citrus x aurantium</i>                         |
| <i>Citrus sphaerocarpa</i>                                 | Cultivated hybrid                                 |
| <i>Citrus sudachi</i>                                      | <i>Citrus reticulata</i>                          |
| <i>Citrus tachibana</i>                                    | Not listed  |
| <i>Citrus tamurana</i>                                     | Cultivated hybrid                                 |
| <i>Citrus tangelo</i> (tangelo)                            | <i>Citrus x aurantium</i>                         |
| <i>Citrus tangerine</i> (tangerine)                        | <i>Citrus reticulata</i>                          |
| <i>Citrus tankan</i>                                       | <i>Citrus reticulata</i>                          |
| <i>Citrus unshiu</i>                                       | <i>Citrus reticulata</i>                          |

**Table 4.** Physical and chemical properties of *citrus aurantium dulcis* (orange) peel wax.

| Property   | Description                           | Reference |
|--|---------------------------------------|-----------|
| <b>Citrus Aurantium Dulcis (Orange) Peel Wax</b> |                                       |           |
| Color  | light reddish-brown to orange         | 6         |
| Odor   | mild to very low characteristic       | 6         |
| Appearance                                       | semi-solid                            | 6         |
| molecular weight                                 | > 400                                 | 4         |
| melting point                                    | 45-57 °C refined; 35-50 °C deodorized | 6         |
| congealing point                                 | 45-55 °C refined; 30-45 °C deodorized | 6         |
| acid value                                       | 8-20 refined; 10-20 deodorized        | 6         |
| saponification value                             | 70-110 refined and deodorized         | 6         |
| hydroxyl value                                   | 20-50 refined; 10-40 deodorized       | 6         |
| log P  | > 3.5                                 | 4         |
| UV absorbance                                    | 210-240 nm                            | 6         |

**Table 5.** Constituents that are established contact allergens in humans, according to the SCCS.

| <b>Constituent</b>                                  | <b>categorized according to number of patients reacting positively and to the number of patients tested<br/>(&gt;1000 patients tested, unless indicated as r.t., i.e., rarely tested)<sup>5</sup></b> |
|---|---|
| $\beta$ -caryophyllene                              | $\leq 10$ (oxidized and non-oxidized)   |
| carvone   | $\leq 10$ (r.t.)  |
| citral  | 101 to 1000   |
| citronellol   | 11-100  |
| coumarin  | 101 to 1000   |
| farnesol  | 101 to 1000   |
| geraniol  | 101 to 1000   |
| linalyl acetate                                     | $\leq 10$   |
| $\alpha$ - and $\beta$ -pinene                      | 11-100  |
| (DL)-limonene                                       | 11-100 (non-oxidized); 101 to 1000 (oxidized)   |
| terpineol (mixture of isomers)/ $\alpha$ -terpineol | $\leq 10$   |
| terpinolene   | 11-100  |

**Table 6.** Primary chemical composition of citrus aurantium dulcis (orange) peel wax by percent

6

|   |         |
|---|---------|
| unsaturated monoesters, hydroxyl-monoesters, and monoesters | 50-65   |
| free fatty acids C12-C26                                    | 6-15    |
| hydrocarbons C21- C33                                       | 8-15    |
| sterol esters   | 5-18    |
| free sterols  | 4-8     |
| free alcohols   | 2-7     |
| carotenoids   | 0.5-2   |
| glycolipids   | 0.5-2   |
| phospholipids   | 0.5-2   |
| flavonoids  | 0.2-1   |
| fragrance compounds, natural                                | 0.2-0.8 |

**Table 7.** Constituents of citrus aurantium dulcis (orange) peel wax with color or aroma characteristics.

6

| color compounds (carotenoids) | aroma compounds<br>(alcohols, aldehydes, ketones, esters, and hydrocarbons) |
|-------------------------------|---|
| phytoene                      | octan-1-ol  |
| phytoluene                    | nonanal   |
| $\alpha$ -carotene            | linalool  |
| $\beta$ -carotene             | <i>p</i> -mentha-2,8-dien-1-ol  |
| $\gamma$ -carotene            | sabinol   |
| $\delta$ -carotene            | isopulegol  |
| lycopene                      | 4-methylacetophenone  |
| cryptoxanthin                 | $\alpha$ -terpineol   |
| hydroxy- $\alpha$ -carotene   | ethyl octanoate   |
| cyroflevin                    | decanal   |
| rubiflavin                    | carveol   |
| rubixanthin                   | neral   |
| lutein                        | carvone   |
| canthaxanthin                 | piperitone  |
| zeaxanthin                    | geranial  |
| antheraxanthin                | perillyl alcohol  |
| violaxanthin                  | $\alpha$ -cubebene  |
| luteoxanthin                  | hexyl hexanoate   |
| auroxanthin                   | $\beta$ -elemene  |
| $\beta$ -citraurin            | $\beta$ -famesene   |
| liavoxanthin                  | caryophyllene   |
| sintaxanthin                  | $\gamma$ -selinene  |
| xanthophylls                  | $\beta$ -copaene  |
|                               | $\delta$ -cadinene  |
|                               | bisabolene  |
|                               | valencene   |



**Table 8.** Frequency (2015) and concentration of use (2013) according to duration and type of exposure for *Citrus* peel-derived ingredients.<sup>7,8</sup>

|                              | # of Uses  | Max Conc of Use (%) | # of Uses                               | Max Conc of Use (%)      | # of Uses                        | Max Conc of Use (%) | # of Uses                                | Max Conc of Use (%)        |
|------------------------------|--|---------------------|---|--------------------------|----------------------------------|---------------------|--|----------------------------|
|                              | Citrus Aurantium Dulcis (Orange) Peel Wax <sup>g</sup> |                     | Citrus Aurantium Tachibana Peel Extract |                          | Citrus Depressa Peel Extract     |                     | Citrus Grandis (Grapefruit) Peel Extract |                            |
| <b>Totals<sup>†</sup></b>    | <b>4</b>   | <b>0.005-0.5</b>    | <b>NR</b>                               | <b>0.0008</b>            | <b>NR</b>                        | <b>0.0014</b>       | <b>48</b>                                | <b>0.0001-0.5</b>          |
| <b>Duration of Use</b>       |  |                     |   |                          |                                  |                     |  |                            |
| Leave-On                     | 4  | 0.07-0.5            | NR                                      | 0.0008                   | NR                               | 0.0014              | 38                                       | 0.0001-0.5                 |
| Rinse Off                    | NR   | 0.005-0.39          | NR                                      | NR                       | NR                               | NR                  | 10                                       | 0.0225-0.03                |
| Diluted for (Bath) Use       | NR   | NR                  | NR                                      | NR                       | NR                               | NR                  | NR                                       | NR                         |
| <b>Exposure Type</b>         |  |                     |   |                          |                                  |                     |  |                            |
| Eye Area                     | NR   | 0.15-0.16           | NR                                      | NR                       | NR                               | NR                  | 3  | 0.5                        |
| Incidental Ingestion         | NR   | 0.5                 | NR                                      | NR                       | NR                               | NR                  | 1  | NR                         |
| Incidental Inhalation-Spray  | NR   | NR                  | NR                                      | NR                       | NR                               | NR                  | 14 <sup>a</sup> ; 9 <sup>b</sup>         | NR                         |
| Incidental Inhalation-Powder | NR   | NR                  | NR                                      | NR                       | NR                               | 0.0014 <sup>c</sup> | 9 <sup>b</sup>                           | 0.0001-0.0005 <sup>c</sup> |
| Dermal Contact               | 4  | 0.7-0.39            | NR                                      | 0.0008                   | NR                               | 0.0014              | 44                                       | 0.0001-0.03                |
| Deodorant (underarm)         | NR   | NR                  | NR                                      | NR                       | NR                               | NR                  | NR                                       | NR                         |
| Hair - Non-Coloring          | NR   | 0.005-0.045         | NR                                      | NR                       | NR                               | NR                  | 1  | NR                         |
| Hair-Coloring                | NR   | NR                  | NR                                      | NR                       | NR                               | NR                  | 2  | NR                         |
| Nail                         | NR   | NR                  | NR                                      | NR                       | NR                               | NR                  | NR                                       | NR                         |
| Mucous Membrane              | NR   | 0.5                 | NR                                      | NR                       | NR                               | NR                  | 2  | NR                         |
| Baby Products                | NR   | NR                  | NR                                      | NR                       | NR                               | NR                  | NR                                       | NR                         |
| <br>                         |  |                     |   |                          |                                  |                     |  |                            |
|                              | Citrus Junos Peel Extract                              |                     | Citrus Limon (Lemon) Peel Extract       |                          | Citrus Limon (Lemon) Peel Powder |                     | Citrus Medica Limonum (Lemon) Peel Wax   |                            |
| <b>Totals<sup>†</sup></b>    | <b>1</b>   | <b>0.0012-0.036</b> | <b>171</b>                              | <b>0.0001-0.51</b>       | <b>4</b>                         | <b>NR</b>           | <b>1</b>                                 | <b>NR</b>                  |
| <b>Duration of Use</b>       |  |                     |   |                          |                                  |                     |  |                            |
| Leave-On                     | 1  | 0.0012-0.036        | 67                                      | 0.0001-0.25              | 2                                | NR                  | NR                                       | NR                         |
| Rinse Off                    | NR   | NR                  | 103                                     | 0.0011-0.51              | 2                                | NR                  | 1  | NR                         |
| Diluted for (Bath) Use       | NR   | NR                  | 1                                       | NR                       | NR                               | NR                  | NR                                       | NR                         |
| <b>Exposure Type</b>         |  |                     |   |                          |                                  |                     |  |                            |
| Eye Area                     | 1  | NR                  | 4                                       | NR                       | NR                               | NR                  | NR                                       | NR                         |
| Incidental Ingestion         | NR   | 0.0012              | 3                                       | 0.0005                   | NR                               | NR                  | NR                                       | NR                         |
| Incidental Inhalation-Spray  | NR   | NR                  | 1; 21 <sup>a</sup> ; 19 <sup>b</sup>    | 0.012 <sup>a</sup>       | 1 <sup>b</sup>                   | NR                  | NR                                       | NR                         |
| Incidental Inhalation-Powder | NR   | NR                  | 19 <sup>b</sup>                         | 0.0001-0.25 <sup>c</sup> | 1 <sup>b</sup>                   | NR                  | NR                                       | NR                         |
| Dermal Contact               | 1  | 0.0012-0.036        | 89                                      | 0.0001-0.51              | 3                                | NR                  | 1  | NR                         |
| Deodorant (underarm)         | NR   | NR                  | 1 <sup>a</sup>                          | NR                       | NR                               | NR                  | NR                                       | NR                         |
| Hair - Non-Coloring          | NR   | NR                  | 76                                      | 0.0011-0.01              | NR                               | NR                  | NR                                       | NR                         |
| Hair-Coloring                | NR   | NR                  | 2                                       | NR                       | NR                               | NR                  | NR                                       | NR                         |
| Nail                         | NR   | NR                  | 1                                       | NR                       | 1                                | NR                  | NR                                       | NR                         |
| Mucous Membrane              | NR   | 0.0012              | 16                                      | 0.0005-0.51              | 1                                | NR                  | 1  | NR                         |
| Baby Products                | NR   | NR                  | 1                                       | NR                       | NR                               | NR                  | NR                                       | NR                         |

**Table 8.** Frequency (2015) and concentration of use (2013) according to duration and type of exposure for *Citrus* peel-derived ingredients.<sup>7,8</sup>

|  | # of Uses                                     | Max Conc of Use (%)      | # of Uses                                 | Max Conc of Use (%)  | # of Uses   | Max Conc of Use (%) | # of Uses  | Max Conc of Use (%) |
|--|---|--------------------------|---|----------------------|---|---------------------|--|---------------------|
|  | Citrus Nobilis (Mandarin Orange) Peel Extract |                          | Citrus Paradisi (Grapefruit) Peel Extract |                      | Citrus Reticulata (Tangerine) Peel Extract <sup>b</sup> |                     | Citrus Tachibana (Tachibana) Peel Extract <sup>e</sup> |                     |
| <b>Totals<sup>f</sup></b>                                      | <b>19</b>                                     | <b>0.0003-0.03</b>       | <b>13</b>                                 | <b>0.0017-0.0068</b> | <b>30</b>   | <b>NR</b>           | <b>3</b>   | <b>NR</b>           |
| <b>Duration of Use</b>   |   |                          |   |                      |   |                     |  |                     |
| Leave-On   | 8   | 0.0025-0.009             | 7   | 0.0017               | 25  | NR                  | 5  | NR                  |
| Rinse Off  | 11  | 0.0003-0.03              | 6   | 0.0068               | 5   | NR                  | 1  | NR                  |
| Diluted for (Bath) Use   | NR  | 0.0005-0.0025            | NR  | NR                   | NR  | NR                  | NR   | NR                  |
| <b>Exposure Type</b>   |   |                          |   |                      |   |                     |  |                     |
| Eye Area   | NR  | NR                       | NR  | NR                   | 5   | NR                  | NR   | NR                  |
| Incidental Ingestion   | NR  | NR                       | 3   | NR                   | NR  | NR                  | NR   | NR                  |
| Incidental Inhalation-Spray                                    | 4 <sup>a</sup> ; 2 <sup>b</sup>               | NR                       | 3 <sup>a</sup>                            | NR                   | 15 <sup>d</sup> ; 3 <sup>b</sup>                        | NR                  | 1 <sup>a</sup> ; 3 <sup>b</sup>                        | NR                  |
| Incidental Inhalation-Powder                                   | 2 <sup>b</sup>                                | 0.0025 <sup>c</sup>      | NR  | NR                   | 3 <sup>b</sup>  | NR                  | 3 <sup>b</sup>   | NR                  |
| Dermal Contact   | 15  | 0.0005-0.03              | 4   | 0.0017-0.0068        | 30  | NR                  | 6  | NR                  |
| Deodorant (underarm)   | NR  | NR                       | NR  | NR                   | NR  | NR                  | NR   | NR                  |
| Hair - Non-Coloring  | 4   | 0.0003-0.005             | 6   | NR                   | NR  | NR                  | NR   | NR                  |
| Hair-Coloring  | NR  | NR                       | NR  | NR                   | NR  | NR                  | NR   | NR                  |
| Nail   | NR  | NR                       | NR  | NR                   | NR  | NR                  | NR   | NR                  |
| Mucous Membrane  | 7   | 0.0005-0.0025            | 5   | NR                   | 3   | NR                  | NR   | NR                  |
| Baby Products  | NR  | NR                       | NR  | NR                   | NR  | NR                  | NR   | NR                  |
| <b>Citrus Unshiu (Satsuma Orange) Peel Extract<sup>i</sup></b> |   |                          |   |                      |   |                     |  |                     |
| <b>Totals<sup>f</sup></b>                                      | <b>40</b>                                     | <b>0.000002-0.94</b>     |   |                      |   |                     |  |                     |
| <b>Duration of Use</b>   |   |                          |   |                      |   |                     |  |                     |
| Leave-On   | 31  | 0.0002-0.094             |   |                      |   |                     |  |                     |
| Rinse Off  | 8   | 0.000002-0.94            |   |                      |   |                     |  |                     |
| Diluted for (Bath) Use   | 1   | 0.03                     |   |                      |   |                     |  |                     |
| <b>Exposure Type</b>   |   |                          |   |                      |   |                     |  |                     |
| Eye Area   | 3   | 0.000002-0.002           |   |                      |   |                     |  |                     |
| Incidental Ingestion   | NR  | NR                       |   |                      |   |                     |  |                     |
| Incidental Inhalation-Spray                                    | 9 <sup>a</sup> ; 15 <sup>b</sup>              | NR                       |   |                      |   |                     |  |                     |
| Incidental Inhalation-Powder                                   | 15 <sup>b</sup>                               | 0.002-0.094 <sup>c</sup> |   |                      |   |                     |  |                     |
| Dermal Contact   | 39  | 0.000002-0.94            |   |                      |   |                     |  |                     |
| Deodorant (underarm)   | NR  | NR                       |   |                      |   |                     |  |                     |
| Hair - Non-Coloring  | 1   | NR                       |   |                      |   |                     |  |                     |
| Hair-Coloring  | NR  | NR                       |   |                      |   |                     |  |                     |
| Nail   | NR  | NR                       |   |                      |   |                     |  |                     |
| Mucous Membrane  | 2   | 0.03                     |   |                      |   |                     |  |                     |
| Baby Products  | NR  | NR                       |   |                      |   |                     |  |                     |

NR = Not reported.

<sup>f</sup> Because each ingredient may be used in cosmetics with multiple exposure types, the sum of all exposure types may not equal the sum of total uses.<sup>a</sup> It is possible these products may be sprays, but it is not specified whether the reported uses are sprays.<sup>b</sup> Not specified whether a powder or a spray, so this information is captured for both categories of incidental inhalation.<sup>c</sup> It is possible these products may be powders, but it is not specified whether the reported uses are powders.<sup>d</sup> Listed as Citrus Aurantium (Bitter Orange) in the VCRP database.<sup>e</sup> Only listed in the VCRP database, not an INCI ingredient. Included because of similarity.<sup>f</sup> Includes three uses listed under Citrus Sinensis (Sweet Orange) Peel Extract in the VCRP database.<sup>g</sup> Listed as Citrus Sinensis (Sweet Orange) Peel Wax in the VCRP database.<sup>h</sup> Listed as Citrus Reticulata (Mandarin Orange) Peel Extract in the VCRP database.<sup>i</sup> Listed as Citrus Unshiu (Satsuma Orange) Peel Extract in the VCRP database.

**Table 9.** Ingredients that are not reported to be in use

Citrus Aurantifolia (Lime) Peel Water  
Citrus Aurantium Amara (Bitter Orange) Peel  
Citrus Aurantium Bergamia (Bergamot) Peel Water  
Citrus Aurantium Sinensis Peel Extract  
Citrus Depressa Peel Powder  
Citrus Grandis (Grapefruit) Peel  
Citrus Grandis (Grapefruit) Peel Powder  
Citrus Hassaku/Natsudaidai Peel Powder  
Citrus Iyo Peel Extract  
Citrus Iyo Peel Water  
Citrus Jabara Peel Extract  
Citrus Jabara Peel Water  
Citrus Junos Peel Powder  
Citrus Junos Peel Water  
Citrus Limon (Lemon) Peel  
Citrus Limon (Lemon) Peel Water  
Citrus Natsudaidai Peel Extract  
Citrus Nobilis (Mandarin Orange) Peel Powder  
Citrus Reticulata (Tangerine) Peel Powder  
Citrus Shunkokan Peel Extract  
Citrus Sunki Peel Extract  
Citrus Tachibana/Reticulata Peel Powder  
Citrus Tangelo Peel Powder  
Citrus Tangerina (Tangerine) Peel  
Citrus Tangerina (Tangerine) Peel Extract  
Citrus Unshiu Peel Powder  
Citrus Unshiu Peel Water

**Table 10.** Dermal irritation studies for Citrus peel-derived ingredients

| Test Article                                 | Concentration/Dose | Test Population      | Procedure  | Results       | Reference      |
|--|--------------------|----------------------|--|---------------|----------------|
| <b>NON-HUMAN</b>                             |                    |                      |  |               |                |
| Citrus Aurantium Dulcis<br>(Orange) Peel Wax | 100%               | details not provided | MATEX in vitro toxicity testing system; details not provided | no irritation | <sup>4,6</sup> |
| <b>HUMAN</b>                                 |                    |                      |  |               |                |
| Citrus Aurantium Dulcis<br>(Orange) Peel Wax | 100%               | details not provided | 48 h patch test; details not provided                        | no irritation | <sup>4,6</sup> |

**Table 11.** Photosensitization and phototoxicity studies

| Test Article   | Concentration/Dose           | Test Population                               | Procedure   | Results  | Reference |
|--|------------------------------|---|---|--|-----------|
| <b>NON-HUMAN</b>   |                              |   |   |  |           |
| lemon fruit juice and lemon peel juice (Tahitian and Sicilian varieties) | undiluted; liberally applied | 3 adult rats (strain not specified) per group | <ul style="list-style-type: none"> <li>-rats were painted with fresh lemon fruit juice or lemon peel juice from 2 lemon varieties on depilated skin on the right back; left side was negative control with only sunlight exposure</li> <li>-rats were placed in plastic tubes with eight orifices to allow natural sunlight through</li> <li>-exposure to sunlight was 2.5, 5, 7.5, or 10 min</li> <li>-experiment repeated with Tahitian variety lemon peel juice with sun block SPF 45, UVA and UVB</li> <li>-biopsies performed for each time period for histopathological studies and photodocumentation</li> </ul> | <ul style="list-style-type: none"> <li>-phytophotodermatitis observed after 48 h after exposure to both types of peel juice</li> <li>-no reactions observed to peel juice without sun exposure or to sun exposure alone</li> <li>-minimum exposure time of 2.5 min sufficient to induce phototoxic reaction, with longer exposures causes more intense reactions</li> <li>-histopathological studies showed epithelial time-dependent vacuolar degeneration</li> <li>-sunblock diminished reaction intensity, but did not prevent it</li> </ul>  | 17        |
| lemon peel juice (Tahitian variety)                                      | undiluted; liberally applied | 4 albino rats                                 | <ul style="list-style-type: none"> <li>-epilated right half of back of rats was sprayed with peel juice</li> <li>-one quadrant exposed to natural sunlight for 5 min and the other for 8 min;</li> <li>-left back served as control</li> <li>-biopsies taken after 1, 2, 3, 4, 5, 6, 24, 48, and 72 h from both sides</li> </ul>  | <ul style="list-style-type: none"> <li>-normal epidermis observed for first 6 time intervals on both sides</li> <li>-after 24 h, treated area showed keratinocyte necrosis, cytoplasmic vacuolization and spongiosis in all rats, independent of exposure time</li> <li>-after 48 h, erythema evident, strong vacuolization observed that progressed to sub- or intraepidermal blisters</li> <li>-erythema persisted after 72 h at a lesser intensity</li> <li>-control side has isolated keratinocyte necrosis with only 8 min of exposure after 24 h, but after 48 h only slight spongiosis was observed which resolved by 72 h</li> </ul> | 18        |
| lemon peel juice (Tahitian variety)                                      | undiluted                    | 4 adult rats (strain not specified)           | <ul style="list-style-type: none"> <li>-test material was applied to depilated skin on the right side of the animal's back, left side served as a control</li> <li>-animals exposed for 8 min to mid-day sunlight</li> <li>-biopsies performed immediately after induction and after 1 and 2 h and evaluated by transmission electron microscopy</li> <li>-at 24 and 48 h after induction, light microscopy performed on tissues to evaluate changes</li> </ul>   | <ul style="list-style-type: none"> <li>-no histological changes observed on control sites</li> <li>-immediately after induction, keratinocyte cytoplasmatic vacuolization and membrane ruptures near vacuolization sties were observed</li> <li>-at 1 h after, desmosomal changes observed in addition to vacuolization, keratin filaments were not attached to desmosomal plaques, and free desmosomes and membrane ruptures were observed</li> <li>-at 2 h after, similar changes were observed in addition to granular degeneration of keratin</li> </ul>   | 19        |

**Table 11.** Photosensitization and phototoxicity studies

| Test Article  | Concentration/Dose | Test Population   | Procedure  | Results  | Reference     |
|---|--------------------|---|--|--|---------------|
| <b>HUMAN</b>  |                    |   |  |  |               |
| citrus aurantium dulcis (orange) peel wax                               | 100% undiluted     | 11 subjects, fair skinned with skin types I-III             | <ul style="list-style-type: none"> <li>- 2 sites treated with 0.2 ml of the test material and 1 site was untreated; patches were occluded and applied to the back</li> <li>- 24 h after dosing, subjects were exposed to sunlight for 5-10 min, a Solar UV Simulator® with a 150 watt xenon arc lamp (UVA and UVB 290-400 nm) with a Schott WG 345 to filter out UVB (290-320 nm) so that only UVA was delivered (320-400 nm).</li> <li>- test sites were examined 15 min, 24 h, and 48 h after irradiation</li> </ul> | no phototoxic response was observed  | <sup>21</sup> |
| sweet orange peel, mesocarp, and fruit and alcohol extractions of all 3 | undiluted          | 3 subjects with type I skin and 1 subject with type II skin | <ul style="list-style-type: none"> <li>-in duplicate Finn Chambers, peel, mesocarp, or fruit were applied directly to skin or as alcohol extract solutions (0.2 g/0.2 ml) at 20 µl on paper discs</li> <li>-closed patches were 1 h in duration</li> <li>- 48 h after dosing, subjects were exposed to sunlight for 30 min, a Phillips blacklight TL 20W/09 (320-440 nm) that delivered a total dose of 2.5 J/cm<sup>2</sup></li> <li>- test sites were examined 8, 24, 48, 72, and 96 h after irradiation</li> </ul>  | <ul style="list-style-type: none"> <li>-strong erythema (++) observed in 2 subjects with type I skin and strong erythema and infiltration (+++) observed in 1 subject with type I skin after 48 h after irradiation and exposure to pure peel and peel extract</li> <li>-slight erythema observed in all 3 type I subjects after exposure to pure peel and peel extract with no sun exposure after 48 h</li> <li>-no reactions observed to mesocarp or fruit, either pure or extract</li> <li>-no reactions induced in the type II skin subject</li> </ul> | <sup>20</sup> |

## REFERENCES

1. Nikitakis J and Breslawec HP. International Cosmetic Ingredient Dictionary and Handbook. 15 ed. Washington, DC: Personal Care Products Council, 2014.
2. Burnett CL, Fiume MM, Bergfeld WF, Belsito DV, Hill RA, Klaassen CD, Liebler DC, Marks JG, Shank RC, Slaga TJ, Snyder PW, and Gill LG. Safety Assessment of Citrus-Derived Peel Oils as Used in Cosmetics. 1620 L Street NW, Suite 1200, Washington, DC 20036-4702, Cosmetic Ingredient Review. 2014.
3. Personal Care Products Council. 6-5-2015. Review of Citrus Genus Species Names.
4. Koster Keunen. 2008. Toxicology and safety assessment for orange peel wax.
5. European Commission. Scientific Committee on Consumer Safety (SCCS) opinion on fragrance allergens in cosmetic products. [http://ec.europa.eu/health/scientific\\_committees/consumer\\_safety/docs/scce\\_o\\_102.pdf](http://ec.europa.eu/health/scientific_committees/consumer_safety/docs/scce_o_102.pdf). Last Updated 2012. Date Accessed 9-3-2013.
6. Puleo SL and Rit TP. Orange peel wax. *Cosmetics and Toiletries*. 1994;109(8):42-48.
7. Food and Drug Administration (FDA). Frequency of use of cosmetic ingredients. *FDA Database*. 2015. Washington, DC: FDA.
8. Personal Care Products Council. 7-25-2013. Concentration of use by FDA Product Category: Citrus Derived Ingredients. 24 pages.
9. Rothe H, Fautz R, Gerber E, Neumann L, Rettinger K, Schuh W, and Gronewold C. Special aspects of cosmetic spray safety evaluations: Principles on inhalation risk assessment. *Toxicol Lett*. 2011;205(2):97-104.
10. Rothe H. Special Aspects of Cosmetic Spray Evaluation. 9-26-2011.
11. Bremmer HJ, Prud'homme de Lodder LCH, and Engelen JGM. Cosmetics Fact Sheet: To assess the risks for the consumer; Updated version for ConsExpo 4. 2006. Report No. RIVM 320104001/2006. pp. 1-77.
12. Johnsen MA. The Influence of Particle Size. *Spray Technology and Marketing*. 2004;14(11):24-27.
13. European Commission. Scientific Committee on Consumer Products (SCCP) Opinion on Furocoumarins in Cosmetic Products. 12-13-2005. [http://ec.europa.eu/health/ph\\_risk/committees/04\\_sccp/docs/scce\\_o\\_036.pdf](http://ec.europa.eu/health/ph_risk/committees/04_sccp/docs/scce_o_036.pdf). Date Accessed 6-3-2013. Report No. SCCP/0942/05.
14. International Fragrance Association. IFRA standard for citrus oils and other furocoumarins-containing essential oils. [http://www.ifra.org/en-us/standards\\_restricted](http://www.ifra.org/en-us/standards_restricted). Last Updated 10-14-2009. Date Accessed 2-26-2013.
15. International Fragrance Association. IFRA standard for 7-methoxycoumarin. <http://www.ifra.org/en-us/search/s/lime#.UiQD0TXD-Uk>. Last Updated 2009. Date Accessed 9-1-2013.
16. Integrated Laboratory Systems. Bitter orange (*Citrus aurantium* var. amara) extracts and constituents ( $\pm$ )-p-Synephrine [CAS No. 94-07-5] and ( $\pm$ )-p-octapamine [CAS No. 104-14-3]. Review of toxicological literature prepared for the National Toxicology Program. [http://ntp.niehs.nih.gov/ntp/htdocs/Chem\\_Background/ExSumPdf/Bitterorange\\_508.pdf](http://ntp.niehs.nih.gov/ntp/htdocs/Chem_Background/ExSumPdf/Bitterorange_508.pdf). Last Updated 2004. Date Accessed 3-7-2013.
17. Gonçalves NEL, de Almeida HL, Hallal EC, and Amado M. Experimental phytophotodermatitis. *Photodermatol Photoimmunol Photomed*. 2005;21:318-321.
18. Jorge VM, de Almeida HL, and Amado M. Serial light microscopy of experimental phytophotodermatitis in animal model. *J Cutan Pathol*. 2009;36:338-341.

19. de Almeida HL, Sotto MN, de Castro LAS, and Rocha NM. Transmission electron microscopy of the preclinical phase of experimental phytophotodermatitis. *Clinics*. 2008;63:371-374.
20. Volden G, Krokan H, Kavli G, and Midelfart K. Phototoxic and contact toxic reactions of the exocarp of sweet oranges: A common cause of cheilitis? *Contact Dermatitis*. 1983;9:201-204.
21. Consumer Product Testing Co. 1993. Phototoxicity of Orange Wax 100%.
22. Vester L, Thyssen JP, Menné T, and Johansen JD. Occupational food-related hand dermatoses seen over a 10-year period. *Contact Dermatitis*. 2012;66:264-270.

---

## Safety Assessment of Citrus-Derived Peel Oils as Used in Cosmetics

---

Status: Final Report  
Release Date: September 30, 2014  
Panel Meeting Date: September 8-9, 2014

The 2014 Cosmetic Ingredient Review Expert Panel members are: Chairman, Wilma F. Bergfeld, M.D., F.A.C.P.; Donald V. Belsito, M.D.; Ronald A. Hill, Ph.D.; Curtis D. Klaassen, Ph.D.; Daniel C. Liebler, Ph.D.; James G. Marks, Jr., M.D., Ronald C. Shank, Ph.D.; Thomas J. Slaga, Ph.D.; and Paul W. Snyder, D.V.M., Ph.D. The CIR Director is Lillian J. Gill, D.P.A. This report was prepared by Christina Burnett, Senior Scientific Analyst/Writer and Monice Fiume, Assistant Director/Senior Scientific Analyst.

---

### Cosmetic Ingredient Review

1620 L Street NW, Suite 1200 ◇ Washington, DC 20036-4702 ◇ ph 202.331.0651 ◇ fax 202.331.0088 ◇  
[cirinfo@cir-safety.org](mailto:cirinfo@cir-safety.org)

## **ABSTRACT**

The CIR Expert Panel assessed the safety of 14 Citrus-derived peel oil ingredients and concluded that these ingredients are safe for use in cosmetic products when finished products, excluding rinse-off products, do not contain more than 0.0015% (15 ppm) 5-methoxysoralen (5-MOP), and when formulated to be non-sensitizing and non-irritating. The citrus-derived peel oil ingredients are most frequently reported to function in cosmetics as fragrances and/or skin conditioning agents. The Panel reviewed the available animal and clinical data to determine the safety of these ingredients. Because final product formulations may contain multiple botanicals, each containing similar constituents of concern, formulators are advised to be aware of these constituents and to avoid reaching levels that may be hazardous to consumers. Industry should use good manufacturing practices to limit impurities that could be present in botanical ingredients.

## **INTRODUCTION**

Citrus-derived peel oils are widely used as cosmetic ingredients, and are most frequently reported to function in cosmetics as fragrances and/or skin conditioning agents (Table 1). This report assesses the safety of the following 14 citrus-derived peel oils:

|   |   |
|---|---|
| Citrus Aurantifolia (Lime) Peel Oil             | Citrus Junos Peel Oil                     |
| Citrus Aurantium Amara (Bitter Orange) Peel Oil | Citrus Limon (Lemon) Peel Oil             |
| Citrus Aurantium Currassaviensis Peel Oil       | Citrus Medica Vulgaris Peel Oil           |
| Citrus Aurantium Dulcis (Orange) Peel Oil       | Citrus Nobilis (Mandarin Orange) Peel Oil |
| Citrus Clementina Peel Oil                      | Citrus Reticulata (Tangerine) Peel Oil    |
| Citrus Grandis (Grapefruit) Peel Oil            | Citrus Tachibana/Reticulata Peel Oil      |
| Citrus Iyo Peel Oil                             | Citrus Tangerina (Tangerine) Peel Oil     |

The citrus ingredients in this assessment are found in foods, and daily exposure from food use would result in much larger systemic exposures than those from use in cosmetic products. Additionally, essential oils, oleoresins (solvent-free), and natural extracts (including distillates) derived from some citrus fruits are generally recognized as safe (GRAS) for their intended use in foods for human and animal consumption according to the Food and Drug Administration (FDA). Volatile oils of limes, lemons, grapefruits, bitter oranges, oranges, and tangerines are described as flavoring agents in the United States Pharmacopeia (USP) Food Chemicals Codex.<sup>1</sup> Thus, the systemic toxicity potential of citrus-derived peel oils via oral exposure is not addressed further in this report. The primary focus of the safety assessment of these citrus ingredients as used in cosmetics is on the potential for irritation and sensitization from dermal exposure.

The CIR does not review ingredients that function only as fragrance ingredients because, as fragrances, the safety of these ingredients is evaluated by the Research Institute for Fragrance Materials (RIFM). Three of the citrus-derived peel oils in this report function only as fragrance ingredients, according to the *International Cosmetic Ingredient Dictionary and Handbook* (see Table 2).<sup>2</sup> However, RIFM has not confirmed that these three ingredients function only as fragrances and therefore within its purview, thus CIR is reviewing the safety of these ingredients.

Botanicals such as citrus contain hundreds of constituents, some of which have the potential to cause toxic effects. For example, bergapten (aka 5-methoxysoralen or 5-MOP) is a naturally-occurring phototoxic furanocoumarin (psoralen) in citrus peel oils. In this assessment, CIR is reviewing information available to evaluate the potential toxicity of each of the citrus-derived peel oils as a whole, complex substance. Except for specific constituents of concern, CIR is not reviewing information that may be available to assess the potential toxicity of the individual constituents of which the citrus-derived ingredients are composed. CIR requested information on the concentrations (including ranges, means, upper 95 percent confidence limits, detection limits, etc.) of individual constituents in citrus-derived peel oils used in cosmetics to facilitate the safety assessment of these ingredients. Such information on constituents that have been identified as constituents of concern by the Panel in previous safety assessments, or by other recognized scientific expert review bodies, is especially important.

Some toxicological data on lemon oil and sweet orange oil (synonyms: lemon, ext. and orange, sweet, ext., respectively) reviewed in this safety assessment were obtained from robust summaries of data submitted to the European Chemical Agency (ECHA) by companies as part of the REACH chemical registration process. These data are available on the ECHA website.<sup>3,4</sup>

Note: In many of the published studies included in this assessment, the information provided is not sufficient to determine how well the substance being tested represents the cosmetic ingredient. In this safety assessment, if a substance tested in a study is not clearly a cosmetic ingredient, because of lack of information on the genus and species from which the substance was derived and/or the method of extraction used, the test substance will be referred to by a common name (e.g. lime oil). If the substance is clearly a cosmetic ingredient, the International Nomenclature of Cosmetic Ingredients (INCI) name will be used (e.g. “*citrus aurantifolia* (lime) peel oil”). In some instances, the part of the plant from which the oil was expressed is not known but, based on the method of manufacture, the oil could have been expressed from the peels of the citrus fruit. Additionally, some inconsistencies were noted in both taxonomic and INCI naming conventions. For example, this report includes the sweet orange ingredient described as *citrus aurantium dulcis* (orange) peel oil in the *International Cosmetic Ingredient Dictionary and Handbook*.<sup>2</sup> In contrast, most of the published literature and FDA refer to this ingredient as *citrus sinensis* (sweet orange) peel oil. Another example of a naming inconsistency is *citrus grandis* (grapefruit) peel oil; *Citrus grandis* is generally considered a name for a pummelo, and is more commonly called *Citrus maxima*. The INCI Committee of the Personal Care Products Council (Council) is working to correct some of these errors.

## CHEMISTRY

### **Definition and General Characterization**

The definitions and functions of the citrus-derived peel oils included in this report are provided in Table 1. In some cases, the definition provides insight on the method(s) of manufacture. It should be noted that essential oils are hydrophobic, liquid, volatile aroma compounds from plants. These are typically mixtures of small molecules, but their chemical structures can vary widely. The volatile nature of essential oils makes them likely to be useful as fragrances, but does not preclude other functions for them in cosmetics.

There are numerous *Citrus* varieties distributed throughout the world; most citrus fruits are grown in the temperate and tropical zones in both the northern and southern hemispheres.<sup>5</sup> Citrus can be propagated and new varieties can be produced by cultivating asexual nuclear or chance seedlings or by crossing or mutation.

### **Physical and Chemical Properties**

Physical and chemical properties of the citrus-derived peel oils are provided in Table 3.

### **Method of Manufacturing**

A suitable antioxidant can be added to citrus oil during preparation.<sup>1</sup>

Bitter orange oil and orange oil are obtained using a cold-pressed extraction method from the fresh peel of the fruit of *Citrus aurantium* and *Citrus sinensis*, respectively.<sup>1</sup> *Citrus grandis* oil<sup>6</sup> and *Citrus junos* oil<sup>7</sup> are also extracted using a cold-press method. Tangerine oil (cold-pressed) is obtained from the peels of the ripe fruit of the Dancy tangerine, *Citrus nobilis* or *Citrus reticulata*, and from some other closely related varieties.<sup>1</sup>

Lemon oil and lime oil, expressed, are produced by pressing the outer rind of the ripe fruit by hand or by machine.<sup>8</sup> More economical processes involve an integrated juice-oil procedure. These oils can also be produced by distillation of expressed oils or direct distillation of fruit; distilling (rectifying) removes terpenes. Steam distillation removes non-volatile furocoumarins.

Citrus iyo oil is produced by removing the peel from the fruit, homogenization of the peel with distilled water, and lyophilization.<sup>9</sup> The oil is purified using vacuum distillation.

Mandarin peel oil, expressed (identified in the literature as *Citrus reticulata*), is prepared by expression of the peels of the ripe fruit of the mandarin orange.<sup>10</sup>

### **Constituents/Composition**

The citrus-derived peel oils are complex botanicals composed of numerous constituents; there is great variation among citrus species and cultivars because of frequent bud mutations, interspecific and intergeneric hybridization, and apomixis (i.e., one or more of several types of asexual reproduction).<sup>11</sup> The composition of citrus oils will vary based on the location where the plant is grown, the maturity of the plant, and storage conditions.<sup>5</sup> The method of extraction will also affect the composition.

Citrus oils contain large amounts of monoterpene hydrocarbons. Limonene is the constituent present in the greatest amount, often comprising greater than 90% of the oil, and the amount present can vary within the oil; for example, limonene is reported to compose 38.1%-95.8% *C. limon* (lemon) peel essential oils, cold pressed.<sup>12,13</sup> Citrus oils

also contain sesquiterpene hydrocarbons, which are responsible for the characteristic flavors of these oils.<sup>12</sup> Table 4 lists the chemical compositions of cold-pressed,<sup>6,7,11-16</sup> hydrodistilled,<sup>17-21</sup> lyophilization/vacuum distillation,<sup>9</sup> and steam-distilled<sup>22</sup> peel oils sorted by citrus plant species, Table 5 presents the typical levels of 5-MOP found in some of the oils, and Table 6 provides the levels of major coumarins and furocoumarins in lemon and lime oil. Table 7 lists citrus constituents that are established contact allergens, according the European Commission's Scientific Committee on Consumer Safety (SCCS).

## USE

### Cosmetic

Table 8 presents the current product-formulation use data for citrus-derived peel oils. These ingredients are most frequently reported to function as fragrances and/or skin conditioning agents-miscellaneous.<sup>2</sup>

According to information supplied to the FDA by industry as part of the Voluntary Cosmetic Registration Program (VCRP), citrus limon (lemon) peel oil has the most reported uses in cosmetic and personal care products, with a total of 490; more than half of the uses are in leave-on skin care preparations.<sup>23</sup> Citrus aurantium dulcis (orange) peel oil (reported as citrus sinensis (sweet orange) peel oil by the VCRP) has the second greatest number of overall uses reported, with a total of 289; about half of those uses are in leave-on skin care preparations.

In a use concentration survey conducted by the Council, citrus limon (lemon) peel oil had a maximum use concentration range of 0.0001% to 0.5% with 0.5% reported in “other” skin care preparations.<sup>24</sup> Citrus aurantium dulcis (orange) peel oil had a maximum use concentration range of 0.00002% to 29%, with 29% reported in non-coloring hair conditioners.

In some cases, reports of uses were received from the VCRP, but no concentration of use data were provided. For example, citrus junos peel oil is reported to be used in 6 formulations, but no use concentration data were available. In other cases, no reported uses were identified by the VCRP, but a maximum use concentration was provided in the industry survey. For example, citrus grandis (grapefruit) peel oil was not reported in the VCRP database to be in use, but the industry survey indicated that it is used at concentrations up to 0.05%. It should be presumed that citrus grandis (grapefruit) peel oil is used in at least one cosmetic formulation.

Table 9 lists the seven citrus-derived peel oils not indicated to be in use based on the VCRP data and the results of the Council concentration of use survey.

Under the rules governing cosmetic products in the European Union, citrus-derived ingredients must have furocoumarin content below 1 mg/kg in sun-protection products and in bronzing products.<sup>25</sup> The International Fragrance Association (IFRA) has issued standards for citrus oils and other furocoumarin-containing essential oils.<sup>26</sup> Thus, finished products that are applied to the skin, excluding rinse-off products like bath preparations and soaps, must not contain more than 0.0015%, or 15 ppm, 5-MOP. This equates to 0.0075%, or 75 ppm, in a fragrance compound used at 20% in a consumer product that is applied to the skin. If the level of 5-MOP has not been determined, limits specified for individual oils should be observed, and when such oils are used in combination with other phototoxic ingredients, the potential for an additive effect should be considered and use levels should be reduced accordingly. Restrictions for furocoumarin-containing essential oils have been recommended for bitter orange oil expressed, grapefruit oil expressed, lemon oil cold pressed, and lime oil expressed.

An IFRA standard also has been issued for 7-methoxycoumarin, which is prohibited for use in fragrance compounds.<sup>27</sup> Based on established maximum levels of this substance from commercially-available natural sources (like essential oils, extracts and absolutes), exposure to 7-methoxycoumarin from the use of these oils and extracts is regarded to be acceptable if the level of 7-methoxycoumarin in the finished product does not exceed 100 ppm. An example of a maximum concentration based on this standard is 0.1% for lime cold pressed oil.

Additionally, IFRA has set a standard stating that d-, l-, and dl-limonene and natural products containing substantial amounts of it, should only be used when the level of peroxides is kept to the lowest practical level; such products should have a peroxide value of <20 mmol/l.<sup>28</sup> This standard is also cited by the European Commission.<sup>29</sup> The European Union also states that limonene must be included in the list of ingredients when its concentration exceeds 0.001% in leave-on products and 0.01% in rinse-off products.

The IFRA has also set limits on the amounts of some citrus-derived oils in finished products. For leave-on products applied to skin areas exposed to direct sunlight, these limits include: 1.25% bitter orange peel expressed;<sup>30</sup> 4% grapefruit oil expressed;<sup>31</sup> 2% lemon oil cold-pressed;<sup>32</sup> 0.7% lime oil expressed.<sup>33</sup> There are no restrictions for any of these oils in rinse-off products and products that are not applied to the skin. IFRA specified that if combinations of phototoxic fragrance ingredients are used, the use levels must be reduced accordingly, so that the sum of the concentrations of all phototoxic fragrance ingredients, expressed as a percentage of their respective recommended maximum levels, shall not exceed 100% in the consumer product. Additionally, the IFRA general standard described above for ‘Citrus oils and other furocoumarins-containing essential oils’ must be considered.

#### **Non-Cosmetic**

The essential oils, oleoresins (solvent-free), and natural extractives (including distillates) derived from the following citrus fruits are GRAS for their intended use in foods for human consumption: *Citrus aurantifolia* (lime); *Citrus aurantium* (bitter orange; the flowers and peel); *Citrus limon* (lemon); *Citrus reticulata* (tangerine); *Citrus reticulata blanco* (mandarin); *Citrus sinensis* (orange; the leaf, flowers, and peel) and citrus peels (species not specified) (21CFR182.20). These essential oils, oleoresins (solvent-free), and natural extractives (including distillates) of these citrus fruits are GRAS for their intended use in animal drugs, feeds, and related products (21CFR582.20).

Citrus essential oils are used in the pharmaceutical industry as flavoring agents to mask the unpleasant taste of drugs.<sup>18</sup> *Citrus aurantium* amara (bitter orange) and extracts of its dried fruit and peel have been used in traditional Western medicines and in Chinese and Japanese herbal medicines.<sup>34</sup>

#### **TOXICOLOGICAL STUDIES**

As noted earlier, the citrus ingredients in this assessment are found in foods, and daily exposures from food use would result in a much larger systemic exposure than those from use in cosmetic products. Essential oils, oleoresins (solvent-free), and natural extracts (including distillates) derived from some citrus fruits are GRAS for their intended use in foods for human and animal consumption according to the FDA. Volatile oils of limes, lemons, grapefruits, bitter oranges, oranges, and tangerines are described as flavoring agents in the USP Food Chemicals Codex.<sup>1</sup> Therefore, the systemic toxicity potential of these ingredients is not addressed further in this report. The primary focus of this safety assessment is on the potential for irritation and sensitization from dermal exposure to these citrus ingredients as used in cosmetic products.

#### **Acute Toxicity**

##### **Dermal – Non-Human**

###### Lemon Oil

The dermal LD<sub>50</sub> of lemon oil was greater than 10 g/kg in rabbits.<sup>3</sup> An occlusive patch of undiluted oil was applied to the skin of six animals for 24 h. One animal died during the observation period.

###### Mandarin Oil – Expressed (*Citrus reticulata*)

The dermal LD<sub>50</sub> of mandarin peel oil (*Citrus reticulata*) was greater than 5 g/kg in rabbits.<sup>10</sup> An occlusive patch of undiluted oil was applied to the skin of seven animals for 24 h.

###### Orange Oil

The dermal LD<sub>50</sub> of sweet orange oil was greater than 5 g/kg in female New Zealand White rabbits.<sup>4</sup> An occlusive patch of undiluted oil was applied to the skin of 10 animals for 24 h. Signs of skin irritation were reported, including moderate redness in 10/10 animals, slight edema in 3/10 animals, and moderate edema in 5/10 animals.

#### **REPRODUCTIVE AND DEVELOPMENTAL TOXICITY**

No published reproductive and developmental studies on citrus-derived peel oils were identified in a literature search for these ingredients, and no unpublished data were submitted.

#### **GENOTOXICITY**

Genotoxicity studies for in vitro assays are summarized in Table 10. No genotoxic effects were observed for lemon oil or sweet orange oil in bacterial reverse mutation assays, mouse lymphoma cell mutation assays, and Chinese hamster chromosome aberration assays.<sup>3,4</sup>

## **CARCINOGENICITY**

### Orange Oil, Lemon Oil, Grapefruit Oil and Lime Oil

Tumor-promoting activity was observed in mouse skin exposed to essential oils of orange (sweet), lemon, grapefruit, or lime.<sup>35</sup> Chemical constituents of these oils were not fully identified in this study, although the terpene and non-terpene fractions were separated. Groups of 10 male and 10 female strain 101 mice received a single application of 9,10-dimethyl-1,2-benzanthracene (DMBA) in acetone (300 µg in 0.2 ml in 4 groups, 225 µg in 0.15 ml in a fifth group). Group 1 was a control group that received no further treatments. Groups 2 through 5 received weekly applications of 0.25 ml of the test substances 3 weeks after the application of DMBA.

By the fifth week, papillomas were observed in Group 3 (lemon oil), Group 4 (grapefruit oil), and Group 5 (lime oil). Papillomas were observed in Group 2 (orange oil) by the 12<sup>th</sup> week. After 33 weeks, 10/20 mice in the lemon oil and lime oil treatment groups and 13/20 mice in the grapefruit oil and orange oil groups had papillomas. Only 1 mouse in the control group had papillomas after 33 weeks, and the affected site was not the treated skin. Additionally, one female mouse of the lemon oil group developed a sebaceous-gland tumor of the nipple. No malignant skin tumors were observed in the orange oil group: treatment for this group was stopped after 42 weeks. Squamous cell carcinomas of the skin were observed in two mice from the lemon oil group and two mice of the grapefruit oil group between weeks 36 and 55. One malignant skin tumor was observed in the lime oil group at week 34; however, the mouse was found dead and a proper histological examination was not possible. No malignant skin tumors were observed in the control group. Non-dermal tumors during the treatment period were observed in one mouse of the orange oil group (a hemangioma of the subcutaneous tissue starting at week 7) and in one mouse of the grapefruit oil group (a spindle cell sarcoma of the subcutaneous tissues). No tumors of the internal organs were observed. The survival of all the mice, including the controls, in this experiment was poor because of a very high incidence of renal disease.<sup>35</sup>

### Orange Oil

Tumor-promoting activity was observed in mouse skin exposed to orange (sweet) oil.<sup>35</sup> In the study, groups of 10 male and 10 female strain 101 mice received a single application of DMBA in acetone (300 µg in 0.15 ml). One group (15 mice of each sex) was a control group that received no further treatments. Two groups received weekly applications of 0.25 ml of 40% orange oil in acetone or 80% orange oil in acetone 3 weeks after the initial application of DMBA. The applications continued for 37 weeks.

Papillomas were observed in both groups treated with orange oil starting on the 12<sup>th</sup> week. After 33 weeks, 5/10 mice treated with 40% orange oil and 10/10 mice treated with 80% orange oil had papillomas, and at study end, only 1 tumor of each group was found outside of the treated area. Four mice in the control group had papillomas by week 33, but these tumors were outside of the treated area of the skin. Malignant tumors were observed in one mouse of each treatment group, arising from the pre-existing papilloma. Both tumors were squamous-cell carcinomas infiltrating the panniculus muscle. Additionally, tumors of the urethral orifice were observed in 4 female mice of the 40% orange oil group. The survival of all the mice in this experiment was poor due to a very high incidence of renal disease.

In the same study, tumor-promoting activity was observed in mice exposed to undiluted orange oil after pretreating the mice with either dermal or intraperitoneal injections of urethane. The effect was weak compared to the effects observed after DMBA induction.

A similar experiment performed in the same study tested the carcinogenic effects of orange oil without pretreatment with DMBA or urethane. The mice were treated once weekly with 0.25 ml of 40% or 80% orange oil in acetone or undiluted orange oil for 38 (diluted) or 46 (undiluted) weeks. This study found no evidence of direct tumorigenic effects on the treated mouse skin. Urethral orifice tumors were observed in one female mouse of the 40% orange oil group and in one female mouse of the 80% orange oil group. A papilloma was observed on the head of a mouse (outside of the treatment site) that was treated with 80% orange oil.<sup>35</sup>

## **IRRITATION AND SENSITIZATION**

### **Dermal Irritation**

Dermal irritation studies are summarized in Table 11. Lemon oil, orange oil, and mandarin peel oil all produced some reaction in irritation studies in animals, but in human subjects, no irritation was observed after topical exposure to lemon oil (up to 20%) or mandarin peel oil (8%).<sup>3,4,10,36</sup>

## Ocular Irritation

### Lemon Oil

Lemon oil tested at 5% was not irritating to the eyes of 3 albino rabbits.<sup>3</sup> Each rabbit had 0.1 ml of the test material instilled into the right eye with no further treatment. The left eye served as the control. Eyes were examined every 24 h for 4 days and then again on the 7<sup>th</sup> day. No corneal opacity or iris congestion was observed. An intense conjunctival irritation involving chemosis and discharge occurred. Treated eyes were normal on the 7<sup>th</sup> day.

### Orange Oil

Orange oil tested undiluted did not induce significant or irreversible damage to the eyes of three male New Zealand White rabbits.<sup>4</sup> The test was performed in accordance with OECD guideline 405. The test material (0.1 ml) was instilled into one eye of each rabbit. The mean scores calculated for the three animals across 3 scoring times were 0.0 for corneal opacity and iris lesions and 1.0 for reddening of the conjunctivae.

## Sensitization

Sensitization studies are presented in Table 12. Mandarin peel oil (8% in petrolatum) was not sensitizing in human maximization tests. In studies of 250 dermatitic patients, less than 2.5% had positive reactions to bitter orange oil, lemon oil, or sweet orange oil tested at 2% in paraffin.<sup>3,4,10,37</sup>

## Phototoxicity and Photosensitization

Phototoxicity and photosensitization studies are presented in Table 13. Phototoxic potential was observed for sweet orange oil and lemon oil in in vitro studies. No phototoxic responses were noted in some animal studies of lime oil, lemon oil, grapefruit oil, mandarin oil, or tangerine oil; however, signs of phototoxicity were observed in response to undiluted lime oil and lime oil diluted to concentrations of 15%; undiluted bitter orange oil, and undiluted lemon oil and lemon oil diluted to concentrations of 50%. In human studies, phototoxic reactions were observed in response to undiluted bitter orange oil, lemon oil (1%), sweet orange oil (1%), and undiluted and diluted expressed lime oil (30%). Many of the citrus-derived peel oils contain constituents that are photoactive agents, although those noted to be furocoumarin-free tended not to induce photosensitization.<sup>19,30,38-41</sup>

## Occupational Exposure

In a retrospective study (2001-2010) of professional food handlers in Denmark, 8.5% (16/188) of the patients had positive skin prick test reactions to orange peel and 7.9% (15/191) of the patients had positive skin prick test reactions to lemon peel.<sup>42</sup>

## SUMMARY

The 14 citrus-derived peel oils described in this report function primarily as skin conditioning agents-miscellaneous and fragrance. Botanicals such as citrus are composed of hundreds of constituents, some of which have the potential to cause toxic effects; for example, bergapten (aka 5-methoxypsoralen or 5-MOP) is a naturally-occurring, phototoxic furanocoumarin (psoralen) in citrus peel oils. Presently, CIR reviewed the information available on the potential toxicity of each of the citrus peel oil-derived ingredients as a whole, complex substance; CIR did not review the potential toxicity information on the individual constituents of which the citrus-derived ingredients are comprised. CIR requested information on the concentrations (including ranges, means, upper 95 percent confidence limits, detection limits, etc.) of individual constituents in the citrus peel oil-derived ingredients used in cosmetics, to facilitate the safety assessment of these ingredients. Such information on constituents that have been identified as of concern by the Panel in previous safety assessments, or by other recognized scientific expert review bodies, is especially important.

Citrus oils contain large amounts of monoterpene hydrocarbons; limonene is present in the greatest amount, composing 38.1-95.8% of the oils. Citrus oils also contain sesquiterpene hydrocarbons, which are responsible for the characteristic flavor of these oils.

Citrus limon (lemon) peel oil has the most reported uses in cosmetics and personal care products, with a total of 490; more than half of the uses are in leave-on skin care preparations. The range of highest maximum use concentrations for citrus limon (lemon) peel oil is 0.0001% to 0.5%, with 0.5% reported in “other” skin care preparations. Citrus aurantium dulcis (orange) peel oil (reported as citrus sinensis (sweet orange) peel oil to the VCRP) has the second greatest number of overall uses reported, with a total of 289; about half of those uses are in leave-on skin care preparations. Citrus aurantium dulcis (orange) peel oil had a highest maximum use concentration range of 0.00002% to 29%, with 29% reported in non-coloring hair conditioners.

Under the rules governing cosmetic products in the European Union, citrus-derived ingredients must have furocoumarin content below 1 mg/kg in sun-protection and bronzing products. IFRA also has issued standards for citrus oils and other furocoumarin-containing essential oils. Finished products that are applied to the skin, excluding rinse-off products like bath preparations and soaps, must not contain more than 0.0015% or 15 ppm 5-MOP. If the level of 5-MOP has not been determined, limits specified for individual oils should be observed, and when such oils are used in combination with other phototoxic ingredients, the potential additive effect should be taken into consideration and use levels should be reduced accordingly. Restrictions for furocoumarin-containing essential oils and limits on the amounts of citrus-derived oils in finished products have been recommended for bitter orange oil expressed, grapefruit oil expressed, lemon oil cold pressed, and lime oil expressed.

The European Union also set standards for limonene, stating that limonene must be included in the list of ingredients when its concentration exceeds 0.001% in leave-on products and 0.01% in rinse-off products.

The citrus-peel oils in this assessment are found in foods, and the daily exposure from food use would result in a much larger systemic dose than that resulting from use in cosmetic products. Essential oils, oleoresins (solvent-free), and natural extractives (including distillates) derived from some citrus fruits are GRAS for their intended use in foods for human and animal consumption,

The dermal LD<sub>50</sub> of undiluted mandarin peel oil (*Citrus reticulata*) and undiluted sweet orange oil was greater than 5 g/kg in rabbits. In undiluted lemon oil, the dermal LD<sub>50</sub> was greater than 10 g/kg in rabbits.

No genotoxic effects were observed in lemon oil or sweet orange oil in bacterial reverse mutation assays, mouse lymphoma cell mutation assays, and Chinese hamster chromosome aberration assays.

Tumor-promoting activity was observed in mouse skin exposed to undiluted essential oils of orange (sweet), lemon, grapefruit, or lime after pretreatment with DMBA. Related studies of 40%, 80%, or 100% orange oil following pretreatment with DMBA or urethane also reported tumor-promoting activity, although the effect was weaker in the mice induced with urethane. No tumorigenic effects were observed in mice tested with orange oil without pretreatment with DMBA or urethane. Survival rates of the mice, including controls, in these experiments were poor because of a very high incidence of renal disease

Irritation was observed in animals treated with unspecified concentrations of mandarin peel oil. In human subjects, no irritation was observed after topical exposure to lemon oil (up to 20%) or mandarin peel oil (8%).

In rabbits, lemon oil tested at 5% was not irritating and orange oil tested undiluted did not induce significant or irreversible damage to the eyes.

Mandarin peel oil (8% in petrolatum) was not sensitizing in human maximization tests. In studies of 250 dermatitic patients, less than 2.5% had positive reactions to bitter orange oil, lemon oil, or sweet orange oil tested at 2% in paraffin.

Phototoxic potential was observed for sweet orange oil and lemon oil in *in vitro* studies. No phototoxic responses were noted in some animal studies of lime oil, lemon oil, grapefruit oil, mandarin oil, or tangerine oil; however, phototoxic reactions were observed in response to undiluted lime oil and lime oil diluted to concentrations of 15%; undiluted bitter orange oil, and undiluted lemon oil and lemon oil diluted to concentrations of 50%. In human studies, phototoxic reactions were observed in response to undiluted bitter orange oil, lemon oil (1%), sweet orange oil (1%), and undiluted and diluted expressed lime oil (30%). Many of the citrus-derived peel oils contain constituents that are photoactive agents, although those noted to be furocoumarin-free tended not to induce photosensitization.

A retrospective occupational study of food handlers noted positive reactions to orange and lemon peels.

No published studies on reproductive and development toxicity of citrus-derived peel oils were discovered and no unpublished data were submitted to address these topics.

## **DISCUSSION**

The citrus ingredients in this assessment are found in foods, and daily exposures from the consumption of foods can be expected to yield much larger systemic exposures to these ingredients than those from the use of cosmetic products. Essential oils, oleoresins (solvent-free), and natural extracts (including distillates) derived from some citrus fruits are GRAS in foods and animal feeds. Additionally, volatile oils of limes, lemons, grapefruits, bitter oranges, oranges, and tangerines are used as flavoring agents. Consequently, the primary focus of this safety assessment is on the potential for irritation and sensitization from dermal exposures to the citrus ingredients.

Most of the reports that the Panel reviewed were not sufficiently detailed to enable determining how well the substances tested represent the cosmetic ingredients included in this safety assessment. For example, the genus and species of the plants from which the test substances were derived, the cultivation methods used to grow the plants, and the methods of extraction are not specified in many of these studies.

The Panel expressed concern about the potential for constituents in citrus-derived peel oils, including the furocoumarin 5-MOP, to cause phototoxicity. IFRA has issued standards for citrus oils and other furocoumarin-containing essential oils, and the Panel agreed that adherence to the IFRA standards for such constituents will prevent phototoxicity. According to these standards, finished products that are applied to the skin, excluding rinse-off products, must not contain more than 0.0015%, or 15 ppm, 5-MOP. An IFRA standard also has been issued for 7-methoxycoumarin; based on established maximum levels of this substance from commercially-available natural sources (like essential oils, extracts and absolutes), exposure to 7-methoxycoumarin from the use of these oils and extracts is regarded to be acceptable if the level of 7-methoxycoumarin in the finished product does not exceed 100 ppm.

Additionally, based on the findings of a rodent carcinogenicity study in which tumor promotion activity may have been caused by repeated skin irritation and resultant proliferation of DMBA-treated basal cells, the Panel concluded that citrus-derived peel oils could potentially act as tumor-promoters if formulated to reach irritant levels. Thus, these botanical ingredients must be formulated to be non-irritating.

The Panel noted that, because botanical ingredients are complex mixtures, there is concern that multiple botanical ingredients may each contribute to the final concentration of a single constituent. Therefore, when formulating products, manufacturers should avoid reaching levels in final formulation of plant constituents that may cause sensitization or other adverse effects. Specific examples of constituents that could induce adverse effects are limonene, citral, and other monoterpenes, furocoumarins (such as 5- MOP and 7-methoxycoumarin).

Finally, the Panel expressed concern about pesticide residues and heavy metals that may be present in botanical ingredients. They stressed that the cosmetics industry should continue to use current good manufacturing practices (cGMPs) to limit impurities.

### **CONCLUSION**

The CIR Expert Panel concluded the citrus-derived peel oils are safe for use in cosmetic products, excluding rinse-off products, do not contain more than 0.0015% (15 ppm) 5-methoxysoralen (5-MOP), and when formulated to be non-sensitizing and non-irritating.

|   |   |
|---|---|
| citrus aurantifolia (lime) peel oil*            | citrus junos peel oil                     |
| citrus aurantium amara (bitter orange) peel oil | citrus limon (lemon) peel oil             |
| citrus aurantium curassaviensis peel oil*       | citrus medica vulgaris peel oil*          |
| citrus aurantium dulcis (orange) peel oil       | citrus nobilis (mandarin orange) peel oil |
| citrus clementina peel oil*                     | citrus reticulata (tangerine) peel oil*   |
| citrus grandis (grapefruit) peel oil            | citrus tachibana/reticulata peel oil*     |
| citrus iyo peel oil*                            | citrus tangerina (tangerine) peel oil     |

\*Not reported to be in current use. Were ingredients in this group not in current use to be used in the future, the expectation is that they would be used in product categories and at concentrations comparable to others in this group.

**TABLES****Table 1. Definitions and functions of Citrus-derived ingredients.**

| Ingredient   | Definition <sup>2</sup>   | Function <sup>2</sup>   |
|--|---|---|
| Citrus Aurantifolia (Lime) Peel Oil  | Citrus Aurantifolia (Lime) Peel Oil is the volatile oil obtained from the peel of <i>Citrus aurantifolia</i> .  | Fragrance Ingredients   |
| Citrus Aurantium Amara (Bitter Orange) Peel Oil<br>CAS No. 68916-04-1                    | Citrus Aurantium Amara (Bitter Orange) Peel Oil is the volatile oil obtained from the peel of <i>Citrus aurantium amara</i> .                           | Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous |
| Citrus Aurantium Currassoviensis Peel Oil  | Citrus Aurantium Currassoviensis Peel Oil is the volatile oil derived from the peel of the laraha orange, <i>Citrus aurantium currassoviensis</i> .     | Fragrance Ingredients   |
| Citrus Aurantium Dulcis (Orange) Peel Oil<br>CAS No. 8008-57-9                           | Citrus Aurantium Dulcis (Orange) Peel Oil is the volatile oil obtained by expression from the peel of <i>Citrus sinensis</i> .                          | Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous |
| Citrus Clementina Peel Oil   | Citrus Clementina Peel Oil is the volatile oil obtained from the peel of <i>Citrus clementina</i> .   | Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous |
| Citrus Grandis (Grapefruit) Peel Oil<br>CAS No. 8016-20-4                                | Citrus Grandis (Grapefruit) Peel Oil is the volatile oil obtained from the peel of the grapefruit, <i>Citrus grandis</i> .                              | Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous |
| Citrus Iyo Peel Oil  | Citrus Iyo Peel Oil is the volatile oil obtained from the peel of <i>Citrus iyo</i> .   | Skin-Conditioning Agents - Emollient                            |
| Citrus Junos Peel Oil  | Citrus Junos Peel Oil is the volatile oil obtained from the peel of <i>Citrus junos</i> .   | Cosmetic Astringents  |
| Citrus Limon (Lemon) Peel Oil<br>CAS No. 8008-56-8; 8020-19-7;<br>84929-31-7; 85085-28-5 | Citrus Limon (Lemon) Peel Oil is the volatile oil obtained from the peel of <i>Citrus limon</i> .   | Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous |
| Citrus Medica Vulgaris Peel Oil  | Citrus Medica Vulgaris Peel Oil is the volatile oil obtained from the peel of <i>Citrus medica vulgaris</i> .   | Fragrance Ingredients   |
| Citrus Nobilis (Mandarin Orange) Peel Oil<br>CAS No. 8008-31-9; 84696-35-5               | Citrus Nobilis (Mandarin Orange) Peel Oil is the oil obtained from the peel of the mandarin orange, <i>Citrus nobilis</i> .                             | Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous |
| Citrus Reticulata (Tangerine) Peel Oil<br>CAS No. 8008-31-9                              | Citrus Reticulata (Tangerine) Peel Oil is the volatile oil obtained from the peel of <i>Citrus reticulata</i> .   | Deodorant Agents; Flavoring Agents; Fragrance Ingredients       |
| Citrus Tachibana/Reticulata Peel Oil   | Citrus Tachibana/Reticulata Peel Oil is the volatile oil obtained from the peel of the hybrid of <i>Citrus tachibana</i> and <i>Citrus reticulata</i> . | Skin-Conditioning Agents - Emollient                            |
| Citrus Tangerina (Tangerine) Peel Oil  | Citrus Tangerina (Tangerine) Peel Oil is the volatile oil obtained from the peel of <i>Citrus tangerina</i> .   | Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous |

**Table 2. Citrus-ingredients that potentially function solely as fragrance ingredients.**

Citrus Aurantifolia (Lime) Peel Oil  
 Citrus Aurantium Currassoviensis Peel Oil  
 Citrus Medica Vulgaris Peel Oil

**Table 3. Physical and chemical properties of Citrus-derived peel oils.**

| Property   | Description   | Reference |
|--|---|-----------|
| <i>Citrus aurantifolia</i> (Lime) Oil  |   |           |
| Color  | colorless to greenish yellow  | 8         |
| Odor   | fresh citrus, intense   | 8         |
| optical rotation   | +34° to +47°  | 8         |
| Solubility   | insoluble in water, soluble in ethanol and propylene glycol   | 8         |
| refractive index   | 1.4477-1.4745   | 8         |
| specific gravity   | 0.855-0.863   | 8         |
| <i>Citrus aurantifolia</i> or <i>Citrus latifolia</i> (Lime) Oil (Distilled) |   |           |
| Color  | colorless to greenish yellow  | 1         |
| Odor   | mild citrus, floral   | 1         |
| optical rotation/angular rotation  | +34° to +47°  | 1         |
| Solubility   | soluble in most fixed oils and mineral oil; insoluble in glycerin and propylene glycol  | 1         |
| solubility in alcohol  | 1 ml sample dissolves in 5 ml of 90% alcohol  | 1         |
| Aldehydes  | between 0.5% and 2.5% of aldehydes, calculated as citral  | 1         |
| refractive index   | 1.474 – 1.477 at 20 °C  | 1         |
| specific gravity   | 0.855-0.863   | 1         |
| <i>Citrus aurantifolia</i> (Lime) Oil (Cold-Pressed)                         |   |           |
| Color  | yellow to brown green to green liquid   | 1         |
| Odor   | fresh lime peel   | 1         |
| optical rotation/angular rotation  | Mexican type: +35° to +41°; Tahitian type: +38° to +53°   | 1         |
| Solubility   | soluble in most fixed oils and mineral oil; insoluble in glycerin and propylene glycol  | 1         |
| Aldehydes  | Mexican type: no less than 4.5% and no more than 8.5% of aldehydes, calculated as citral; Tahitian type: no less than 3.2% and no more than 7.5% of aldehydes, calculated as citral           | 1         |
| refractive index   | Mexican type: 1.482-1.486; Tahitian type: 1.476-1.486   | 1         |
| residue of evaporation   | Mexican type: 10.0% to 14.5%; Tahitian type: 5.0% to 12.0%  | 1         |
| specific gravity   | Mexican type: 0.872-0.881; Tahitian type: 0.858-0.876   | 1         |
| UV absorbance  | max. at 315 nm; Mexican type: no less than 0.45; Tahitian type: no less than 0.24   | 1         |
| <i>Citrus aurantium</i> (Bitter Orange) Oil (Cold-Pressed)                   |   |           |
| Color  | pale yellow or yellow-brown liquid  | 1         |
| Odor   | characteristic aromatic odor of the Seville orange  | 1         |
| optical rotation/angular rotation  | +88° to +98°  | 1         |
| Solubility   | miscible with absolute alcohol and with an equal volume of glacial acetic acid; soluble in fixed oils and mineral oil; slightly soluble in propylene glycol; relatively insoluble in glycerin | 1         |
| Aldehydes  | no less than 0.5% and no more than 1.0% of aldehydes, calculated as decyl aldehyde  | 1         |
| refractive index   | 1.472-1.476 at 20° C  | 1         |
| residue of evaporation   | 2.0-5.0%  | 1         |
| specific gravity   | 0.845-0.851   | 1         |
| <i>Citrus clementina</i>   |   |           |
| color  | orange to brownish liquid   | 43        |
| odor   | characteristic  | 43        |
| optical rotation   | +89 - +97° (15°C)   | 43        |
| solubility   | insoluble in water; soluble in ethyl alcohol  | 43        |
| refractive index   | 1.5640 – 1.4820 (20°C)  | 43        |
| specific gravity   | 0.840 – 0.875 (15°C)  | 43        |
| <i>Citrus limon</i> (Lemon) Oil  |   |           |
| Color  | pale to deep yellow or greenish yellow  | 8         |
| Odor   | fresh citrus, intense   | 8         |
| optical rotation   | +57 to +65.6  | 8         |
| Solubility   | insoluble in water, soluble in ethanol and propylene glycol   | 8         |
| refractive index   | 1.474-1.467   | 8         |
| specific gravity   | 0.849-0.855   | 8         |
| <i>Citrus limon</i> (Lemon) Oil (Distilled)                                  |   |           |
| Color  | colorless to pale yellow liquid   | 1         |
| Odor   | fresh lemon peel  | 1         |
| optical rotation/angular rotation  | +55° to +75°  | 1         |
| Solubility   | soluble in most fixed oil, mineral oil, and alcohol (with haze); insoluble in glycerin and propylene glycol   | 1         |
| solubility in alcohol  | 1 ml sample dissolves in 5 ml of 90% alcohol  | 1         |
| Aldehydes  | between 1.0% and 3.5% of aldehydes, calculated as citral  | 1         |
| refractive index   | 1.470 – 1.475 at 20 °C  | 1         |
| specific gravity   | 0.842-0.856   | 1         |
| UV absorbance  | max. at 315 nm, no less than 0.01   | 1         |
| <i>Citrus limon</i> (Lemon) Oil (Cold-Pressed)                               |   |           |
| Color  | pale to deep yellow or green-yellow   | 1         |
| Odor   | fresh lemon peel  | 1         |
| optical rotation/angular rotation  | California and Italian types: +57° to +65.6°; Desert type: +67° to +78°   | 1         |

**Table 3. Physical and chemical properties of Citrus-derived peel oils.**

| Property   | Description  | Reference |
|--|--|-----------|
| Solubility   | miscible with dehydrated alcohol and glacial acetic acid   | 1         |
| solubility in alcohol  | 1 ml of sample dissolves in 3 ml of 95% alcohol, slight haze possible  | 1         |
| Aldehydes  | Desert type: no less than 1.7% of aldehydes, calculated as citral; California type: no less than 2.2% and no more than 3.8% of aldehydes, calculated as citral; Italian type: no less than 3.0% and no more than 5.5% of aldehydes, calculated as citral | 1         |
| refractive index   | 1.473-1.476 at 20 °C   | 1         |
| residue of evaporation   | between 5.0% to 14.5%  | 1         |
| specific gravity   | Desert type: 0.846-0.851; California and Italian types: 0.849-0.855  | 1         |
| UV absorbance  | max. at 315 nm; Desert and California types: no less than 0.2; Italian type: no less than 0.49   | 1         |
| <i>Citrus nobilis</i> or <i>Citrus reticulata</i> (Tangerine) Oil (Cold-Pressed) |  |           |
| Color  | red-orange to brown-orange   | 1         |
| Odor   | pleasant, orange   | 1         |
| optical rotation/angular rotation  | +88° to +96°   | 1         |
| Solubility   | soluble in most fixed oils and mineral oil; slightly soluble in propylene glycol; relatively insoluble in glycerin   | 1         |
| Aldehydes  | 0.8% to 1.9% of aldehydes, calculated as decyl aldehyde  | 1         |
| refractive index   | 1.473-1.476 at 20 °C   | 1         |
| residue of evaporation   | 2.3% - 5.8%  | 1         |
| specific gravity   | 0.844-0.854  | 1         |
| <i>Citrus Reticulata</i> Peel Oil  |  |           |
| physical state and appearance  | clear, mobile, dark-orange to reddish-orange or brownish-orange liquid   | 10        |
| Odor   | orange-like  | 10        |
| optical rotation   | +63° to +78°   | 10        |
| refractive index   | 1.4730-1.4770 (20°C)   | 10        |
| specific gravity   | 0.847-0.853 (25/25°C)  | 10        |
| <i>Citrus sinensis</i> (Orange) Oil (Distilled)                                  |  |           |
| Color  | colorless to pale yellow liquid  | 1         |
| Odor   | mild citrus floral   | 1         |
| optical rotation/angular rotation  | +94° to +99°   | 1         |
| Solubility   | soluble in most fixed oil, mineral oil, and alcohol (with haze); insoluble in glycerin and propylene glycol  | 1         |
| solubility in alcohol  | 1 ml sample dissolves in 5 ml of 90% alcohol   | 1         |
| refractive index   | 1.471 – 1.474 at 20 °C   | 1         |
| specific gravity   | 0.840-0.844  | 1         |
| UV absorbance  | max. at 330 nm, no less than 0.01  | 1         |
| <i>Citrus sinensis</i> (Orange) Oil (Cold-Pressed)                               |  |           |
| Color  | intensely yellow, orange, or deep orange liquid  | 1         |
| Odor   | characteristic of fresh, sweet orange peel   | 1         |
| optical rotation/angular rotation  | +94° to +99°   | 1         |
| Solubility   | miscible with dehydrated alcohol and carbon disulfide; soluble in glacial acetic acid no less than 1.2% and no more than 2.5% of aldehydes, calculated as decyl aldehyde   | 1         |
| Aldehydes  | 1  | 1         |
| refractive index   | 1.472-1.474 at 20 °C   | 1         |
| specific gravity   | 0.842-0.846  | 1         |
| UV absorbance  | max. at 330 nm; California type: no less than 0.130; Florida type: no less than 0.240  | 1         |

**Table 4. Chemical composition (%) of citrus peel oils<sup>a</sup>**

**Table 4. Chemical composition (%) of citrus peel oils\***

| Table II. Chemical composition (%) of citrus peels | <i>C. aurantiifolia</i> (lime) peel oil | <i>C. aurantium amara</i> (bitter orange) essential oil |     |                                 |       | <i>C. aurantium dulcis</i> (orange) essential oil | <i>C. clementina</i> peel essential oil | <i>C. grandis</i> (grapefruit) peel essential oil | <i>C. iyo</i> peel essential oil                | <i>C. junos</i> peel essential oil                       |       |       |
|--|---|---|-----|---------------------------------|-------|---|---|---|---|--|-------|-------|
|  | cold-pressed <sup>13</sup>              | cold-pressed <sup>14</sup>                              |     | hydrodistilled <sup>18,20</sup> |       | cold-pressed <sup>14</sup>                        | hydrodistillation <sup>17</sup>         | cold-pressed <sup>6</sup>                         | lyophilization/vacuum distillation <sup>9</sup> | cold-pressed <sup>7</sup> or not specified <sup>16</sup> |       |       |
|  | Min                                     | Max   | Min | Max                             | Min   | Max   | Min                                     | Max   | Min   | Max  | Min   | Max   |
| (5-(6',7'-dihydroxy-geranylxy)psolarene)           |   |   | X   |                                 |       |   |   |   |   |  |       |       |
| (5-(6',7'-epoxy-geranylxy)psolarene)               |   |   | X   |                                 |       |   |   |   |   |  |       |       |
| 5,7-dimethoxycoumarin                              |   |   | X   |                                 |       |   |   |   |   |  |       |       |
| 6-methylhept-5-en-2-one                            |   | trace   |     |                                 |       |   |   |   |   |  |       |       |
| 7-methoxy-8(2',3'-dihydroxy)isopentenylcoumarin    |   |   | X   |                                 |       |   |   |   |   |  |       |       |
| 7-methoxy-8(2',3'-epoxy)isopentenylcoumarin        |   |   | X   |                                 |       |   |   |   |   |  |       |       |
| 7-methoxy-8-isopentenylcoumarin                    |   |   | X   |                                 |       |   |   |   |   |  |       |       |
| 7-methoxy-8-(2'-one-isopentyl)coumarin)            |   |   | X   |                                 |       |   |   |   |   |  |       |       |
| 30 carvacrol                                       |   |   |     |                                 | trace | 0.69  |   |   |   |  |       |       |
| <i>allo</i> -ocimene                               |   | trace   |     |                                 |       |   |   |   |   |  |       |       |
| aromadendrene                                      |   |   |     |                                 |       |   |   |   |   | ND   | trace |       |
| bicycloelemene                                     |   |   |     |                                 |       |   |   |   |   | trace  |       |       |
| bicyclogermacrene                                  | trace                                   | 0.4   |     |                                 |       |   |   |   |   | 0.7  | 2.0   |       |
| borneol  |   |   |     |                                 | 0.08  | 0.16  |   |   |   |  |       |       |
| bornyl acetate                                     | trace                                   | trace   |     |                                 | trace |   |   |   |   |  |       |       |
| camphene   | trace                                   | 0.2   |     |                                 | trace | 0.24  |   |   |   | trace  |       |       |
| camphor  |   |   |     |                                 | 0.17  | 6.37  |   |   |   |  |       |       |
| caryophyllene                                      |   |   |     |                                 |       |   |   |   |   | ND   | trace |       |
| caryophyllene oxide                                | trace                                   | 0.1   |     |                                 | 0.08  | 0.21  |   |   | trace   |  |       |       |
| cedrol   |   |   |     |                                 |       |   |   |   | trace   |  |       |       |
| <i>cis</i> -dihydrocarvone                         |   |   |     |                                 |       |   | 0.03                                    | 0.28  |   |  |       |       |
| <i>cis</i> -limonene-1,2-oxide                     | trace                                   | 0.1   |     |                                 |       |   |   |   |   |  |       |       |
| <i>cis</i> -linalool oxide THF                     |   | trace   |     |                                 | trace | 3.4   |   |   |   |  |       |       |
| <i>cis</i> - $\beta$ -ocimene                      |   |   |     |                                 | 0.30  |   |   |   |   |  |       |       |
| <i>cis</i> -sabinene hydrate                       |   |   |     |                                 | trace | 0.18  |   |   |   | trace  | 0.1   |       |
| citronellal  | trace                                   | 1.6   |     |                                 |       |   |   | 0.03  | 0.08  | 0.1  |       |       |
| citronellol  | trace                                   | 0.6   |     |                                 |       |   | trace                                   | 0.07  |   |  | ND    | trace |
| citronellyl acetate                                | 0.1                                     | 0.2   |     |                                 |       |   |   |   |   |  |       |       |
| cumin aldehyde                                     |   |   |     |                                 |       |   |   |   |   | 0.005-0.05   |       |       |
| decanal  | trace                                   | 0.3   |     |                                 | 0.16  |   |   |   |   | 0.3  | trace |       |
| dihydrocarveol                                     |   |   |     |                                 |       |   |   |   | trace   |  |       |       |
| dodecanol  |   | trace   |     |                                 |       |   |   |   |   | 0.1  | ND    | trace |
| elemol   |   |   |     |                                 |       |   |   |   | trace   |  | trace |       |
| eugenol  |   |   |     |                                 |       |   |   |   |   | ND   | trace |       |
| geranial   | 0.5                                     | 6.1   |     |                                 |       |   |   |   |   | 0.1  |       |       |
| geraniol   | trace                                   | 0.3   |     |                                 |       |   |   |   |   |  |       |       |
| geranyl acetate                                    | 0.1                                     | 2.4   |     |                                 | trace | 0.11  |   |   |   |  |       |       |

**Table 4.** Chemical composition (%) of citrus peel oils\*

**Table 4.** Chemical composition (%) of citrus peel oils\*

**Table 4.** Chemical composition (%) of citrus peel oils\*

Table 4. Chemical composition (%) of citrus peel oils\*

|                         | <i>C. limon</i> (lemon) peel essential oils |       |                              |      | <i>C. nobilis</i> (mandarin orange) essential oil |     | <i>C. sinensis</i> (orange) peel oil |      |                              |      | <i>C. reticulata</i> (tangerine) peel oil |      |                                 |      |      |      |
|-------------------------|---|-------|------------------------------|------|---|-----|--------------------------------------|------|------------------------------|------|---|------|---------------------------------|------|------|------|
|                         | cold-pressed <sup>12,13</sup>               |       | hydrodistilled <sup>18</sup> |      | cold-pressed <sup>14</sup>                        |     | cold-pressed <sup>11,12,15,16</sup>  |      | hydrodistilled <sup>44</sup> |      | steam-distilled <sup>22</sup>             |      | hydrodistilled <sup>21,44</sup> |      |      |      |
|                         | Min   | Max   | Min                          | Max  | Min   | Max | Min                                  | Max  | Min                          | Max  | Min                                       | Max  | Min                             | Max  | Min  | Max  |
| <i>cis</i> -β-farnesene |   |       |                              |      |   |     |                                      |      |                              |      |   |      |                                 |      | 0.1  |      |
| <i>cis</i> -β-ocimene   |   |       |                              |      |   |     |                                      |      |                              |      |   |      |                                 |      |      |      |
| citral                  |   | 0.27  |                              |      |   |     |                                      | 0.26 |                              |      |   |      |                                 |      |      |      |
| citranellyl acetate     |   |       |                              |      |   |     |                                      | 1.74 | 7.74                         |      |   |      |                                 |      |      |      |
| citronellal             | trace                                       | 0.4   |                              |      |   |     |                                      | 0.01 | 0.22                         |      |   |      |                                 |      |      |      |
| citronellol             | trace                                       | 0.15  | trace                        | 0.04 |   |     |                                      | 0.06 | 0.2                          |      |   |      |                                 | 0.45 | 0.78 |      |
| citronellyl acetate     | trace                                       | 0.3   |                              |      |   |     |                                      | 4.18 | 0.71                         | 1.6  |   |      |                                 | 0.8  | 1.2  |      |
| copaene                 |   |       |                              |      |   |     |                                      |      |                              |      |   |      |                                 |      | 0.12 |      |
| decanal                 | trace                                       | trace |                              |      |   |     |                                      | 0.21 | 0.71                         | 1.02 |   |      |                                 | 0.11 | 2.33 | 7.71 |
| decanol                 |   |       |                              |      |   |     |                                      | 0.35 |                              |      |   |      |                                 |      |      |      |
| dehydrolinalool         |   |       |                              |      |   |     |                                      |      |                              |      |   |      |                                 | 0.40 |      |      |
| dodecanol               |   |       |                              |      |   |     |                                      | 0.03 |                              |      |   |      |                                 | 0.42 | 0.65 |      |
| elemol                  |   |       |                              |      |   |     |                                      |      |                              |      |   |      |                                 | 0.35 | 0.89 |      |
| eugenol                 |   |       |                              |      |   |     |                                      |      |                              | 0.53 |   |      |                                 |      |      |      |
| farnesol                |   |       |                              |      |   |     |                                      |      |                              |      |   |      |                                 |      | 1.14 |      |
| geranial                | 0.1   | 2.9   |                              |      |   |     | trace                                | 0.11 |                              |      |   |      |                                 |      |      |      |
| geraniol                | trace                                       | 0.2   |                              |      |   |     |                                      |      |                              |      |   |      |                                 |      |      |      |
| geranyl acetate         | trace                                       | 3.2   | trace                        | 0.56 |   |     |                                      |      |                              |      |   |      |                                 |      |      |      |
| germacarene             |   |       |                              |      |   |     |                                      |      |                              |      |   |      |                                 | 0.30 | 1.07 |      |
| germacrene D            | trace                                       | 0.8   | 0.019                        | 1.35 |   |     |                                      | 0.08 |                              |      |   |      |                                 | 0.27 |      |      |
| n-heptane               |   |       |                              |      |   |     |                                      |      |                              |      |   |      |                                 |      | 0.4  |      |
| hexadecane              |   |       |                              |      |   |     |                                      | 0.2  |                              |      |   |      |                                 |      |      |      |
| isophorone              |   |       |                              |      |   |     |                                      |      | 1.09                         | 2.92 |   |      |                                 |      |      |      |
| isopropyl cresol        |   |       |                              |      |   |     |                                      |      |                              |      |   |      |                                 |      | 1.36 |      |
| lemonol                 |   |       |                              |      |   |     |                                      |      |                              |      |   |      |                                 | 0.28 |      |      |
| limonene oxide          |   |       |                              |      |   |     |                                      |      |                              | 0.76 |   |      |                                 |      |      |      |
| linalool                | 0.1   | 25.1  | 0                            | 1.59 |   |     | 0.12                                 | 2.32 | 1.52                         | 2.1  |   | 0.22 | 0.7                             | 2.56 |      |      |
| linalool oxide          |   |       |                              |      |   |     |                                      |      | 0.48                         | 1.12 |   |      |                                 |      | 0.6  |      |
| linalyl acetate         | trace                                       | 31.2  | trace                        | 2.61 |   |     | trace                                |      |                              |      |   |      |                                 | 0.28 | 0.4  |      |
| longipinene             |   |       |                              |      |   |     |                                      |      |                              |      |   |      |                                 |      | 0.4  |      |
| menthadien-1-ol         |   |       |                              |      |   |     |                                      |      |                              |      |   |      |                                 |      | 0.42 |      |
| myrcene                 | 0.7   | 10.16 | trace                        | 1.54 |   |     |                                      | 2.5  |                              |      |   |      |                                 | 6.27 |      |      |
| neral                   | trace                                       | 1.5   |                              |      |   |     |                                      | 0.06 |                              |      |   |      |                                 |      |      |      |
| nerol                   | trace                                       | 0.1   | trace                        | 0.24 |   |     |                                      |      |                              |      |   |      |                                 |      |      |      |
| neryl acetate           | 0.1   | 3.9   |                              |      |   |     |                                      | 0.04 |                              |      |   |      |                                 |      |      |      |
| nikkol                  |   |       |                              |      |   |     |                                      |      | 5.7                          |      |   |      |                                 |      |      |      |
| nonanal                 | trace                                       | 0.3   | trace                        |      |   |     |                                      | 0.08 |                              |      |   |      |                                 |      |      |      |
| n-nonane                |   |       |                              |      |   |     |                                      | 0.2  |                              |      |   |      |                                 |      |      |      |
| nootkatone              |   |       |                              |      |   |     |                                      | 0.01 |                              |      |   |      |                                 | 0.30 | 3.95 |      |
| octanal                 | trace                                       | 0.1   | 0.02                         | 1.59 |   |     | 0.34                                 | 0.8  |                              |      |   |      |                                 | 1.06 | 1.15 |      |
| octyl acetate           | trace                                       | 0.1   |                              |      |   |     |                                      |      |                              |      |   |      |                                 |      |      |      |
| p-cymene                | 0.1   | 7.8   | 0.23                         | 9.84 |   |     |                                      |      |                              |      |   |      |                                 |      |      |      |
| p-cymenene              | trace                                       | 0.3   |                              |      |   |     |                                      |      |                              |      |   |      |                                 |      |      |      |
| pentadecane             |   |       |                              |      |   |     |                                      | 0.2  |                              |      |   |      |                                 |      |      |      |
| perillaldehyde          |   |       |                              |      |   |     |                                      | 0.03 |                              |      |   |      |                                 | 1.64 | 1.65 |      |
| piperitenone            |   |       |                              |      |   |     |                                      |      |                              | 0.42 |   |      |                                 |      |      |      |
| sabinene                | trace                                       | 6.3   | 3.8                          | 6.48 |   |     | 0.21                                 | 0.5  | 0.37                         | 0.62 |   | 1.29 |                                 | 0.49 |      |      |

Table 4. Chemical composition (%) of citrus peel oils\*

|                                      | <i>C. limon</i> (lemon) peel essential oils |       |                              |       | <i>C. nobilis</i> (mandarin orange) essential oil |     | <i>C. sinensis</i> (orange) peel oil |       |                              |      |                               |     | <i>C. reticulata</i> (tangerine) peel oil |      |      |      |
|--------------------------------------|---|-------|------------------------------|-------|---|-----|--------------------------------------|-------|------------------------------|------|-------------------------------|-----|---|------|------|------|
|                                      | cold-pressed <sup>12,13</sup>               |       | hydrodistilled <sup>18</sup> |       | cold-pressed <sup>14</sup>                        |     | cold-pressed <sup>11,12,15,16</sup>  |       | hydrodistilled <sup>44</sup> |      | steam-distilled <sup>22</sup> |     | hydrodistilled <sup>21,44</sup>           |      |      |      |
|                                      | Min   | Max   | Min                          | Max   | Min   | Max | Min                                  | Max   | Min                          | Max  | Min                           | Max | Min                                       | Max  | Min  | Max  |
| spathulenol                          | trace                                       | 0.1   | trace                        |       |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| terpineol-4                          | trace                                       | 0.1   |                              |       |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| terpinen-4-ol                        |   |       | trace                        | 1.28  |   |     |                                      |       |                              |      |                               |     |   |      | 0.1  |      |
| terpinolene                          | trace                                       | 0.8   | 0.02                         | 0.22  |   |     |                                      |       | 0.08                         |      |                               |     |   |      |      |      |
| terpinyl acetate                     |   | 0.5   | trace                        | 0.15  |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| tetradecane                          |   |       |                              |       |   |     |                                      |       | 0.2                          |      |                               |     |   |      |      |      |
| thymol                               | trace                                       | 1.1   |                              |       |   |     |                                      |       | trace                        |      |                               |     |   |      |      |      |
| <i>trans</i> - $\alpha$ -bergamotene | 0.2   | 1.3   |                              |       |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| <i>trans</i> -carveol                |   |       |                              |       |   |     |                                      |       |                              |      |                               |     | 0.44                                      |      |      |      |
| <i>trans</i> -limonene oxide         |   |       |                              |       |   |     |                                      |       | 0.01                         |      |                               |     | 0.20                                      |      |      |      |
| <i>trans</i> -limonene-1,2-oxide     | trace                                       | 0.6   |                              |       |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| <i>trans</i> -linalool oxide THF     | trace                                       | trace |                              |       |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| <i>trans</i> -p-1,8-dienol           |   |       |                              |       |   |     |                                      |       |                              |      |                               |     | 0.52                                      |      |      |      |
| <i>trans</i> -p-menth-2-en-1-ol      | trace                                       | 0.1   |                              |       |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| <i>trans</i> -p-2,8-menthdien-1-ol   |   |       |                              |       |   |     |                                      |       | 0.79                         | 1.07 |                               |     |   |      |      |      |
| <i>trans</i> -sabinene hydrate       | trace                                       | 0.1   |                              |       |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| tricyclen                            |   |       | 0.02                         | 0.16  |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| valencene                            |   |       | trace                        | 0.37  |   |     |                                      |       | 0.05                         | 0.41 | 1.2                           |     |   |      |      |      |
| $\alpha$ -bisabolene                 |   | 0.2   |                              |       |   |     |                                      |       |                              |      |                               |     |   |      |      | 0.46 |
| $\alpha$ -cadinol                    |   |       |                              |       |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| $\alpha$ -copaene                    |   |       |                              |       |   |     |                                      |       | 0.04                         |      |                               |     |   |      |      |      |
| $\alpha$ -cubebene                   |   |       |                              |       |   |     |                                      |       |                              |      | 0.7                           |     |   |      |      | 0.48 |
| $\alpha$ -farnesene                  |   |       |                              |       |   |     |                                      |       |                              |      |                               |     | 0.36                                      | 0.48 |      |      |
| $\alpha$ -humulene                   | trace                                       | 0.2   | trace                        | 0.04  |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| $\alpha$ -phellandrene               | trace                                       | 0.6   |                              |       |   |     |                                      |       |                              |      | 0.46                          |     |   |      |      |      |
| $\alpha$ -pinene                     | 0.1   | 2.63  | 1.14                         | 5.9   |   |     |                                      | 0.35  | 1.4                          | 1.65 | 2.48                          |     | 1.49                                      | 0.6  | 1.67 |      |
| $\alpha$ -sinensal                   |   |       |                              |       |   |     |                                      |       |                              | 0.35 | 0.49                          |     |   | 0.93 | 5.0  |      |
| $\alpha$ -terpinene                  | trace                                       | 0.4   | trace                        | 1.05  |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| $\alpha$ -terpineneol                |   |       | 0.93                         | 1.7   |   |     |                                      |       |                              |      |                               |     |   |      | 1.51 |      |
| $\alpha$ -terpineol                  | trace                                       | 0.4   |                              |       |   |     |                                      |       | 0.07                         | 2.34 | 3.1                           |     | 0.14                                      | 0.2  | 1.1  |      |
| $\alpha$ -terpinolene                |   | 0.25  |                              |       |   |     |                                      |       | 1.56                         | 2.06 |                               |     |   | 0.38 |      | 0.1  |
| $\alpha$ -thujene                    | trace                                       | 1.7   | trace                        | 0.38  |   |     |                                      | 0.04  | 0.11                         |      |                               |     |   | 0.11 |      |      |
| $\alpha$ -thujone                    |   |       | trace                        | 0.35  |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| $\beta$ -bisabolene                  | 0.2   | 2.0   |                              |       |   |     |                                      |       |                              |      |                               |     |   |      |      |      |
| $\beta$ -caryophyllene               |   |       |                              |       |   |     |                                      |       |                              |      |                               |     | 0.21                                      |      | 1.39 |      |
| $\beta$ -cubebene                    |   |       |                              |       |   |     |                                      |       | 0.03                         |      |                               |     |   |      | 0.37 |      |
| $\beta$ -elemene                     | trace                                       | 0.5   |                              |       |   |     |                                      |       | 0.1                          |      |                               |     |   |      |      |      |
| $\beta$ -elemene                     |   |       |                              |       |   |     |                                      |       |                              |      |                               |     | 0.17                                      |      |      |      |
| $\beta$ -farnesene                   |   |       |                              |       |   |     |                                      |       |                              |      |                               |     | 3.64                                      |      |      |      |
| $\beta$ -gurjurenene                 |   |       |                              |       |   |     |                                      |       | 0.0                          |      |                               |     |   |      |      |      |
| $\beta$ -myrcene                     |   |       |                              |       |   |     |                                      |       | 1.88                         | 3.76 | 4.41                          |     |   | 3.27 | 4.05 |      |
| $\beta$ -ocimene                     |   |       |                              |       |   |     |                                      |       |                              |      |                               |     | 0.27                                      |      |      |      |
| $\beta$ -phellandrene                | 0.1   | 4.2   |                              |       |   |     |                                      |       |                              |      |                               |     |   |      | 1.8  |      |
| $\beta$ -pinene                      | 0.1   | 15.8  | 0.63                         | 31.49 |   |     |                                      | trace | 5.45                         |      |                               |     | 0.41                                      | 0.2  | 0.4  |      |
| $\beta$ -sinensal                    |   |       |                              |       |   |     |                                      |       |                              | 0.33 | 0.83                          |     |   | 0.67 |      |      |

**Table 4. Chemical composition (%) of citrus peel oils\***

|                        | <i>C. limon</i> (lemon) peel essential oils |       |                              |      | <i>C. nobilis</i> (mandarin orange) essential oil |     | <i>C. sinensis</i> (orange) peel oil |      |                              |      |                               |      | <i>C. reticulata</i> (tangerine) peel oil |      |      |  |
|------------------------|---|-------|------------------------------|------|---|-----|--------------------------------------|------|------------------------------|------|-------------------------------|------|---|------|------|--|
|                        | cold-pressed <sup>12,13</sup>               |       | hydrodistilled <sup>18</sup> |      | cold-pressed <sup>14</sup>                        |     | cold-pressed <sup>11,12,15,16</sup>  |      | hydrodistilled <sup>44</sup> |      | steam-distilled <sup>22</sup> |      | hydrodistilled <sup>21,44</sup>           |      |      |  |
|                        | Min   | Max   | Min                          | Max  | Min   | Max | Min                                  | Max  | Min                          | Max  | Min                           | Max  | Min                                       | Max  |      |  |
| γ-eudesmol             |   |       |                              |      |   |     |                                      |      |                              |      |                               |      |   |      | 1.08 |  |
| γ-munrolene            |   |       |                              |      |   |     |                                      |      |                              |      |                               |      |   |      | 1.16 |  |
| γ-terpinene            | trace                                       | 18.57 | 0.04                         | 9.96 |   |     | 0.2                                  | 1.21 |                              |      |                               | 3.34 | 0.23                                      | 2.6  |      |  |
| δ-amorphene            |   |       |                              |      |   |     |                                      | 0.05 |                              |      |                               |      |   |      |      |  |
| δ-cadinene             |   |       |                              |      |   |     |                                      |      | 0.32                         |      |                               |      |   | 0.88 |      |  |
| δ-3-carene             |   |       |                              |      |   |     |                                      | 0.14 |                              |      |                               | 0.69 |   |      |      |  |
| Δ <sup>3</sup> -carene | 0.1   | 4.2   | trace                        |      |   |     |                                      |      | 0.78                         | 1.03 |                               |      |   |      |      |  |

\*includes information on various cultivars and/or harvest times

ND – none detected

X – denotes these compounds were present; however, the amount present was not specified

**Table 5. Typical levels of 5-methoxysoralen (5-MOP)**

| Ingredient                 | 5-MOP level <sup>26</sup> |
|----------------------------|---------------------------|
| Tangerine oil cold pressed | 50 ppm                    |
| Mandarin oil cold pressed  | 250 ppm                   |

**Table 6. Levels of major coumarins and furocoumarins in lemon oil and lime oil**

| Compound                    | % in Lemon Oil <sup>8</sup> | % in Lime Oil <sup>8</sup> | Photosensitizing Activity <sup>8</sup> |
|-----------------------------|-----------------------------|----------------------------|--|
| 5-geranoxysoralen           | 0.0387                      | 2.2-2.5                    | 0                                      |
| 5-geranoxo-7-methoxycoumrin | 0.0603                      | 2.2-5.2                    | 0                                      |
| 5-geranoxo-8-methoxysoralen | not analyzed                | 0.945                      | 0                                      |
| 5,7-dimethoxycoumarin       | 0.0295                      | 0.464                      | 0                                      |
| 5,8-dimethoxysoralen        | not analyzed                | 0.508                      | 0                                      |
| Oxypeucedanin               | 0.005-0.073                 | 0.0025                     | +                                      |
| 5-methoxysoralen            | 0.0001-0.0087               | 0.17-0.33                  | ++++                                   |

**Table 7. Constituents that are established contact allergens in humans, according to the SCCS**

| Constituent   | categorized according to number of patients reacting positively and to the number of patients tested<br>(>1000 patients tested, unless indicated as r.t., i.e., rarely tested) <sup>45</sup> |
|---|--|
| $\beta$ -caryophyllene                              | $\leq$ 10 (oxidized and non-oxidized)  |
| carvone   | $\leq$ 10 (r.t.)   |
| citral  | 101 to 1000  |
| citronellol   | 11-100   |
| coumarin  | 101 to 1000  |
| farnesol  | 101 to 1000  |
| geraniol  | 101 to 1000  |
| linalyl acetate                                     | $\leq$ 10  |
| $\alpha$ - and $\beta$ -pinene                      | 11-100   |
| (DL)-limonene                                       | 11-100 (non-oxidized); 101 to 1000 (oxidized)  |
| terpineol (mixture of isomers)/ $\alpha$ -terpineol | $\leq$ 10  |
| terpinolene   | 11-100   |

**Table 8. Frequency (2014) and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients.**

23,24

|                              | # of Uses <sup>46</sup>                         | Max Conc of Use (%)   | # of Uses  | Max Conc of Use (%)   | # of Uses   | Max Conc of Use (%) | # of Uses  | Max Conc of Use (%) |
|------------------------------|---|---|--|-----------------------|---|---------------------|--|---------------------|
|                              | Citrus Aurantium Amara (Bitter Orange) Peel Oil | Citrus Aurantium Dulcis (Orange) Peel Oil (listed as Citrus Sinensis (Sweet Orange) Peel Oil in VCRP) | Citrus Grandis (Grapefruit) Peel Oil             | Citrus Junos Peel Oil |   |                     |  |                     |
| <b>Totals<sup>1</sup></b>    | <b>127</b>                                      | <b>0.05-2</b>   | <b>289</b>                                       | <b>0.00002-29</b>     | <b>NR</b>   | <b>0.00004-0.05</b> | <b>6</b>   | <b>NR</b>           |
| <b>Duration of Use</b>       |   |   |  |                       |   |                     |  |                     |
| Leave-On                     | 74  | 0.2-2   | 156  | 0.00038-0.54          | NR  | 0.0004-0.0008       | 4  | NR                  |
| Rinse-Off                    | 45  | 0.05-0.25   | 110  | 0.00002-29            | NR  | 0.00004-0.05        | 2  | NR                  |
| Diluted for (Bath) Use       | 8   | NR  | 23   | 0.33                  | NR  | 0.0014              | NR   | NR                  |
| <b>Exposure Type</b>         |   |   |  |                       |   |                     |  |                     |
| Eye Area                     | 2   | NR  | 3  | 0.1                   | NR  | NR                  | NR   | NR                  |
| Incidental Ingestion         | 1   | 0.75  | 4  | NR                    | NR  | NR                  | NR   | NR                  |
| Incidental Inhalation-Spray  | 27 <sup>2</sup> , 28 <sup>6</sup>               | NR  | 56 <sup>2</sup> ; 55 <sup>6</sup>                | 0.00038 <sup>2</sup>  | NR  | NR                  | 2  | NR                  |
| Reported Spray               | NR  | NR  | NR   | NR                    | NR  | NR                  | NR   | NR                  |
| Incidental Inhalation-Powder | 28 <sup>6</sup>                                 | 0.9-2 <sup>4</sup>  | 3 <sup>4</sup> ; 55 <sup>6</sup>                 | 0.03-0.4 <sup>4</sup> | NR  | 0.0004 <sup>4</sup> | 1  | NR                  |
| Reported Powder              | NR  | NR  | NR   | NR                    | NR  | NR                  | NR   | NR                  |
| Dermal Contact               | 115   | 0.05-2  | 218  | 0.001-0.4             | NR  | 0.00004-0.05        | 6  | NR                  |
| Deodorant (underarm)         | NR  | NR  | 1 <sup>2</sup>                                   | NR                    | NR  | NR                  | NR   | NR                  |
| Reported Spray               | NR  | NR  | NR   | NR                    | NR  | NR                  | NR   | NR                  |
| Reported as Not Spray        | NR  | NR  | NR   | NR                    | NR  | NR                  | NR   | NR                  |
| Hair - Non-Coloring          | 11  | NR  | 65   | 0.00002-29            | NR  | 0.005               | NR   | NR                  |
| Hair-Coloring                | NR  | NR  | NR   | NR                    | NR  | NR                  | NR   | NR                  |
| Nail                         | NR  | NR  | 2  | 0.5-0.54              | NR  | NR                  | NR   | NR                  |
| Mucous Membrane              | 21  | 0.25-0.75   | 56   | 0.1-0.33              | NR  | 0.0014              | 1  | NR                  |
| Baby Products                | 6   | NR  | 8  | NR                    | NR  | NR                  | NR   | NR                  |
|                              | <b>Citrus Limon (Lemon) Peel Oil</b>            |   | <b>Citrus Nobilis (Mandarin Orange) Peel Oil</b> |                       | <b>Citrus Reticulata (Mandarin Orange) Peel Oil<sup>7</sup></b> |                     | <b>Citrus Sinensis Sanguinello (Blood Orange) Peel Oil<sup>7</sup></b> |                     |
| <b>Totals<sup>1</sup></b>    | <b>490</b>                                      | <b>0.0001-0.5</b>   | <b>152</b>                                       | <b>0.00005-0.1</b>    | <b>2</b>  | <b>NR</b>           | <b>8</b>   | <b>NR</b>           |
| <b>Duration of Use</b>       |   |   |  |                       |   |                     |  |                     |
| Leave-On                     | 297   | 0.0001-0.5  | 86   | 0.00005-0.1           | 1   | NR                  | 4  | NR                  |
| Rinse-Off                    | 165   | 0.0006-0.001  | 58   | 0.00005-0.03          | 1   | NR                  | 4  | NR                  |
| Diluted for (Bath) Use       | 28  | 0.012   | 8  | NR                    | NR  | NR                  | NR   | NR                  |
| <b>Exposure Type</b>         |   |   |  |                       |   |                     |  |                     |
| Eye Area                     | 9   | NR  | NR   | NR                    | NR  | NR                  | NR   | NR                  |
| Incidental Ingestion         | 8   | NR  | 1  | 0.0099                | NR  | NR                  | NR   | NR                  |
| Incidental Inhalation-Spray  | 84 <sup>2</sup> ; 96 <sup>6</sup>               | 0.06 <sup>6</sup>   | 45 <sup>2</sup> ; 26 <sup>6</sup>                | NR                    | 1 <sup>6</sup>  | NR                  | 1 <sup>2</sup> ; 2   | NR                  |
| Reported Spray               | NR  | NR  | NR   | NR                    | NR  | NR                  | 1  | NR                  |
| Incidental Inhalation-Powder | 1 <sup>4</sup> ; 96 <sup>6</sup>                | 0.001-0.14 <sup>4</sup> ; 0.06 <sup>6</sup>   | 26 <sup>6</sup>                                  | 0.00005-0.14          | 1 <sup>6</sup>  | NR                  | 2 <sup>6</sup>   | NR                  |
| Reported Powder              | NR  | NR  | NR   | NR                    | NR  | NR                  | NR   | NR                  |
| Dermal Contact               | 411   | 0.0001-0.5  | 136  | 0.00005-0.1           | 2   | NR                  | 8  | NR                  |
| Deodorant (underarm)         | NR  | NR  | NR   | NR                    | NR  | NR                  | NR   | NR                  |
| Reported Spray               | NR  | NR  | NR   | NR                    | NR  | NR                  | NR   | NR                  |
| Reported as Not Spray        | NR  | 0.002   | NR   | NR                    | NR  | NR                  | NR   | NR                  |
| Hair - Non-Coloring          | 67  | NR  | 15   | 0.00005-0.03          | NR  | NR                  | NR   | NR                  |
| Hair-Coloring                | NR  | NR  | NR   | NR                    | NR  | NR                  | NR   | NR                  |
| Nail                         | 3   | 0.0001-0.14   | NR   | 0.012                 | NR  | NR                  | NR   | NR                  |
| Mucous Membrane              | 96  | 0.001-0.012   | 40   | 0.0099                | NR  | NR                  | 4  | NR                  |
| Baby Products                | 8   | NR  | NR   | NR                    | NR  | NR                  | NR   | NR                  |

**Table 8. Frequency (2014) and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients.<sup>23,24</sup>**

|  | # of Uses <sup>46</sup>         | Max Conc of Use (%)    | # of Uses | Max Conc of Use (%) | # of Uses | Max Conc of Use (%) | # of Uses | Max Conc of Use (%) |
|--|---------------------------------|------------------------|-----------|---------------------|-----------|---------------------|-----------|---------------------|
| Citrus Tangerina (Tangerine)<br>Peel Oil |                                 |                        |           |                     |           |                     |           |                     |
| <b>Totals<sup>1</sup></b>                | <b>34</b>                       | <b>0.0000013</b>       |           |                     |           |                     |           |                     |
| <b>Duration of Use</b>                   |                                 |                        |           |                     |           |                     |           |                     |
| Leave-On                                 | 18                              | 0.0000013              |           |                     |           |                     |           |                     |
| Rinse-Off                                | 15                              | 0.0000013              |           |                     |           |                     |           |                     |
| Diluted for (Bath) Use                   | 1                               | NR                     |           |                     |           |                     |           |                     |
| <b>Exposure Type</b>                     |                                 |                        |           |                     |           |                     |           |                     |
| Eye Area                                 | NR                              | NR                     |           |                     |           |                     |           |                     |
| Incidental Ingestion                     | 1                               | NR                     |           |                     |           |                     |           |                     |
| Incidental Inhalation-Spray              | 5 <sup>2</sup> , 8 <sup>6</sup> | 0.0000013 <sup>2</sup> |           |                     |           |                     |           |                     |
| Reported Spray                           | 1                               | NR                     |           |                     |           |                     |           |                     |
| Incidental Inhalation-Powder             | 8 <sup>6</sup>                  | NR                     |           |                     |           |                     |           |                     |
| Reported Powder                          | NR                              | NR                     |           |                     |           |                     |           |                     |
| Dermal Contact                           | 26                              | NR                     |           |                     |           |                     |           |                     |
| Deodorant (underarm)                     | NR                              | NR                     |           |                     |           |                     |           |                     |
| Reported Spray                           | NR                              | NR                     |           |                     |           |                     |           |                     |
| Reported as Not Spray                    | NR                              | NR                     |           |                     |           |                     |           |                     |
| Hair - Non-Coloring                      | 7                               | 0.0000013              |           |                     |           |                     |           |                     |
| Hair-Coloring                            | NR                              | NR                     |           |                     |           |                     |           |                     |
| Nail                                     | NR                              | NR                     |           |                     |           |                     |           |                     |
| Mucous Membrane                          | 7                               | NR                     |           |                     |           |                     |           |                     |
| Baby Products                            | NR                              | NR                     |           |                     |           |                     |           |                     |

NR = Not reported.

1. Because each ingredient may be used in cosmetics with multiple exposure types, the sum of all exposure types may not equal the sum of total uses.
2. It is possible these products may be sprays, but it is not specified whether the reported uses are sprays.
3. Use in a spray product has been reported in response to a survey conducted by the Council.
4. It is possible these products may be powders, but it is not specified whether the reported uses are powders.
5. Use in a powder product has been reported in response to a survey conducted by the Council.
6. Not specified whether a powder or a spray, so this information is captured for both categories of incidental inhalation.
7. Not listed as an INCI name; included because of similarity

**Table 9. Ingredients that are not reported to be in use**

Citrus Aurantifolia (Lime) Peel Oil  
 Citrus Aurantium Currassoviensis Peel Oil  
 Citrus Clementina Peel Oil  
 Citrus Iyo Peel Oil  
 Citrus Medica Vulgaris Peel Oil  
 Citrus Reticulata (Tangerine) Peel Oil  
 Citrus Tachibana/Reticulata Peel Oil

**Table 10 . Genotoxicity**

| Test Article                | Concentration/Dose | Procedure  | Results  | Reference    |
|-----------------------------|--------------------|--|--|--------------|
| <b>IN VITRO</b>             |                    |  |  |              |
| lemon oil in ethanol        | 10-5000 µg/plate   | Reverse mutation assay using <i>Salmonella typhimurium</i> strains TA98, TA100, TA1535, and TA1537 and <i>Escherichia coli</i> strain WP2uvrA, with and without S9 metabolic activation. | Toxicity was observed in all test strains except WP2uvrA with and without S9; no significant dose-related increases in the number of revertant colonies in any test strain at any dose level, with or without metabolic activation; controls yielded expected results; lemon oil was not mutagenic in this assay.            | <sup>3</sup> |
| lemon oil in ethanol        | 40-100 µg/ml       | Cell mutation assay in mouse lymphoma L5178Y TK+/-cells in accordance with OECD guideline 476 in 2 independent experiments; with and without S9 metabolic activation                     | No significant increases in the mutation frequency were observed in either experiment, with or without S9 activation; controls yielded the expected results; lemon oil did not induce gene mutations in mouse lymphoma cells   | <sup>3</sup> |
| lemon oil in ethanol        | up to 0.125 mg/ml  | Chromosome aberration study using Chinese hamster lung fibroblasts (CHL) in accordance with OECD guideline 473, without metabolic activation, 100 metaphases examined                    | The incidence of polyploidy cells at 24 h post-treatment was 1.0%, and the incidence of cells with structural chromosome aberrations at 24 h after treatment was 2.0%; the test material did not significantly induce chromosomal aberrations in CHL cells; lemon oil was not considered clastogenic.                        | <sup>3</sup> |
| sweet orange oil in ethanol | 1-5000 µg/plate    | Reverse mutation assay using <i>Salmonella typhimurium</i> strains TA98, TA100, TA1535, and TA1537 and <i>Escherichia coli</i> strain WP2uvrA, with and without S9 metabolic activation. | Cytotoxicity was observed in all test strains except WP2uvrA with and without S9; no significant dose-related increases in the number of revertant colonies in any test strain at any dose level, with or without metabolic activation; controls yielded expected results; sweet orange oil was not mutagenic in this assay. | <sup>4</sup> |
| sweet orange oil in ethanol | 40-100 µg/ml       | Cell mutation assay in mouse lymphoma L5178Y TK+/-cells in accordance with OECD guideline 476 in 2 independent experiments; with and without S9 metabolic activation                     | The test material did not induce a significant increase in the mutation frequency in both experiments, with or without metabolic activation; sweet orange oil did not induce gene mutations in mouse lymphoma cells  | <sup>4</sup> |
| sweet orange oil in ethanol | up to 0.125 mg/ml  | Chromosome aberration study using Chinese hamster lung fibroblasts (CHL) in accordance with OECD guideline 473, without metabolic activation, 100 metaphases examined                    | The incidence of polyploidy cells at 48 h post-treatment was 1.0%, and the incidence of cells with structural chromosome aberrations at 48 h after treatment was 1.0%; the test material did not significantly induce chromosomal aberrations in CHL cells; sweet orange oil was not considered clastogenic.                 | <sup>4</sup> |

**Table 11. Dermal irritation studies for Citrus-derived ingredients**

| Test Article  | Concentration/Dose                 | Test Population  | Procedure  | Results  | Reference     |
|---|------------------------------------|--|--|--|---------------|
| <b>NON-HUMAN</b>  |                                    |  |  |  |               |
| lemon oil   | 5 ml/kg                            | 6 New Zealand White rabbits                                    | acute dermal toxicity limit test scored under the Draize method; 24-h occlusive patches on intact and abraded skin | irritating   | <sup>3</sup>  |
| orange oil, cold pressed  | 0.5 ml of undiluted material       | 3 male albino rabbits  | skin irritation study conducted according to OECD guideline 404; semi-occluded patch for 4 h                       | mean erythema/eschar scores were 2.0, 1.7, and 2.0; mean edema scores were 2.0, 1.3, and 1.3; irritating to skin | <sup>4</sup>  |
| mandarin peel oil, expressed (described as <i>Citrus reticulata</i> ) | 5 mg/kg                            | 7 rabbits  | 24-h occlusive, single dose study  | slight erythema and edema  | <sup>10</sup> |
| mandarin peel oil, expressed (described as <i>Citrus reticulata</i> ) | not reported                       | hairless mice and miniature swine; details not provided        | open patch tests; details not provided   | 2 of 3 samples were irritating   | <sup>10</sup> |
| <b>HUMAN</b>  |                                    |  |  |  |               |
| lemon oil   | 0.3%, 2% or 20%; multiple vehicles | 34 subjects at 0.3%, 30 subjects at 2%, and 35 subjects at 20% | 24-72 h occlusive patch tests  | no irritation at 0.3% and 20%, 1 + reaction at 2%  | <sup>36</sup> |
| mandarin peel oil, expressed (described as <i>Citrus reticulata</i> ) | 8% in petrolatum                   | 5 subjects   | 48 h closed patch test; details not provided   | no irritation  | <sup>10</sup> |

**Table 12. Sensitization studies for Citrus-derived ingredients**

| Test Article   | Concentration/Dose | Test Population   | Procedure  | Results  | Reference     |
|--|--------------------|---|--|--|---------------|
| <b>HUMAN - Patch</b>   |                    |   |  |  |               |
| bitter orange oil  | 2% in paraffin     | 200 patients with dermatitis tested with 35 essential oils plus an additional 50 patients with balsam sensitivity | sensitization patch study, details not provided        | 6 positive reactions   | <sup>37</sup> |
| lemon oil  | 2% in paraffin     | 200 patients with dermatitis tested with 35 essential oils plus an additional 50 patients with balsam sensitivity | sensitization patch study, details not provided        | 4 positive reactions, details not provided   | <sup>37</sup> |
| lemon oil  | not reported       | 100 subjects  | Marzulli-Maibach sensitization technique; open patches | 2% of the subjects had a positive skin reaction at the first reading after challenge, no reactions were noted at the 48 and 72 h readings, study concluded the test material was not sensitizing | <sup>3</sup>  |
| mandarin oil, expressed (described as <i>Citrus reticulata</i> ) | 8% in petrolatum   | 25 subjects   | maximization study, details not provided               | not sensitizing  | <sup>10</sup> |
| sweet orange oil   | 2% in paraffin     | 200 patients with dermatitis tested with 35 essential oils plus an additional 50 patients with balsam sensitivity | sensitization patch study, details not provided        | 3 positive reactions, details not provided   | <sup>37</sup> |
| sweet orange oil   | not reported       | 100 subjects  | Marzulli-Maibach sensitization technique; open patches | 4% of the subjects had positive skin reaction at the first reading after challenge, no reactions were noted at the 48 and 72 h readings, study concluded the test material was not sensitizing   | <sup>4</sup>  |

**Table 13. Photosensitization and phototoxicity studies**

| Test Article                                      | Concentration/Dose*  | Test Population                       | Procedure   | Results   | Reference |
|---|--|---------------------------------------|---|---|-----------|
| <b>ALTERNATIVE STUDIES</b>                        |  |                                       |   |   |           |
| sweet orange oil, including deterpenated kind     | concentrations not reported; tested in PBS, ethanol, or DMSO with samples from 3 suppliers | 3T3 Balb/c fibroblasts                | -3T3 neutral red uptake phototoxicity test<br>-light source was a doped mercury-metal halide lamp, filtered with 50% transmission at 335 nm to diminish UVB   | borderline phototoxic, positive phototoxic results observed more frequently with the vehicles PBS and ethanol with certain supplied samples | 38        |
| lemon oil, including deterpenated kind            | same as above  | same as above                         | same as above   | borderline phototoxic, positive phototoxic results observed in all 3 vehicles, but were more prominent in the deterpenated sample           | 38        |
| sweet orange oil, including deterpenated kind     | up to 3.16% in water with samples from 3 suppliers   | same as above                         | same as above   | potential for phototoxicity observed  | 38        |
| lemon oil, including deterpenated kind            | same as above  | same as above                         | same as above   | cytotoxicity observed with deterpenated lemon oil; potential for phototoxicity observed   | 38        |
| <b>NON-HUMAN</b>                                  |  |                                       |   |   |           |
| lime oil, distilled (psoralen-free)               | undiluted; 20 µl   | hairless mice, 6/grp                  | - a single dose was applied to a 2 cm <sup>2</sup> area on the back;<br>animals were exposed to irradiation 30 min after dosing<br>- one group was exposed to a compact-arc xenon lamp for 2 min (wavelengths <295 nm or 320-280 nm excluded)<br>- one group was exposed to a long-arc xenon lamp for 40 min at a distance of 1 m; the weighted energy was 0.1667 W/m <sup>2</sup><br>- one group was exposed to 4 fluorescent black light lamps (UVB eliminated) for 1 h at an integrated UVA intensity of 3 W/m <sup>2</sup><br>-positive controls were treated with 0.01% 8-methoxysoralen in methanol; negative controls with an appropriate vehicle<br>- test sites were examined 4, 24, 48, 72, and 96 h after exposure | - a phototoxic response was not observed with any of the light sources  | 40        |
| lime oil, distilled (psoralen-free)               | undiluted; 20 µl   | miniature swine, 2/grp                | as above  | - a phototoxic response was not observed with any of the light sources  | 40        |
| lime oil, expressed                               | undiluted and diluted; 20 µl   | hairless mice, 6/grp                  | as above  | - a phototoxic response was observed with all three light sources<br>- the lowest phototoxic concentration was 15%                          | 40        |
| lime oil, expressed                               | undiluted and diluted; 20 µl   | miniature swine, 2/grp                | as above  | - a phototoxic response was observed with all three light sources<br>- the lowest phototoxic concentration was 30%                          | 40        |
| grapefruit oil                                    | undiluted; 20 µl   | 6 hairless mice and 2 miniature swine | - as above  | not photosensitizing  | 40        |
| lime oil distilled (psoralen-free)                | undiluted; 20 µl   | 6 hairless mice and 2 miniature swine | - as above  | not photosensitizing  | 40        |
| lime oil; expressed and rectified                 | undiluted; 20 µl   | 6 hairless mice and 2 miniature swine | - as above  | not photosensitizing  | 40        |
| lime oil Persian Florida; expressed and rectified | undiluted; 20 µl   | 6 hairless mice and 2 miniature swine | - as above  | not photosensitizing  | 40        |

**Table 13. Photosensitization and phototoxicity studies**

| Test Article                             | Concentration/Dose*                 | Test Population                       | Procedure  | Results   | Reference |
|--|-------------------------------------|---------------------------------------|--|---|-----------|
| mandarin oil                             | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | not photosensitizing  | 40        |
| mandarin oil, Italian                    | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | not photosensitizing  | 40        |
| oil of lemon, California                 | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | not photosensitizing  | 40        |
| oil of lemon, distilled                  | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | not photosensitizing  | 40        |
| oil mandarin, Italian                    | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | not photosensitizing  | 40        |
| oil of tangerine                         | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | not photosensitizing  | 40        |
| orange oil; cold pressed                 | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | not photosensitizing  | 40        |
| California lemon oil                     | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | - a phototoxic response was observed  | 40        |
| Italian lemon oil                        | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | - a phototoxic response was observed  | 40        |
| oil lemon, Greek; cold pressed           | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | - a phototoxic response was observed  | 40        |
| oil lemon, Italian                       | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | - a phototoxic response was observed  | 40        |
| oil lemon, IC (not defined)              | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | - a phototoxic response was observed  | 40        |
| lime oil expressed                       | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | - a phototoxic response was observed  | 40        |
| oil limes Persian                        | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | - a phototoxic response was observed  | 40        |
| oil limes, expressed and rectified       | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | - a phototoxic response was observed  | 40        |
| lime oil, expressed and rectified        | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | - a phototoxic response was observed  | 40        |
| bitter orange oil                        | undiluted; 20 µl                    | 6 hairless mice and 2 miniature swine | - as above   | - a phototoxic response was observed  | 40        |
| lemon oil from multiple regional sources | 20, 50, or 100% in ethanol; 0.02 ml | albino guinea pigs                    | - the oil was applied to the shaved back of the animals<br>- the animals were then exposed to UVA radiation (320-400 nm, 13 J/cm <sup>2</sup> )<br>- erythema was evaluated 24, 48, and 72 h after irradiation<br>- the samples were then fractionated subsequent phototoxicity testing of the isolated components was performed | -concentrations of 50% and 100% elicited phototoxicity in most of the samples tested<br>- lemon oils from different regions had different phototoxicity potencies<br>- oxypeucedanin and 5-methoxysoralen (furocoumarins) were identified as phototoxic | 41        |

**Table 13. Photosensitization and phototoxicity studies**

| Test Article                                | Concentration/Dose*   | Test Population       | Procedure  | Results  | Reference |
|---|---|-----------------------|--|--|-----------|
| <b>HUMAN</b>                                |   |                       |  |  |           |
| bitter orange peel oil                      | undiluted; 5 µl/cm <sup>2</sup>                                   | 8 subjects            | - an occlusive patch was applied to a 2 cm x 2 cm area<br>- 1 cm site on each subject was exposed to visible light t of 20 J/cm <sup>2</sup> UVA<br>- the test sites were scored after 24 and 48 h   | all subjects reacted (details not provided)  | 30        |
| lemon oil, including deterpened kind        | up to 1% in water from samples from 3 supplier; dose not provided | 5 female subjects     | - 2 occlusive 10 mm diameter Finn Chambers on both sides of the lower back<br>- exposure time to test material was 1 h<br>- irradiation immediately to 1 site after patch removal at a dose of 5 J/cm <sup>2</sup> as measured in the UVA range<br>- test sites scored after 24, 48, and 72 h<br>- light source was a doped mercury-metal halide lamp, filtered with 50% transmission at 335 nm to diminish UVB  | -phototoxic reactions concurrent with an irritation reactions were observed in lemon oil at 1% in 4/5 subjects up to 72 h after irradiation<br>-phototoxic reactions were observed in deterpened lemon oil at 0.1% in 2/5 subjects at 48 and 72 h after irradiation<br>-no reactions were observed at concentrations of 0.1% or lower in lemon oil and 0.01% in deterpened lemon oil | 38        |
| sweet orange oil, including deterpened kind | same as above   | same as above         | -same as above   | -phototoxic reaction were observed in orange oil at 1% in 3/5 subjects at 24 h and 2/5 subjects at 48 and 72 h after irradiation<br>-no reactions were observed at concentrations of 0.1% or lower in orange oil or 0.1% and 0.01% in deterpened orange oil  | 38        |
| lime oil, distilled                         | undiluted   | 10 Caucasian subjects | - a single dose was applied to a 2 cm <sup>2</sup> area on the back<br>- 30 min after dosing, subjects were exposed to sunlight for 30 min or a compact-arc xenon lamp for 2 min (wavelengths <295 nm or 320-280 nm excluded)<br>- positive controls were treated with 0.01% 8-methoxysoralen in methanol; negative controls with an appropriate vehicle<br>- test sites were examined 4, 24, 48, 72, and 96 h after exposure  | no phototoxic response was observed  | 40        |
| lime oil, expressed                         | undiluted and diluted; 20 µl                                      | 10 Caucasian subjects | - a single dose was applied to a 2 cm <sup>2</sup> area on the back<br>- 30 min after dosing, 1 treated site and the control untreated site were exposed to sunlight for 30 min, a compact-arc xenon lamp for 2 min (wavelengths <295 nm or 320-280 nm excluded), or 4 fluorescent black light lamps (UVB eliminated) for 1 h at an integrated UVA intensity of 3 W/m <sup>2</sup><br>- positive controls were treated with 0.01% 8-methoxysoralen in methanol; negative controls with an appropriate vehicle<br>- test sites were examined 4, 24, 48, 72, and 96 h after exposure | - a phototoxic response was observed with all three light sources<br>- the lowest phototoxic concentration with the simulated light sources was 30%  | 40        |

\* the solvent is specified when known

## REFERENCES

1. Council of Experts, United States Pharmacopeial Convention. Food Chemicals Codex. 8th ed. Rockville, MD: United States Pharmacopeia (USP), 2012.
2. Nikitakis J and Breslawec HP. International Cosmetic Ingredient Dictionary and Handbook. 15 ed. Washington, DC: Personal Care Products Council, 2014.
3. European Chemicals Agency. Lemon, ext. <http://echa.europa.eu/>. Date Accessed 4-29-2014.
4. European Chemicals Agency. Orange, sweet, ext. <http://echa.europa.eu/>. Date Accessed 4-29-2014.
5. Sawamura M (ed). Citrus Essential Oils. Flavor and Fragrance. Hoboken, NJ: John Wiley & Sons, Inc, 2010.
6. Njoroge SM, Koaze H, Karanja PN, and Sawamura M. Volatile constituents of redblush grapefruit (*Citrus paradisi*) and pummelo (*Citrus grandis*) peel essential oils from Kenya. *J Agric Food Chem.* 12-14-2005;53(25):9790-9794.
7. Lan-Phi NT, Shimamura T, Ukeda H, and Sawamura M. Chemical and aroma profiles of yuzu (*Citrus junos*) peel oils of different cultivars. *Food Chemistry.* 2009;115:1042-1047.
8. National Toxicology Program (NTP). Lemon Oil (CASRN 8008-56-8) and Lime Oil (CASRN 8008-26-2). 2000. [http://ntp.niehs.nih.gov/ntp/htdocs/Chem\\_Background/ExSumPDF/LemonLimeOils\\_508.pdf](http://ntp.niehs.nih.gov/ntp/htdocs/Chem_Background/ExSumPDF/LemonLimeOils_508.pdf). Date Accessed 6-3-2013.
9. Uchida K, Matsumoto M, Kobayashi A, and Yamanishi T. Composition of oxygenated compounds in peel oil from *Citrus iyo* and its variation during storage. *Agric Biol Chem.* 1983;47(8):1841-1845.
10. Ford RA, Api AM, and Letizia CS. Mandarin oil, expressed. *Food and Chemical Toxicology.* 1992;30(Suppl.):69S-70S.
11. Azar PA, Nekoei M, Larijani K, and Bahraminasab S. Chemical composition of the essential oils of *Citrus sinensis* cv. *Valencia* and a quantitative structure-retention relationship study for prediction of retention indices by multiple linear regression. *J Serb Chem Soc.* 2011;76(12):1627-1637.
12. Ahmad MM, Salim-Ur-Rehman, Iqbal Z, Anjum FM, and Sultan JI. Genetic variability to essential oil composition in four citrus fruit species. *Pak J Bot.* 2014;38(2):319-324.
13. Lota M-L, de Rocca Serra D, Tomi F, Jacquemond C, and Casanova J. Volatile components of peel and leaf oils of lemon and lime species. *J Agric Food Chem.* 2002;50(4):796-805.
14. Dugo P, Mondello L, Dugo L, Stanganelli R, and Dugo G. LC-MS for the identification of oxygen heterocyclic compounds in citrus essential oils. *J Pharm Biomed Anal.* 2000;24:147-154.
15. Qiao Y, Xie BJ, Zhang Y, Zhang Y, Fan G, Yao XL, and Pan SY. Characterization of aroma active compounds in fruit juice and peel oil of Jinchen sweet orange fruit (*Citrus sinensis* (L.) Osbeck) by GC-MS and GC-O. *Molecules.* 2008;13:1333-1344.
16. Singh G and Singh OP. Chemistry of essential oils of Citrus species. *Natural Product Radiance.* 2002;Sept-Oct:8-21.
17. Bermejo A., Llosa M.J., and Cano A. Analysis of bioactive compounds in seven citrus cultivars. *Food Sci Technol.Int.* 2011;17(1):55-62.
18. Bourgou S, Rahali FZ, Ourghemmi I, and Tounsi MS. Changes of peel essential oil composition of four Tunisian citrus during fruit maturation. *The Scientific World Journal.* 2012;2012:1-10.

19. Kejlová K, Jírová D, Bendová H, Kandárová H, Weidenhoffer Z, Kolárová H, and Liesbsch M. Phototoxicity of bergamot oil assessed by in vitro techniques in combination with human patch tests. *Toxicol In Vitro*. 2007;21:1298-1303.
20. Sarrou E, Chatzopoulou P, Dimassi-Theriou K, and Therios I. Volatile constituents and antioxidant activity of peel, flowers and leaf oils of *Citrus aurantium*L. growing in Greece. *Molecules*. 2013;18:10639-10647.
21. Sultana HS, li M, and anda BP. Influence of volatile constituents of fruit peels of *Citrus reticulata Blanco* on clinically isolated pathogenic microorganisms under *In-vitro*. *Asian Pacific Journal of Tropical Biomedicine*. 2012;S1299-S1302.
22. Tao N-g, Liu Y-j, and Zhang M-l. Chemical composition and antimicrobial activities of essential oil for the peel of bingtang sweet orange (*Citrus sinensis* Osbeck). *International Journal of Food Science and Technology*. 2009;44:1281-1285.
23. Food and Drug Administration (FDA). Frequency of use of cosmetic ingredients. *FDA Database*. 2014. Washington, DC: FDA.
24. Personal Care Products Council. 7-25-2013. Concentration of use by FDA Product Category: Citrus Derived Ingredients. 24 pages.
25. European Commission. Scientific Committee on Consumer Products (SCCP) Opinion on Furocoumarins in Cosmetic Products. 12-13-2005. [http://ec.europa.eu/health/ph\\_risk/committees/04\\_sccp/docs/sccp\\_o\\_036.pdf](http://ec.europa.eu/health/ph_risk/committees/04_sccp/docs/sccp_o_036.pdf). Date Accessed 6-3-2013. Report No. SCCP/0942/05.
26. International Fragrance Association. IFRA standard for citrus oils and other furocoumarins-containing essential oils. [http://www.ifraorg.org/en-us/standards\\_restricted](http://www.ifraorg.org/en-us/standards_restricted). Date Accessed 2-26-2013.
27. International Fragrance Association. IFRA standard for 7-methoxycoumarin. <http://www.ifraorg.org/en-us/search/s/lime#UiQD0TXD-Uk>. Date Accessed 9-1-2013.
28. International Fragrance Association. IFRA Standards for limonene. [www.ifraorg.org/view\\_document.aspx?docId=22594](http://www.ifraorg.org/view_document.aspx?docId=22594). Date Accessed 8-5-2014.
29. European Commission. Opinion of the Scientific Committee on Cosmetic Products and Non-Food Products intended for Consumers Concerning an Initial List of Perfumery Materials which Must Not Form Part of Cosmetic Products Except Subject to the Restrictions and Conditions Laid Down. SCCNFP/0392/00, final. [http://ec.europa.eu/health/ph\\_risk/committees/sccp/documents/out150\\_en.pdf](http://ec.europa.eu/health/ph_risk/committees/sccp/documents/out150_en.pdf). Date Accessed 8-5-2014.
30. International Fragrance Association. IFRA standard for bitter orange peel oil expressed. [www.ifraorg.org/view\\_document.aspx?docId=23155](http://www.ifraorg.org/view_document.aspx?docId=23155). Date Accessed 3-7-2013.
31. International Fragrance Association. IFRA standard for grapefruit oil expressed. [http://www.ifraorg.org/en-us/search/s/grapefruit油\\_expressed#.UiP-7DXD-Uk](http://www.ifraorg.org/en-us/search/s/grapefruit油_expressed#.UiP-7DXD-Uk). Date Accessed 3-7-0013.
32. International Fragrance Association. IFRA standard for lemon oil cold pressed. [http://www.ifraorg.org/en-us/search/s/lemon油\\_cold\\_pressed#.UiQAQDXD-Uk](http://www.ifraorg.org/en-us/search/s/lemon油_cold_pressed#.UiQAQDXD-Uk). Date Accessed 3-7-2013.
33. International Fragrance Association. IFRA standard for lime oil expressed. [http://www.ifraorg.org/en-us/search/s/lime油\\_expressed#.UiQA\\_zXD-Uk](http://www.ifraorg.org/en-us/search/s/lime油_expressed#.UiQA_zXD-Uk). Date Accessed 9-1-2013.
34. Integrated Laboratory Systems. Bitter orange (*Citrus aurantium* var. amara) extracts and constituents (±)-p-Synephrine [CAS No. 94-07-5] and (±)-p-octapamine [CAS No. 104-14-3]. Review of toxicological literature prepared for the National Toxicology Program. [http://ntp.niehs.nih.gov/ntp/htdocs/Chem\\_Background/ExSumPdf/Bitterorange\\_508.pdf](http://ntp.niehs.nih.gov/ntp/htdocs/Chem_Background/ExSumPdf/Bitterorange_508.pdf). Date Accessed 3-7-2013.

35. Roe FJC and Peirce WEH. Tumor promotion by citrus oils: Tumors of the skin and urethral orifice in mice. *JNCI*. 1960;24(6):1389-1403.
36. FujiiT, Furukawa S, and Suzuki S. Studies on compounded perfumes for toilet goods. On the non-irritative compounded perfumes for soaps. *Yukugaku*. 1972;21(12):904-908.
37. Rudzki E, Grzywa Z, and Bruo WS. Sensitivity to 35 essential oils. *Contact Dermatitis*. 1976;2:196-200.
38. Kejlová K, Jírová D, Bendová H, Gajdos P, and Kolárová H. Phototoxicity of essential oils intended for cosmetic use. *Toxicol In Vitro*. 2010;24:2084-2089.
39. Yasui Y and Hirone T. Action spectrum for bergamot-oil phototoxicity measured by sunburn cell counting. *J Dermatol*. 1994;21:319-322.
40. Forbes PD, Urbach F, and Davies RE. Phototoxicity testing of fragrance raw materials. *Fd Cosmet Toxicol*. 1977;15:55-60.
41. Naganuma M, Hirose S, Nakayama Y, Nakajima K, and Someya T. A study of phototoxicity of lemon oil. *Arch Dermatol Res*. 1985;278:31-36.
42. Vester L, Thyssen JP, Menné T, and Johansen JD. Occupational food-related hand dermatoses seen over a 10-year period. *Contact Dermatitis*. 2012;66:264-270.
43. New Directions Laboratory. Material Safety Data Sheet: Celmentine Essential Oil (*Citrus clementina*). [www.newdirections.com.au/msds-view/download.php?id=16410](http://www.newdirections.com.au/msds-view/download.php?id=16410). Date Accessed 8-8-2014.
44. Kamal GM, Anwar F, Hussain AI, Sarri N, and Ashraf MY. Yield and chemical composition of *Citrus* essential oils as affected by drying pretreatment of peels. *International Food Research Journal*. 2011;18(4):1275-1282.
45. European Commission. Scientific Committee on Consumer Safety (SCCS) opinion on fragrance allergens in cosmetic products. [http://ec.europa.eu/health/scientific\\_committees/consumer\\_safety/docs/scs\\_o\\_102.pdf](http://ec.europa.eu/health/scientific_committees/consumer_safety/docs/scs_o_102.pdf). Date Accessed 9-3-2013.
46. Food and Drug Administration (FDA). Frequency of use of cosmetic ingredients. *FDA Database*. 2013.

**2015 FDA VCRP RAW DATA**

|               |  |  |    |
|---------------|--|--|----|
| 99900190<br>5 | CITRUS AURANTIFOLIA (LIME) PEEL<br>EXTRACT       | 12A - Cleansing                        | 2  |
| 99900190<br>5 | CITRUS AURANTIFOLIA (LIME) PEEL<br>EXTRACT       | 12D - Body and Hand (exc shave)        | 1  |
| 99900190<br>5 | CITRUS AURANTIFOLIA (LIME) PEEL<br>EXTRACT       | 12F - Moisturizing                     | 5  |
| 99900190<br>5 | CITRUS AURANTIFOLIA (LIME) PEEL<br>EXTRACT       | 12J - Other Skin Care Preps            | 5  |
| 99900190<br>5 | CITRUS AURANTIFOLIA (LIME) PEEL<br>EXTRACT       | 13A - Suntan Gels, Creams, and Liquids | 1  |
| 99900399<br>4 | CITRUS AURANTIFOLIA (LIME) PEEL<br>POWDER        | 12H - Paste Masks (mud packs)          | 1  |
| 99900156<br>9 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL WAX     | 05F - Shampoos (non-coloring)          | 1  |
| 99900156<br>9 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL WAX     | 07E - Lipstick                         | 3  |
| 99900156<br>9 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL WAX     | 10A - Bath Soaps and Detergents        | 1  |
| 97708187<br>0 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL EXTRACT | 02A - Bath Oils, Tablets, and Salts    | 1  |
| 97708187<br>0 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL EXTRACT | 03C - Eye Shadow                       | 2  |
| 97708187<br>0 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL EXTRACT | 04A - Cologne and Toilet waters        | 1  |
| 97708187<br>0 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL EXTRACT | 05A - Hair Conditioner                 | 5  |
| 97708187<br>0 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL EXTRACT | 05F - Shampoos (non-coloring)          | 4  |
| 97708187<br>0 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL EXTRACT | 07I - Other Makeup Preparations        | 1  |
| 97708187<br>0 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL EXTRACT | 10A - Bath Soaps and Detergents        | 1  |
| 97708187<br>0 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL EXTRACT | 11E - Shaving Cream                    | 1  |
| 97708187<br>0 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL EXTRACT | 12A - Cleansing                        | 1  |
| 97708187<br>0 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL EXTRACT | 12C - Face and Neck (exc shave)        | 4  |
| 97708187<br>0 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL EXTRACT | 12D - Body and Hand (exc shave)        | 3  |
| 97708187<br>0 | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL EXTRACT | 12F - Moisturizing                     | 11 |
| 97708187      | CITRUS AURANTIUM (BITTER<br>ORANGE) PEEL EXTRACT | 12G - Night                            | 2  |

|          |  |  |   |
|----------|--|--|---|
| 0        | ORANGE) PEEL EXTRACT                               |  |   |
| 97708187 | CITRUS AURANTIUM (BITTER<br>0 ORANGE) PEEL EXTRACT | 12H - Paste Masks (mud packs)                            | 1 |
| 97708187 | CITRUS AURANTIUM (BITTER<br>0 ORANGE) PEEL EXTRACT | 12I - Skin Fresheners                                    | 1 |
| 97708187 | CITRUS AURANTIUM (BITTER<br>0 ORANGE) PEEL EXTRACT | 12J - Other Skin Care Preps                              | 5 |
| 97708187 | CITRUS AURANTIUM (BITTER<br>0 ORANGE) PEEL EXTRACT | 13A - Suntan Gels, Creams, and Liquids                   | 2 |
| 99900325 | CITRUS AURANTIUM (BITTER<br>6 ORANGE) PEEL POWDER  | 10A - Bath Soaps and Detergents                          | 1 |
| 99900325 | CITRUS AURANTIUM (BITTER<br>6 ORANGE) PEEL POWDER  | 12A - Cleansing  | 1 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 02D - Other Bath Preparations                            | 1 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 03D - Eye Lotion   | 1 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 05A - Hair Conditioner                                   | 3 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 05E - Rinses (non-coloring)                              | 1 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 05F - Shampoos (non-coloring)                            | 3 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 05G - Tonics, Dressings, and Other Hair<br>Grooming Aids | 8 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 05H - Wave Sets  | 2 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 05I - Other Hair Preparations                            | 2 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 07A - Blushers (all types)                               | 1 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 07C - Foundations  | 2 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 07I - Other Makeup Preparations                          | 1 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 09A - Dentifrices  | 2 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 10A - Bath Soaps and Detergents                          | 9 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 10E - Other Personal Cleanliness Products                | 2 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 12A - Cleansing  | 2 |
| 97709182 | CITRUS AURANTIUM DULCIS<br>9 (ORANGE) PEEL EXTRACT | 12C - Face and Neck (exc shave)                          | 3 |

|               |  |   |   |
|---------------|--|---|---|
| 97709182<br>9 | CITRUS AURANTIUM DULCIS<br>(ORANGE) PEEL EXTRACT | 12D - Body and Hand (exc shave)   | 1 |
| 97709182<br>9 | CITRUS AURANTIUM DULCIS<br>(ORANGE) PEEL EXTRACT | 12F - Moisturizing  | 4 |
| 97709182<br>9 | CITRUS AURANTIUM DULCIS<br>(ORANGE) PEEL EXTRACT | 12G - Night   | 1 |
| 97709182<br>9 | CITRUS AURANTIUM DULCIS<br>(ORANGE) PEEL EXTRACT | 12J - Other Skin Care Preps   | 2 |
| 99900139<br>2 | CITRUS AURANTIUM DULCIS<br>(ORANGE) PEEL POWDER  | 07B - Face Powders  | 1 |
| 99900139<br>2 | CITRUS AURANTIUM DULCIS<br>(ORANGE) PEEL POWDER  | 10E - Other Personal Cleanliness Products   | 2 |
| 99900139<br>2 | CITRUS AURANTIUM DULCIS<br>(ORANGE) PEEL POWDER  | 12A - Cleansing   | 2 |
| 99900139<br>2 | CITRUS AURANTIUM DULCIS<br>(ORANGE) PEEL POWDER  | 12D - Body and Hand (exc shave)   | 3 |
| 99900139<br>2 | CITRUS AURANTIUM DULCIS<br>(ORANGE) PEEL POWDER  | 12H - Paste Masks (mud packs)   | 2 |
| 99900139<br>2 | CITRUS AURANTIUM DULCIS<br>(ORANGE) PEEL POWDER  | 12J - Other Skin Care Preps   | 1 |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT      | 03D - Eye Lotion  | 2 |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT      | 03G - Other Eye Makeup Preparations   | 1 |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT      | 05A - Hair Conditioner  | 1 |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT      | 06A - Hair Dyes and Colors (all types<br>requiring caution statements and patch<br>tests) | 2 |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT      | 07E - Lipstick  | 1 |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT      | 07F - Makeup Bases  | 1 |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT      | 10A - Bath Soaps and Detergents   | 1 |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT      | 12A - Cleansing   | 3 |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT      | 12C - Face and Neck (exc shave)   | 7 |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT      | 12D - Body and Hand (exc shave)   | 2 |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT      | 12F - Moisturizing  | 6 |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT      | 12G - Night   | 5 |

|               |   |  |    |
|---------------|---|--|----|
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT | 12H - Paste Masks (mud packs)                            | 3  |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT | 12I - Skin Fresheners                                    | 1  |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT | 12J - Other Skin Care Preps                              | 10 |
| 99900190<br>6 | CITRUS GRANDIS (GRAPEFRUIT)<br>PEEL EXTRACT | 13A - Suntan Gels, Creams, and Liquids                   | 2  |
| 99900338<br>0 | CITRUS JUNOS PEEL EXTRACT                   | 03D - Eye Lotion   | 1  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 01A - Baby Shampoos                                      | 1  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 02A - Bath Oils, Tablets, and Salts                      | 1  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 03D - Eye Lotion   | 2  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 03G - Other Eye Makeup Preparations                      | 2  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 04B – Perfumes   | 1  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 05A - Hair Conditioner                                   | 33 |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 05F - Shampoos (non-coloring)                            | 26 |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 05G - Tonics, Dressings, and Other Hair<br>Grooming Aids | 1  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 05I - Other Hair Preparations                            | 15 |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 06G - Hair Bleaches                                      | 2  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 07E – Lipstick   | 1  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 08E - Nail Polish and Enamel                             | 1  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 09A – Dentifrices  | 2  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 10A - Bath Soaps and Detergents                          | 7  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 10B - Deodorants (underarm)                              | 1  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 10E - Other Personal Cleanliness Products                | 5  |
| 97709177<br>2 | CITRUS LIMON (LEMON) PEEL<br>EXTRACT        | 11E - Shaving Cream                                      | 1  |
| 97709177      | CITRUS LIMON (LEMON) PEEL                   | 12A – Cleansing  | 23 |

|          |  |  |    |
|----------|--|--|----|
| 2        | EXTRACT  |  |    |
| 97709177 | CITRUS LIMON (LEMON) PEEL<br>2 EXTRACT           | 12C - Face and Neck (exc shave)                          | 13 |
| 97709177 | CITRUS LIMON (LEMON) PEEL<br>2 EXTRACT           | 12D - Body and Hand (exc shave)                          | 6  |
| 97709177 | CITRUS LIMON (LEMON) PEEL<br>2 EXTRACT           | 12F – Moisturizing                                       | 15 |
| 97709177 | CITRUS LIMON (LEMON) PEEL<br>2 EXTRACT           | 12G – Night  | 1  |
| 97709177 | CITRUS LIMON (LEMON) PEEL<br>2 EXTRACT           | 12H - Paste Masks (mud packs)                            | 3  |
| 97709177 | CITRUS LIMON (LEMON) PEEL<br>2 EXTRACT           | 12I - Skin Fresheners                                    | 4  |
| 97709177 | CITRUS LIMON (LEMON) PEEL<br>2 EXTRACT           | 12J - Other Skin Care Preps                              | 4  |
| 99900273 | CITRUS LIMON (LEMON) PEEL<br>8 POWDER            | 08G - Other Manicuring Preparations                      | 1  |
| 99900273 | CITRUS LIMON (LEMON) PEEL<br>8 POWDER            | 10E - Other Personal Cleanliness Products                | 1  |
| 99900273 | CITRUS LIMON (LEMON) PEEL<br>8 POWDER            | 12A - Cleansing  | 1  |
| 99900273 | CITRUS LIMON (LEMON) PEEL<br>8 POWDER            | 12D - Body and Hand (exc shave)                          | 1  |
| 99900267 | CITRUS MEDICA LIMONUM<br>0 (LEMON) PEEL WAX      | 10E - Other Personal Cleanliness Products                | 1  |
| 90063835 | CITRUS NOBILIS (MANDARIN<br>ORANGE) PEEL EXTRACT | 05A - Hair Conditioner                                   | 2  |
| 90063835 | CITRUS NOBILIS (MANDARIN<br>ORANGE) PEEL EXTRACT | 05F - Shampoos (non-coloring)                            | 1  |
| 90063835 | CITRUS NOBILIS (MANDARIN<br>ORANGE) PEEL EXTRACT | 05G - Tonics, Dressings, and Other Hair<br>Grooming Aids | 1  |
| 90063835 | CITRUS NOBILIS (MANDARIN<br>ORANGE) PEEL EXTRACT | 07A - Blushers (all types)                               | 1  |
| 90063835 | CITRUS NOBILIS (MANDARIN<br>ORANGE) PEEL EXTRACT | 10A - Bath Soaps and Detergents                          | 2  |
| 90063835 | CITRUS NOBILIS (MANDARIN<br>ORANGE) PEEL EXTRACT | 10E - Other Personal Cleanliness Products                | 5  |
| 90063835 | CITRUS NOBILIS (MANDARIN<br>ORANGE) PEEL EXTRACT | 12A - Cleansing  | 1  |
| 90063835 | CITRUS NOBILIS (MANDARIN<br>ORANGE) PEEL EXTRACT | 12D - Body and Hand (exc shave)                          | 2  |
| 90063835 | CITRUS NOBILIS (MANDARIN<br>ORANGE) PEEL EXTRACT | 12F - Moisturizing                                       | 3  |
| 90063835 | CITRUS NOBILIS (MANDARIN<br>ORANGE) PEEL EXTRACT | 12J - Other Skin Care Preps                              | 1  |

## ORANGE) PEEL EXTRACT

|               |   |  |    |
|---------------|---|--|----|
| 99900411<br>6 | CITRUS PARADISI (GRAPEFRUIT)<br>PEEL EXTRACT        | 05A - Hair Conditioner                                   | 2  |
| 99900411<br>6 | CITRUS PARADISI (GRAPEFRUIT)<br>PEEL EXTRACT        | 05F - Shampoos (non-coloring)                            | 2  |
| 99900411<br>6 | CITRUS PARADISI (GRAPEFRUIT)<br>PEEL EXTRACT        | 05G - Tonics, Dressings, and Other Hair<br>Grooming Aids | 2  |
| 99900411<br>6 | CITRUS PARADISI (GRAPEFRUIT)<br>PEEL EXTRACT        | 07E - Lipstick   | 3  |
| 99900411<br>6 | CITRUS PARADISI (GRAPEFRUIT)<br>PEEL EXTRACT        | 10A - Bath Soaps and Detergents                          | 2  |
| 99900411<br>6 | CITRUS PARADISI (GRAPEFRUIT)<br>PEEL EXTRACT        | 12G - Night  | 1  |
| 99900411<br>6 | CITRUS PARADISI (GRAPEFRUIT)<br>PEEL EXTRACT        | 12J - Other Skin Care Preps                              | 1  |
| 99900261<br>9 | CITRUS RETICULATA (MANDARIN<br>ORANGE) PEEL EXTRACT | 03D - Eye Lotion   | 3  |
| 99900261<br>9 | CITRUS RETICULATA (MANDARIN<br>ORANGE) PEEL EXTRACT | 03G - Other Eye Makeup Preparations                      | 2  |
| 99900261<br>9 | CITRUS RETICULATA (MANDARIN<br>ORANGE) PEEL EXTRACT | 10A - Bath Soaps and Detergents                          | 1  |
| 99900261<br>9 | CITRUS RETICULATA (MANDARIN<br>ORANGE) PEEL EXTRACT | 10E - Other Personal Cleanliness Products                | 2  |
| 99900261<br>9 | CITRUS RETICULATA (MANDARIN<br>ORANGE) PEEL EXTRACT | 12A - Cleansing  | 2  |
| 99900261<br>9 | CITRUS RETICULATA (MANDARIN<br>ORANGE) PEEL EXTRACT | 12C - Face and Neck (exc shave)                          | 1  |
| 99900261<br>9 | CITRUS RETICULATA (MANDARIN<br>ORANGE) PEEL EXTRACT | 12D - Body and Hand (exc shave)                          | 2  |
| 99900261<br>9 | CITRUS RETICULATA (MANDARIN<br>ORANGE) PEEL EXTRACT | 12F - Moisturizing                                       | 13 |
| 99900261<br>9 | CITRUS RETICULATA (MANDARIN<br>ORANGE) PEEL EXTRACT | 12G - Night  | 2  |
| 99900261<br>9 | CITRUS RETICULATA (MANDARIN<br>ORANGE) PEEL EXTRACT | 12J - Other Skin Care Preps                              | 2  |
| 99900402<br>4 | CITRUS SINENSIS (SWEET ORANGE)<br>PEEL EXTRACT      | 10E - Other Personal Cleanliness Products                | 1  |
| 99900402<br>4 | CITRUS SINENSIS (SWEET ORANGE)<br>PEEL EXTRACT      | 12A - Cleansing  | 1  |
| 99900402<br>4 | CITRUS SINENSIS (SWEET ORANGE)<br>PEEL EXTRACT      | 12F - Moisturizing                                       | 1  |
| 99900412<br>9 | CITRUS SINENSIS (SWEET ORANGE)<br>PEEL WAX          | 11A - Aftershave Lotion                                  | 4  |

|               |   |                                     |    |
|---------------|---|-------------------------------------|----|
| 99900404<br>6 | CITRUS TACHIBANA (TACHIBANA<br>ORANGE) PEEL EXTRACT | 12A - Cleansing                     | 1  |
| 99900404<br>6 | CITRUS TACHIBANA (TACHIBANA<br>ORANGE) PEEL EXTRACT | 12F - Moisturizing                  | 1  |
| 99900404<br>6 | CITRUS TACHIBANA (TACHIBANA<br>ORANGE) PEEL EXTRACT | 12J - Other Skin Care Preps         | 3  |
| 99900381<br>5 | CITRUS TACHIBANA PEEL EXTRACT                       | 12C - Face and Neck (exc shave)     | 3  |
| 99900144<br>5 | CITRUS UNSHIU (SATSUMA<br>ORANGE) PEEL EXTRACT      | 02A - Bath Oils, Tablets, and Salts | 1  |
| 99900144<br>5 | CITRUS UNSHIU (SATSUMA<br>ORANGE) PEEL EXTRACT      | 03D - Eye Lotion                    | 3  |
| 99900144<br>5 | CITRUS UNSHIU (SATSUMA<br>ORANGE) PEEL EXTRACT      | 05F - Shampoos (non-coloring)       | 1  |
| 99900144<br>5 | CITRUS UNSHIU (SATSUMA<br>ORANGE) PEEL EXTRACT      | 10A - Bath Soaps and Detergents     | 1  |
| 99900144<br>5 | CITRUS UNSHIU (SATSUMA<br>ORANGE) PEEL EXTRACT      | 12A - Cleansing                     | 5  |
| 99900144<br>5 | CITRUS UNSHIU (SATSUMA<br>ORANGE) PEEL EXTRACT      | 12C - Face and Neck (exc shave)     | 14 |
| 99900144<br>5 | CITRUS UNSHIU (SATSUMA<br>ORANGE) PEEL EXTRACT      | 12D - Body and Hand (exc shave)     | 1  |
| 99900144<br>5 | CITRUS UNSHIU (SATSUMA<br>ORANGE) PEEL EXTRACT      | 12F - Moisturizing                  | 7  |
| 99900144<br>5 | CITRUS UNSHIU (SATSUMA<br>ORANGE) PEEL EXTRACT      | 12H - Paste Masks (mud packs)       | 1  |
| 99900144<br>5 | CITRUS UNSHIU (SATSUMA<br>ORANGE) PEEL EXTRACT      | 12I - Skin Fresheners               | 2  |
| 99900144<br>5 | CITRUS UNSHIU (SATSUMA<br>ORANGE) PEEL EXTRACT      | 12J - Other Skin Care Preps         | 4  |



**TO:** Lillian Gill, Ph.D.  
Director - COSMETIC INGREDIENT REVIEW (CIR)

**FROM:** Halyna Breslawec, Ph.D.  
Industry Liaison to the CIR Expert Panel

**DATE:** July 25, 2013

**SUBJECT:** Concentration of Use by FDA Product Category: Citrus-Derived Ingredients

A handwritten signature in blue ink that reads "Halyna". The signature is written in a cursive style with a horizontal line underneath it.

**Concentration of Use by FDA Product Category - Citrus-Derived Ingredients\***

|   |   |
|---|---|
| Citrus Aurantifolia (Lime)/Citrus Limon (Lemon) Fruit Water | Citrus Aurantium Dulcis (Orange) Flower Extract           |
| Citrus Aurantifolia (Lime) Flower Extract                   | Citrus Aurantium Dulcis (Orange) Flower/Leaf/Stem Powder  |
| Citrus Aurantifolia (Lime) Fruit                            | Citrus Aurantium Dulcis (Orange) Flower Oil               |
| Citrus Aurantifolia (Lime) Fruit Extract                    | Citrus Aurantium Dulcis (Orange) Flower Water             |
| Citrus Aurantifolia (Lime) Fruit Water                      | Citrus Aurantium Dulcis (Orange) Flower Wax               |
| Citrus Aurantifolia (Lime) Juice                            | Citrus Aurantium Dulcis (Orange) Fruit Extract            |
| Citrus Aurantifolia (Lime) Leaf Oil                         | Citrus Aurantium Dulcis (Orange) Fruit Powder             |
| Citrus Aurantifolia (Lime) Oil                              | Citrus Aurantium Dulcis (Orange) Fruit Water              |
| Citrus Aurantifolia (Lime) Peel                             | Citrus Aurantium Dulcis (Orange) Juice                    |
| Citrus Aurantifolia (Lime) Peel Extract                     | Citrus Aurantium Dulcis (Orange) Leaf Extract             |
| Citrus Aurantifolia (Lime) Peel Oil                         | Citrus Aurantium Dulcis (Orange) Oil                      |
| Citrus Aurantifolia (Lime) Peel Powder                      | Citrus Aurantium Dulcis (Orange) Peel Extract             |
| Citrus Aurantifolia (Lime) Peel Water                       | Citrus Aurantium Dulcis (Orange) Peel Oil                 |
| Citrus Aurantifolia (Lime) Seed Oil                         | Citrus Aurantium Dulcis (Orange) Peel Powder              |
| Citrus Aurantifolia (Lime) Seed Oil Unsaponifiables         | Citrus Aurantium Dulcis (Orange) Peel Wax                 |
| Citrus Aurantium Amara (Bitter Orange) Flower Extract       | Citrus Aurantium Dulcis (Orange) Seed Extract             |
| Citrus Aurantium Amara (Bitter Orange) Flower Oil           | Citrus Aurantium Dulcis (Orange) Seed Oil                 |
| Citrus Aurantium Amara (Bitter Orange) Flower Water         | Citrus Aurantium Dulcis (Orange) Seed Oil Unsaponifiables |
| Citrus Aurantium Amara (Bitter Orange) Flower Wax           | Citrus Aurantium Sinensis (Orange) Fiber                  |
| Citrus Aurantium Amara (Bitter Orange) Fruit Extract        | Citrus Aurantium Sinensis Peel Extract                    |
| Citrus Aurantium Amara (Bitter Orange) Fruit Juice Extract  | Citrus Aurantium Sinensis Powder                          |
| Citrus Aurantium Amara (Bitter Orange) Leaf/Twig Extract    | Citrus Aurantium Tachibana Peel Extract                   |
| Citrus Aurantium Amara (Bitter Orange) Leaf/Twig Oil        | Citrus Clementina Fruit Extract                           |
| Citrus Aurantium Amara (Bitter Orange) Peel                 | Citrus Clementina Juice                                   |
| Citrus Aurantium Amara (Bitter Orange) Peel Extract         | Citrus Clementina Peel Oil                                |
| Citrus Aurantium Amara (Bitter Orange) Peel Oil             | Citrus Depressa Fruit Extract                             |
| Citrus Aurantium Amara (Bitter Orange) Peel Powder          | Citrus Depressa Fruit Water                               |
| Citrus Aurantium Bergamia (Bergamot) Fruit Extract          | Citrus Depressa Peel Extract                              |
| Citrus Aurantium Bergamia (Bergamot) Fruit Oil              | Citrus Depressa Peel Powder                               |
| Citrus Aurantium Bergamia (Bergamot) Fruit Water            | Citrus Glauca Fruit Extract                               |
| Citrus Aurantium Bergamia (Bergamot) Leaf Extract           | Citrus Grandis (Grapefruit)                               |
| Citrus Aurantium Bergamia (Bergamot) Leaf Oil               | Citrus Grandis (Grapefruit) Extract                       |
| Citrus Aurantium Bergamia (Bergamot) Fruit Extract          | Citrus Grandis (Grapefruit) Fruit Extract                 |
| Citrus Aurantium Bergamia (Bergamot) Leaf Extract           | Citrus Grandis (Grapefruit) Fruit Water                   |
| Citrus Aurantium Bergamia (Bergamot) Leaf Oil               | Citrus Grandis (Grapefruit) Juice                         |
| Citrus Aurantium Bergamia (Bergamot) Peel Oil               | Citrus Grandis (Grapefruit) Leaf Extract                  |
| Citrus Aurantium Bergamia (Bergamot) Peel Water             |   |
| Citrus Aurantium Currassuviiensis Peel Oil                  |   |
| Citrus Aurantium Dulcis (Orange) Flower                     |   |

Citrus Grandis (Grapefruit) Peel  
Citrus Grandis (Grapefruit) Peel Extract  
Citrus Grandis (Grapefruit) Peel Oil  
Citrus Grandis (Grapefruit) Peel Powder  
Citrus Grandis (Grapefruit) Seed Extract  
Citrus Grandis (Grapefruit) Seed Oil  
Citrus Grandis (Grapefruit) Seed Oil Unsaponifiables  
Citrus Grandis/Paradisi Fruit Water  
Citrus Grandis Peel/Seed Extract  
Citrus Hassaku Fruit Extract  
Citrus Hassaku/Natsudaidai Fruit Juice  
Citrus Hassaku/Natsudaidai Fruit Powder  
Citrus Hystrix Leaf Extract  
Citrus Iyo Fruit Extract  
Citrus Iyo Oil  
Citrus Iyo Peel Extract  
Citrus Iyo Peel Oil  
Citrus Iyo Peel Water  
Citrus Jabara Juice  
Citrus Jabara Peel Extract  
Citrus Jabara Peel Water  
Citrus Jabara Peel Powder  
Citrus Jabara Pericarp Extract  
Citrus Japonica Fruit Extract  
Citrus Junos Extract  
Citrus Junos Fruit Extract  
Citrus Junos Fruit Juice  
Citrus Junos Fruit Oil  
Citrus Junos Fruit Water  
Citrus Junos Peel Extract  
Citrus Junos Peel Oil  
Citrus Junos Peel Powder  
Citrus Junos Peel Water  
Citrus Junos Seed Extract  
Citrus Junos Seed Oil  
Citrus Limon (Lemon) Flower/Leaf/Stem Extract  
Citrus Limon (Lemon) Flower/Leaf/Stem Oil  
Citrus Limon (Lemon) Fruit Extract  
Citrus Limon (Lemon) Fruit Powder  
Citrus Limon (Lemon) Fruit Water  
Citrus Limon (Lemon) Juice  
Citrus Limon (Lemon) Juice Extract  
Citrus Limon (Lemon) Juice Powder  
Citrus Limon (Lemon) Leaf Extract  
Citrus Limon (Lemon) Leaf Oil  
Citrus Limon (Lemon) Leaf/Peel/Stem Oil  
Citrus Limon (Lemon) Peel  
Citrus Limon (Lemon) Peel Extract  
Citrus Limon (Lemon) Peel Oil  
Citrus Limon (Lemon) Peel Powder  
Citrus Limon (Lemon) Peel Water  
Citrus Limon (Lemon) Peel Wax  
Citrus Limon (Lemon) Seed Oil  
Citrus Madurensis Fruit Extract  
Citrus Madurensis Fruit Juice  
Citrus Medica Vulgaris Fruit Extract  
Citrus Medica Vulgaris Peel Oil  
Citrus Natsudaidai Flower Water  
Citrus Natsudaidai Peel Extract  
Citrus Nobilis (Mandarin Orange)  
Citrus Nobilis (Mandarin Orange) Fruit Extract  
Citrus Nobilis (Mandarin Orange) Fruit Juice  
Citrus Nobilis (Mandarin Orange) Oil  
Citrus Nobilis (Mandarin Orange) Peel Extract  
Citrus Nobilis (Mandarin Orange) Peel Oil  
Citrus Nobilis (Mandarin Orange) Peel Powder  
Citrus Nobilis (Mandarin Orange) Water  
Citrus Paradisi (Grapefruit) Fruit Extract  
Citrus Paradisi (Grapefruit) Fruit Water  
Citrus Paradisi (Grapefruit) Juice  
Citrus Paradisi (Grapefruit) Peel Extract

Citrus Paradisi (Grapefruit) Peel Oil  
 Citrus Paradisi (Grapefruit) Seed Extract  
 Citrus Paradisi (Grapefruit) Seed Oil  
 Citrus Reticulata (Tangerine) Extract  
 Citrus Reticulata (Tangerine) Fruit  
 Citrus Reticulata (Tangerine) Fruit Extract  
 Citrus Reticulata (Tangerine) Fruit Water  
 Citrus Reticulata (Tangerine) Leaf Oil  
 Citrus Reticulata (Tangerine) Leaf Water  
 Citrus Reticulata (Tangerine) Peel Extract  
 Citrus Reticulata (Tangerine) Peel Oil  
 Citrus Reticulata (Tangerine) Peel Powder  
 Citrus Shunkokan Fruit Extract  
 Citrus Shunkokan Peel Extract  
 Citrus Sinensis (Orange) Fruit Extract  
 Citrus Sinensis (Orange) Fruit Water  
 Citrus Sinensis Sanguinello (Blood Orange) Peel Oil  
 Citrus Sphaerocarpa Fruit Juice  
 Citrus Sudachi Fruit Extract  
 Citrus Sudachi Fruit Juice  
 Citrus Sunki Peel Extract  
 Citrus Tachibana Peel Extract  
 Citrus Tachibana/Reticulata Fruit Juice  
 Citrus Tachibana/Reticulata Peel Oil  
 Citrus Tachibana/Reticulata Peel Powder  
 Citrus Tamurana Flower Extract  
 Citrus Tamurana Fruit Extract  
 Citrus Tangelo Fruit Juice  
 Citrus Tangelo Fruit Powder  
 Citrus Tangelo Peel Powder  
 Citrus Tangerina (Tangerine) Extract  
 Citrus Tangerina (Tangerine) Fruit  
 Citrus Tangerina (Tangerine) Fruit Extract  
 Citrus Tangerina (Tangerine) Fruit Water  
 Citrus Tangerina (Tangerine) Peel  
 Citrus Tangerina (Tangerine) Peel Extract  
 Citrus Tangerina (Tangerine) Peel Oil  
 Citrus Tankan Fruit Extract  
 Citrus Tankan Fruit Water  
 Citrus Unshiu/Citrus Reticulata/Citrus Iyo Fruit Water  
 Citrus Unshiu Extract  
 Citrus Unshiu Flower Powder  
 Citrus Unshiu Flower Water  
 Citrus Unshiu Fruit Extract  
 Citrus Unshiu Fruit Juice  
 Citrus Unshiu Fruit Oil  
 Citrus Unshiu Fruit Powder  
 Citrus Unshiu Fruit Water  
 Citrus Unshiu Peel Extract  
 Citrus Unshiu Peel Powder  
 Citrus Unshiu Peel Water  
 Citrus Unshiu Pericarp Extract  
 Citrus Unshiu/Sinensis/Reticulata Fruit Extract  
 Microcitrus Australasica Fruit Extract  
 Microcitrus Australis Fruit Extract

| Ingredient                                | FDA Code† | Product Category             | Maximum Concentration of Use |
|---|-----------|------------------------------|------------------------------|
| Citrus Aurantifolia (Lime) Flower Extract | 02B       | Bubble baths                 | 0.0005%                      |
| Citrus Aurantifolia (Lime) Flower Extract | 02D       | Other bath preparations      | 0.0005%                      |
| Citrus Aurantifolia (Lime) Flower Extract | 04E       | Other fragrance preparations | 0.0005%                      |

|   |     |   |                |
|---|-----|---|----------------|
| Citrus Aurantifolia (Lime) Flower Extract | 05F | Shampoos (noncoloring)  | 0.005%         |
| Citrus Aurantifolia (Lime) Flower Extract | 10A | Bath soaps and detergents   | 0.0005%        |
| Citrus Aurantifolia (Lime) Flower Extract | 12D | Body and hand products<br>not spray                               | 0.0005%        |
| Citrus Aurantifolia (Lime) Fruit Extract  | 02D | Other bath preparations   | 0.002%         |
| Citrus Aurantifolia (Lime) Fruit Extract  | 04E | Other fragrance preparations                                      | 0.001%         |
| Citrus Aurantifolia (Lime) Fruit Extract  | 05A | Hair conditioners   | 0.01%          |
| Citrus Aurantifolia (Lime) Fruit Extract  | 05D | Permanent waves   | 0.01%          |
| Citrus Aurantifolia (Lime) Fruit Extract  | 05F | Shampoos (noncoloring)  | 0.0005-0.005%  |
| Citrus Aurantifolia (Lime) Fruit Extract  | 05G | Tonics, dressings and other hair grooming aids                    | 0.01%          |
| Citrus Aurantifolia (Lime) Fruit Extract  | 05I | Other hair preparations (noncoloring)                             | 0.005%         |
| Citrus Aurantifolia (Lime) Fruit Extract  | 10A | Bath soaps and detergents   | 0.005%         |
| Citrus Aurantifolia (Lime) Fruit Extract  | 10E | Other personal cleanliness products                               | 0.06-0.2%      |
| Citrus Aurantifolia (Lime) Fruit Extract  | 11E | Shaving cream (aerosol, brushless and lather)                     | 0.0002-0.0097% |
| Citrus Aurantifolia (Lime) Fruit Extract  | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.0001-0.002%  |
| Citrus Aurantifolia (Lime) Fruit Extract  | 12D | Body and hand products<br>not spray                               | 0.001-0.2%     |
| Citrus Aurantifolia (Lime) Fruit Extract  | 12E | Foot powders and sprays   | 0.0009%        |
| Citrus Aurantifolia (Lime) Fruit Extract  | 12F | Moisturizing products<br>not spray                                | 0.05%          |
| Citrus Aurantifolia (Lime) Fruit Extract  | 12H | Paste masks and mud packs   | 0.0025%        |
| Citrus Aurantifolia (Lime) Peel           | 12H | Paste masks and mud packs   | 1.5%           |

|   |     |   |              |
|---|-----|---|--------------|
| Citrus Aurantifolia (Lime) Peel Extract               | 05F | Shampoos (noncoloring)  | 0.00025%     |
| Citrus Aurantifolia (Lime) Peel Extract               | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.0005%      |
| Citrus Aurantifolia (Lime) Peel Extract               | 12D | Body and hand products<br>not spray                               | 0.009%       |
| Citrus Aurantifolia (Lime) Peel Extract               | 12F | Moisturizing products<br>not spray                                | 0.0005%      |
| Citrus Aurantifolia (Lime) Peel Extract               | 12H | Paste masks and mud packs   | 0.00001%     |
| Citrus Aurantifolia (Lime) Peel Extract               | 12J | Other skin care products  | 0.001-0.025% |
| Citrus Aurantium Amara (Bitter Orange) Flower Extract | 12C | Face and neck products<br>not spray                               | 5%           |
| Citrus Aurantium Amara (Bitter Orange) Flower Extract | 12D | Body and hand products<br>not spray                               | 0.023%       |
| Citrus Aurantium Amara (Bitter Orange) Flower Oil     | 02A | Bath oils, tablets and salts                                      | 0.001%       |
| Citrus Aurantium Amara (Bitter Orange) Flower Oil     | 05F | Shampoos (noncoloring)  | 0.001%       |
| Citrus Aurantium Amara (Bitter Orange) Flower Oil     | 10A | Bath soaps and detergents   | 0.001%       |
| Citrus Aurantium Amara (Bitter Orange) Flower Oil     | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.02%        |
| Citrus Aurantium Amara (Bitter Orange) Flower Oil     | 12C | Face and neck products<br>not spray                               | 0.4%         |
| Citrus Aurantium Amara (Bitter Orange) Flower Oil     | 12D | Body and hand products<br>not spray                               | 0.001-0.1%   |
| Citrus Aurantium Amara (Bitter Orange) Flower Oil     | 12G | Night products<br>not spray                                       | 0.6%         |
| Citrus Aurantium Amara (Bitter Orange) Flower Oil     | 12H | Paste masks and mud packs   | 0.02%        |
| Citrus Aurantium Amara (Bitter Orange) Flower Water   | 12C | Face and neck products  |              |

|  |     |  |          |  |
|--|-----|--|----------|--|
|  |     |  |          |  |
| Citrus Aurantium Amara (Bitter Orange) Flower Water  | 12G | not spray  | 0.0005%  |  |
| Citrus Aurantium Amara (Bitter Orange) Flower Water  | 12H | Night products<br>not spray  | 2-4%     |  |
| Citrus Aurantium Amara (Bitter Orange) Fruit Extract | 03C | Paste masks and mud packs  | 0.0004%  |  |
| Citrus Aurantium Amara (Bitter Orange) Fruit Extract | 03D | Eye shadow   | 0.0001%  |  |
| Citrus Aurantium Amara (Bitter Orange) Fruit Extract | 03G | Eye lotion   | 0.0002%  |  |
| Citrus Aurantium Amara (Bitter Orange) Fruit Extract | 07C | Other eye makeup preparations  | 0.002%   |  |
| Citrus Aurantium Amara (Bitter Orange) Fruit Extract | 07E | Foundations  | 0.00002% |  |
| Citrus Aurantium Amara (Bitter Orange) Fruit Extract | 07H | Lipstick   | 0.002%   |  |
| Citrus Aurantium Amara (Bitter Orange) Fruit Extract | 12A | Makeup fixatives   | 0.00002% |  |
| Citrus Aurantium Amara (Bitter Orange) Fruit Extract | 12C | Skin cleansing (cold creams, cleansing lotions, liquids and pads)<br>Face and neck products<br>not spray | 0.0001%  |  |
| Citrus Aurantium Amara (Bitter Orange) Fruit Extract | 12D | Body and hand products<br>not spray  | 0.00002% |  |
| Citrus Aurantium Amara (Bitter Orange) Leaf/Twig Oil | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads)  | 0.04%    |  |
| Citrus Aurantium Amara (Bitter Orange) Leaf/Twig Oil | 12D | Body and hand products<br>not spray  | 1.5%     |  |
| Citrus Aurantium Amara (Bitter Orange) Leaf/Twig Oil | 12G | Night products<br>not spray  | 0.1%     |  |
| Citrus Aurantium Amara (Bitter Orange) Peel Extract  | 03C | Eye shadow   | 0.18%    |  |
| Citrus Aurantium Amara (Bitter Orange) Peel Extract  | 05A | Hair conditioners  | 0.001%   |  |
| Citrus Aurantium Amara (Bitter Orange) Peel Extract  | 05F | Shampoos (noncoloring)   | 0.001%   |  |

|   |     |   |                  |
|---|-----|---|------------------|
| Citrus Aurantium Amara (Bitter Orange) Peel Extract | 05G | Tonics, dressings and other hair grooming aids                    | 0.001%           |
| Citrus Aurantium Amara (Bitter Orange) Peel Extract | 07A | Blushers (all types)  | 0.0002%          |
| Citrus Aurantium Amara (Bitter Orange) Peel Extract | 07C | Foundations   | 0.0002%          |
| Citrus Aurantium Amara (Bitter Orange) Peel Extract | 07E | Lipstick  | 0.0002%          |
| Citrus Aurantium Amara (Bitter Orange) Peel Extract | 08A | Basecoats and undercoats (manicuring preparations)                | 0.00002%         |
| Citrus Aurantium Amara (Bitter Orange) Peel Extract | 08E | Nail polish and enamel  | 0.00014%         |
| Citrus Aurantium Amara (Bitter Orange) Peel Extract | 12C | Face and neck products<br>not spray                               | 0.0005%          |
| Citrus Aurantium Amara (Bitter Orange) Peel Oil     | 07E | Lipstick  | 0.75%            |
| Citrus Aurantium Amara (Bitter Orange) Peel Oil     | 10A | Bath soaps and detergents   | 0.25%            |
| Citrus Aurantium Amara (Bitter Orange) Peel Oil     | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.2%             |
| Citrus Aurantium Amara (Bitter Orange) Peel Oil     | 12C | Face and neck products<br>not spray                               | 2%               |
| Citrus Aurantium Amara (Bitter Orange) Peel Oil     | 12D | Body and hand products<br>not spray                               | 0.9%             |
| Citrus Aurantium Amara (Bitter Orange) Peel Oil     | 12G | Night products<br>not spray                                       | 0.2%             |
| Citrus Aurantium Amara (Bitter Orange) Peel Oil     | 12H | Paste masks and mud packs   | 0.05%            |
| Citrus Aurantium Amara (Bitter Orange) Peel Powder  | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 6%               |
| Citrus Aurantium Bergamia (Bergamot) Fruit Extract  | 05A | Hair conditioners   | 0.000001-0.0001% |
| Citrus Aurantium Bergamia (Bergamot) Fruit Extract  | 05B | Hair sprays<br>pump spray   | 0.000001%        |
| Citrus Aurantium Bergamia (Bergamot) Fruit Extract  | 05F | Shampoos (noncoloring)  | 0.000001-0.0001% |

|  |     |   |                    |
|--|-----|---|--------------------|
| Citrus Aurantium Bergamia (Bergamot) Fruit Extract | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.0025-0.0063%     |
| Citrus Aurantium Bergamia (Bergamot) Fruit Extract | 12C | Face and neck products<br>not spray                               | 0.0001-0.001%      |
| Citrus Aurantium Bergamia (Bergamot) Fruit Extract | 12J | Other skin care products  | 0.82%              |
| Citrus Aurantium Bergamia (Bergamot) Fruit Oil     | 05F | Shampoos (noncoloring)  | 0.005%             |
| Citrus Aurantium Bergamia (Bergamot) Fruit Oil     | 05G | Tonics, dressings and other hair grooming aids                    | 0.0017-0.05%       |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 02B | Bubble baths  | 0.1%               |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 03D | Eye lotion  | 0.01%              |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 03G | Other eye makeup preparations                                     | 0.002%             |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 04A | Colognes and toilet waters  | 0.01%              |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 05A | Hair conditioners   | 0.0025-0.005%      |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 05B | Hair sprays<br>aerosol<br>pump spray                              | 0.0025%<br>0.0025% |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 05D | Permanent waves   | 0.002%             |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 05F | Shampoos (noncoloring)  | 0.0025-0.005%      |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 05G | Tonics, dressings and other hair grooming aids                    | 0.0013%            |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 07C | Foundations   | 0.002%             |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 07H | Makeup fixatives  | 0.002%             |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 08B | Cuticle softeners   | 0.001%             |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 10A | Bath soaps and detergents   | 0.01%              |
| Citrus Aurantium Dulcis (Orange) Flower Extract    | 10E | Other personal cleanliness products                               | 0.01-0.2%          |

|   |     |   |                    |
|---|-----|---|--------------------|
| Citrus Aurantium Dulcis (Orange) Flower Extract | 11A | Aftershave lotions  | 0.007%             |
| Citrus Aurantium Dulcis (Orange) Flower Extract | 11E | Shaving cream (aerosol, brushless and lather)                     | 0.000023%          |
| Citrus Aurantium Dulcis (Orange) Flower Extract | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.0001%            |
| Citrus Aurantium Dulcis (Orange) Flower Extract | 12D | Body and hand products<br>not spray<br>spray                      | 0.01-0.2%<br>0.01% |
| Citrus Aurantium Dulcis (Orange) Flower Extract | 12F | Moisturizing products<br>not spray                                | 0.00013%           |
| Citrus Aurantium Dulcis (Orange) Flower Extract | 12G | Night products<br>not spray                                       | 0.00003%           |
| Citrus Aurantium Dulcis (Orange) Flower Extract | 12H | Paste masks and mud packs   | 0.0002-0.002%      |
| Citrus Aurantium Dulcis (Orange) Flower Extract | 12J | Other skin care preparations                                      | 0.00013-0.001%     |
| Citrus Aurantium Dulcis (Orange) Flower Oil     | 07E | Lipstick  | 0.9%               |
| Citrus Aurantium Dulcis (Orange) Flower Oil     | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.000001%          |
| Citrus Aurantium Dulcis (Orange) Fruit Extract  | 03D | Eye lotion  | 0.1%               |
| Citrus Aurantium Dulcis (Orange) Fruit Extract  | 05A | Hair conditioners   | 0.0054%            |
| Citrus Aurantium Dulcis (Orange) Fruit Extract  | 05F | Shampoos (noncoloring)  | 0.0007%            |
| Citrus Aurantium Dulcis (Orange) Fruit Extract  | 05I | Other hair preparations (noncoloring)                             | 0.25%              |
| Citrus Aurantium Dulcis (Orange) Fruit Extract  | 08B | Cuticle softeners   | 0.2%               |
| Citrus Aurantium Dulcis (Orange) Fruit Extract  | 10A | Bath soaps and detergents   | 0.041%             |
| Citrus Aurantium Dulcis (Orange) Fruit Extract  | 10E | Other personal cleanliness products                               | 0.004-0.039%       |
| Citrus Aurantium Dulcis (Orange) Fruit Extract  | 11A | Aftershave lotions  | 0.1%               |

|  |     |   |                |
|--|-----|---|----------------|
| Citrus Aurantium Dulcis (Orange) Fruit Extract | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.00003-0.2%   |
| Citrus Aurantium Dulcis (Orange) Fruit Extract | 12C | Face and neck products<br>not spray                               | 0.002-0.32%    |
| Citrus Aurantium Dulcis (Orange) Fruit Extract | 12D | Body and hand products<br>not spray                               | 0.0005-0.12%   |
| Citrus Aurantium Dulcis (Orange) Fruit Extract | 12F | Moisturizing products<br>not spray                                | 0.00003-0.004% |
| Citrus Aurantium Dulcis (Orange) Fruit Extract | 12G | Night products<br>not spray                                       | 1.2%           |
| Citrus Aurantium Dulcis (Orange) Fruit Extract | 12H | Paste masks and mud packs   | 0.002-0.04%    |
| Citrus Aurantium Dulcis (Orange) Fruit Extract | 13B | Indoor tanning preparations                                       | 0.001%         |
| Citrus Aurantium Dulcis (Orange) Fruit Water   | 07C | Foundations   | 2%             |
| Citrus Aurantium Dulcis (Orange) Fruit Water   | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 2%             |
| Citrus Aurantium Dulcis (Orange) Fruit Water   | 12C | Face and neck products<br>not spray                               | 10%            |
| Citrus Aurantium Dulcis (Orange) Fruit Water   | 12D | Body and hand products<br>not spray                               | 3%             |
| Citrus Aurantium Dulcis (Orange) Fruit Water   | 12H | Paste masks and mud packs   | 19%            |
| Citrus Aurantium Dulcis (Orange) Juice         | 05G | Tonics, dressings and other hair grooming aids                    | 0.000038%      |
| Citrus Aurantium Dulcis (Orange) Oil           | 02A | Bath oils, tablets and salts                                      | 0.93%          |
| Citrus Aurantium Dulcis (Orange) Oil           | 03D | Eye lotion  | 0.033%         |
| Citrus Aurantium Dulcis (Orange) Oil           | 05E | Rinses (noncoloring)  | 0.033%         |
| Citrus Aurantium Dulcis (Orange) Oil           | 05F | Shampoos (noncoloring)  | 0.043%         |

|   |     |   |                       |
|---|-----|---|-----------------------|
| Citrus Aurantium Dulcis (Orange) Oil          | 07A | Blushers (all types)  | 0.047%                |
| Citrus Aurantium Dulcis (Orange) Oil          | 07B | Face powders  | 0.0014%               |
| Citrus Aurantium Dulcis (Orange) Oil          | 07C | Foundations   | 0.0066-0.025%         |
| Citrus Aurantium Dulcis (Orange) Oil          | 07E | Lipstick  | 0.033-0.95%           |
| Citrus Aurantium Dulcis (Orange) Oil          | 08B | Cuticle softeners   | 0.025%                |
| Citrus Aurantium Dulcis (Orange) Oil          | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.021-0.2%            |
| Citrus Aurantium Dulcis (Orange) Oil          | 12C | Face and neck products<br>not spray<br>spray                      | 0.025-0.14%<br>0.011% |
| Citrus Aurantium Dulcis (Orange) Oil          | 12D | Body and hand products<br>not spray                               | 0.066%                |
| Citrus Aurantium Dulcis (Orange) Oil          | 12F | Moisturizing products<br>not spray                                | 0.033%                |
| Citrus Aurantium Dulcis (Orange) Oil          | 13A | Suntan products<br>not spray                                      | 0.02%                 |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 02B | Bubble baths  | 0.0025%               |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 02D | Other bath preparations   | 0.0025%               |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 03D | Eye lotion  | 0.0002%               |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 03G | Other eye makeup preparations                                     | 0.0005%               |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 04E | Other fragrance preparations                                      | 0.001%                |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 05A | Hair conditioners   | 0.001%                |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 05B | Hair sprays<br>pump spray   | 0.001%                |

|   |     |   |                 |
|---|-----|---|-----------------|
| Citrus Aurantium Dulcis (Orange) Peel Extract | 05F | Shampoos (noncoloring)  | 0.0001-0.001%   |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 05G | Tonics, dressings and other hair grooming aids                    | 0.00001%        |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 07E | Lipstick  | 1.9%            |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 10A | Bath soaps and detergents   | 0.0001%         |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 10E | Other personal cleanliness products                               | 0.000025-0.008% |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.00005-0.65%   |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 12C | Face and neck products<br>not spray                               | 0.0002-0.013%   |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 12D | Body and hand products<br>not spray                               | 0.00002-0.33%   |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 12F | Moisturizing products<br>not spray                                | 0.0065%         |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 12G | Night products<br>not spray                                       | 0.0001%         |
| Citrus Aurantium Dulcis (Orange) Peel Extract | 12H | Paste masks and mud packs   | 0.0002-0.0011%  |
| Citrus Aurantium Dulcis (Orange) Peel Oil     | 02D | Other bath preparations   | 0.33%           |
| Citrus Aurantium Dulcis (Orange) Peel Oil     | 03E | Eye makeup remover  | 0.1%            |
| Citrus Aurantium Dulcis (Orange) Peel Oil     | 05A | Hair conditioners   | 0.00002-29%     |
| Citrus Aurantium Dulcis (Orange) Peel Oil     | 05F | Shampoos (noncoloring)  | 0.00002%        |
| Citrus Aurantium Dulcis (Orange) Peel Oil     | 05G | Tonics, dressings and other hair grooming aids                    | 0.00038%        |
| Citrus Aurantium Dulcis (Orange) Peel Oil     | 08E | Nail polish and enamel  | 0.5%            |
| Citrus Aurantium Dulcis (Orange) Peel Oil     | 08G | Other manicuring preparations                                     | 0.54%           |

|  |     |   |            |
|--|-----|---|------------|
| Citrus Aurantium Dulcis (Orange) Peel Oil    | 10A | Bath soaps and detergents   | 0.1%       |
| Citrus Aurantium Dulcis (Orange) Peel Oil    | 11E | Shaving cream (aerosol, brushless and lather)                     | 0.17%      |
| Citrus Aurantium Dulcis (Orange) Peel Oil    | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.001-0.1% |
| Citrus Aurantium Dulcis (Orange) Peel Oil    | 12B | Depilatories  | 0.1%       |
| Citrus Aurantium Dulcis (Orange) Peel Oil    | 12C | Face and neck products<br>not spray                               | 0.12-0.3%  |
| Citrus Aurantium Dulcis (Orange) Peel Oil    | 12D | Body and hand products<br>not spray                               | 0.03-0.4%  |
| Citrus Aurantium Dulcis (Orange) Peel Oil    | 12G | Night products<br>not spray                                       | 0.3%       |
| Citrus Aurantium Dulcis (Orange) Peel Oil    | 12H | Paste masks and mud packs   | 0.0066%    |
| Citrus Aurantium Dulcis (Orange) Peel Oil    | 12J | Other skin care preparations                                      | 0.14%      |
| Citrus Aurantium Dulcis (Orange) Peel Powder | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 6%         |
| Citrus Aurantium Dulcis (Orange) Peel Wax    | 03D | Eye lotion  | 0.16%      |
| Citrus Aurantium Dulcis (Orange) Peel Wax    | 03F | Mascara   | 0.15%      |
| Citrus Aurantium Dulcis (Orange) Peel Wax    | 05A | Hair conditioners   | 0.005%     |
| Citrus Aurantium Dulcis (Orange) Peel Wax    | 05F | Shampoos (noncoloring)  | 0.045%     |
| Citrus Aurantium Dulcis (Orange) Peel Wax    | 07E | Lipstick  | 0.5%       |
| Citrus Aurantium Dulcis (Orange) Peel Wax    | 11A | Aftershave lotions  | 0.15%      |
| Citrus Aurantium Dulcis (Orange) Peel Wax    | 12A | Skin cleansing (cold creams, cleansing lotions liquids and pads)  | 0.39%      |
| Citrus Aurantium Dulcis (Orange) Peel Wax    | 12J | Other skin care preparations                                      | 0.07%      |
| Citrus Aurantium Tachibana Peel Extract      | 12J | Other skin care preparations                                      | 0.0008%    |

|   |     |   |                 |
|---|-----|---|-----------------|
| Citrus Depressa Peel Extract              | 12D | Body and hand products<br>not spray                               | 0.0014%         |
| Citrus Glauca Fruit Extract               | 05A | Hair conditioners   | 0.003%          |
| Citrus Glauca Fruit Extract               | 05F | Shampoos (noncoloring)  | 0.0051%         |
| Citrus Grandis (Grapefruit)               | 03D | Eye lotion  | 0.5%            |
| Citrus Grandis (Grapefruit) Extract       | 05F | Shampoos (noncoloring)  | 0.01%           |
| Citrus Grandis (Grapefruit) Fruit Extract | 02A | Bath oils, tablets and salts                                      | 0.005%          |
| Citrus Grandis (Grapefruit) Fruit Extract | 02D | Other bath preparations   | 0.01%           |
| Citrus Grandis (Grapefruit) Fruit Extract | 04A | Colognes and toilet waters  | 0.01%           |
| Citrus Grandis (Grapefruit) Fruit Extract | 05A | Hair conditioners   | 0.000001-0.01%  |
| Citrus Grandis (Grapefruit) Fruit Extract | 05D | Permanent waves   | 0.01%           |
| Citrus Grandis (Grapefruit) Fruit Extract | 05E | Rinses (noncoloring)  | 0.0005%         |
| Citrus Grandis (Grapefruit) Fruit Extract | 05F | Shampoo (noncoloring)   | 0.0000005-0.01% |
| Citrus Grandis (Grapefruit) Fruit Extract | 05G | Tonics, dressings and other hair grooming aids                    | 0.005-0.01%     |
| Citrus Grandis (Grapefruit) Fruit Extract | 07E | Lipstick  | 0.01-0.02%      |
| Citrus Grandis (Grapefruit) Fruit Extract | 10A | Bath soaps and detergents   | 0.1%            |
| Citrus Grandis (Grapefruit) Fruit Extract | 10E | Other personal cleanliness products                               | 0.001-0.002%    |
| Citrus Grandis (Grapefruit) Fruit Extract | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.0005-1%       |
| Citrus Grandis (Grapefruit) Fruit Extract | 12C | Face and neck products<br>not spray                               | 0.015-15%       |
| Citrus Grandis (Grapefruit) Fruit Extract | 12D | Body and hand products<br>not spray                               | 0.0001-0.09%    |

|   |     |   |              |
|---|-----|---|--------------|
| Citrus Grandis (Grapefruit) Fruit Extract | 12E | Foot powders and sprays   | 0.0001%      |
| Citrus Grandis (Grapefruit) Fruit Extract | 12H | Paste masks and mud packs   | 0.1-8%       |
| Citrus Grandis (Grapefruit) Fruit Extract | 12I | Skin fresheners   | 0.01%        |
| Citrus Grandis (Grapefruit) Fruit Extract | 12J | Other skin care preparations                                      | 0.01%        |
| Citrus Grandis (Grapefruit) Fruit Extract | 13A | Suntan products<br>not spray                                      | 0.0001%      |
| Citrus Grandis (Grapefruit) Fruit Water   | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.0029%      |
| Citrus Grandis (Grapefruit) Juice         | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.01%        |
| Citrus Grandis (Grapefruit) Peel Extract  | 03F | Mascara   | 0.5%         |
| Citrus Grandis (Grapefruit) Peel Extract  | 12A | Skin cleansing (cold cream, cleansing lotions, liquids and pads)  | 0.0225%      |
| Citrus Grandis (Grapefruit) Peel Extract  | 12C | Face and neck products<br>not spray                               | 0.0001%      |
| Citrus Grandis (Grapefruit) Peel Extract  | 12D | Body and hand products<br>not spray                               | 0.0005%      |
| Citrus Grandis (Grapefruit) Peel Extract  | 12F | Moisturizing creams, lotions and powders<br>not spray             | 0.009%       |
| Citrus Grandis (Grapefruit) Peel Extract  | 12H | Pastes masks and mud packs  | 0.03%        |
| Citrus Grandis (Grapefruit) Peel Extract  | 12J | Other skin care preparations                                      | 0.0008%      |
| Citrus Grandis (Grapefruit) Peel Oil      | 02D | Other bath preparations   | 0.0014%      |
| Citrus Grandis (Grapefruit) Peel Oil      | 05F | Shampoos (noncoloring)  | 0.005%       |
| Citrus Grandis (Grapefruit) Peel Oil      | 12B | Depilatories  | 0.0001-0.05% |
| Citrus Grandis (Grapefruit) Peel Oil      | 12D | Body and hand creams<br>not spray                                 | 0.0004%      |

|  |     |   |                          |
|--|-----|---|--------------------------|
| Citrus Grandis (Grapefruit) Peel Oil     | 12H | Paste masks and mud packs   | 0.00004%                 |
| Citrus Grandis (Grapefruit) Peel Oil     | 12J | Other skin care preparations                                      | 0.0008%                  |
| Citrus Grandis (Grapefruit) Seed Extract | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.75%                    |
| Citrus Grandis (Grapefruit) Seed Extract | 12C | Face and neck products<br>not spray                               | 0.053-2%                 |
| Citrus Grandis (Grapefruit) Seed Extract | 12H | Paste masks and mud packs   | 0.75%                    |
| Citrus Grandis (Grapefruit) Seed Extract | 12I | Skin fresheners   | 0.15%                    |
| Citrus Japonica Fruit Extract            | 05A | Hair conditioners   | 0.0038%                  |
| Citrus Japonica Fruit Extract            | 05F | Shampoos (noncoloring)  | 0.0038%                  |
| Citrus Junos Fruit Extract               | 04B | Perfumes  | 0.001%                   |
| Citrus Junos Fruit Extract               | 07C | Foundations   | 0.001%                   |
| Citrus Junos Fruit Extract               | 07E | Lipstick  | 0.001%                   |
| Citrus Junos Fruit Extract               | 10E | Other personal cleanliness products                               | 0.0005%                  |
| Citrus Junos Fruit Extract               | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.001%                   |
| Citrus Junos Fruit Extract               | 12C | Face and neck products<br>not spray                               | 0.002%                   |
| Citrus Junos Fruit Extract               | 12D | Body and hand products<br>not spray<br>spray                      | 0.0005-0.001%<br>0.0005% |
| Citrus Junos Peel Extract                | 07E | Lipstick  | 0.0012%                  |
| Citrus Junos Peel Extract                | 07G | Rouges  | 0.0012%                  |
| Citrus Junos Peel Extract                | 12F | Moisturizing products<br>not spray                                | 0.036%                   |

|                                    |     |   |            |
|------------------------------------|-----|---|------------|
| Citrus Junos Seed Extract          | 02A | Bath oils, tablets and salts                                      | 0.001%     |
| Citrus Junos Seed Extract          | 03D | Eye lotion  | 0.001%     |
| Citrus Junos Seed Extract          | 07C | Foundations   | 0.001%     |
| Citrus Junos Seed Extract          | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.001%     |
| Citrus Junos Seed Extract          | 12C | Face and neck products<br>not spray                               | 0.0045%    |
| Citrus Junos Seed Extract          | 12F | Moisturizing products<br>not spray                                | 0.001%     |
| Citrus Junos Seed Oil              | 05G | Tonic dressings and other hair grooming aids                      | 0.01 %     |
| Citrus Junos Seed Oil              | 12C | Face and neck products<br>not spray                               | 0.1%       |
| Citrus Junos Seed Oil              | 12D | Body and hand products<br>not spray                               | 0.11%      |
| Citrus Limon (Lemon) Fruit Extract | 05A | Hair conditioners   | 0.004%     |
| Citrus Limon (Lemon) Fruit Extract | 05D | Permanent waves   | 0.002%     |
| Citrus Limon (Lemon) Fruit Extract | 05F | Shampoos (noncoloring)  | 0.005%     |
| Citrus Limon (Lemon) Fruit Extract | 05I | Other hair preparations (noncoloring)                             | 0.004%     |
| Citrus Limon (Lemon) Fruit Extract | 07C | Foundations   | 0.02-0.04% |
| Citrus Limon (Lemon) Fruit Extract | 07E | Lipstick  | 0.03%      |
| Citrus Limon (Lemon) Fruit Extract | 08B | Cuticle softeners   | 0.0001%    |
| Citrus Limon (Lemon) Fruit Extract | 08G | Other manicuring preparations                                     | 0.01-0.5%  |
| Citrus Limon (Lemon) Fruit Extract | 10A | Bath soaps and detergents   | 0.04%      |

|                                    |     |   |                        |
|------------------------------------|-----|---|------------------------|
| Citrus Limon (Lemon) Fruit Extract | 10E | Other personal cleanliness products<br>hand scrub                 | 0.0028-0.02%<br>0.039% |
| Citrus Limon (Lemon) Fruit Extract | 11A | Aftershave lotions  | 0.1%                   |
| Citrus Limon (Lemon) Fruit Extract | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.0025-0.5%            |
| Citrus Limon (Lemon) Fruit Extract | 12C | Face and neck products<br>not spray                               | 0.24-0.5%              |
| Citrus Limon (Lemon) Fruit Extract | 12D | Body and hand products<br>not spray                               | 0.0001-0.4%            |
| Citrus Limon (Lemon) Fruit Extract | 12F | Moisturizing products<br>not spray                                | 0.004%                 |
| Citrus Limon (Lemon) Fruit Extract | 12G | Night products<br>not spray                                       | 1.2%                   |
| Citrus Limon (Lemon) Fruit Extract | 12H | Paste masks and mud packs   | 0.002-0.5%             |
| Citrus Limon (Lemon) Fruit Extract | 12J | Other skin care preparations                                      | 0.8%                   |
| Citrus Limon (Lemon) Fruit Extract | 13B | Indoor tanning products   | 0.001%                 |
| Citrus Limon (Lemon) Fruit Water   | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 1%                     |
| Citrus Limon (Lemon) Juice         | 05F | Shampoos (noncoloring)  | 0.05%                  |
| Citrus Limon (Lemon) Juice         | 05G | Tonic, dressings and other hair grooming aids                     | 0.05%                  |
| Citrus Limon (Lemon) Juice         | 12B | Depilatories  | 0.035%                 |
| Citrus Limon (Lemon) Juice         | 12C | Face products<br>not spray  | 1%                     |
| Citrus Limon (Lemon) Juice Extract | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.05%                  |
| Citrus Limon (Lemon) Juice Extract | 12D | Body and hand products<br>not spray                               | 0.2%                   |

|                                   |     |   |                |
|-----------------------------------|-----|---|----------------|
| Citrus Limon (Lemon) Peel Extract | 05A | Hair conditioners   | 0.0011-0.01%   |
| Citrus Limon (Lemon) Peel Extract | 05F | Shampoos (noncoloring)  | 0.0011%        |
| Citrus Limon (Lemon) Peel Extract | 07E | Lipstick  | 0.0005%        |
| Citrus Limon (Lemon) Peel Extract | 10E | Other personal cleanliness products                               | 0.51%          |
| Citrus Limon (Lemon) Peel Extract | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.057%         |
| Citrus Limon (Lemon) Peel Extract | 12C | Face and neck products<br>not spray                               | 0.0001-0.0075% |
| Citrus Limon (Lemon) Peel Extract | 12D | Body and hand products<br>not spray                               | 0.25%          |
| Citrus Limon (Lemon) Peel Extract | 12F | Moisturizing creams, lotions and powders                          | 0.012%         |
| Citrus Limon (Lemon) Peel Extract | 12H | Paste masks and mud packs   | 0.002-0.04%    |
| Citrus Limon (Lemon) Peel Oil     | 02D | Other bath preparations   | 0.012%         |
| Citrus Limon (Lemon) Peel Oil     | 08G | Other manicuring preparations                                     | 0.0001-0.14%   |
| Citrus Limon (Lemon) Peel Oil     | 10A | Bath soaps and detergents   | 0.001%         |
| Citrus Limon (Lemon) Peel Oil     | 10B | Deodorants (underarm)<br>not spray                                | 0.002%         |
| Citrus Limon (Lemon) Peel Oil     | 11A | Aftershave lotions  | 0.0001%        |
| Citrus Limon (Lemon) Peel Oil     | 12D | Body and hand products<br>not spray                               | 0.0001-0.14%   |
| Citrus Limon (Lemon) Peel Oil     | 12E | Foot powders and sprays   | 0.06%          |
| Citrus Limon (Lemon) Peel Oil     | 12H | Paste masks and mud packs   | 0.0006%        |
| Citrus Limon (Lemon) Peel Oil     | 12J | Other skin care preparations                                      | 0.012-0.5%     |

|  |     |   |                        |
|--|-----|---|------------------------|
| Citrus Madurensis Fruit Extract                | 02D | Other bath preparations   | 0.0005%                |
| Citrus Madurensis Fruit Extract                | 12D | Body and hand products<br>not spray                               | 0.0005%                |
| Citrus Nobilis (Mandarin Orange) Fruit Extract | 05A | Hair conditioners   | 0.001-0.01%            |
| Citrus Nobilis (Mandarin Orange) Fruit Extract | 05D | Permanent waves   | 0.01%                  |
| Citrus Nobilis (Mandarin Orange) Fruit Extract | 05F | Shampoos (noncoloring)  | 0.01%                  |
| Citrus Nobilis (Mandarin Orange) Fruit Extract | 05G | Tonics, dressings and other hair grooming aids                    | 0.001-0.01%            |
| Citrus Nobilis (Mandarin Orange) Fruit Extract | 05I | Other hair preparations (noncoloring)                             | 0.005%                 |
| Citrus Nobilis (Mandarin Orange) Fruit Extract | 10A | Bath soaps and detergents   | 0.04%                  |
| Citrus Nobilis (Mandarin Orange) Fruit Extract | 10E | Other personal cleanliness products                               | 0.002%                 |
| Citrus Nobilis (Mandarin Orange) Fruit Extract | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.0018%                |
| Citrus Nobilis (Mandarin Orange) Fruit Extract | 12C | Face and neck products<br>not spray                               | 0.0018%                |
| Citrus Nobilis (Mandarin Orange) Fruit Extract | 12D | Body and hand products<br>not spray                               | 0.002-0.04%<br>0.0075% |
| Citrus Nobilis (Mandarin Orange) Oil           | 07G | Rouges  | 0.075%                 |
| Citrus Nobilis (Mandarin Orange) Peel Extract  | 02B | Bubble baths  | 0.0025%                |
| Citrus Nobilis (Mandarin Orange) Peel Extract  | 02D | Other bath preparations   | 0.0005%                |
| Citrus Nobilis (Mandarin Orange) Peel Extract  | 05A | Hair conditioners   | 0.00025-0.005%         |
| Citrus Nobilis (Mandarin Orange) Peel Extract  | 05F | Shampoos (noncoloring)  | 0.00025-0.005%         |
| Citrus Nobilis (Mandarin Orange) Peel Extract  | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.0025-0.023%          |

|   |     |   |               |
|---|-----|---|---------------|
| Citrus Nobilis (Mandarin Orange) Peel Extract | 12D | Body and hand products<br>not spray                               | 0.0025%       |
| Citrus Nobilis (Mandarin Orange) Peel Extract | 12F | Moisturizing products<br>not spray                                | 0.009%        |
| Citrus Nobilis (Mandarin Orange) Peel Extract | 12H | Paste masks and mud packs   | 0.0051-0.03%  |
| Citrus Nobilis (Mandarin Orange) Peel Oil     | 05A | Hair conditioners   | 0.0005%       |
| Citrus Nobilis (Mandarin Orange) Peel Oil     | 05F | Shampoos (noncoloring)  | 0.00005-0.03% |
| Citrus Nobilis (Mandarin Orange) Peel Oil     | 07E | Lipstick  | 0.0099%       |
| Citrus Nobilis (Mandarin Orange) Peel Oil     | 08B | Cuticle softeners   | 0.012%        |
| Citrus Nobilis (Mandarin Orange) Peel Oil     | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.00005-0.02% |
| Citrus Nobilis (Mandarin Orange) Peel Oil     | 12C | Face and neck products<br>not spray                               | 0.05%         |
| Citrus Nobilis (Mandarin Orange) Peel Oil     | 12D | Body and hand products<br>not spray                               | 0.00005-0.1%  |
| Citrus Nobilis (Mandarin Orange) Peel Oil     | 12F | Moisturizing products<br>not spray                                | 0.05%         |
| Citrus Nobilis (Mandarin Orange) Peel Oil     | 12G | Night products<br>not spray                                       | 0.05%         |
| Citrus Nobilis (Mandarin Orange) Peel Oil     | 12J | Other skin care preparations<br>rinse-off                         | 0.05%         |
| Citrus Paradisi (Grapefruit) Fruit Extract    | 05F | Shampoos (noncoloring)  | 0.005%        |
| Citrus Paradisi (Grapefruit) Fruit Extract    | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.2%          |
| Citrus Paradisi (Grapefruit) Fruit Extract    | 12C | Face and neck products<br>not spray                               | 0.3%          |

|  |     |   |               |
|--|-----|---|---------------|
| Citrus Paradisi (Grapefruit) Fruit Extract | 12D | Body and hand products<br>not spray                               | 0.05-1.5%     |
| Citrus Paradisi (Grapefruit) Fruit Extract | 12F | Moisturizing products<br>not spray                                | 0.05%         |
| Citrus Paradisi (Grapefruit) Fruit Extract | 12H | Paste masks and mud packs   | 0.16%         |
| Citrus Paradisi (Grapefruit) Peel Extract  | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.0068%       |
| Citrus Paradisi (Grapefruit) Peel Extract  | 12J | Other skin care preparations                                      | 0.0017%       |
| Citrus Paradisi (Grapefruit) Peel Oil      | 05B | Hair sprays<br>pump spray   | 0.00068%      |
| Citrus Paradisi (Grapefruit) Peel Oil      | 12F | Moisturizing products<br>not spray                                | 0.5%          |
| Citrus Tangerina (Tangerine) Peel Oil      | 05A | Hair conditioners   | 0.0000013%    |
| Citrus Tangerina (Tangerine) Peel Oil      | 05F | Shampoos (noncoloring)  | 0.0000013%    |
| Citrus Tangerina (Tangerine) Peel Oil      | 05G | Tonic, dressings and other hair grooming aids                     | 0.0000013%    |
| Citrus Unshiu Peel Extract                 | 02A | Bath oils, tablets and salts                                      | 0.03%         |
| Citrus Unshiu Peel Extract                 | 03D | Eye lotion  | 0.002%        |
| Citrus Unshiu Peel Extract                 | 03E | Eye makeup remover  | 0.000002%     |
| Citrus Unshiu Peel Extract                 | 07C | Foundations   | 0.0002%       |
| Citrus Unshiu Peel Extract                 | 12A | Skin cleansing (cold creams, cleansing lotions, liquids and pads) | 0.002-0.94%   |
| Citrus Unshiu Peel Extract                 | 12C | Face and neck products<br>not spray                               | 0.002-0.94%   |
| Citrus Unshiu Peel Extract                 | 12D | Body and hand products<br>not spray                               | 0.002-0.0095% |

|                            |     |                                    |                |
|----------------------------|-----|------------------------------------|----------------|
| Citrus Unshiu Peel Extract | 12F | Moisturizing products<br>not spray | 0.00095-0.002% |
|----------------------------|-----|------------------------------------|----------------|

\*Ingredients included in the title of the table but not found in the table were included in the concentration of use survey, but no uses were reported.

†Product category codes used by FDA

Information collected in 2013  
Table prepared: July 25, 2013