Safety Assessment of Citrus-Derived Ingredients as Used in Cosmetics

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All interested persons are provided 60 days from the above release date to comment on this safety assessment and to identify additional published data that should be included or provide unpublished data which can be made public and included. Information may be submitted without identifying the source or the trade name of the cosmetic product containing the ingredient. All unpublished data submitted to CIR will be discussed in open meetings, will be available at the CIR office for review by any interested party and may be cited in a peer-reviewed scientific journal. Please submit data, comments, or requests to the CIR Director, Dr. Lillian Gill.

The 2013 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, Scientific Analyst/Writer and Monice Fiume, Senior Scientific Analyst/Writer.

Cosmetic Ingredient Review

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INTRODUCTION

Citrus-derived oils, extracts, juices, powders, waxes, and waters are widely used as cosmetic ingredients, and function primarily as skin conditioning agents-miscellaneous and fragrance. This report assesses the safety of 198 citrus-derived ingredients. The full list of ingredients in this report is found in Table 1.

This report includes cosmetic ingredients that have been previously reviewed by the Cosmetic Ingredient Review (CIR) Expert Panel. The Panel concluded in 2010 that citrus aurantifolia (lime) seed oil, citrus aurantifolia (lime) seed oil unsaponifiables, citrus aurantium dulcis (orange) seed oil, citrus aurantium dulcis (orange) seed oil unsaponifiables, citrus grandis (grapefruit) seed oil, citrus grandis (grapefruit) seed oil unsaponifiables, citrus limon (lemon) seed oil, and citrus paradisi (grapefruit) seed oil were "safe in the present practices of use and concentration" as described in the safety assessment of plant-derived fatty acid oils.[1]

Usually, the CIR does not review ingredients that only function as fragrance ingredients because, as fragrances, the safety of these ingredients is evaluated by the Research Institute for Fragrance Materials (RIFM). Twenty-two of the citrus-derived ingredients in this report function only as fragrance ingredients, according to the International Cosmetic Ingredient Dictionary and Handbook (see Table 2).[2] The CIR is in the process of confirming with the RIFM that these ingredients are fragrance ingredients; if confirmed, these ingredients will be deleted from this safety assessment.

Botanicals such as citrus are comprised of hundreds of constituents, some of which have the potential to cause toxic effects; for example, bergapten (aka 5-methoxysporalen or 5-MOP) is a naturally occurring furanocoumarin (psoralen) in bergamot oil that causes phototoxicity. Presently, CIR is reviewing the information available on the potential toxicity of each citrus-derived ingredient as a whole, complex substance; CIR is not reviewing the potential toxicity information on the individual constituents of which the citrus-derived ingredients are comprised. CIR is requesting information on the concentrations (including ranges, means, upper 95 percent confidence limits, detection limits, etc…) of individual constituents in the citrus-derived ingredients used in cosmetics, to facilitate the safety assessment of these ingredients as used in cosmetics. Such information on constituents that have been identified as constituents of concern by the CIR Expert Panel in previous safety assessments, or by other recognized scientific expert review bodies, is especially important.

Note: In many of the published studies, the information provided is not sufficient to determine how well the substance being tested represents the cosmetic-grade ingredient. In this safety assessment report, if a substance tested in a study is not clearly a cosmetic-grade ingredient, the test substance will be referred to by a common name (e.g. lime oil). If the substance is clearly a cosmetic-grade ingredient, the International Nomenclature of Cosmetic Ingredients (INCI) name will be used to refer to the test substance (e.g. "citrus aurantifolia (lime) oil"). Additionally, data were discovered in the published literature on "Petitgrain Bigarade Oil" that indicate the source to be either bitter orange (generic) or citrus reticulata (tangerine) leaf oil. Information is requested to clarify the composition of this oil.

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 an ingredient is obtained from. In some cases, the definition provides insight on the method(s) of manufacture.

Physical and Chemical Properties

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

Method of Manufacturing

Figures 1 and 2 are generic representations of the methods of manufacturing for fruit waters and citrus aurantium amara (bitter orange) flower wax.

Bergamot Oil

Bergamot oil (cold-pressed) is obtained by pressing, without the use of heat, the fresh peel of the fruit of *Citrus bergamia* [3].

Bitter Orange Oil

Bitter orange oil (cold-pressed) is obtained by expression, without the use of heat, from the fresh peel of the fruit of *Citrus aurantium*.[3]

Lemon Oil

Lemon oil, expressed, is produced by pressing the outer rind of the ripe fruit by hand or by machine.[4] More economical processes involve an integrated juice-oil procedure. Lemon oil can also be produced by distillation of expressed oils or direct distillation of fruit. Distilling (rectifying) removes terpenes. Steam distillation removes non-volatile furocoumarins.

Lime Oil

Lime oil is produced using the same methods previously described for lemon oil.[4]

Grapefruit Oil

Grapefruit oil (cold-pressed) is obtained by expression from the fresh peel of the grapefruit *Citrus paradisi*.[3]

Mandarin Oil – Expressed

Mandarin peel oil expressed (identified as *Citrus reticulata*) is prepared by the expression of the peels of the ripe fruit of the mandarin orange.[5]

Citrus Aurantium Dulcis (Orange) Peel Wax

In 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.[6] 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.

Orange Oil

Orange oil (cold-pressed) is obtained by the expression, without the use of heat, from the fresh peel of the ripe fruit of *Citrus sinensis*.[3] Distilled orange oil is obtained from the fresh peel or juice of the fruit of *Citrus sinensis*, with or without the previous separation of the juice, pulp, or peel.

Tangerine Oil

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.[3]

Constituents/Composition

The citrus ingredients are complex botanicals made up of numerous constituents. Table 4 lists constituents by plant part for the major citrus species (lemon, lime, grapefruit, sweet orange, and bitter orange). Table 5 lists major constituents by citrus plant species. Table 6 gives the typical levels of 5-MOP that are found in some of the oils and Table 7 provides the levels of major coumarins and furocoumarins in lemon and lime oil. Table 8 lists citrus constituents that are established contact allergens, according the European Commission's Scientific Committee on Consumer Safety (SCCS). Table 9 presents the cosmetic allergens certificate of analysis for orange, lemon, tangerine, and grapefruit fruit waters.

Citrus Aurantium Amara (Bitter Orange) Flower Wax

In data provided by a supplier, citrus aurantium amara (bitter orange) flower wax had less than 0.1 mg/kg heavy metals (arsenic, cadmium, and lead) and no detectable pesticides (< 0.005 mg/kg) or polycyclic aromatic hydrocarbons (< 0.25 µg/kg).[7] Concentrations of aflatoxins (B1, B2, G1, G2) were less than 0.1 µg/kg, with the total aflatoxins concentration less than 0.4 µg/kg, and dioxins were less than 0.6 pg/g.

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.[6] 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.[6] 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 most of linoleic, oleic, linolenic, arachidic, and erucic acids.[8] The fatty alcohol portion of the ester is mostly dotriacontanol (C32) and tetratricontanol (C34).

Tables 10 and 11 present additional chemical composition data on citrus aurantium dulcis (orange) peel wax.

USE

Cosmetic

Table 12 presents the current product-formulation use data for citrus-derived ingredients. These ingredients function primarily as skin conditioning agents-miscellaneous and fragrance.[2] Functions were not reported for the following ingredients: citrus aurantifolia (lime) fruit; citrus aurantium amara (bitter orange) flower wax; citrus aurantium dulcis (orange) juice; citrus grandis (grapefruit); citrus nobilis (mandarin orange); and citrus tangerina (tangerine) fruit.

According to information supplied to the Food and Drug Administration (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 510; more than half of the uses are in leave-on skin care preparations.[9] Citrus limon (lemon) fruit extract has the second greatest number of overall uses reported, with a total of 448; more than half of those uses are in leave-on skin care preparations.

In the Personal Care Products Council's use concentration survey, citrus limon (lemon) peel oil had a highest maximum use concentration range of 0.0001% to 0.5% with 0.5% reported in "other" skin care preparations.[10] Citrus limon (lemon) fruit extract had a highest maximum use concentration range of 0.0001% to 1.2%, with 1.2% reported in night skin

care products. Most of the other use concentrations that were reported had similar ranges. However, maximum use concentrations as high as 29% were reported for citrus aurantium dulcis (orange) peel oil in hair conditioners and as high as 19% for citrus aurantium dulcis (orange) fruit water in paste masks and mud packs.

In some cases, reports of uses were received from the VCRP, but no concentration of use data were provided. For example, citrus aurantifolia (lime) oil is reported to be used in 160 formulations, but no use concentration data were available. In other cases, no reported uses were received from 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 leave-on formulations at up to 1.5%. It should be presumed that citrus aurantifolia (lime) peel is used in at least one cosmetic formulation.

Table 13 lists all citrus-derived ingredients not indicated to be in use based on the VCRP data or the results of the Council concentration of use survey.

Some of these ingredients were reported to be used in hair sprays and body and hand sprays and could possibly be inhaled. For example, Citrus Nobilis (Mandarin Orange) Fruit Extract was reported to be used in body and hand sprays at a maximum concentration of 0.0075%. 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.[11-14] 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.[12,13] There is some evidence indicating that deodorant spray products can release substantially larger fractions of particulates having aerodynamic equivalent diameters in the range considered to be respirable.[13] However, the information is not sufficient to determine whether significantly greater lung exposures result from the use of deodorant sprays, compared to other cosmetic sprays.

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.[15] The International Fragrance Association (IFRA) has issued standards for citrus oils and other furocoumarin-containing essential oils.[16] 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 bergamot oil expressed, 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.[17] 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. Based on this standard, the maximum concentration of lime cold pressed oil is 0.1%, for example

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;[18] 0.4% bergamot oil expressed;[19] 4% grapefruit oil expressed;[20] 2% lemon oil cold-pressed;[21] 0.7% lime oil expressed.[22] 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 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 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 fruits 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.[23]

Bergamot oil is used in aromatherapy and is an analgesic, antidepressant, antimicrobial, digestive aid, sedative, fever reducer, and has anticholesterol effects.[24]

TOXICOKINETICS

No published toxicokinetics studies on citrus-derived ingredients were identified in a literature search for these ingredients and no unpublished data were submitted.

TOXICOLOGICAL STUDIES

Acute Toxicity

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. Also, as noted earlier, 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. Volatile oils of limes, lemons, bergamots, grapefruits, bitter oranges, oranges, and tangerines are described as flavoring agents in the USP Food Chemicals Codex.[3] 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 dermal exposure.

Dermal – Non-Human

Bitter Orange *or* Citrus Reticulata (Tangerine) Leaf Oil

The dermal LD_{50} of either bitter orange or citrus reticulata (tangerine) leaf oil (described as "petitgrain bigarade oil") was reported as greater 2 g/kg in rabbits; however, only 2 rabbits were used in the study.[25] An occlusive patch of undiluted test material was applied for 24 h.

Mandarin Oil – Expressed (*Citrus reticulata*)

The dermal LD_{50} of mandarin peel oil (*Citrus reticulata*) was greater than 5 g/kg in rabbits.[5] An occlusive patch of undiluted oil was applied to the skin of seven animals for 24 h.

Repeated Dose Toxicity

No published repeated dose toxicity studies on citrus-derived ingredients were identified in a literature search for these ingredients and no unpublished data were submitted.

REPRODUCTIVE AND DEVELOPMENTAL TOXICITY

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

GENOTOXICITY

No published genotoxicity studies on citrus-derived ingredients were identified in a literature search for these ingredients and no unpublished data were submitted.

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.[26] In the study, 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 2-5 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 12th 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 on the treated skin. Additionally, 1 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 was stopped after 42 weeks. Squamous cell carcinomas of the skin were observed in 2 mice from the lemon oil group and 2 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 1 mouse of the orange oil group (a hemangioma of the subcutaneous tissue starting at week 7) and in 1 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 in this experiment was poor due to a very high incidence of renal disease.[26]

Orange Oil

Tumor-promoting activity was observed in mouse skin exposed to orange (sweet) oil.[26] 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 12th week. After 33 weeks, 5/10 mice treated with 40% orange oil and 10/10 mice treated with 80% orange oil has 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. 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.[26]

IRRITATION AND SENSITIZATION

Dermal Irritation

Dermal irritation studies are summarized in Table 14. In an in vitro test, no irritation potential was observed for citrus aurantium dulcis (orange) peel wax tested at 100%. Varying degrees of irritation were observed in animals treated with undiluted citrus aurantium amara (bitter orange) flower wax, unreported concentrations of either bitter orange or citrus reticulata (tangerine) leaf oil (described as “petitgrain bigarade oil”), or unreported concentrations of mandarin peel oil. In human subjects, no irritation was observed after topical exposure to citrus aurantium dulcis (orange) peel wax (100%), bergamot oil (up to 15%), either bitter orange or citrus reticulata (tangerine) leaf oil (described as “petitgrain bigarade oil”; up to 8%), lemon oil (up to 20%), or mandarin peel oil (8%).

Ocular Irritation

Citrus Aurantium Amara (Bitter Orange) Flower Wax

The eye tolerance of citrus aurantium amara (bitter orange) flower wax (> 50%) was tested in vitro using the SIRC cell strain.[27] Tolerance was evaluated by measuring cytotoxicity. Negative controls solutions were physiological serum or sample diluent and the positive control solutions were 0.01% to 0.2% SDS. Negligible cytotoxicity was observed.

Sensitization

Sensitization studies are presented in Table 15. Either bitter orange or citrus reticulata (tangerine) leaf oil (described as “petitgrain bigarade oil”) and mandarin peel oil were not sensitizing in human maximization tests. In studies of 250 dermatitic patients, less than 2.5% had positive reactions to bergamot oil, bitter orange oil, lemon oil, or sweet orange oil tested at 2% in paraffin.

Phototoxicity and Photosensitization

Phototoxicity and photosensitization studies are presented in Table 16. Citrus aurantium dulcis (orange) peel wax (100%) was not photosensitizing in a human study. Mixed results were observed in non-human and human phototoxicity and photosensitization studies of diluted and undiluted bergamot oil, either bitter orange or citrus reticulata (tangerine) leaf oil (described as “petitgrain bigarade oil”), lime oil, lemon oil, lemon fruit and peel juice, grapefruit oil, mandarin oil, tangerine oil, bitter orange oil, bitter orange peel oil, orange peel, orange mesocarp, and orange fruit. Many of the citrus-derived ingredients contain constituents that are photoactive agents, although those noted to be furocoumarin-free tended not to induce photosensitization.

Case Studies

Case studies describing reactions to citrus-derived ingredients are summarized in Table 17. Phototoxicity and photosensitization were noted in several patients exposed to bergamot oil or limes/lime juice.

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.[28]

SUMMARY

The 198 citrus-derived ingredients described in this report function primarily as skin conditioning agents-miscellaneous and fragrance. Botanicals such as citrus are comprised of hundreds of constituents, some of which have the potential to cause toxic effects; for example, bergapten (aka 5-methoxysporalen or 5-MOP) is a naturally occurring furanocoumarin (psoralen) in bergamot oil that causes phototoxicity. Presently, CIR is reviewing the information available on the potential toxicity of each citrus-derived ingredient as a whole, complex substance; CIR is not reviewing the potential toxicity information on the individual constituents of which the citrus-derived ingredients are comprised. CIR is requesting information on the concentrations (including ranges, means, upper 95 percent confidence limits, detection limits, etc.) of individual constituents in the citrus-derived ingredients used in cosmetics, to facilitate the safety assessment of these ingredients as used in cosmetics. Such information on constituents that have been identified as constituents of concern by the CIR Expert Panel in previous safety assessments, or by other recognized scientific expert review bodies, is especially important.

Citrus limon (lemon) peel oil has the most reported uses in cosmetics and personal care products, with a total of 510; 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 limon (lemon) fruit extract has the second greatest number of overall uses reported, with a total of 448; more than half of those uses are in leave-on skin care preparations. The range of highest maximum use concentrations for citrus limon (lemon) fruit extract is 0.0001% to 1.2%, with 1.2% reported in night skin care products. Most of the other use concentrations that were reported for other citrus-derived ingredients had similar ranges; however, use concentrations as high as 29% were reported for citrus aurantium dulcis (orange) peel oil in hair conditioners and as high as 19% for citrus aurantium dulcis (orange) fruit water in paste masks and mud packs.

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 bergamot oil expressed, bitter orange oil expressed, grapefruit oil expressed, lemon oil cold pressed, and lime oil expressed.

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.

The dermal LD_{50} of undiluted either bitter orange or citrus reticulata (tangerine) leaf oil (described as "petitgrain bigarade oil") was reported as greater than 2 g/kg in rabbits. The dermal LD_{50} of undiluted mandarin peel oil (*Citrus reticulata*) was greater than 5 g/kg in rabbits.

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 in these experiments were poor because of a very high incidence of renal disease

In an in vitro test, no irritation potential was observed for citrus aurantium dulcis (orange) peel wax tested at 100%. Varying degrees of irritation were observed in animals exposed to undiluted citrus aurantium amara (bitter orange) flower wax, unreported concentrations of either bitter orange or citrus reticulata (tangerine) leaf oil (described as "petitgrain bigarade oil"), or unreported concentrations of mandarin peel oil. In human subjects, no irritation was observed using citrus aurantium dulcis (orange) peel wax (100%), bergamot oil (up to 15%), bitter orange or citrus reticulata (tangerine) leaf oil (up to 8%), lemon oil (up to 20%), or mandarin peel oil (8%).

Essentially no cytotoxicity was observed in an in vitro eye tolerance study of citrus aurantium amara (bitter orange) flower wax (> 50%) using the SIRC cell strain.

Either bitter orange or citrus reticulata (tangerine) leaf oil (described as "petitgrain bigarade oil") and mandarin peel oil were not sensitizing in human maximization tests. In studies of 250 dermatitic patients, less than 2.5% had positive reactions to bergamot oil, bitter orange oil, lemon oil, or sweet orange oil tested at 2% in paraffin.

Citrus aurantium dulcis (orange) peel wax (100%) was not photosensitizing in a human study. Mixed results were observed in non-human and human phototoxicity and photosensitization studies of diluted and undiluted bergamot oil, either bitter orange or citrus reticulata (tangerine) leaf oil (described as “petitgrain bigarade oil”), lime oil, lemon oil, lemon fruit and peel juice, grapefruit oil, mandarin oil, tangerine oil, bitter orange oil, bitter orange peel oil, orange peel, orange mesocarp, and orange fruit. Many of the citrus-derived ingredients contain constituents that are photoactive; those that are noted to be furocoumarin-free tended not to induce photosensitization.

Phototoxicity and photosensitization were noted in several patients exposed to bergamot oil or limes/lime juice. A retrospective occupational study of food handlers noted positive reactions to orange and lemon peels.

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

FIGURES

Figure 1. Method of manufacturing of fruit waters.[29]

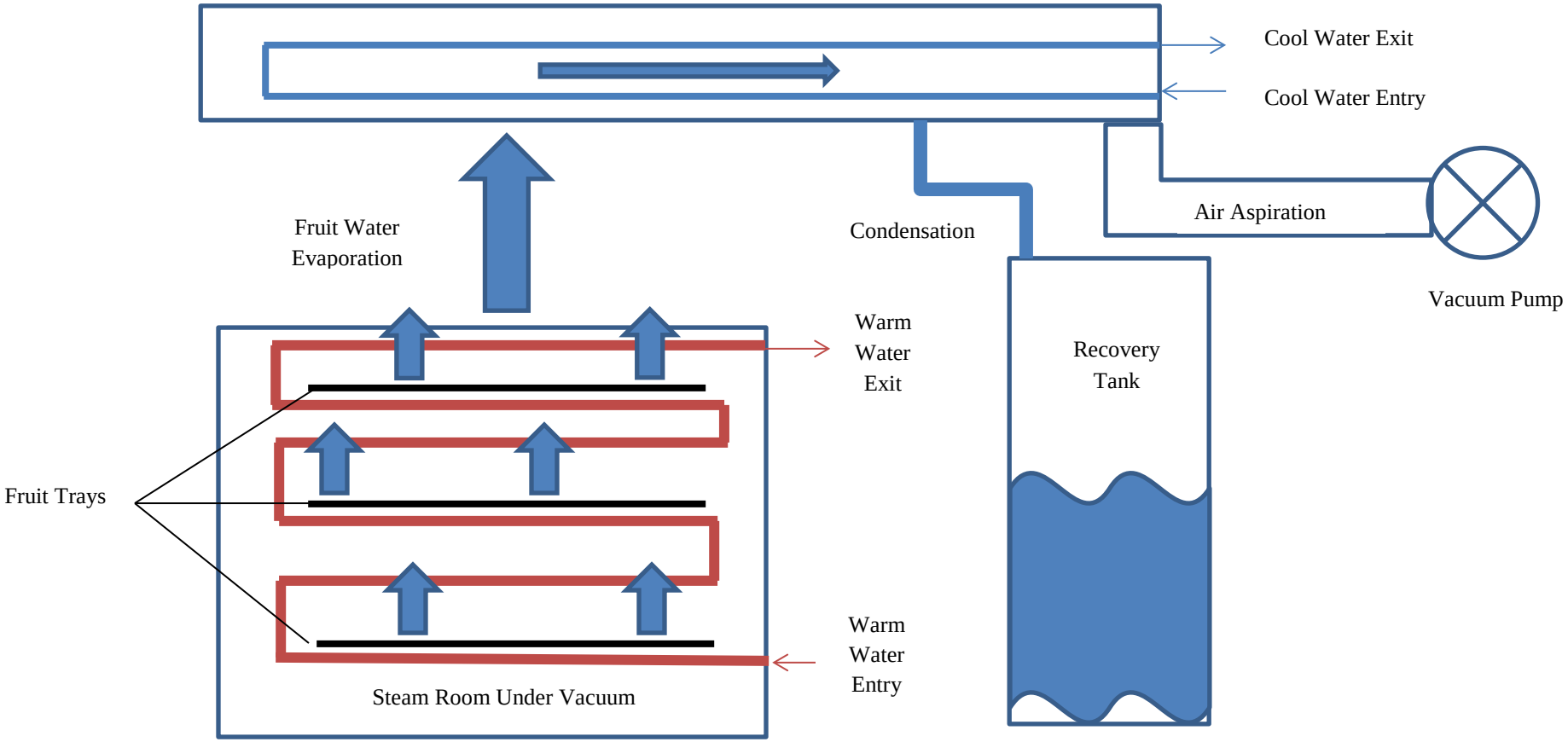
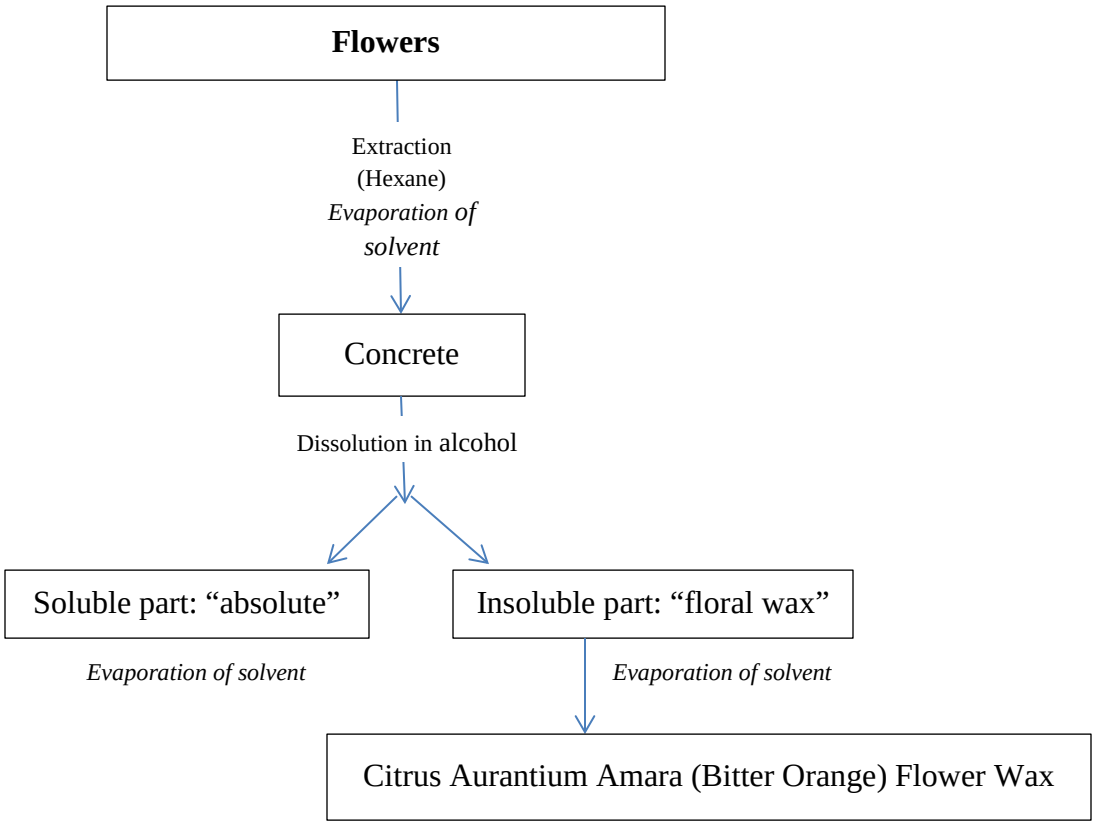


Figure 2. Manufacturing flow chart of Citrus Aurantium Amara (Bitter Orange) Flower Wax.[30]



TABLES

Table 1. Definitions and functions of Citrus-derived ingredients [2]

Ingredient	Definition	Function
Citrus Aurantifolia (Lime)/Citrus Limon (Lemon) Fruit Water	Citrus Aurantifolia (Lime)/Citrus Limon (Lemon) Fruit Water is an aqueous solution of the steam distillate obtained from the fruit of *Citrus aurantifolia* and *Citrus limon.*	Skin-Conditioning Agents - Humectant
Citrus Aurantifolia (Lime) Flower Extract	Citrus Aurantifolia (Lime) Flower Extract is the extract of the flowers of *Citrus aurantifolia.*	Cosmetic Astringents; Skin-Conditioning Agents - Miscellaneous
Citrus Aurantifolia (Lime) Fruit	Citrus Aurantifolia (Lime) Fruit is the fruit of *Citrus aurantifolia.*	Not reported
Citrus Aurantifolia (Lime) Fruit Extract CAS No. 90063-52-8	Citrus Aurantifolia (Lime) Fruit Extract is the extract of the fruit of *Citrus aurantifolia*.	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantifolia (Lime) Fruit Water	Citrus Aurantifolia (Lime) Fruit Water is an aqueous solution of the steam distillates obtained from the fruit of *Citrus aurantifolia*.	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantifolia (Lime) Juice	Citrus Aurantifolia (Lime) Juice is the liquid expressed from the fresh pulp of the lime, *Citrus aurantifolia.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantifolia (Lime) Leaf Oil	Citrus Aurantifolia (Lime) Leaf Oil is the volatile oil obtained from the leaves of *Citrus aurantifolia.*	Fragrance Ingredients
Citrus Aurantifolia (Lime) Oil CAS No. 8008-26-2	Citrus Aurantifolia (Lime) Oil is the volatile oil obtained from the whole plant, *Citrus aurantifolia*.	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Aurantifolia (Lime) Peel	Citrus Aurantifolia (Lime) Peel is the peel obtained from *Citrus aurantifolia.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantifolia (Lime) Peel Extract CAS No. 90063-52-8	Citrus Aurantifolia (Lime) Peel Extract is the extract of the peel of *Citrus aurantifolia*.	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantifolia (Lime) Peel Oil	Citrus Aurantifolia (Lime) Peel Oil is the volatile oil obtained from the peel of *Citrus aurantifolia.*	Fragrance Ingredients
Citrus Aurantifolia (Lime) Peel Powder	Citrus Aurantifolia (Lime) Peel Powder is the powder obtained from the dried, ground peel of *Citrus aurantifolia.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantifolia (Lime) Peel Water	Citrus Aurantifolia (Lime) Peel Water is the aqueous solution of the steam distillates obtained from the peel of *Citrus aurantifolia.*	Fragrance Ingredients
Citrus Aurantifolia (Lime) Seed Oil*	Citrus Aurantifolia (Lime) Seed Oil is the oil expressed from the seeds of *Citrus aurantifolia.*	Flavoring Agents; Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Aurantifolia (Lime) Seed Oil Unsaponifiables*	Citrus Aurantifolia (Lime) Seed Oil Unsaponifiables is the fraction of lime seed oil which is not saponified in the refining recovery of lime seed oil fatty acids.	Hair Conditioning Agents; Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Amara (Bitter Orange) Flower Extract CAS No. 72968-50-4	Citrus Aurantium Amara (Bitter Orange) Flower Extract is the extract of the flowers of *Citrus aurantium amara.*	Skin-Conditioning Agents - Occlusive
Citrus Aurantium Amara (Bitter Orange) Flower Oil	Citrus Aurantium Amara (Bitter Orange) Flower Oil is the volatile oil obtained from the flowers of *Citrus aurantium amara*.	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Amara (Bitter Orange) Flower Water	Citrus Aurantium Amara (Bitter Orange) Flower Water is an aqueous solution of the steam distillate obtained from the flowers of *Citrus aurantium amara*.	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Amara (Bitter Orange) Flower Wax	Citrus Aurantium Amara (Bitter Orange) Flower Wax is a wax obtained from the flower of *Citrus aurantium amara.*	Not reported
Citrus Aurantium Amara (Bitter Orange) Fruit Extract CAS No. 84625-25-2	Citrus Aurantium Amara (Bitter Orange) Fruit Extract is the extract of the fruit of *Citrus aurantium amara.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Amara (Bitter Orange) Fruit Juice Extract	Citrus Aurantium Amara (Bitter Orange) Fruit Juice Extract is the extract of the fruit juice of *Citrus aurantium amara.*	Hair Conditioning Agents; Nail Conditioning Agents; Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Amara (Bitter Orange) Leaf/Twig Extract CAS No. 72968-50-4; 8016-38-4	Citrus Aurantium Amara (Bitter Orange) Leaf/Twig Extract is the extract of the leaves and twigs of *Citrus aurantium amara.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Amara (Bitter Orange) Leaf/Twig Oil	Citrus Aurantium Amara (Bitter Orange) Leaf/Twig Oil is the volatile oil obtained from the leaves and twigs of *Citrus aurantium amara*.	Flavoring Agents; Fragrance Ingredients
Citrus Aurantium Amara (Bitter Orange) Peel	Citrus Aurantium Amara (Bitter Orange) Peel is the peel of *Citrus aurantium amara.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Amara (Bitter Orange) Peel Extract CAS No. 72968-50-4	Citrus Aurantium Amara (Bitter Orange) Peel Extract is the extract of the peel of *Citrus aurantium amara.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Amara (Bitter Orange) Peel Oil CAS No. 68916-04-1	Citrus Aurantium Amara (Bitter Orange) Peel Oil is the volatile oil obtained from the peel of *Citrus aurantium amara.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous

Table 1. Definitions and functions of Citrus-derived ingredients [2]

Ingredient	Definition	Function
Citrus Aurantium Amara (Bitter Orange) Peel Powder	Citrus Aurantium Amara (Bitter Orange) Peel Powder is the powder obtained from the dried, ground peel of *Citrus aurantium amara*.	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Bergamia (Bergamot) Fruit Extract CAS No. 89957-91-5	Citrus Aurantium Bergamia (Bergamot) Fruit Extract is the extract of the fruit of *Citrus aurantium bergamia.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Bergamia (Bergamot) Fruit Oil CAS No. 68648-33-9; 8007-75-8; 85049-52-1	Citrus Aurantium Bergamia (Bergamot) Fruit Oil is the psoralen-free volatile oil obtained from the fruit of *Citrus aurantium bergamia.*	Fragrance Ingredients
Citrus Aurantium Bergamia (Bergamot) Fruit Water	Citrus Aurantium Bergamia (Bergamot) Fruit Water is an aqueous solution of the steam distillate obtained from the fruit of *Citrus aurantium bergamia.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Bergamia (Bergamot) Leaf Extract	Citrus Aurantium Bergamia (Bergamot) Leaf Extract is the extract of the leaves of *Citrus aurantium bergamia.*	Cosmetic Astringents
Citrus Aurantium Bergamia (Bergamot) Leaf Oil	Citrus Aurantium Bergamia (Bergamot) Leaf Oil is the volatile oil obtained from the leaves of *Citrus aurantium bergamia.*	Cosmetic Astringents
Citrus Aurantium Bergamia (Bergamot) Peel Oil CAS No. 89957-91-5	Citrus Aurantium Bergamia (Bergamot) Peel Oil is the volatile oil obtained from the peel of *Citrus aurantium bergamia*.	Fragrance Ingredients
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 *Citrus aurantium bergamia.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Currassuviensis Peel Oil	Citrus Aurantium Currassuviensis Peel Oil is the volatile oil derived from the peel of the laraha orange, *Citrus aurantium currassuviensis.*	Fragrance Ingredients
Citrus Aurantium Dulcis (Orange) Flower	Citrus Aurantium Dulcis (Orange) Flower is the flower of *Citrus aurantium dulcis.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Dulcis (Orange) Flower Extract	Citrus Aurantium Dulcis (Orange) Flower Extract is the extract of the flowers of *Citrus aurantium dulcis.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Dulcis (Orange) Flower/Leaf/Stem Powder	Citrus Aurantium Dulcis (Orange) Flower/Leaf/Stem Powder is the powder obtained from the dried, ground flowers, leaves and stems of *Citrus aurantium dulcis.*	Exfoliants
Citrus Aurantium Dulcis (Orange) Flower Oil CAS No. 8016-38-4	Citrus Aurantium Dulcis (Orange) Flower Oil is the volatile oil obtained from the flowers of *Citrus aurantium dulcis.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Dulcis (Orange) Flower Water CAS No. 8030-28-2	Citrus Aurantium Dulcis (Orange) Flower Water is an aqueous solution of the steam distillate obtained from the flowers of the orange, *Citrus aurantium dulcis.*	Fragrance Ingredients
Citrus Aurantium Dulcis (Orange) Flower Wax	Citrus Aurantium Dulcis (Orange) Flower Wax is a wax obtained from the flowers of *Citrus aurantium dulcis.*	Skin-Conditioning Agents - Occlusive
Citrus Aurantium Dulcis (Orange) Fruit Extract CAS No. 84012-28-2	Citrus Aurantium Dulcis (Orange) Fruit Extract is the extract of the fruit of *Citrus aurantium dulcis.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Dulcis (Orange) Fruit Powder	Citrus Aurantium Dulcis (Orange) Fruit Powder is the powder obtained from the dried, ground fruit of *Citrus aurantium dulcis.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Dulcis (Orange) Fruit Water	Citrus Aurantium Dulcis (Orange) Fruit Water is an aqueous solution of the steam distillate obtained from the fruit of the orange, *Citrus aurantium dulcis.*	Flavoring Agents; Fragrance Ingredients
Citrus Aurantium Dulcis (Orange) Juice	Citrus Aurantium Dulcis (Orange) Juice is the liquid expressed from the pulp of the orange, *Citrus aurantium dulcis.*	Not reported
Citrus Aurantium Dulcis (Orange) Leaf Extract	Citrus Aurantium Dulcis (Orange) Leaf Extract is the extract of the leaves of *Citrus aurantium dulcis.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Dulcis (Orange) Oil	Citrus Aurantium Dulcis (Orange) Oil is the volatile oil obtained from the whole plant, *Citrus aurantium dulcis*.	Fragrance Ingredients
Citrus Aurantium Dulcis (Orange) Peel Extract	Citrus Aurantium Dulcis (Orange) Peel Extract is the extract of the peel of *Citrus aurantium dulcis.*	Binders; Emulsion Stabilizers; Skin-Conditioning Agents - Miscellaneous; Viscosity Increasing Agents - Aqueous
Citrus Aurantium Dulcis (Orange) Peel Oil CAS No. 8008-57-9	Citrus Aurantium Dulcis (Orange) Peel Oil is the volatile oil obtained by expression from the peel of *Citrus sinensis.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Dulcis (Orange) Peel Powder	Citrus Aurantium Dulcis (Orange) Peel Powder is the powder obtained from the dried, ground peel of *Citrus aurantium dulcis.*	Absorbents
Citrus Aurantium Dulcis (Orange) Peel Wax	Citrus Aurantium Dulcis (Orange) Peel Wax is a wax obtained from the peel of the orange, *Citrus aurantium dulcis.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Dulcis (Orange) Seed Extract	Citrus Aurantium Dulcis (Orange) Seed Extract is the extract of the seeds of *Citrus aurantium dulcis.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Dulcis (Orange) Seed Oil*	Citrus Aurantium Dulcis (Orange) Seed Oil is the oil expressed from the seeds of *Citrus aurantium dulcis.*	Flavoring Agents; Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Dulcis (Orange) Seed	Citrus Aurantium Dulcis (Orange) Seed Oil Unsaponifiables is the	Hair Conditioning Agents; Skin-

Table 1. Definitions and functions of Citrus-derived ingredients [2]

Ingredient	Definition	Function
Oil Unsaponifiables*	fraction of orange seed oil which is not saponified in the refining recovery of orange seed oil fatty acids.	Conditioning Agents - Miscellaneous
Citrus Aurantium Sinensis (Orange) Fiber	Citrus Aurantium Sinensis (Orange) Fiber is the fiber obtained from the pulp of *Citrus aurantium sinensis.*	Emulsion Stabilizers
Citrus Aurantium Sinensis Peel Extract	Citrus Aurantium Sinensis Peel Extract is the extract of the peel of *Citrus aurantium sinenesis.*	Skin-Conditioning Agents - Miscellaneous
Citrus Aurantium Sinensis Powder	Citrus Aurantium Sinensis Powder is the powder obtained the dried ground plant, *Citrus aurantium sinensis.*	Exfoliants
Citrus Aurantium Tachibana Peel Extract	Citrus Aurantium Tachibana Peel Extract is the extract of the peel of *Citrus aurantium tachibana.*	Skin-Conditioning Agents - Humectant
Citrus Clementina Fruit Extract	Citrus Clementina Fruit Extract is the extract of the fruit of *Citrus clementina.*	Skin-Conditioning Agents - Miscellaneous
Citrus Clementina Juice	Citrus Clementina Juice is the juice expressed from the pulp of *Citrus clementina*.	Skin-Conditioning Agents - Miscellaneous
Citrus Clementina Peel Oil	Citrus Clementina Peel Oil is the volatile oil obtained from the peel of *Citrus clementina*.	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Depressa Fruit Extract	Citrus Depressa Fruit Extract is the extract of the fruit of *Citrus depressa*.	Skin-Conditioning Agents - Miscellaneous
Citrus Depressa Fruit Water	Citrus Depressa Fruit Water is an aqueous solution of the steam distillate obtained from the fruit of *Citrus depressa.*	Skin-Conditioning Agents - Humectant
Citrus Depressa Peel Extract	Citrus Depressa Peel Extract is the extract of the peel of *Citrus depressa*.	Skin-Conditioning Agents - Humectant
Citrus Depressa Peel Powder	Citrus Depressa Peel Powder is the powder obtained from the dried, ground peel of *Citrus depressa.*	Skin-Conditioning Agents - Miscellaneous
Citrus Glauca Fruit Extract CAS No. 1174331-62-4	Citrus Glauca Fruit Extract is the extract of the fruit of *Citrus glauca.*	Antistatic Agents; Hair Conditioning Agents; Skin-Conditioning Agents - Humectant
Citrus Grandis (Grapefruit)	Citrus Grandis (Grapefruit) is a plant material derived from the whole plant, *Citrus grandis.*	Not reported
Citrus Grandis (Grapefruit) Extract	Citrus Grandis (Grapefruit) Extract is the extract of the whole plant, *Citrus grandis.*	Skin-Conditioning Agents - Miscellaneous
Citrus Grandis (Grapefruit) Fruit Extract	Citrus Grandis (Grapefruit) Fruit Extract is the extract of the fruit of *Citrus grandis.*	Preservatives; Skin-Conditioning Agents - Miscellaneous
Citrus Grandis (Grapefruit) Fruit Water	Citrus Grandis (Grapefruit) Fruit Water is an aqueous solution of the steam distillate obtained from the fruit of *Citrus grandis.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Grandis (Grapefruit) Juice	Citrus Grandis (Grapefruit) Juice is the liquid expressed from the fresh pulp of the grapefruit, *Citrus grandis.*	Skin-Conditioning Agents - Miscellaneous
Citrus Grandis (Grapefruit) Leaf Extract	Citrus Grandis (Grapefruit) Leaf Extract is the extract of the leaves of *Citrus grandis.*	Skin-Conditioning Agents - Miscellaneous
Citrus Grandis (Grapefruit) Peel	Citrus Grandis (Grapefruit) Peel is the peel of *Citrus grandis.*	Skin-Conditioning Agents - Miscellaneous
Citrus Grandis (Grapefruit) Peel Extract	Citrus Grandis (Grapefruit) Peel Extract is the extract of the peel of *Citrus grandis.*	Skin-Conditioning Agents - Miscellaneous
Citrus Grandis (Grapefruit) Peel Oil CAS No. 8016-20-4	Citrus Grandis (Grapefruit) Peel Oil is the volatile oil obtained from the peel of the grapefruit, *Citrus grandis.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Grandis (Grapefruit) Peel Powder	Citrus Grandis (Grapefruit) Peel Powder is the powder obtained from the dried, ground peel of *Citrus grandis.*	Absorbents
Citrus Grandis (Grapefruit) Seed Extract	Citrus Grandis (Grapefruit) Seed Extract is the extract of the seeds of *Citrus grandis.*	Preservatives
Citrus Grandis (Grapefruit) Seed Oil*	Citrus Grandis (Grapefruit) Seed Oil is the oil expressed from the seeds of *Citrus grandis.*	Skin-Conditioning Agents - Emollient
Citrus Grandis (Grapefruit) Seed Oil Unsaponifiables*	Citrus Grandis (Grapefruit) Seed Oil Unsaponifiables is the fraction of grapefruit seed oil which is not saponified in the refining recovery of grapefruit seed oil fatty acids.	Hair Conditioning Agents; Skin-Conditioning Agents - Miscellaneous
Citrus Grandis/Paradisi Fruit Water	Citrus Grandis/Paradisi Fruit Water is an aqueous solution of the steam distillate obtained from the fruit of the hybrid of *Citrus paradisi* and *Citrus grandis.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Grandis Peel/Seed Extract	Citrus Grandis Peel/Seed Extract is the extract of the peel and seeds of *Citrus grandis.*	Antifungal Agents; Antimicrobial Agents; Preservatives
Citrus Hassaku Fruit Extract	Citrus Hassaku Fruit Extract is the extract of the fruit of *Citrus hassaku.*	Skin-Conditioning Agents - Humectant
Citrus Hassaku/Natsudaidai Fruit Juice	Citrus Hassaku/Natsudaidai Fruit Juice is the juice expressed from the fruit of a hybrid of *Citrus hassaku* and *Citrus natsudaidai.*	Skin-Conditioning Agents - Humectant
Citrus Hassaku/Natsudaidai Fruit Powder	Citrus Hassaku/Natsudaidai Fruit Powder is the powder obtained from the dried, ground fruit of a hybrid of *Citrus hassaku* and *Citrus natsudaidai*.	Skin-Conditioning Agents - Emollient
Citrus Hassaku/Natsudaidai Peel Powder	Citrus Hassaku/Natsudaidai Peel Powder is the powder obtained from the dried, ground peel of a hybrid of *Citrus hassaku* and *Citrus natsudaidai*.	Flavoring Agents

Table 1. Definitions and functions of Citrus-derived ingredients [2]

Ingredient	Definition	Function
Citrus Hystrix Leaf Extract	Citrus Hystrix Leaf Extract is the extract of the leaves of *Citrus hystrix.*	Skin-Conditioning Agents - Miscellaneous
Citrus Iyo Fruit Extract	Citrus Iyo Fruit Extract is the extract of the fruit of *Citrus iyo.*	Skin-Conditioning Agents - Emollient; Skin-Conditioning Agents - Humectant
Citrus Iyo Oil	Citrus Iyo Oil is the oil expressed from the whole plant, *Citrus iyo*.	Skin-Conditioning Agents - Emollient
Citrus Iyo Peel Extract	Citrus Iyo Peel Extract is the extract of the peel of *Citrus iyo.*	Skin-Conditioning Agents - Humectant
Citrus Iyo Peel Oil	Citrus Iyo Peel Oil is the volatile oil obtained from the peel of *Citrus iyo.*	Skin-Conditioning Agents - Emollient
Citrus Iyo Peel Water	Citrus Iyo Peel Water is an aqueous solution of the steam distillate obtained from the peel of *Citrus iyo.*	Skin-Conditioning Agents - Humectant
Citrus Jabara Juice	Citrus Jabara Juice is the liquid expressed from the fruit of *Citrus jabara.*	Skin-Conditioning Agents - Miscellaneous
Citrus Jabara Peel Extract	Citrus Jabara Peel Extract is the extract of the peel of *Citrus jabara.*	Skin-Conditioning Agents - Miscellaneous
Citrus Jabara Peel Powder	Citrus Jabara Peel Powder is the powder obtained from the dried, ground peels of *Citrus jabara.*	Fragrance Ingredients
Citrus Jabara Peel Water	Citrus Jabara Peel Water is an aqueous solution of the steam distillate obtained from the peel of *Citrus jabara*.	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Jabara Pericarp Extract	Citrus Jabara Pericarp Extract is the extract of the pericarp of *Citrus jabara.*	Humectants; Skin-Conditioning Agents - Miscellaneous
Citrus Japonica Fruit Extract	Citrus Japonica Fruit Extract is the extract obtained from the fruit of *Citrus japonica.*	Skin-Conditioning Agents - Miscellaneous
Citrus Junos Extract	Citrus Junos Extract is the extract of the whole plant, *Citrus junos.*	Antioxidants
Citrus Junos Fruit Extract	Citrus Junos Fruit Extract is the extract of the fruit of *Citrus junos.*	Skin-Conditioning Agents - Miscellaneous
Citrus Junos Fruit Juice	Citrus Junos Fruit Juice is the juice expressed from the fruit of *Citrus junos.*	Skin-Conditioning Agents - Humectant
Citrus Junos Fruit Oil	Citrus Junos Fruit Oil is the volatile oil obtained from the fruit of *Citrus junos.*	Fragrance Ingredients
Citrus Junos Fruit Powder	Citrus Junos Fruit Powder is the powder obtained from the dried, ground fruit of *Citrus junos.*	Exfoliants
Citrus Junos Fruit Water	Citrus Junos Fruit Water is the aqueous solution of the steam distillates obtained the fruit of *Citrus junos.*	Fragrance Ingredients
Citrus Junos Peel Extract	Citrus Junos Peel Extract is the extract of the peel of *Citrus junos.*	Skin-Conditioning Agents - Miscellaneous
Citrus Junos Peel Oil	Citrus Junos Peel Oil is the volatile oil obtained from the peel of *Citrus junos.*	Cosmetic Astringents
Citrus Junos Peel Powder	Citrus Junos Peel Powder is the dried, ground powder obtained from the peels of *Citrus junos.*	Fragrance Ingredients
Citrus Junos Peel Water	Citrus Junos Peel Water is an aqueous solution of the steam distillate obtained from the peel of *Citrus junos.*	Skin-Conditioning Agents - Miscellaneous
Citrus Junos Seed Extract	Citrus Junos Seed Extract is the extract of the seeds of *Citrus junos.*	Antioxidants
Citrus Junos Seed Oil	Citrus Junos Seed Oil is the oil expressed from the seeds of *Citrus junos.*	Skin-Conditioning Agents - Emollient
Citrus Limon (Lemon) Flower/Leaf/Stem Extract CAS No. 84929-31-7; 85085-28-5	Citrus Limon (Lemon) Flower/Leaf/Stem Extract is the extract of the flowers, leaves and stems of *Citrus limon.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Limon (Lemon) Flower/Leaf/Stem Oil CAS No. 84929-31-7; 85085-28-5	Citrus Limon (Lemon) Flower/Leaf/Stem Oil is the volatile oil obtained from the flowers, leaves and stems of *Citrus limon.*	Fragrance Ingredients
Citrus Limon (Lemon) Fruit Extract CAS No. 84929-31-7; 85085-28-5	Citrus Limon (Lemon) Fruit Extract is the extract of the fruit of *Citrus limon.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous; Skin-Conditioning Agents - Occlusive
Citrus Limon (Lemon) Fruit Oil	Citrus Limon (Lemon) Fruit Oil is the volatile oil obtained from the fruit of *Citrus limon.*	Cosmetic Astringents
Citrus Limon (Lemon) Fruit Powder	Citrus Limon (Lemon) Fruit Powder is the powder obtained from the dried fruit of *Citrus limon.*	Skin-Conditioning Agents - Miscellaneous
Citrus Limon (Lemon) Fruit Water	Citrus Limon (Lemon) Fruit Water is an aqueous solution of the steam distillate obtained from the fruit of *Citrus limon.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Limon (Lemon) Juice CAS No. 84929-31-7; 85085-28-5	Citrus Limon (Lemon) Juice is the liquid expressed from the fresh pulp of the lemon, *Citrus limon.*	Skin-Conditioning Agents - Miscellaneous
Citrus Limon (Lemon) Juice Extract CAS No. 84929-31-7; 85085-28-5	Citrus Limon (Lemon) Juice Extract is the extract of the juice of *Citrus limon.*	Skin-Conditioning Agents - Miscellaneous
Citrus Limon (Lemon) Juice Powder CAS No. 84929-31-7; 85085-28-5	Citrus Limon (Lemon) Juice Powder is the powder obtained from the dried juice of *Citrus limon.*	Skin-Conditioning Agents - Miscellaneous

Table 1. Definitions and functions of Citrus-derived ingredients [2]

Ingredient	Definition	Function
Citrus Limon (Lemon) Leaf Extract	Citrus Limon (Lemon) Leaf Extract is the extract of the leaves of *Citrus limon*.	Antioxidants
Citrus Limon (Lemon) Leaf Oil CAS No. 84929-31-7; 85085-28-5	Citrus Limon (Lemon) Leaf Oil is the volatile oil obtained from the leaves of *Citrus limon.*	Fragrance Ingredients
Citrus Limon (Lemon) Leaf/Peel/Stem Oil CAS No. 84929-31-7; 85085-28-5	Citrus Limon (Lemon) Leaf/Peel/Stem Oil is the volatile oil obtained from the leaves, peels, and stems of *Citrus limon.*	Skin-Conditioning Agents - Miscellaneous
Citrus Limon (Lemon) Peel CAS No. 84929-31-7; 85085-28-5; 92346-89-9	Citrus Limon (Lemon) Peel is the peel of *Citrus limon.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Limon (Lemon) Peel Extract CAS No. 84929-31-7; 85085-28-5	Citrus Limon (Lemon) Peel Extract is the extract of the peel of *Citrus limon.*	Skin Protectants; Skin-Conditioning Agents - Emollient
Citrus Limon (Lemon) Peel Oil CAS No. 8008-56-8; 8020-19-7; 84929-31-7; 85085-28-5	Citrus Limon (Lemon) Peel Oil is the volatile oil obtained from the peel of *Citrus limon.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Limon (Lemon) Peel Powder CAS No. 84929-31-7; 85085-28-5	Citrus Limon (Lemon) Peel Powder is the powder obtained from the dried, ground peel of *Citrus limon.*	Absorbents
Citrus Limon (Lemon) Peel Water 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 *Citrus limon.*	Skin-Conditioning Agents - Miscellaneous
Citrus Limon (Lemon) Peel Wax CAS No. 84929-31-7; 85085-28-5	Citrus Limon (Lemon) Peel Wax is the wax obtained from the peel of *Citrus limon.*	Skin-Conditioning Agents - Occlusive
Citrus Limon (Lemon) Seed Oil* CAS No. 84929-31-7; 85085-28-5	Citrus Limon (Lemon) Seed Oil is the oil expressed from the seeds of *Citrus limon.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Madurensis Fruit Extract	Citrus Madurensis Fruit Extract is the extract of the fruit of *Citrus madurensis.*	Hair Conditioning Agents; Skin-Conditioning Agents - Miscellaneous
Citrus Madurensis Fruit Juice	Citrus Madurensis Fruit Juice is the juice expressed from the fruit of *Citrus madurensis*.	Flavoring Agents
Citrus Medica Vulgaris Fruit Extract CAS No. 92346-90-2	Citrus Medica Vulgaris Fruit Extract is the extract of the fruit of *Citrus medica vulgaris.*	Antioxidants; Chelating Agents
Citrus Medica Vulgaris Peel Oil	Citrus Medica Vulgaris Peel Oil is the volatile oil obtained from the peel of *Citrus medica vulgaris.*	Fragrance Ingredients
Citrus Natsudaidai Flower Water	Citrus Natsudaidai Flower Water is the aqueous solution of the steam distillates obtained from the flowers of *Citrus natsudaidai.*	Fragrance Ingredients
Citrus Natsudaidai Peel Extract	Citrus Natsudaidai Peel Extract is the extract of the peel of *Citrus natsudaidai*.	Skin-Conditioning Agents - Humectant
Citrus Nobilis (Mandarin Orange)	Citrus Nobilis (Mandarin Orange) is a plant material derived from the whole plant, *Citrus nobilis.*	Not reported
Citrus Nobilis (Mandarin Orange) Fruit Extract	Citrus Nobilis (Mandarin Orange) Fruit Extract is the extract of the fruit of *Citrus nobilis.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Nobilis (Mandarin Orange) Fruit Juice	Citrus Nobilis (Mandarin Orange) Fruit Juice is the liquid expressed from the fruit of the mandarin orange, *Citrus nobilis.*	Bath Soaps and Detergents
Citrus Nobilis (Mandarin Orange) Oil	Citrus Nobilis (Mandarin Orange) Oil is the volatile oil obtained from the whole plant, *Citrus nobilis.*	Fragrance Ingredients
Citrus Nobilis (Mandarin Orange) Peel Extract CAS No. 90063-83-5	Citrus Nobilis (Mandarin Orange) Peel Extract is the extract of the peel of *Citrus nobilis.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Nobilis (Mandarin Orange) Peel Oil 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, *Citrus nobilis.*	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 *Citrus nobilis.*	Abrasives
Citrus Nobilis (Mandarin Orange) Water	Citrus Nobilis (Mandarin Orange) Water is an aqueous solution of the steam distillate obtained from *Citrus nobilis.*	Skin-Conditioning Agents - Miscellaneous
Citrus Paradisi (Grapefruit) Fruit Extract CAS No. 90045-43-5 (generic)	Citrus Paradisi (Grapefruit) Fruit Extract is the extract of the fruit of *Citrus paradisi*.	Skin-Conditioning Agents - Miscellaneous
Citrus Paradisi (Grapefruit) Fruit Water CAS No. 90045-43-5 (generic)	Citrus Paradisi (Grapefruit) Fruit Water is an aqueous solution of the steam distillate obtained from the fruit of *Citrus paradisi.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Paradisi (Grapefruit) Juice CAS No. 90045-43-5 (generic)	Citrus Paradisi (Grapefruit) Juice is the liquid expressed from the fresh pulp of the grapefruit *Citrus paradisi.*	Skin-Conditioning Agents - Miscellaneous
Citrus Paradisi (Grapefruit) Peel Extract CAS No. 90045-43-5 (generic)	Citrus Paradisi (Grapefruit) Peel Extract is the extract obtained from the peel of *Citrus paradisi*.	Skin-Conditioning Agents - Miscellaneous
Citrus Paradisi (Grapefruit) Peel Oil CAS No. 90045-43-5 (generic)	Citrus Paradisi (Grapefruit) Peel Oil is the volatile oil obtained from the peel of *Citrus paradisi*.	Fragrance Ingredients
Citrus Paradisi (Grapefruit) Seed Extract CAS No. 90045-43-5 (generic)	Citrus Paradisi (Grapefruit) Seed Extract is the extract of the seeds of *Citrus paradisi*.	Skin-Conditioning Agents - Miscellaneous
Citrus Paradisi (Grapefruit) Seed Oil* CAS No. 90045-43-5 (generic)	Citrus Paradisi (Grapefruit) Seed Oil is the oil expressed from the seeds of *Citrus paradisi.*	Moisturizing Preparations

Table 1. Definitions and functions of Citrus-derived ingredients [2]

Ingredient	Definition	Function
Citrus Reticulata (Tangerine) Extract	Citrus Reticulata (Tangerine) Extract is the extract of the whole plant, *Citrus reticulata.*	Skin-Conditioning Agents - Miscellaneous
Citrus Reticulata (Tangerine) Fruit	Citrus Reticulata (Tangerine) Fruit is the fruit of *Citrus reticulata.*	Skin-Conditioning Agents - Miscellaneous
Citrus Reticulata (Tangerine) Fruit Extract	Citrus Reticulata (Tangerine) Fruit Extract is the extract of the fruit of *Citrus reticulata.*	Drug Astringents - Skin Protectant Drugs
Citrus Reticulata (Tangerine) Fruit Water	Citrus Reticulata (Tangerine) Fruit Water is the aqueous solution of the steam distillates obtained from the fruit of *Citrus reticulata.*	Fragrance Ingredients
Citrus Reticulata (Tangerine) Leaf Oil CAS No. 8014-17-3	Citrus Reticulata (Tangerine) Leaf Oil is the volatile oil derived from the leaves of *Citrus reticulata*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Reticulata (Tangerine) Leaf Water	Citrus Reticulata (Tangerine) Leaf Water is an aqueous solution of the steam distillate obtained from the leaves of *Citrus reticulata.*	Skin-Conditioning Agents - Miscellaneous
Citrus Reticulata (Tangerine) Peel Extract	Citrus Reticulata (Tangerine) Peel Extract is the extract of the peel of *Citrus reticulata.*	Skin-Conditioning Agents - Miscellaneous
Citrus Reticulata (Tangerine) Peel Oil CAS No. 8008-31-9	Citrus Reticulata (Tangerine) Peel Oil is the volatile oil obtained from the peel of *Citrus reticulata.*	Deodorant Agents; Flavoring Agents; Fragrance Ingredients
Citrus Reticulata (Tangerine) Peel Powder	Citrus Reticulata (Tangerine) Peel Powder is the powder obtained from the dried, ground peel of *Citrus reticulata.*	Skin-Conditioning Agents - Miscellaneous
Citrus Shunkokan Fruit Extract	Citrus Shunkokan Fruit Extract is the extract of the fruit of *Citrus shunkokan.*	Antioxidants
Citrus Shunkokan Peel Extract	Citrus Shunkokan Peel Extract is the extract of the peel of *Citrus shunkokan.*	Antioxidants
Citrus Sinensis (Orange) Fruit Extract	Citrus Sinensis (Orange) Fruit Extract is the extract of the fruit of *Citrus sinensis.*	Antioxidants; Skin-Conditioning Agents - Miscellaneous
Citrus Sinensis (Orange) Fruit Water	Citrus Sinensis (Orange) Fruit Water is an aqueous solution of the steam distillate obtained from the fruit of *Citrus sinensis.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Sphaerocarpa Fruit Juice	Citrus Sphaerocarpa Fruit Juice is the juice expressed from the fruit of *Citrus sphaerocarpa.*	Skin-Conditioning Agents - Miscellaneous
Citrus Sudachi Fruit Extract	Citrus Sudachi Fruit Extract is the extract of the fruit of *Citrus sudachi.*	Skin-Conditioning Agents - Humectant
Citrus Sudachi Fruit Juice	Citrus Sudachi Fruit Juice is the juice expressed from the fruit of *Citrus sudachi.*	Skin-Conditioning Agents - Humectant
Citrus Sunki Peel Extract	Citrus Sunki Peel Extract is the extract of the peel of *Citrus sunki.*	Humectants; Skin Protectants; Skin-Conditioning Agents - Humectant
Citrus Tachibana/Reticulata Fruit Juice	Citrus Tachibana/Reticulata Fruit Juice is the juice expressed from the fruit of a hybrid of *Citrus tachbana* and *Citrus reticulata.*	Flavoring Agents; Skin-Conditioning Agents - Miscellaneous
Citrus Tachibana/Reticulata Peel Oil	Citrus Tachibana/Reticulata Peel Oil is the volatile oil obtained from the peel of the hybrid of *Citrus tachibana* and *Citrus reticulata.*	Skin-Conditioning Agents - Emollient
Citrus Tachibana/Reticulata Peel Powder	Citrus Tachibana/Reticulata Peel Powder is the powder obtained from the finely ground peel of a hybrid of *Citrus tachibana* and *Citrus reticulata.*	Skin-Conditioning Agents - Miscellaneous
Citrus Tamurana Flower Extract	Citrus Tamurana Flower Extract is the extract of the flowers of *Citrus tamurana.*	Skin-Conditioning Agents - Miscellaneous
Citrus Tamurana Fruit Extract	Citrus Tamurana Fruit Extract is the extract of the fruit of *Citrus tamurana.*	Skin-Conditioning Agents - Humectant
Citrus Tangelo Fruit Juice	Citrus Tangelo Fruit Juice is the juice expressed from the fruit of *Citrus tangelo.*	Skin-Conditioning Agents - Humectant
Citrus Tangelo Fruit Powder	Citrus Tangelo Fruit Powder is the powder obtained from the dried, ground fruit, *Citrus tangelo.*	Skin-Conditioning Agents - Emollient
Citrus Tangelo Peel Powder	Citrus Tangelo Peel Powder is the powder obtained from the dried, ground peel of *Citrus tangelo.*	Flavoring Agents
Citrus Tangerina (Tangerine) Extract	Citrus Tangerina (Tangerine) Extract is the extract of the tangerine, *Citrus tangerina*.	Skin-Conditioning Agents - Miscellaneous
Citrus Tangerina (Tangerine) Fruit	Citrus Tangerina (Tangerine) Fruit is the fruit of *Citrus tangerina*.	Not reported
Citrus Tangerina (Tangerine) Fruit Water	Citrus Tangerina (Tangerine) Fruit Water is an aqueous solution of the steam distillate obtained from the fruit of *Citrus tangerina.*	Skin-Conditioning Agents - Miscellaneous
Citrus Tangerina (Tangerine) Peel	Citrus Tangerina (Tangerine) Peel is the peel of the tangerine, *Citrus tangerina.*	Abrasives
Citrus Tangerina (Tangerine) Peel Extract	Citrus Tangerina (Tangerine) Peel Extract is the extract of the peel of *Citrus tangerina.*	Cosmetic Astringents
Citrus Tangerina (Tangerine) Peel Oil	Citrus Tangerina (Tangerine) Peel Oil is the volatile oil obtained from the peel of *Citrus tangerina.*	Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Tankan Fruit Extract	Citrus Tankan Fruit Extract is the extract of the fruit of *Citrus tankan.*	Skin-Conditioning Agents - Humectant
Citrus Tankan Fruit Water	Citrus Tankan Fruit Water is the aqueous solution of the steam distillates obtained from the fruit of *Citrus tankan.*	Humectants

Table 1. Definitions and functions of Citrus-derived ingredients [2]

Ingredient	Definition	Function
Citrus Unshiu/Citrus Reticulata/Citrus Iyo Fruit Water	Citrus Unshiu/Citrus Reticulata/Citrus Iyo Fruit Water is the aqueous solution of the steam distillates obtained from the fruit of *Citrus unshiu*, *Citrus reticulata* and *Citrus Iyo.*	Fragrance Ingredients
Citrus Unshiu Extract CAS No. 98106-71-9	Citrus Unshiu Extract is the extract of the whole plant, *Citrus unshiu.*	Skin-Conditioning Agents - Miscellaneous
Citrus Unshiu Flower Powder	Citrus Unshiu Flower Powder is the powder obtained from the dried, ground flowers of *Citrus unshiu*.	Exfoliants
Citrus Unshiu Flower Water	Citrus Unshiu Flower Water is an aqueous solution of the steam distillates obtained from the flowers of *Citrus unshiu.*	Fragrance Ingredients
Citrus Unshiu Fruit Extract	Citrus Unshiu Fruit Extract is the extract of the fruit of *Citrus unshiu.*	Antioxidants; Hair Conditioning Agents; Skin Protectants; Skin-Conditioning Agents - Emollient; Sunscreen Agents
Citrus Unshiu Fruit Juice	Citrus Unshiu Fruit Juice is the juice expressed from the fruit of *Citrus unshiu.*	Skin-Conditioning Agents - Humectant
Citrus Unshiu Fruit Oil	Citrus Unshiu Fruit Oil is the volatile oil derived from the fruit of *Citrus unshiu.*	Skin-Conditioning Agents - Emollient
Citrus Unshiu Fruit Powder	Citrus Unshiu Fruit Powder is the powder obtained from the dried, ground fruit of *Citrus unshiu*.	Antioxidants; Exfoliants; Fragrance Ingredients; Skin-Conditioning Agents - Miscellaneous
Citrus Unshiu Fruit Water	Citrus Unshiu Fruit Water is the aqueous solution of the steam distillates obtained from the fruit of *Citrus unshiu.*	Hair Conditioning Agents; Skin-Conditioning Agents - Miscellaneous
Citrus Unshiu Peel Extract	Citrus Unshiu Peel Extract is the extract of the peel of *Citrus unshiu.*	Skin-Conditioning Agents - Miscellaneous
Citrus Unshiu Peel Powder	Citrus Unshiu Peel Powder is the powder of the dried, ground peel of *Citrus unshiu.*	Fragrance Ingredients
Citrus Unshiu Peel Water	Citrus Unshiu Peel Water is the aqueous solution of the steam distillates obtained from the peel of *Citrus unshiu.*	Skin Protectants
Citrus Unshiu Pericarp Extract	Citrus Unshiu Pericarp Extract is the extract of the pericarp of *Citrus unshiu.*	Skin-Conditioning Agents - Miscellaneous
Citrus Unshiu/Sinensis/Reticulata Fruit Extract	Citrus Unshiu/Sinensis/Reticulata Fruit Extract is the extract of the fruit of *Citrus unshiu*, *Citrus sinensis*, and *Citrus reticulata.*	Skin-Conditioning Agents - Miscellaneous
Microcitrus Australasica Fruit Extract	Microcitrus Australasica Fruit Extract is the extract of the fruit of *Microcitrus australasica.*	Skin-Conditioning Agents - Miscellaneous
Microcitrus Australis Fruit Extract	Microcitrus Australis Fruit Extract is the extract of the fruit of *Microcitrus Australis*.	Skin-Conditioning Agents - Miscellaneous

*Previously reviewed by CIR.[1]

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

Citrus Aurantifolia (Lime) Leaf Oil
Citrus Aurantifolia (Lime) Peel Oil
Citrus Aurantifolia (Lime) Peel Water
Citrus Aurantium Bergamia (Bergamot) Fruit Oil
Citrus Aurantium Bergamia (Bergamot) Peel Oil
Citrus Aurantium Currassuviensis Peel Oil
Citrus Aurantium Dulcis (Orange) Flower Water
Citrus Aurantium Dulcis (Orange) Oil
Citrus Jabara Peel Powder
Citrus Junos Fruit Oil
Citrus Junos Fruit Water
Citrus Junos Peel Powder
Citrus Limon (Lemon) Flower/Leaf/Stem Oil
Citrus Limon (Lemon) Leaf Oil
Citrus Medica Vulgaris Peel Oil
Citrus Natsudaidai Flower Water
Citrus Nobilis (Mandarin Orange) Oil
Citrus Paradisi (Grapefruit) Peel Oil
Citrus Reticulata (Tangerine) Fruit Water
Citrus Unshiu/Citrus Reticulata/Citrus Iyo Fruit Water
Citrus Unshiu Flower Water
Citrus Unshiu Peel Powder

Table 3. Physical and chemical properties of Citrus-derived ingredients

Property	Description	Reference
	Bergamot Oil (Cold-Pressed)	
Color	green to yellow-green or yellow-brown	3
Odor	fragrant, sweet-fruity	3
optical rotation/angular rotation	+12º to +30º	3
Solubility	miscible with alcohol and glacial acetic acid; soluble in most fixed oils; insoluble in glycerin and propylene glycol	3
solubility in alcohol	1 ml of sample dissolves in 2 ml of 90% alcohol	3
Esters	no less than 36.0% of esters, calculated as linalyl acetate	3
refractive index	1.465-1.468 at 20º C	3
residue of evaporation	no more than 6.0%	3
specific gravity	0.871-0.879	3
UV absorbance	max. at 315 nm; no less than 0.32	3
	Bitter Orange Oil (Cold-Pressed)	
Color	pale yellow or yellow-brown	3
Odor	characteristic aromatic odor of the Seville orange	3
optical rotation/angular rotation	+88º to +98º	3
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	3
Aldehydes	no less than 0.5% and no more than 1.0% of aldehydes, calculated as decyl aldehyde	3
refractive index	1.472-1.476 at 20º C	3
residue of evaporation	2.0-5.0%	3
specific gravity	0.845-0.851	3
	Grapefruit Oil (Cold-Pressed)	
Color	yellow, sometimes red	3
optical rotation/angular rotation	+91º to +96º	3
Solubility	soluble in most fixed oils and mineral oil with opalescence or cloudiness; slightly soluble in propylene glycol; insoluble in glycerin	3
refractive index	1.475-1.478 at 20º C	3
residue of evaporation	5.0% -10.0%	3
specific gravity	0.848-0.856	3
	Citrus Aurantifolia (Lime) Oil	
Color	colorless to greenish yellow	4
Odor	fresh citrus, intense	4
optical rotation	+34º to +47º	4
Solubility	insoluble in water, soluble in ethanol and propylene glycol	4
refractive index	1.4477-1.4745	4
specific gravity	0.855-0.863	4
	Lime Oil (Distilled)	
Color	colorless to greenish yellow	3
Odor	mild citrus, floral	3
optical rotation/angular rotation	+34º to +47º	3
Solubility	soluble in most fixed oils and mineral oil; insoluble in glycerin and propylene glycol	3
solubility in alcohol	1 ml sample dissolves in 5 ml of 90% alcohol	3
Aldehydes	between 0.5% and 2.5% of aldehydes, calculated as citral	3
refractive index	1.474 – 1.477 at 20 ºC	3
specific gravity	0.855-0.863	3
	Lime Oil (Cold-Pressed)	
Color	yellow to brown green to green	3
Odor	fresh lime peel	3
optical rotation/angular rotation	Mexican type: +35º to +41º; Tahitian type: +38º to +53º	3
Solubility	soluble in most fixed oils and mineral oil; insoluble in glycerin and propylene glycol	3
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	3
refractive index	Mexican type: 1.482-1.486; Tahitian type: 1.476-1.486	3
residue of evaporation	Mexican type: 10.0% to 14.5%; Tahitian type: 5.0% to 12.0%	3
specific gravity	Mexican type: 0.872-0.881; Tahitian type: 0.858-0.876	3
UV absorbance	max. at 315 nm; Mexican type: no less than 0.45; Tahitian type: no less than 0.24	3
	Citrus Limon (Lemon) Oil	
Color	pale to deep yellow or greenish yellow	4
Odor	fresh citrus, intense	4
optical rotation	+57 to +65.6	4
Solubility	insoluble in water, soluble in ethanol and propylene glycol	4
refractive index	1.474-1.467	4
specific gravity	0.849-0.855	4
	Lemon Oil (Distilled)	

Table 3. Physical and chemical properties of Citrus-derived ingredients

Property	Description	Reference
Color	colorless to pale yellow	3
Odor	fresh lemon peel	3
optical rotation/angular rotation	+55º to +75º	3
Solubility	soluble in most fixed oil, mineral oil, and alcohol (with haze); insoluble in glycerin and propylene glycol	3
solubility in alcohol	1 ml sample dissolves in 5 ml of 90% alcohol	3
Aldehydes	between 1.0% and 3.5% of aldehydes, calculated as citral	3
refractive index	1.470 – 1.475 at 20 ºC	3
specific gravity	0.842-0.856	3
UV absorbance	max. at 315 nm, no less than 0.01	3
Lemon Oil (Cold-Pressed)		
Color	pale to deep yellow or green-yellow	3
Odor	fresh lemon peel	3
optical rotation/angular rotation	California and Italian types: +57º to +65.6º; Desert type: +67º to +78º	3
Solubility	miscible with dehydrated alcohol and glacial acetic acid	3
solubility in alcohol	1 ml of sample dissolves in 3 ml of 95% alcohol, slight haze possible	3
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	3
refractive index	1.473-1.476 at 20 ºC	3
residue of evaporation	between 5.0% to 14.5%	3
specific gravity	Desert type: 0.846-0.851; California and Italian types: 0.849-0.855	3
UV absorbance	max. at 315 nm; Desert and California types: no less than 0.2; Italian type: no less than 0.49	3
Citrus Aurantium Dulcis (Orange) Peel Wax		
Color	light reddish-brown to orange	8
Odor	mild to very low characteristic	8
Appearance	semi-solid	8
molecular weight	> 400	6
melting point	45-57 ºC refined; 35-50 ºC deodorized	8
congealing point	45-55 ºC refined; 30-45 ºC deodorized	8
acid value	8-20 refined; 10-20 deodorized	8
saponification value	70-110 refined and deodorized	8
hydroxyl value	20-50 refined; 10-40 deodorized	8
log P	> 3.5	6
UV absorbance	210-240 nm	8
Orange Oil (Distilled)		
Color	colorless to pale yellow	3
Odor	mild citrus floral	3
optical rotation/angular rotation	+94º to +99º	3
Solubility	soluble in most fixed oil, mineral oil, and alcohol (with haze); insoluble in glycerin and propylene glycol	3
solubility in alcohol	1 ml sample dissolves in 5 ml of 90% alcohol	3
refractive index	1.471 – 1.474 at 20 ºC	3
specific gravity	0.840-0.844	3
UV absorbance	max. at 330 nm, no less than 0.01	3
Orange Oil (Cold-Pressed)		
Color	intensely yellow, orange, or deep orange	3
Odor	characteristic of fresh, sweet orange peel	3
optical rotation/angular rotation	+94º to +99º	3
Solubility	miscible with dehydrated alcohol and carbon disulfide; soluble in glacial acetic acid	3
Aldehydes	no less than 1.2% and no more than 2.5% of aldehydes, calculated as decyl aldehyde	3
refractive index	1.472-1.474 at 20 ºC	3
specific gravity	0.842-0.846	3
UV absorbance	max. at 330 nm; California type: no less than 0.130; Florida type: no less than 0.240	3
Bitter Orange or Citrus Reticulata (Tangerine) Leaf Oil (described as "petitgrain bigarade oil")		
physical state and appearance	pale-yellow to amber liquid	25
Odor	fresh-floral, sweet	25
Citrus Reticulata Peel Oil		
physical state and appearance	clear, mobile, dark-orange to reddish-orange or brownish-orange liquid	5
Odor	orange-like	5
optical rotation	+63° to +78°	5
refractive index	1.4730-1.4770 (20°C)	5
specific gravity	0.847-0.853 (25/25°C)	5

Table 3. Physical and chemical properties of Citrus-derived ingredients

Property	Description	Reference
	Tangerine Oil (Cold-Pressed)	
Color	red-orange to brown-orange	[3]
Odor	pleasant, orange	[3]
optical rotation/angular rotation	+88º to +96º	[3]
Solubility	soluble in most fixed oils and mineral oil; slightly soluble in propylene glycol; relatively insoluble in glycerin	[3]
Aldehydes	0.8% to 1.9% of aldehydes, calculated as decyl aldehyde	[3]
refractive index	1.473-1.476 at 20 ºC	[3]
residue of evaporation	2.3% - 5.8%	[3]
specific gravity	0.844-0.854	[3]

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
(+)-6-iso-propenyl-4,8-alpha-dimethyl-4-alpha-(r)-5,6-(r)-7,8,8-alpha(r)-hexahydro-2-(1H)napthalenone	-		FR: NS		
(+)-8,9-didehydro-alpha-vetivone	-		FR: NS		
(+)-8,9-didehydro-nootkatone	-		FR: NS		
(+)-alpha-cyperone	-		FR: NS		
(+)-alpha-vetivone	-		FR: NS		
(+)-auraptenal	-		-		P: NS
(+)-nootkatone	-		P: NS		
1,4-cineole	-	FR: 180	-	-	-
1,8-cineole	LEO: 11,00-70,000	FR: 70	-	-	-
1,10-dihydro-alpha-vetivone	-		FR: NS		
10-epi-alpha-cyperone	-		FR:NS		
2-H-1:8(3-beta-d-glucopyranosyl-oxy-2-hydroxy-3-methyl-butyl)-7-methoxy-benzopyran-2-one	-		P: NS		
2,2-dimethyl-5(-1)-methyl-1-propenyl)tetra-hydrofuran	-	P: 30	-	-	-
2,4-trans, trans-o-feruloyl-glucaric acid	-		-	Peri: NS	
2-methyl-1-propanol	-		-	FR: 0.07	
2-trans-o-feruloyl-glucaric-acid	-		-	Peri: NS	
24-methylene-cycloartenol	-		Peri: NS		
24-methylene-lophenol	-		Peri: NS		
2,6,6-trimethyl-2-vinyl-tetrahydropyran	-	FR: 16	-	-	-
2”-o-xylosyl-vitexin	FL: NS		-		
2’-trans-o-feruloyl-galactaric-acid	-		-	Peri: NS	
2’-trans-o-p-coumaroyl-galactaric acid	-			Peri: NS	
2’-trans-o-p-coumaroyl-glucaric-acid	-			Peri: NS	
2’,4’,5-trihydroxy-flavonone-7-o-beta-d-glucosyl-rhamnoside	Peri: NS		-		
3,3’,4,5,6,7,8-heptamethoxy-flavone				FR: NS	
3’,4’5-trihydroxy-flavone-7-o-beta-d-rhamnsoyl	P:NS		-		

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
3',4',5,6,7,8-hexamethoxyflavone	-		Peri: NS		
3',4'5-trihydroxy-flavonone-7-o-beta-d-rhamnsoyl	P: NS				
3-(4-hydroxy-3-methoxy-phenyl)-1-glucosyl-prop-2-ene	Peri: NS				
3,7(11)-eudesmadien-2-one	-		P: NS		
3-hexen-1-ol	EO: NS				
3-hydroxy-ethyl-hexanoate	-		FR: NS	FR: NS	
3-methyl-but-1-ene				EO: NS	
3-methyl-butan-1-ol				FR: NS	
4',5,6,7,8-pentamethoxy-flavone	-		Peri: NS		
4',5,6,7-tetrahydoxy-flavone-8-o-beta-d-glucoside	-		FR: NS		
4',5,7-trihydroxy-3',6,8-trimethoxy-flavone-3-o-beta-d-glucoside	P: NS				
4',5,7-trihydroxy-3',8-dimethoxy-flavone-3-o-beta-d-glucoside	Peri: NS				
4',5,7-trihydroxy-3',8-dimethoxy-flavone-3-o-beta-d-glucosyl-rhamnoside	Peri: NS				
4',5,7-trihydroxy-flavone-6-c-glucoside	-		FR: NS		
4',5,7-trihydroxy-flavone-6,8-di-c-glucoside	Peri: NS				
4',5,7-trihydroxy-flavone-6-o-beta-d-rhamnosyl	P: NS				
4',5,7-trihydroxy-flavone-8-o-beta-d-rhamnosyl	P: NS				
4',5-dihydroxy-flavonone-7-o-beta-d-rhamnosyl-glucoside	-		FR: NS		
4',7-dihydroxy-3'-methoxy-flavonone-8-o-beta-d-glucosyl-rhamnoside	Peri: NS				
4-(3-methyl-2-butenoxy)-acetophenone	Peri: NS				
4-(3-methyl-2-butenoxy)-iso-nitroso-acetophenone				Peri: 48	
4-terpinenol					Peri: NS
4-terpineol					P: NS
5,6-dihydro-beta-beta-caroten-3,3',5,6-tetrol				FR: NS	
5,6-dihydroergosterol	-		P: NS		
5,7-dimethoxycoumarin	EO: NS				
5,8-epoxy-5,5',8-tetrahydro-beta,beta-caroten-3,3'5'6'-tetrol				P: NS	
5,8-epoxy-5,8-dihydro-8'-apo-beta-caroten-3,10-diol				FJ: NS	
5-(3,7-dimethyl-6-epoxy-2-octenyl)-oxypsoralen	-		Peri: NS		
5-(6,7-dihydroxy-3,7-dimethyl-2-octenyl)-oxypsoralen	-		Peri: NS		
5-geranoxy-7-methoxycoumarin	EO: 630				
5-geranoxy-7-methoxypsoralen	EO: NS				
5-geranyl-oxypsoralen	Peri: NS				
5-hydroxy-4'-methoxy-flavanone-7-o-beta-d-rhamnosyl-glucoside	-		FR: NS		
5-hydroxyauranetin					P: NS
5-isopentenoxy-7-methoxycoumarin	EO: NS				
5-methoxy-psoralen	-	FR: NS	-	-	-
6,7-dimethyoxycoumarin	B: 162			B: 162	FR: NS
6-8-di-c-glucosyl-diosmetin	Peri: NS				
6-c-glucosyl-diosmetin	Peri: NS				
7-(3,7-dimethyl-6-epxoy-oct-trans-2-enyl)-oxycoumarin	-		Peri: NS		
7-geranyl-oxycoumarin	-		Peri: NS		
7-glucosyl-apigenin	FL: NS				
7-methoxy-8(2,3-dihydroxy-isopentyl)-coumarin	-		Peri: NS		
7-methoxy-8(2,3-epoxy-isopentenyl)-coumarin	-		Peri: NS		
7-obacunol	-		S: 8-9		
7-pentahydroxy-2',3',5,5'-pentahydroxy-flavanone-7-(6-o-alpha-l-	Peri: NS				

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
rhamnosyl-beta-d-glucoside					
7-rhamno-glucosyl-diosmetin	FL: NS				
7-rhamno-glucosyl-luteolin	FL: NS				
8-c-glucosyl-diosmetin	Peri: NS				
8-geran-oxypsoralen	Peri: NS				
Acetaldehyde				FJ: 3-15	P: NS
acetic-acid	EO: NS		FR: NS	P: NS	FL: NS; P: NS;
Adenosine	Peri: NS				
Alanine	-		FR: 90	FR: 30-3775	
alpha, alpha-p-trimethylbenzyl-alcohol	P: NS	FR: 60	-	-	-
alpha-alpha-p-trimethyl-benzyl	-	P: NS	-	-	-
alpha-amino-butyric-acid	P: NS		FR: 190		
alpha-bergamotene	EO: 250	FR: 50-250	-	FR: 6	-
alpha-bisabolene	-	FR: 250-400	-	-	-
alpha-carotene	-		FR: NS	FR: 0.19-1.9	
alpha-copaene	EO: NS			Peri: NS	
alpha-crytoxanthin	-		FR: NS		
alpha-cubebene	EO: NS				
alpha-humulene	EO: 10				P: NS
alpha-hydroxy-carotene				Peri: NS	
alpha-ionone					P: NS
alpha-linolenic-acid	-	FR: 190-1615	FR: 50-550	FR: 70-528	-
alpha-p-dimethyl-styrene	-	FR: 50	-	-	-
alpha-phellandrene	EO: 20	FR: 20	-	-	L: 1-20
alpha-pinene	EO: 40-500; LEO: 500-2000; PeriEO: 5000-14,000	FR: 80-240	FR: NS	FR: 10-60; P: NS	L: 1; P: NS
alpha-sinesal				FR: 3; Peri: NS	
alpha-terpinene	EO: 70; Peri: NS	FR: 80	-	-	L: 1
alpha-terpineol	EO: 6-50; LEO: 11,000-125,000; PeriEO: 4000-73,000	FR: 30-590	-	FR: 10-50; FJ: 0.09-1.1	L: 460-760; P: NS
alpha-terpinyl-acetate					L: 20-229
alpha-terpinyl-propionate	EO: NS				
alpha-thujene	EO: 16-40	FR: 40	-	-	-
alpha-tocopherol	-		FR: 3-29	FR: 4-29	
alpha-ylangene					P: NS
Aluminum	-		FR: 1-330	FR: 1-165	
Antheraxanthin				FR: NS	
anthranilic-acid-methyl-ether					FL: 4-26; L: NS
apigenin-7-o-alpha-l-rhamno-glucoside				L: NS	
apigenin-7-o-beta-d-rutinoside	-		L: 5		
apigenin-c-glycoside	P: NS				
apoviolaxanth-10'-al				Peri: NS	
Araban	-		FR: NS	FR: NS	
Arginine	-		FR: 470-760	FR: 230-4908	
Arsenic	-		FR: 0.001-4.4	FR: 0.001-0.154	
ascorbic-acid	FR: 5208-5566	FR: 291-4444	FR: 337-3862	FR: 500-4071	FR: 420-3947; L: 3000

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
ash	FR: 28,000	FR: 2000-3800	FR: 3050-53,000	FR: 4100-36,920	FR: 5000-64,000
Asparagine	-		FR: 420	FR: 200-1800	
aspartic-acid	-		FR: 810-4700	FR: 70-8607	
Auranetin					FR: NS
Aurantiamarin					FR: NS
Aurantiamene					P: NS
Aurapten					P: NS
Auraptene				FR: NS	
Auraxanthin				FR: 4	
Aureusidin	P: NS				
aureusidin-6-glucoside	P: NS				
aureusidin-6-rhamnoglucoside	P: NS				
Auroptenol					EO: NS
Barium	-		FR: 0.44-22	FR: 0.54-16.5	
benzoic-acid					P: NS
Bergamotene	EO: 16-40				
Bergamottin	EO: 649	FR: NS	Peri: NS		
Bergapten	EO: 10	FR: NS			FR: NS
Bergaptol	-		FR: NS	FR: NS	
beta-apo-8'carotinal				Peri: NS	
beta-apo-caroten-8-al				Peri: NS	
beta-bisabolene	EO: 23-400	FR: 90	-	-	-
beta-carotene	FR: 2	FR: 2	FR: 5	FR: 1-28	FR: 1-27
beta-caryophyllene	LEO: 100				
beta-citraurin				Peri: NS	
beta-copaene					P: NS
beta-crytoxanthin				FR: NS	
beta-cubebene				FR: 10	
beta-elemene	EO: NS			FR: 5	P: NS
beta-humulene	EO: 10				
beta-ocimene					FL: NS; L: NS; P: NS
beta-phellandrene	EO: 80	FR: 90	-	-	-
beta-pinene	EO: 40-1270	FR: 90-1190	-	-	L: 70-170; P: NS;
beta-sinesal				FR: 6	
beta-sitosterol	P: NS		FR: NS	FR: NS	
beta-terpineol	-	FR: 70	-	-	-
beta-zeacarotene				Peri: NS	
Betaine				FR: 390-630	
Borneol	-	FR: 60	-	-	-
Boron	-		FR: 1-33	FR: 1.89-27.5	
Braylin	R: NS		R: NS	R: NS	
Bromine	-		FR: NS	FR: NS	
Butanol					P: NS
butyric-acid				FR: NS	
Byakangelicin	EO: 29				
Byakangelicol	EO: NS				
cadinene	EO: NS				L: NS; P: NS
Cadmium	-		FR: 0.002-0.066	FR: 0.001-0.138	
caffeic-acid	FR: 21-35		FR: 40-51	FR: 36-50	
caffeine	FL: 50		FL: 29	Bud: 0.3; FL: 62;	

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
				L: 6	
calcium	FR: 700-3227	FR: 90-3084	FR: 117-4270	FR: 210-5615	FR: 18-4230
Campesterol	-		FR: NS	FR: NS	
Camphene	EO: 2-50	FR: 50-80	-	-	L: NS; P: NS
capric-acid				FR: NS	
Caprinaldehyde					P: NS
caproic-acid				FR: NS	
caprylic-acid				FR: NS	
carbohydrates	FR: 111,000-863,000	FR: 59,000-895,900	FR: 80,800-948,000	FR: 99,000-887,125	FR: 97,000-909,000
Carotenoids				FR: 12-35	
Carveol	EO: NS				
Carvone	EO: NS			FR: 2-10	P: NS
Caryophyllene	EO: 11-28	FR: 30-250	FR: NS	Peri: NS	P: NS
caryophyllene-oxide	LEO: 0.8				
Catechol	-		P: NS		
Chalconase	-		FR: NS		
Chlorine	-		P: 6	FR: 12-32	
chlorophyll-a	L: NS				
chlorophyll-b	L: NS				
Cholesterol	-		FR: NS	FR: NS	
Choline				FR: 70-160	
Chromium	-		FR: 0.002-0.55	FR: 0.005-0.385	
cinnamic-acid					P: NS
cis-3-hexenol					L: 1
cis-limonene-1,2-oxide	EO: NS				
cis-linalol-oxide	-		FR: NS		
cis-ocimene					L: 1-110
Citiflavanone				RB: NS	
Citrabasine				RB: 14	
citracridone-I				RB: 400	
Citral	EO: 250-300		FR: NS		P: NS
Citrantin					FR: NS
citric-acid	FR: 59,500	FR: 800	FR: 11,900-21,000	FR: 5600-9800	FR: NS; P: NS
Citronellal	LEO: 25,000-89,000	FR: 140		FR: 55	P: NS
citronellic-acid					L: NS
Citronellol	LEO: 20				P: NS
citronellyl-acetate	P: 4-20				
Citronetin	P: NS				
Citronin	P: NS				
Citropten	F: NS				
Citrostadienol	-		Peri: NS		
Citrunobin				RB: NS	
citrusinine-I				RB: 80	
citrusinine-II				RB: 40	
Citrusins				P: NS	
citrusin-a	Peri: NS				
citrusin-b	Peri: NS				
citrusin-c	Peri: NS				

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
Cobalt	-		FR: 0.005-0.22	FR: 0.001-0.055	
Coniferin	Peri: NS		Peri: NS	Peri: NS	
Copper	-	FR: 1-6	FR: 7.7	FR: 0.44-5.5	FR: 4-10
Coumarin					FR: NS
Crenulatin				RB: 60	
Cryptoflavin				Peri: NS	
Cryptoxanthin	-		FR: 0.03-0.3	FR: NS	P: NS
cryptoxanthin-5,5',6,6'-diepoxide				Peri: NS	
cyaniding-3-glucoside				FR: NS	
Cycloartenol	-		Peri: NS		
Cycloeucalenol	-		Peri: NS		
Cysteine	-		FR: 2		
Cysteine				FR: 100-755	
d-cadinene	-		P: NS		
d-citronellic-acid					P: NS
d-galacturonic-acid	FR: NS				
d-limonene	-		P: 9000		P: NS
d-linalol					L: NS
d-nerolidol					L: NS; P: NS
deacetyl-nomilin	S: NS		S: NS	S: NS	
deacetyl-nomilin-17-o-beta-d-glucopyranoside	S: NS				
deacetyl-nomilinic-acid-17-o-beta-d-glucoside	-		S: NS		
decan-1-al	Peri: NS				
Decanal	EO: 6-20	FR: 9-10		FR: 10-60; FJ: 0.15	L: 1
decanoic acid	EO: NS				
Decanol	EO: NS	FR: 6	-	-	-
decyl-acetate	P: 5	FR: 10	-	-	-
decyl-aldehyde	L: NS		FR: NS		FL: NS; P: NS
decylic-acid	-		FR: NS		
Decylpelargonate					P: NS
delphinidin-3-glucoside				FR: NS	
delta-cadinene				Peri: NS	P: NS
delta-3-carene					P: NS
delta-carene	EO: NS				
delta-limonene					FR: NS
deoxy-limonol	-		S: 8		
diconiferyl-alcohol-4-beta-d-glucoside	Peri: NS				
Dihydrokaempferol	-		FR: NS		
dihydrokaempferol-4'-methyl-ether-7-o-rhamnoside				FR: NS	
Dimethoxycoumarin	-	FR: NS	-	-	-
Diosmetin	P: NS				
diosmetin-7-o-alpha-l-rhamno-glucoside				L: NS	
Diosmin	FR: 5			Peri: NS	
Dipentene					L: NS; P: NS
dl-linalol					L: NS
dl-terpineol					L: NS
Dodecanal	EO: 10	FR: 1	-	FR: 5-20	P: NS
dodecen-2-al-(1)					P: NS
dodecanoic acid	EO: NS				

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
Duodecylaldehyde					P: NS; Peri: NS
Elemol				RB: 28,200	
Eo	-	P: 3000-10,000	FR: 6000-10,000	FR: 10,000	FL: 1000-2000; FR: 7000-25,000; L: 3000
epijasmonic-acid-methyl-ester	Peri: NS				
epi-iso-obacunoic-acid-17-o-beta-d-glucoside	-		S: NS		
epoxy-nootkaton				Peri: NS	
epoxy-valencene				FR: NS	
Eriocitrin	FR: 1				
Eriodictyol	-		FR: NS		
Eriodictyoside	FR: NS				
Esculetin	-		FR: NS		
eta-carotene				Peri: NS	
Ethanol				FJ: 64-900	P: NS
ethyl-acetate				FJ: 0.01-0.58	
ethyl-butyrate				FJ: 0.08-1.02	
ethyl-suberenol				RB: 700	
Etrogol				R: NS	
Farnesene	EO: NS			FR: 2-7	
Farnesol					L: NS; P: NS
fat	F: 28,000; S: 300,000-400,000	FR: 2000-26,700	FR: 1000-19,000	FR: 1100-16,000	FR: 8000; S: 448,600
Fenchol	-	FR: 120	-	-	-
ferulic-acid	FR: 14-40		FR: 30-34	FR: 10-19	
feruloyl-putrescine	-		P: 15-41	FR: 5	
Fiber	FR: 17,000-47,000	FR: 3000-67,000	FR: 2000-44,000	FR: 3740-47,000	P: 3000-160,000
Flavoxanthin				Peri: NS	
Fluorine	-		FR: 0.03-0.9	FR: 0.04-0.76	
Folacin				FR: 2	
Foluene	-	P: NS	-	-	-
Formaldehyde					P: NS
formic-acid					Peri: NS; P: NS
Fr				J: NS	
Friedelin	-		Peri: NS		
Fructose	-		P: 12,400	FR: 23,800	
Furfural	-	FR: 1	-	-	-
Furfurol					L: NS; P: NS
Galactan	-		P: NS	FR: NS	
Galactose				FR: NS	
galacturonic-acid	-		FR: NS	FR: NS	
gamma-aminobutyric-acid				FR: 40-730	
gamma-carotene	-		FR: NS		
gamma-elemene					P: NS
gamma-selinene	-	FR: 20	-	-	-
gamma-sitosterol	P: NS				
gamma-terpinene	EO: 290-1400; LEO: 3000-44,000; PeriEO: 12,000-58,000	FR: 60-2170	-	FR: 10; FJ: 0.04-0.46	L: 50-110; Peri: NS; P: NS

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
Geranial	EO: 42-236; LEO: 3000-270,000	FR: 10-680	FR: 420-700	FR: 6-350	L: 1; P: NS;
geranic-acid					L: NS
geraniol	EO: NS		P: NS	FR: 50	L: 200-350; P: NS
geraniol-acetate	LEO: 3000		FR: NS		
geranyl-acetate	EO: 12-310	FR: 30-310	-	-	FR: NS; L: 261
geranyl-butyrate	EO: NS				
geranyl-formate	EO: NS				
geranyl-oxide					L: NS; P: NS
geranyl-oxy-pyranocoumarin	R: NS		R: NS	R: NS	
glucosan	-		P: NS	FR: NS	
Glucose	-		FR: 19,500	FR: 23,600	
Gum					P: NS
glutamic-acid	P: NS		FR: 220-2800	FR: 60-7097	
Glutamine				FR: 30-630	
Glycine	-		FR: NS	FR: 50-7097	
Heptadecanal	EO: NS				
Heptanal	EO: 4			FR: 3-5	
Heptulose	-		FR: NS	FR: NS	
Hesperidin	FR: 44; Peri: 68,800		FR: NS	Peri: 40,600-63,500	FL: NS; FR: 700-2500; L: NS
hesperidin-7-o-alpha-l-rhamno-glucoside				FR: NS	
Hesperidoside	FR: NS				
Hexadecanal	EO: NS				
Hexanal	EO: NS			FR: 1-2; FJ: 0.02-0.65	
Hexanol	EO: NS			FJ: 0.02-0.22	P: NS
Histidine	-		FR: 140	FR: 180-1359	
Hordenene	-		FR: NS		
Hordenine				FR: NS	
Humulene	-		FR: NS		
Hydroxyproline				L: NS	
Imperatorin	FR: NS				
Indol					FL: NS
Indole					P: NS
Iron	FR: 23-72	FR: 67	FR: 1-88	FR: 1-8	FR: 3-260
isocaproic-acid				FR: NS	
Isohesperidin					FR: NS
Isoimperatorin	EO: NS	FR: NS	-	-	
Isoleucine				FR: 250-1888	
Isolimocitrol	EO: NS				
isolimocitrol-3,7,4'-trimethyl-ether	P: NS				
isolimocitrol-3-beta-d-glucoside	P: NS				
isolimonic-acid					P: NS
Isolutein				Peri: NS	
Isomeranzin	-		Peri: NS		
iso-obacunoic-acid-17-o-beta-d-glucoside	-		S: NS		
isopentenyl-psoralens				FR: NS	
Isoprene				EO: NS	
Isopimpinellin	P: NS	FR: NS			

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
Isopulegol	LEO: 40,000				
Isopulegole	LEO: 18,000-114,000				
Isorhamnetin	FL: NS		FR: NS		
isorhamnetin-3-arabinoglucoside	P: NS				
Isorhoifolin	L: NS		L: NS	Peri: NS	
Isosakuranetin	-		FR: NS	FR: NS	
Isoscutellarein					P: NS
Isosinensetin					P: NS
Isotetramethylether					P: NS
isovitexin	Peri: NS				
Jasmone					FL: NS
jasmonic-acid				FR: NS	
jasmonic-acid-methyl-ester	Peri: NS				
Kaempferol	-		FR: NS		
l-camphere					FL : NS
l-linalol					P: NS
l-linalyl-acetate					FR: NS; L: NS
l-stachydrine					L: NS
Lauraldehyde	FR: NS				
lauric-aldehyde					P: NS
Lead	-		FR: 0.02-7.7	FR: 0.02-1.1	
Leucine	-		FR: 240	FR: 230-1136	
Limettin	EO: 295				
Limocitrin	Peri: NS				
limocitrin-3-(6-o-alpha-l-rhamnosyl-beta-d-glucoside	Peri: NS				
limocitrin-3-o-(3	P: NS				
limocitrin-3-o-(5-alpha-glucosyl-3	P: NS				
Limocitrol	Peri: NS				
limocitrol-3-o-(5-alpha-glucosyl-3	P: NS				
Limonene	EO: 2796-8000; LEO: 284,000-754,000; PeriEO: 512,000-774,000	FR: 4700-7500	-	FR: 8300-9700; FJ: 1-278	L: 70-110; P: 1000-8000
limonexic-acid				FR: NS	
Limonin	FR: NS; S: NS		FR: NS; P: 9-140	FR: NS	FR: NS; P: NS
limonin-17-o-beta-d-glucopyranoside	S: NS				
limonoate-a-ring-lactone	FR: NS		FR: NS	FR: NS	
Limonol	-		S: 23		
linalool	EO: 8-30; LEO: 17,000-81,000; PeriEO: 7000-110,000	FR: 9-20	FR: NS	FR: 30-530; FJ: 0.15-4.69	L: 1990-2795
linalyl-acetate	EO: NS		FR: NS		FL: 80-520; L: 4429-5500
linoleic-acid	-	FR: 360-3060	FR: 190-2090	FR: 180-1359	-
Lithium	-		FR: 0.088-2.31	FR: 0.108-1.54	
lochnocarpol-1				R: NS	
Lutein	FR: 0.12-1.2		FR: 0.095-0.95	FR: 3	
Luteolin	FL: NS				
luteolin-7-o-alpha-l-rhamno-glucoside				FR: NS	

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
luteolin-7-o-beta-rutinoside	L: NS			L: NS	
Luteoxanthins				FR: 6	
Lycopene	-		FR: NS		
Lysine	-	FR: 140-1190	FR: 160-1760	FR: 470-3548	-
Magnesium	-		FR: 15-1360	FR: 98-1075	FR: 800-1730
malic-acid	-	FR: 2000	FR: 400-600	FR: 600-2000	P: NS
malonic-acid	-	FR: NS	FR: NS	P: NS	-
Manganese	-		FR: 5	FR: 8	FR: 8
Mannose	-		FR: NS	FR: NS	P: NS
menth-1-en-9-ol	EO: NS				
Meranzin	-		Peri: NS		
Merazine				FR: NS	
meranzin-hydrage	-		Peri: NS		
Mercury	-		FR: 0.001	FR: 0.001	
Methanol		FR: 20-170		FJ: 0.8-80	-
Methionine	-		FR: 3-222	FR: 200-1510	
methyl-anthralinate	-		FR: NS		
methyl-butyrate				FJ: 0.01-0.1	
methyl-heptanone	EO: NS	FR: 1	-	-	-
methyl-heptenone	LEO: 6000				
mevalonic-acid				FR: 0.5; Peri: 6	
Molybdenum	-		FR: 0.1-0.77	FR: 0.1-0.385	
Mucilage	FR: NS				
Mutatochrome				FR: NS	
Mutatoxanthin				FR: 2	
Myrcene	EO: 65-1270; LEO: 13,000	FR: 70-1030	FR: 72-190	FR: 68-210	FL: NS; L: 130-550; P: NS
myristic-acid	-	FR: 10-85	-	-	-
n-dodecasane	-		FR: NS		
n-doriacontane	-		FR: NS		
n-eicosane	-		FR: NS		
n-heneicosane	-		FR: NS		
n-hentriacontane	-		FR: NS		
n-heptacosane	-		FR: NS		
n-hexacosane	-		FR: NS		
n-methyl-tyramine	L: NS		FR: NS	FR: 2	
n-nonacosane	-		FR: NS		
n-nonyl-alcohol	-		FR: NS		
n-octacosane	-		FR: NS		
n-octyl-acetate	-		FR: NS		
n-octyl-alcohol	-		FR: NS		
n-pentacosane	-		FR: NS		
n-pentatriacontane	-		Peri: NS		
n-tetracosane	-		FR: NS		
n-tetratriacontane	-		Peri: NS		
n-triacontane	-		FR: NS		
Naringenin	-		FR: NS	Peri: 35,000-45,800	P: NS
naringenin-4-beta-d-glucoside				P: NS	
naringenin-7-beta-(4-beta-d-glucosyl)-neohesperidoside	-		FR: NS		

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
naringenin-7-beta-(4-beta-d-glucosyl)-rutinoside	-		FR: NS		
naringenin-7-o-beta-d-rutinoside	-		FR: NS		
naringenin-rutinoside	-		FR: NS	FR: NS	
naringenin-rutinoside-4-beta-d-glucoside				FR: NS	
Naringin	Peri: NS		FR: 245; Peri: 4500-14,000; S: 200	FR: NS	FR: NS
naringin-4-beta-d-glucoside	-		P: NS		
naringin-7-o-alpha-l-rhamno-glucoside				FR: NS	
Naringoside	FR: NS				
Narirutin	Peri: NS		FR: NS	Peri: NS	
neo-beta-carotene				Peri: NS	
neochrome-a				Peri: NS	
neochrome-b				Peri: NS	
Neohesperidin	Peri: NS		FR: NS	Peri: 28,000	FR: NS
neohesperidin-dihydrochalcone				Peri: NS	
Neoponcirin				Peri: NS	
Neoxanthin	L: NS				
neoxanthin-a				Peri: NS	
neoxanthin-b				Peri: NS	
Neral	EO: 27-130; LEO: 4000-270,000	FR: 40-460	FR: 136-210	FR: 1-20	L: 1; P: NS
Nerol	LEO: 18,000-76,000				L: 100-150; P: NS
Nerolidol				FL: NS	P: NS
nerol-acetate	EO: 16-310; LEO: 40				
neryl-acetate	-	FR: 1-310	-	FR: 10	FR: NS; L: 55-755
neryl-formate	EO: 20	FR: 20	-	FR: 10	-
Neurosporene	-		FR: NS		
Neurosporin				Peri: NS	
Niacin	FR: NS	FR: 1-29	FR: 2-44	FR: NS	FR: 3-24
nickel	-		FR: 0.04-7.7	FR: 0.01-0.55	
Nitrogen	-		FR: 990-16,360	FR: 500-13,845	
Nobelitin				FR: NS	FR: NS; P: NS
Nomilin	S: NS		S: NS	S: NS	P: NS
nomilin-17-o-beta-d-glucopyranoside	S: NS				
nomilinic-acid	-		P: NS		
nomilinic-acid-17-o-beta-d-glucoside	-		S: NS		
nonan-1-al	EO: 7				
Nonanal	EO: 9-30	FR: 20	-	FR: 6-20	-
Nonane	-	FR: 6	-	-	-
Nonanol	-	FR: 1-10	-	FR: 10	Peri: NS; P: NS
nonyl-acetate	P: NS				
nonyl-aldehyde	EO: NS				Peri: NS; P: NS
Nootkatol				FR: NS	
Nootkatone	P: NS	FR: 1	-	FR: 1	P: NS
Nordentatin				RB: 300	
o-phenylphenol	EO: NS				
Obacunone	S: NS		S: NS	S: NS	
obacunone-17-o-beta-d-glucopyranoside	S: NS				

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
Ocimene	LEO: 10,000				
Octaldehyde					Peri: NS
octan-1-al	Peri: NS			FR: NS	
octanoic acid	EO: NS	FR: 2	-	-	-
Octanal	-	FR: 30-80	-	FR: 20-280; FJ: 0.28	-
Octanol	EO: 10-15	FR: 1	-	-	Peri: NS; P: NS
Octopamine	L: NS		HH: NS	FR: 1	
octyl-acetate	EO: NS			FR: 10	P: NS
octyl-aldehyde	EO: NS		FR: NS		
octylic-acid	-		FR: NS		
oleic-acid	-	P: 160-1360	FR: 120-1320	FR: 20-1510	-
Osthole	R: NS		R: NS	R: NS	
oxalic-acid	-		P: NS	FR: 87	
Oxypeucedanin	EO: 207				
oxypeucedanin-hydrate	EO: 64				
p-alpha-dimethylstyrene	P: NS				
p-coumaric-acid	FR: 6-102		FR: 53	FR: 5-17	
p-cymene	EO: 12-31	FR: 50-1160	-	FR: 20	L: 100-270; P: NS
p-cymol	EO: NS				P: NS
p-hydroquinone				RB: 80	
p-menth-1-ene-8-thiol	-		FR: NS		
p-mentha-1,8-dien-9-yl-acetate	EO: NS				
p-mentha-2,8-dien-1-ol	EO: NS				
palmitic-acid	-	FR: 10-85	FR: 120-1320	FR: 130-982	P: NS
palmitoleic-acid	-	FR: 30-255	P: 10-110	FR: 30-226	-
pantothenic-acid	-	FR: 2-18	P: 3-31	FR: 2-19	
Paradisiol	-		FR: NS		
Pe	P: NS				
Pectin	Peri: NS		FR: NS	FR: 1300-5900	P: NS
Pectinesterase				FR: NS	
Pelargonaldehyde					Peri: NS
pelargonic-acid					Peri: NS; P: NS
Pentanol					Peri: NS; P: NS
pentan-1-ol	-		FR: NS		
Pentadecanal	EO: NS				
Pentadecane	P: NS				
Perillaldehyde	FR: NS	FR: NS	-	FR: 2	-
Phellandrene					Peri: NS; P: NS
Phellopterin	EO: NS				
Phenol					P: NS
phenyl-ethyl-alcohol					FL: NS
phenylacetic-acid					FL: NS; P: NS
Phenylalanine	-		FR: NS	FR: 310-2340	
Phenylethanol					FL: NS
Phlobotannin	-	FR: NS	-	-	-
Phlorin	P: NS		P: NS	P: NS	
Phloroglucinol	-		FR: NS		
Phosphorus	FR: 100-1979	FR: 110-2000	FR: 76-2545	FR: 136-1980	FR: 120-1600
Phytoene	-		FR: NS	FR: 2	

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
Phytofluene	-		FR: NS	FR: 4	
polygalacturonic-acid	-		FR: NS	FR: NS	
Polyhydroxyphloban	-	FR: NS	-	-	-
Poncirin	P: NS		FR: NS		
Poncitrin	-		R: NS	R: NS	
Potassium	FR: 14,700	FR: 820-9533	FR: 1300-16,360	FR: 1400-13,772	FR: 7020-13,800
Proline	-		FR: 590	FR: 60-3473	
propionic-acid				P: NS	
Protein	FR: 10,000-111,000	FR: 4000-65,000	FR: 6000-70,290	FR: 9260-78,000	FR: 6000-56,000
psi-carotene	-		P: NS		
Pyrrol					L: NS
Pyrrole					P: NS
Quercetin	FL: NS		FR: NS		
quercetin-3,5-diglucoside	P: NS				
quinic-acid	-	FR: NS	FR: NS	FR: NS	-
Rhoifolin	-		L: NS		P: NS
Riboflavin	FR: 2-3	FR: 2	FR: 5	FR: 3	FR: 1-3
Rubidium	-		FR: 0.26-22	FR: 0.1-7.7	
Rutin	FR: 1-2; L: NS			L: 9000; Peri: 6100	
Sabinene	EO: 50-175; LEO: 2700	FR: 160	-	FR: 10-60; FJ: 0.15	L: 1-40; Peri: NS; P: NS
Salicylates	FR: NS		FR: 70		
Scoparone				B: NS	
Scopoletin	SH: NS		FR: NS		
Scutellarein				FR: NS	
Selenium	-		FR: 0.027	FR: 0.002	
Selinene	EO: NS				
Serine	-		FR: 150-3100	FR: 40-2410	
Seselin	R: NS		R: NS	R: NS	R: NS
Seslin	-		R: NS	R: NS	
Silicon	-		FR: NS	FR: NS	
Silver	-		FR: 0.022-0.11	FR: 0.027-0.055	
sinapic-acid	FR: 14-18		FR: 4-5	FR: 7-19	
Sinensetin				FR: NS	Peri: NS; P: NS
Sinensiaxanthin				FR: NS	
Sinesetin				P: NS	
Sodium	FR: 470	FR: 10-222	FR: 175	FR: 29	FR: 54-116
Stachydrine	P: NS			FR: NS	L: 1000
stearic-acid	-	FR: 10-85	FR: 10-110	-	-
Stigmasterol	-		FR: NS	FR: NS	
Strontium	-		FR: 3.3-220	FR: 0.054-110	
Subaphyllin	-		FR: NS; L: NS	FR: NS; L: NS	
Suberenol				RB: 700	
Suberosin	R: NS		R: NS	R: NS	
succinic-acid	-	FR: NS	-	FR: NS	-
Sucrose	-		FR: 21,400	FR: 47,000	
Sugars	-	FR: 17,400	FR: 33,000-99,600	FR: 39,600-119,800	-

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
Sulfur	-		FR: 7-2090	FR: 46-1000	
Synephrine	L: NS		FR: NS	FR: 15-43	
Syringin	Peri: NS				
Tangeretin				FR: NS	Peri: NS; P: NS
tannic-acid					P: NS
Tannin					FR: NS
tau-carotene				Peri: NS	
terpenyl-acetate					Peri: NS; P: NS
terpinen-1-ol	-	FR: 70	-	-	-
terpinen-4-ol	EO: 1-40; LEO: 10,000; PeriEO: 1000-11,000	FR: 166	-	FR: 6-550	L: 50-80
Terpinolene	EO: 14-120	FR: 60-120	-	FR: 10	L: 1-10; Peri: NS; P: NS
tetra-o-methyl-scutellarein				FR: NS	P: NS
Tetradecanal	EO: NS			FR: 5-9	
Tetradecane	EO: NS				
Tetrahydrogeraniol	EO: 10				
Thiamin	FR: 4-6	FR: 3	FR: 6	FR: 1-7	FR: 1-6
Threonine	-		FR: 100	FR: 150-1132	
Thymol	LEO: 400; PeriEO: 53,000-111,000				L: 1
thymyl-methyl-ether	-	FR: 2	-	-	-
Tin	-		FR: 0.66-3.3		
Titanium	-		FR: 0.11-7.7	FR: 0.135-3.85	
trans-2-hexenol				FJ: 0.1	
trans-hexen-2-al-1					P: NS
trans-limonene-1,2-oxide	EO: NS				
trans-obacunoic-acid-17-o-beta-d-glucoside	-		S: NS		
trans-ocimene					L: 1-332
Tridecane	-	FR: 2	-	-	-
Tridecanal	EO: NS				
Tryptophan	-	FR: 30-255	FR: 20-220	FR: 90-680	-
Tyramine	L: NS		FR: NS	FR: 1	
Tyrosine	-		FR: 61	FR: 160-1208	
Umbelliferone	SH: NS		FR: NS		P: NS
Umbelliprenin	SH: NS				
Undecanal	EO: NS				P: NS
Undecane	-	FR: 3	-	-	-
uronic-acid	-		FR: NS	FR: NS	
Valencene				FR: 10-20; FJ: 0.04-15.3	P: NS
Valenciachrome				P: NS	
Valenciaxanthin				FR: 3	
valencic-acid				R: NS	
Valine	-		FR: 240	FR: 100-3020	
vicenin-2	Peri: NS				
Violaxanthin	L: NS			FR: NS	Peri: NS: P: NS
vitamin B-6				FR: 1-5	
vitexin-xyloside				FR: NS	

Table 4. Chemical constituents by plant part (amount in ppm) for major Citrus species [31]

Chemical	Citrus limon (Lemon)	Citrus aurantifolia (Lime)	Citrus paradisi (Grapefruit)	Citrus sinensis (Sweet Orange)	Citrus aurantium (Bitter Orange)
Water	FR: 850,000-894,000	FR: 877,000-911,000	FR: 847,000-930,000	FR: 839,000-898,000	FR: 857,000-892,000
Xanthophylls	-	FR: 11-19	-	-	-
Xanthoxyletin	R: NS		R: NS	RB: 24,000	
Xanthyletin	R: NS	P: NS	FR: NS	RB: 45,000	-
Xylan	-		FR: NS	FR: NS	
Xylose	-		FR: NS	FR: NS	
xylosyl-vitexin	FL:NS			L: NS	
Zeaxanthin	L: NS			FR: 2	FR: NS
zeta-carotene	-		FR: NS	FR: 2	
Zinc	-	FR: 1-9	FR: 9	FR: 0.9-13	FR: 16
Zirconium	-		FR: 0.44-2.2	FR: 0.5-1.1	

Table 5. Major constituents of some of the Citrus species

Citrus species	Constituents
Citrus aurantiifolia (lime)[32] pericarp, i.e., fruit, including skin and pulp	- contains an essential oil (7%), whose main components are citral, limonene, β-pinene, and fenchone (up to 15%); - lime oil contains oxypeucedanin. - contains terpineol, bisabolene and other terpenoids - fresh juice of acid limes averages approximately 7.7% citric acid and 0.3% invert sugar - the peel contains a volatile oil, including limonene and citral
Citrus aurantiifolia (lime) plant part not specified[33,34]	- contains coumarins (e.g., isopimpinellin, and limettin), furocoumarins (e.g., psoralens, such as bergapten and xanthotoxin), pyranocoumarins, citral, (+)-limonene, pinenes, alkanes, alkanols, alkanals, citrus acid, and flavonoids
Citrus aurantium (bitter orange)	- contains synephrine alkaloids and para-octopamine[35] - contains the furocoumarins bergapten and oxypeucedanin[35] - the peel, flowers, and leaves contain the flavonoids limonene, hesperidin, neohesperidin, naringin, and tangaretin; the flavonoid content is higher in the flowers than the leaves[35] - the main constituents of the peel are the volatile oil and the glucoside aurantiamarin; other constituents include hesperidin, isohesperidin, hesperic acid, and aurantiamaric acid[23] - in the peel of the immature fruit, the main constituents are naringin and hesperidin[23] - in the flesh of the immature fruit, the main constituent is umbelliferone[23] -volatile oil contains limonene, nerol, geraniol, linalool, linalyl acetate, neryl acetate, geranyl acetate, citronellyl acetate, and methyl anthranilate[34]
Citrus limon (lemon) peel[36]	- 0.2% to 0.6% essential oil, with (+)-limonene, citral, and other monoterpenes as major components -flavonoids such as neohesperidosides and rutinosides of hesperetin and naringenin -flavone glycosides -carotenoids -citric acid and other plant acids -coumarin derivatives -pectins
Citrus limon (lemon) Plant part not specified[34]	-(+)-limonene, citral, n-nonanal, n-decanal, n-dodecanal, linalyl acetate, geranyl acetate, citronellyl acetate, methyl anthranilate, sinensetin, furocoumarins, naringin, nehesperidin dyhydro chalcones, hesperidin, rutin
Citrus paradisi (grapefruit)[37]	- the juice contains vitamin C, furanocoumarins (bergamottin, 6',7'-epoxybergamottin, 6',7'-dihydroxybergamot-tin), flavonoids (naringenin, naringin) and sesquiterpen (nootkatone), bergapten, polyamines (e.g. putrescine), and limonoids; naringin is the most abundant flavonoid in grapefruit juice, present in concentrations of up to 1mM/L - the dried peels contain high amounts of ascorbic acid, polyphenols, and carotenoids
Citrus reticulata (tangerine)[38]	- contains carotenoids, such as beta-cryptoxanthin - the juice concentrate contains beta-cryptoxanthin xanthophyll esters (zeaxanthin and lutein) - the peel contains fat, protein, ash, magnesium, carotenoids, dietary fiber, and polyphenols
Citrus reticulata oil (from the mandarin orange)[5]	- limonene, p-cymene, γ-terpinene, α-thujene, α-pinene, camphene, sabinene, β-pinenemyrcene, methyl heptenone, octanol, octanol, terpinolene, linalool, nonanal, citronellal, terpinen-4-ol, α-terpineol, decanal, nerol, citronellol, neral, geranial, thymol, *N*-methyl anthranilate, caryophyllene, α-humulene, longifolene
Citrus sinensis (sweet orange)[34]	-(+)-limonene, citral, citronellal, nootkatone, sinesal, n-nonanal, n-necanal, n-dodecanal, linalyl acetate, geranyl acetate, citronellyl acetate, methyl anthranilate, furocoumarins, and flavonoids

Table 6. Typical levels of 5-methoxypsoralen (5-MOP)

Ingredient	5-MOP level[16]
Petitgrain Mandarin oil	50 ppm
Tangerine oil cold pressed	50 ppm
Mandarin oil cold pressed	250 ppm

Table 7. Levels of major coumarins and furocoumarins in lemon oil and lime oil

Compound	% in Lemon Oil[4]	% in Lime Oil[4]	Photosensitizing Activity[4]
5-geranoxypsoralen	0.0387	2.2-2.5	0
5-geranoxy-7-methoxycoumrin	0.0603	2.2-5.2	0
5-geranoxy-8-methoxypsoralen	not analyzed	0.945	0
5,7-dimethoxycoumarin	0.0295	0.464	0
5,8-dimethoxypsoralen	not analyzed	0.508	0
Oxypeucedanin	0.005-0.073	0.0025	+
5-methoxypsoralen	0.0001-0.0087	0.17-0.33	++++

Table 8. 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 (>1000 patients tested, unless indicated as r.t., i.e., rarely tested) [39]
β-caryophyllene	≤10 (oxidized and non-oxidized)
carvone	≤10 (r.t.)
citral	101 to 1000
citronellol	11-100
coumarin	101 to 1000
farnesol	101 to 1000
geraniol	101 to 1000
linalyl acetate	≤10
α- and β-pinene	11-100
(DL)-limonene	11-100 (non-oxidized); 101 to 1000 (oxidized)
tepineol (mixture of isomers)/α-terpineol	≤10
terpinolene	11-100

Table 9. Cosmetic allergens certificate from a manufacturer of orange, lemon, tangerine, and grapefruit fruit waters and bitter orange flower wax [40-44]

Allergen	Citrus Sinensis (Orange) Fruit Water	Citrus Limon (Lemon) Fruit Water	Citrus Reticulata (Tangerine) Fruit Water	Citrus Paradisi (Grapefruit) Fruit Water	Citrus Aurantium Amara (Bitter Orange) Flower Wax
Amyl cinnamal	NP	NP	NP	NP	< 5 ppm
Benzyl alcohol	NP	NP	NP	NP	< 20 ppm
Cinnamyl alcohol	NP	NP	NP	NP	< 1 ppm
Citral	NP	Max. content < 100 ppm	NP	NP	< 10 ppm
Eugenol	NP	NP	NP	NP	< 5 ppm
Hydroxycitronellal	NP	NP	NP	NP	< 5 ppm
Isoeugenol	NP	NP	NP	NP	< 5 ppm
Amylcinnamyl alcohol	NP	NP	NP	NP	< 1 ppm
Benzyl salicylate	NP	NP	NP	NP	< 5 ppm
Cinnamal	NP	NP	NP	NP	< 5 ppm
Coumarin	NP	NP	NP	NP	< 15 ppm
Geranlol	NP	Max. content < 100 ppm	NP	NP	< 5 ppm
Hydroxyisohexyl 3-cyclo hexane carboxaldehyde	NP	NP	NP	NP	< 5 ppm
Anise alcohol	NP	NP	NP	NP	< 30 ppm
Benzyl cinnamate	NP	NP	NP	NP	< 15 ppm
Farnesol	NP	NP	NP	NP	< 50 ppm
Butylphenyl methylpropional	NP	NP	NP	NP	< 1 ppm
Linalool	Max. content < 10 ppm	Max. content < 100 ppm	NP	Max. content < 10 ppm	< 50 ppm
Benyl benzoate	NP	NP	NP	NP	< 5 ppm
Citronellol	NP	NP	NP	NP	< 5 ppm
Hexyl cinnamal	NP	NP	NP	NP	< 1 ppm
Limonene	NP	NP	NP	NP	< 200 ppm
Methyl 2-octynoate	NP	NP	NP	NP	< 1 ppm
Alpha-isomethyl ionone	NP	NP	NP	NP	< 1 ppm
Evernia prunastri	NP	NP	NP	NP	ND
Evernia furfuracea	NP	NP	NP	NP	ND

Detection limit 2 ppm.
ND = unable to be detected by GCSM
NP = not present

Table 10. Primary chemical composition of citrus aurantium dulcis (orange) peel wax by percent [8]

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 11. Constituents of citrus aurantium dulcis (orange) peel wax with color or aroma characteristics [8]

color compounds (carotenoids)	**aroma compounds (alcohols, aldehydes, ketones, esters, and hydrocarbons)**
Phytoene	octan-1-ol
Phytolluene	nonanal
α-carotene	linalool
β-carotene	*p*-mentha-2,8-dien-1-ol
γ-carotene	sabinol
δ-carotene	isopulegol
Lycopene	4-methylacetophenone
Cryptoxanthin	α-terpineol
hydroxy-α-carotene	ethyl ocatanoate
Cyroflevin	decanal
Rubiflavin	carveol
Rubixanthin	neral
Lutein	carvone
Canthaxanthin	pipertone
Zeaxanthin	geranial
Antheraxanthin	perillyl alcohol
Violaxanthin	α-cubebene
Luteoxanthin	hexyl hexanoate
Auroxanthin	β-elemene
β-citraurin	β-famesene
Liavoxanthin	caryophyllene
Sintaxanthin	γ-selinene
Xanthophylls	β-copaene
	δ-cadinene
	bisabolene
	valencene

Table 12. Frequency and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients. [9,10]

	# 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 Aurantifolia (Lime) Flower Extract		**Citrus Aurantifolia (Lime) Fruit Extract**		**Citrus Aurantifolia (Lime) Juice**		**Citrus Aurantifolia (Lime) Oil**	
Totals[1]	**4**	**0.0005-0.005**	**63**	**0.0001-0.2**	**1**	**NR**	**160**	**NR**
Duration of Use								
Leave-On	NR	0.0005	26	*0.0009-0.2*	NR	NR	93	NR
Rinse-Off	4	0.0005-0.005	35	*0.0001-0.2*	1	NR	58	NR
Diluted for (Bath) Use	NR	0.0005	2	*0.002*	NR	NR	9	NR
Exposure Type								
Eye Area	NR	NR	NR	NR	NR	NR	2	NR
Incidental Ingestion	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	NR	0.0005	19	0.0009-0.01	NR	NR	77	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	NR	NR	18	0.0009	NR	NR	59	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	1	0.0005	53	0.0001-0.2	NR	NR	141	NR
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	1	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	3	0.005	10	0.0005-0.01	1	NR	19	NR
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	1	0.0005	18	0.002-0.2	NR	NR	34	NR
Baby Products	NR	NR	NR	NR	NR	NR	3	NR

	Citrus Aurantifolia (Lime) Peel		**Citrus Aurantifolia (Lime) Peel Extract**		**Citrus Aurantifolia (Lime) Peel Powder**		**Citrus Aurantium Amara (Bitter Orange) Flower Extract**	
Totals[1]	**NR**	**1.5**	**17**	**0.00001-0.025**	**1**	**NR**	**32**	**0.023-5**
Duration of Use								
Leave-On	NR	NR	12	0.0005-0.025	NR	NR	27	0.023-5
Rinse-Off	NR	1.5	5	0.00001-0.0005	1	NR	5	NR
Diluted for (Bath) Use	NR	NR	NR	NR	NR	NR	NR	NR
Exposure Type								
Eye Area	NR	NR	NR	NR	NR	NR	5	NR
Incidental Ingestion	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	NR	NR	8	NR	NR	NR	19	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	NR	NR	7	NR	NR	NR	18	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	NR	1.5	14	0.00001-0.025	1	NR	32	0.023-5
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	NR	NR	3	0.00025	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	NR	NR	NR	NR	NR	NR	3	NR
Baby Products	NR	NR	NR	NR	NR	NR	NR	NR

Table 12. Frequency and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients. [9,10]

	# 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 Amara (Bitter Orange) Flower Oil		**Citrus Aurantium Amara (Bitter Orange) Flower Water**		**Citrus Aurantium Amara (Bitter Orange) Flower Wax**		**Citrus Aurantium Amara (Bitter Orange) Fruit Extract**	
Totals[1]	**69**	**0.001-0.6**	**23**	**0.0004-4**	**4**	**NR**	**282**	**0.00002-0.002**
Duration of Use								
Leave-On	58	0.001-0.6	17	0.0005-4	4	NR	182	*0.00002-0.002*
Rinse-Off	9	0.001-0.02	6	0.0004	NR	NR	98	*0.0001*
Diluted for (Bath) Use	2	0.001	NR	NR	NR	NR	2	NR
Exposure Type								
Eye Area	3	NR	6	NR	NR	NR	9	0.0001-0.002
Incidental Ingestion	NR	NR	NR	NR	NR	NR	NR	0.002
Incidental Inhalation-Spray?[2,5]	47	NR	11	NR	3	NR	134	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	46	NR	11	NR	3	NR	115	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	67	0.001-0.6	23	0.0004-4	4	NR	250	0.00002-0.002
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	3	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	2	0.001	NR	NR	NR	NR	27	NR
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	2	NR
Mucous Membrane	6	0.001	1	NR	NR	NR	39	0.002
Baby Products	NR	NR	NR	NR	NR	NR	NR	NR

	Citrus Aurantium Amara (Bitter Orange) Fruit Water[6]		**Citrus Aurantium Amara (Bitter Orange) Leaf/Twig Oil**		**Citrus Aurantium Amara (Bitter Orange) Oil**[6]		**Citrus Aurantium Amara (Bitter Orange) Peel Extract**	
Totals[1]	**2**	**NR**	**31**	**0.04-1.5**	**292**	**NR**	**33**	**0.00002-0.18**
Duration of Use								
Leave-On	1	NR	21	0.1-1.5	192	NR	25	0.00002-0.18
Rinse-Off	1	NR	7	0.04	81	NR	7	0.001
Diluted for (Bath) Use	NR	NR	3	NR	19	NR	1	NR
Exposure Type								
Eye Area	NR	NR	NR	NR	3	NR	3	0.18
Incidental Ingestion	NR	NR	NR	NR	3	NR	NR	0.0002
Incidental Inhalation-Spray?[2,5]	NR	NR	18	NR	120	NR	15	0.001
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	NR	NR	18	NR	83	NR	13	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	2	NR	30	0.04-1.5	254	NR	28	0.0002-0.18
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	NR	NR	NR	NR	35	NR	5	0.001
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	NR	0.00002-0.00014
Mucous Membrane	1	NR	6	NR	49	NR	2	0.0002
Baby Products	NR	NR	NR	NR	6	NR	NR	NR

Table 12. Frequency and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients. [9,10]

	# 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 Amara (Bitter Orange) Peel Oil		**Citrus Aurantium Amara (Bitter Orange) Peel Powder**		**Citrus Aurantium Amara (Bitter Orange) Peel Wax[6]**		**Citrus Aurantium Bergamia (Bergamot) Fruit Extract**	
Totals[1]	**116**	**0.05-2**	**2**	**6**	**8**	**NR**	**23**	**0.000001-0.82**
Duration of Use								
Leave-On	72	0.2-2	NR	NR	7	NR	11	0.000001-0.82
Rinse-Off	36	0.05-0.25	2	6	1	NR	12	0.000001-0.0063
Diluted for (Bath) Use	8	NR	NR	NR	NR	NR	NR	NR
Exposure Type								
Eye Area	2	NR	NR	NR	NR	NR	NR	NR
Incidental Ingestion	1	0.75	NR	NR	2	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	53	NR	NR	NR	1	NR	8	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	0.000001[a]
Incidental Inhalation-Powder?[4,5]	45	NR	NR	NR	1	NR	6	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	105	0.05-2	2	6	6	NR	8	0.0001-0.82
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	10	NR	NR	NR	NR	NR	15	0.000001-0.0001
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	19	0.25-0.75	1	NR	3	NR	1	NR
Baby Products	6	NR	NR	NR	NR	NR	NR	NR

	Citrus Aurantium Bergamia (Bergamot) Fruit Oil		**Citrus Aurantium Dulcis (Orange) Flower Extract**		**Citrus Aurantium Dulcis (Orange) Flower Oil**		**Citrus Aurantium Dulcis (Orange) Flower Water**	
Totals[1]	**22**	**0.0017-0.05**	**72**	**0.000023-0.2**	**NR**	**0.000001-0.9**	**19**	**NR**
Duration of Use								
Leave-On	12	0.0017-0.05	31	0.00003-0.2	NR	0.9	10	NR
Rinse-Off	10	0.005	40	0.000023-0.2	NR	0.000001	9	NR
Diluted for (Bath) Use	NR	NR	1	0.1	NR	NR	NR	NR
Exposure Type								
Eye Area	NR	NR	NR	0.002-0.01	NR	NR	4	NR
Incidental Ingestion	NR	NR	NR	NR	NR	0.9	NR	NR
Incidental Inhalation-Spray?[2,5]	10	0.0017-0.05	25	0.0013-0.01	NR	NR	5	NR
Confirmed Spray[3]	NR	NR	NR	0.0025[b]	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	11	NR	19	NR	NR	NR	4	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	17	NR	58	0.000023-0.2	NR	0.000001	18	NR
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	5	0.0017-0.05	14	0.0013-0.005	NR	NR	1	NR
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	0.001	NR	NR	NR	NR
Mucous Membrane	2	NR	11	0.01-0.2	NR	0.9	2	NR
Baby Products	4	NR	NR	NR	NR	NR	NR	NR

Table 12. Frequency and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients. [9,10]

	# 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) Fruit Extract		**Citrus Aurantium Dulcis (Orange) Fruit Water**		**Citrus Aurantium Dulcis (Orange) Juice**		**Citrus Aurantium Dulcis (Orange) Leaf Extract**	
Totals[1]	**NR**	**0.00003-1.2**	**21**	**2-19**	**NR**	**0.000038**	**1**	**NR**
Duration of Use								
Leave-On	NR	0.00003-1.2	18	2-10	NR	0.000038	1	NR
Rinse-Off	NR	0.00003-0.2	3	2-19	NR	NR	NR	NR
Diluted for (Bath) Use	NR	NR	NR	NR	NR	NR	NR	NR
Exposure Type								
Eye Area	NR	0.1	3	NR	NR	NR	NR	NR
Incidental Ingestion	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	NR	0.001	8	NR	NR	0.000038	1	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	NR	NR	7	NR	NR	NR	1	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	NR	0.00003-1.2	20	2-19	NR	NR	1	NR
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	NR	0.0007-0.25	NR	NR	NR	0.000038	NR	NR
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	0.2	NR	NR	NR	NR	NR	NR
Mucous Membrane	NR	0.004-0.041	NR	NR	NR	NR	NR	NR
Baby Products	NR	NR	NR	NR	NR	NR	NR	NR

	Citrus Aurantium Dulcis (Orange) Oil		**Citrus Aurantium Dulcis (Orange) Peel Extract**		**Citrus Aurantium Dulcis (Orange) Peel Oil**		**Citrus Aurantium Dulcis (Orange) Peel Powder**	
Totals[1]	**NR**	**0.0014-0.95**	**65**	**0.00001-1.9**	**NR**	**0.00002-29**	**11**	**6**
Duration of Use								
Leave-On	NR	0.0014-0.95	31	0.00001-1.9	NR	0.00038-0.54	5	NR
Rinse-Off	NR	0.021-0.2	33	0.000025-0.65	NR	0.00002-29	6	NR
Diluted for (Bath) Use	NR	0.93	1	0.0025	NR	0.33	NR	NR
Exposure Type								
Eye Area	NR	0.033	1	0.0002-0.0005	NR	0.1	NR	NR
Incidental Ingestion	NR	0.033-0.95	2	1.9	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	NR	NR	22	0.00001-0.001	NR	0.00038	3	NR
Confirmed Spray[3]	NR	0.011	NR	0.001[c]	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	NR	0.0014	11	NR	NR	NR	4	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	NR	0.0014-0.93	39	0.00002-0.65	NR	0.001-0.4	11	6
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	NR	0.033-0.043	24	0.00001-0.001	NR	0.00002-29	NR	NR
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	0.025	NR	NR	NR	0.5-0.54	NR	NR
Mucous Membrane	NR	0.033-0.95	17	0.000025-1.9	NR	0.1-0.33	1	NR
Baby Products	NR	NR	NR	NR	NR	NR	NR	NR

Table 12. Frequency and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients. [9,10]

	# 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		**Citrus Aurantium Tachibana Peel Extract**		**Citrus Bergamia (Bergamot) Peel Oil[6]**		**Citrus Depressa Peel Extract**	
Totals[1]	**NR**	**0.005-0.5**	**NR**	**0.0008**	**200**	**NR**	**NR**	**0.0014**
Duration of Use								
Leave-On	NR	0.07-0.5	NR	0.0008	113	NR	NR	0.0014
Rinse-Off	NR	0.005-0.39	NR	NR	70	NR	NR	NR
Diluted for (Bath) Use	NR	NR	NR	NR	17	NR	NR	NR
Exposure Type								
Eye Area	NR	0.15-0.16	NR	NR	1	NR	NR	NR
Incidental Ingestion	NR	0.5	NR	NR	2	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	NR	NR	NR	NR	90	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	NR	NR	NR	NR	55	NR	NR	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	NR	0.07-0.39	NR	0.0008	167	NR	NR	0.0014
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	1	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	NR	0.005-0.045	NR	NR	31	NR	NR	NR
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	NR	0.5	NR	NR	48	NR	NR	NR
Baby Products	NR	NR	NR	NR	NR	NR	NR	NR

	Citrus Glauca Fruit Extract		**Citrus Grandis (Grapefruit)**		**Citrus Grandis (Grapefruit) Extract**		**Citrus Grandis (Grapefruit) Fruit Extract**	
Totals[1]	**5**	**0.003-0.0051**	**NR**	**0.5**	**NR**	**0.01**	**225**	**0.0000005-15**
Duration of Use								
Leave-On	NR	NR	NR	0.5	NR	NR	105	0.0001-15
Rinse-Off	5	0.003-0.0051	NR	NR	NR	0.01	118	0.0000005-8
Diluted for (Bath) Use	NR	NR	NR	NR	NR	NR	2	0.005-0.01
Exposure Type								
Eye Area	NR	NR	NR	0.5	NR	NR	4	NR
Incidental Ingestion	NR	NR	NR	NR	NR	NR	8	0.01-0.02
Incidental Inhalation-Spray?[2,5]	NR	NR	NR	NR	NR	NR	80	0.0001-0.01
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	NR	NR	NR	NR	NR	NR	59	0.0001-0.01
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	NR	NR	NR	0.5	NR	NR	141	0.0001-15
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	1	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	5	0.003-0.0051	NR	NR	NR	0.01	70	0.0000005-0.01
Hair-Coloring	NR	NR	NR	NR	NR	NR	6	NR
Nail	NR	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	NR	NR	NR	NR	NR	NR	28	0.001-0.1
Baby Products	NR	NR	NR	NR	NR	NR	NR	NR

Table 12. Frequency and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients. [9,10]

	# 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 Grandis (Grapefruit) Fruit Water		**Citrus Grandis (Grapefruit) Juice**		**Citrus Grandis (Grapefruit) Peel Extract**		**Citrus Grandis (Grapefruit) Peel Oil**	
Totals[1]	**2**	**0.0029**	**14**	**0.01**	**44**	**0.0001-0.5**	**NR**	**0.00004-0.05**
Duration of Use								
Leave-On	NR	NR	10	NR	37	0.0001-0.5	NR	0.0004-0.0008
Rinse-Off	2	0.0029	4	0.01	7	0.0225-0.03	NR	0.00004-0.05
Diluted for (Bath) Use	NR	NR	NR	NR	NR	NR	NR	0.0014
Exposure Type								
Eye Area	NR	NR	NR	NR	3	0.5	NR	NR
Incidental Ingestion	NR	NR	NR	NR	1	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	NR	NR	10	NR	22	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	NR	NR	10	NR	20	NR	NR	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	2	0.0029	14	0.01	40	0.0001-0.03	NR	0.00004-0.05
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	NR	NR	NR	NR	1	NR	NR	0.005
Hair-Coloring	NR	NR	NR	NR	2	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	2	NR	2	NR	2	NR	NR	0.0014
Baby Products	NR	NR	NR	NR	NR	NR	NR	NR

	Citrus Grandis (Grapefruit) Seed Extract		**Citrus Japonica Fruit Extract**		**Citrus Junos Fruit Extract**		**Citrus Junos Peel Extract**	
Totals[1]	**128**	**0.053-2**	**NR**	**0.0038**	**28**	**0.0005-0.002**	**7**	**0.0012-0.036**
Duration of Use								
Leave-On	72	0.053-2	NR	NR	23	0.0005-0.002	7	0.0012-0.036
Rinse-Off	48	0.75	NR	0.0038	5	0.0005-0.001	NR	NR
Diluted for (Bath) Use	8	NR	NR	NR	NR	NR	NR	NR
Exposure Type								
Eye Area	4	NR	NR	NR	6	NR	2	NR
Incidental Ingestion	10	NR	NR	NR	NR	0.001	1	0.0012
Incidental Inhalation-Spray?[2,5]	57	0.15	NR	NR	15	0.001	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	0.0005[d]	NR	NR
Incidental Inhalation-Powder?[4,5]	41	0.15	NR	NR	15	NR	1	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	93	0.053-2	NR	NR	27	0.0005-0.002	5	0.0012-0.036
Deodorant (underarm)-Spray?[2]	9	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	23	NR	NR	0.0038	1	NR	NR	NR
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	25	NR	NR	NR	1	0.0005-0.001	1	0.0012
Baby Products	7	NR	NR	NR	NR	NR	NR	NR

Table 12. Frequency and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients. [9,10]

	# 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 Junos Peel Oil		**Citrus Junos Seed Extract**		**Citrus Junos Seed Oil**		**Citrus Limon (Lemon) Flower/Leaf/Stem Extract**	
Totals[1]	**6**	**NR**	**6**	**0.001-0.0045**	**NR**	**0.01-0.1**	**5**	**NR**
Duration of Use								
Leave-On	4	NR	6	0.001-0.0045	NR	0.01-0.1	5	NR
Rinse-Off	2	NR	NR	0.001	NR	NR	NR	NR
Diluted for (Bath) Use	NR	NR	NR	0.001	NR	NR	NR	NR
Exposure Type								
Eye Area	NR	NR	1	0.001	NR	NR	NR	NR
Incidental Ingestion	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	2	NR	5	NR	NR	0.01	5	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	1	NR	5	NR	NR	NR	5	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	6	NR	6	0.001-0.0045	NR	0.1	5	NR
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	NR	NR	NR	NR	NR	0.01	NR	NR
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	1	NR	NR	0.001	NR	NR	NR	NR
Baby Products	NR	NR	NR	NR	NR	NR	NR	NR

	Citrus Limon (Lemon) Fruit Extract		**Citrus Limon (Lemon) Fruit Water**		**Citrus Limon (Lemon) Juice**		**Citrus Limon (Lemon) Juice Extract**	
Totals[1]	**448**	**0.0001-1.2**	**NR**	**1**	**25**	**0.035-1**	**NR**	**0.05-0.2**
Duration of Use								
Leave-On	314	0.0001-1.2	NR	NR	9	0.05-1	NR	0.2
Rinse-Off	130	0.002-0.5	NR	1	16	0.035-0.05	NR	0.05
Diluted for (Bath) Use	4	NR	NR	NR	NR	NR	NR	NR
Exposure Type								
Eye Area	10	NR	NR	NR	NR	NR	NR	NR
Incidental Ingestion	3	0.03	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	224	0.001	NR	NR	9	0.05	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	194	NR	NR	NR	9	NR	NR	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	363	0.0001-1.2	NR	1	15	0.035-1	NR	0.05-0.2
Deodorant (underarm)-Spray?[2]	1	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	80	0.002-0.005	NR	NR	9	0.05	NR	NR
Hair-Coloring	NR	NR	NR	NR	1	NR	NR	NR
Nail	2	0.0001-0.5	NR	NR	NR	NR	NR	NR
Mucous Membrane	39	0.0028-0.04[e]	NR	NR	1	NR	NR	NR
Baby Products	NR	NR	NR	NR	NR	NR	NR	NR

Table 12. Frequency and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients. [9,10]

	# 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 Limon (Lemon) Peel Extract		**Citrus Limon (Lemon) Peel Oil**		**Citrus Limon (Lemon) Peel Powder**		**Citrus Limon (Lemon) Seed Oil**	
Totals[1]	**186**	**0.0001-0.51**	**510**	**0.0001-0.5**	**5**	**NR**	**9**	**NR**
Duration of Use								
Leave-On	79	0.0001-0.25	309	0.0001-0.5	2	NR	5	NR
Rinse-Off	107	0.0011-0.51	173	0.0006-0.001	3	NR	4	NR
Diluted for (Bath) Use	NR	NR	28	0.012	NR	NR	NR	NR
Exposure Type								
Eye Area	4	NR	9	NR	NR	NR	NR	NR
Incidental Ingestion	3	0.0005	8	NR	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	45	0.012	212	0.06	1	NR	2	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	42	0.012	167	0.06	1	NR	2	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	92	0.0001-0.51	432	0.0001-0.5	4	NR	9	NR
Deodorant (underarm)-Spray?[2]	1	NR	2	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	0.002	NR	NR	NR	NR
Hair - Non-Coloring	89	0.0011-0.01	67	NR	NR	NR	NR	NR
Hair-Coloring	1	NR	NR	NR	NR	NR	NR	NR
Nail	1	NR	3	0.0001-0.14	1	NR	NR	NR
Mucous Membrane	16	0.0005-0.51	99	0.001-0.012	2	NR	2	NR
Baby Products	NR	NR	8	NR	NR	NR	NR	NR

	Citrus Madurensis Fruit Extract		**Citrus Medica Limonum (Lemon) Fruit Water**		**Citrus Medica Limonum (Lemon) Juice Extract**		**Citrus Medica Limonum (Lemon) Peel Wax**	
Totals[1]	**NR**	**0.0005**	**3**	**NR**	**5**	**NR**	**3**	**NR**
Duration of Use								
Leave-On	NR	0.0005	2	NR	1	NR	1	NR
Rinse-Off	NR	NR	1	NR	4	NR	2	NR
Diluted for (Bath) Use	NR	0.0005	NR	NR	NR	NR	NR	NR
Exposure Type								
Eye Area	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Ingestion	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	NR	NR	2	NR	1	NR	1	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	NR	NR	1	NR	1	NR	1	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	NR	0.0005	3	NR	4	NR	3	NR
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	NR	NR	NR	NR	1	NR	NR	NR
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	NR	0.0005	1	NR	2	NR	2	NR
Baby Products	NR	NR	NR	NR	NR	NR	NR	NR

Table 12. Frequency and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients. [9,10]

	# 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 Medica Vulgaris Fruit Extract		**Citrus Nobilis (Mandarin Orange) Fruit Extract**		**Citrus Nobilis (Mandarin Orange) Oil**		**Citrus Nobilis (Mandarin Orange) Peel Extract**	
Totals[1]	**10**	**NR**	**26**	**0.001-0.04**	**35**	**0.075**	**24**	**0.00025-0.03**
Duration of Use								
Leave-On	6	NR	8	0.001-0.04	27	0.075	10	0.0025-0.009
Rinse-Off	4	NR	17	0.001-0.04	4	NR	14	0.00025-0.03
Diluted for (Bath) Use	NR	NR	1	NR	4	NR	NR	0.0005-0.0025
Exposure Type								
Eye Area	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Ingestion	NR	NR	NR	NR	1	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	6	NR	8	0.001-0.01	14	NR	7	NR
Confirmed Spray[3]	NR	NR	NR	0.0075[f]	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	2	NR	5	NR	7	NR	6	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	8	NR	15	0.0018-0.04	34	0.075	17	0.0005-0.03
Deodorant (underarm)-Spray?[2]	1	NR	1	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	2	NR	11	0.001-0.01	NR	NR	7	0.00025-0.005
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	4	NR	6	0.002-0.04	7	NR	6	0.0005-0.0025
Baby Products	NR	NR	NR	NR	2	NR	NR	NR

	Citrus Nobilis (Mandarin Orange) Peel Oil		**Citrus Nobilis (Mandarin Orange) Water**		**Citrus Paradisi (Grapefruit) Fruit Extract**		**Citrus Paradisi (Grapefruit) Peel Extract**	
Totals[1]	**151**	**0.00005-0.1**	**1**	**NR**	**46**	**0.005-1.5**	**NR**	**0.0017-0.0068**
Duration of Use								
Leave-On	89	0.00005-0.1	NR	NR	30	0.05-1.5	NR	0.0017
Rinse-Off	54	0.00005-0.03	1	NR	16	0.005-0.2	NR	0.0068
Diluted for (Bath) Use	8	NR	NR	NR	NR	NR	NR	NR
Exposure Type								
Eye Area	NR	NR	NR	NR	2	NR	NR	NR
Incidental Ingestion	1	0.0099	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	77	NR	NR	NR	18	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	68	NR	NR	NR	16	NR	NR	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	136	0.00005-0.1	1	NR	44	0.05-1.5	NR	0.0017-0.0068
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	14	0.00005-0.03	NR	NR	2	0.005	NR	NR
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	0.012	NR	NR	NR	NR	NR	NR
Mucous Membrane	39	0.0099	1	NR	3	NR	NR	NR
Baby Products	NR	NR	NR	NR	NR	NR	NR	NR

Table 12. Frequency and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients. [9,10]

	# 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 Paradisi (Grapefruit) Peel Oil		**Citrus Paradisi (Grapefruit) Seed Extract**		**Citrus Paradisi (Grapefruit) Seed Oil**		**Citrus Reticulata (Tangerine) Fruit Extract**	
Totals[1]	**224**	**0.00068-0.5**	**38**	**NR**	**8**	**NR**	**8**	**NR**
Duration of Use								
Leave-On	136	0.00068-0.5	29	NR	4	NR	3	NR
Rinse-Off	78	NR	9	NR	4	NR	4	NR
Diluted for (Bath) Use	10	NR	NR	NR	NR	NR	1	NR
Exposure Type								
Eye Area	1	NR	NR	NR	NR	NR	1	NR
Incidental Ingestion	1	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	107	NR	24	NR	4	NR	1	NR
Confirmed Spray[3]	NR	0.00068[g]	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	83	NR	24	NR	3	NR	1	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	191	0.5	38	NR	4	NR	5	NR
Deodorant (underarm)-Spray?[2]	1	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	32	0.00068	NR	NR	4	NR	3	NR
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	45	NR	6	NR	1	NR	2	NR
Baby Products	3	NR	2	NR	NR	NR	1	NR

	Citrus Reticulata (Tangerine) Leaf Oil		**Citrus Reticulata (Tangerine) Peel Extract**		**Citrus Sinensis (Sweet Orange) Fiber**[6]		**Citrus Sinensis (Sweet Orange) Flower Oil**[6]	
Totals[1]	**38**	**NR**	**22**	**NR**	**3**	**NR**	**2**	**NR**
Duration of Use								
Leave-On	22	NR	17	NR	3	NR	NR	NR
Rinse-Off	12	NR	5	NR	NR	NR	2	NR
Diluted for (Bath) Use	4	NR	NR	NR	NR	NR	NR	NR
Exposure Type								
Eye Area	1	NR	4	NR	NR	NR	NR	NR
Incidental Ingestion	1	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	16	NR	11	NR	3	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	13	NR	11	NR	3	NR	NR	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	34	NR	22	NR	3	NR	NR	NR
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	3	NR	NR	NR	NR	NR	2	NR
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	10	NR	3	NR	NR	NR	NR	NR
Baby Products	1	NR	NR	NR	NR	NR	NR	NR

Table 12. Frequency and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients. [9,10]

	# 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 Sinensis (Sweet Orange) Fruit Extract		**Citrus Sinensis (Sweet Orange) Fruit Water**		**Citrus Sinensis (Sweet Orange) Juice[6]**		**Citrus Sinensis (Sweet Orange) Peel Extract[6]**	
Totals[1]	**2**	**NR[6]**	**1**	**NR**	**1**	**NR**	**1**	**NR**
Duration of Use								
Leave-On	NR	NR	NR	NR	1	NR	NR	NR
Rinse-Off	2	NR	1	NR	NR	NR	1	NR
Diluted for (Bath) Use	NR	NR	NR	NR	NR	NR	NR	NR
Exposure Type								
Eye Area	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Ingestion	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	NR	NR	NR	NR	1	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	NR	NR	NR	NR	1	NR	NR	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	1	NR	1	NR	1	NR	1	NR
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	1	NR	NR	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	1	NR	NR	NR	NR	NR	NR	NR
Baby Products	NR	NR	NR	NR	NR	NR	NR	NR

	Citrus Sinensis (Sweet Orange) Peel Oil		**Citrus Sinensis (Sweet Orange) Plant Oil[6]**		**Citrus Sinensis (Sweet Orange) Powder[6]**		**Citrus Sinensis Sanguinello (Blood Orange) Peel Oil[6]**	
Totals[1]	**301**	**NR**	**2**	**NR**	**1**	**NR**	**8**	**NR**
Duration of Use								
Leave-On	164	NR	1	NR	1	NR	4	NR
Rinse-Off	114	NR	1	NR	NR	NR	4	NR
Diluted for (Bath) Use	23	NR	NR	NR	NR	NR	NR	NR
Exposure Type								
Eye Area	2	NR	NR	NR	NR	NR	NR	NR
Incidental Ingestion	3	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	131	NR	1	NR	1	NR	4	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	100	NR	1	NR	1	NR	3	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	230	NR	2	NR	1	NR	8	NR
Deodorant (underarm)-Spray?[2]	4	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	63	NR	NR	NR	NR	NR	NR	NR
Hair-Coloring	3	NR	NR	NR	NR	NR	NR	NR
Nail	2	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	57	NR	1	NR	NR	NR	4	NR
Baby Products	8	NR	NR	NR	NR	NR	NR	NR

Table 12. Frequency and concentration of use (2013) according to duration and type of exposure for Citrus-derived ingredients. [9,10]

	# 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 Tachibana Peel Extract[6]		**Citrus Tangerina (Tangerine) Extract**		**Citrus Tangerina (Tangerine) Peel Oil**		**Citrus Unshiu Peel Extract**	
Totals[1]	**8**	**NR**	**20**	**NR**	**41**	**0.0000013**	**39**	**0.000002-0.094**
Duration of Use								
Leave-On	7	NR	9	NR	19	0.0000013	31	0.0002-0.094
Rinse-Off	1	NR	11	NR	21	0.0000013	7	0.000002-0.094
Diluted for (Bath) Use	NR	NR	NR	NR	1	NR	1	0.03
Exposure Type								
Eye Area	NR	NR	NR	NR	NR	NR	4	0.000002-0.002
Incidental Ingestion	NR	NR	NR	NR	1	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	5	NR	7	NR	14	0.0000013	23	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	5	NR	3	NR	14	NR	23	NR
Confirmed Powder[3]	NR	NR	NR	NR	NR	NR	NR	NR
Dermal Contact	8	NR	10	NR	32	NR	38	0.000002-0.094
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR	NR	NR	NR	NR
Hair - Non-Coloring	NR	NR	10	NR	8	0.0000013	1	NR
Hair-Coloring	NR	NR	NR	NR	NR	NR	NR	NR
Nail	NR	NR	NR	NR	NR	NR	NR	NR
Mucous Membrane	NR	NR	3	NR	7	NR	2	0.03
Baby Products	NR	NR	NR	NR	NR	NR	NR	NR

	Kaffir Lime (Citrus Hystrix) Leaf Oil[6]		**Mandarin Orange (Citrus Nobilis) Fruit Juice**	
Totals[1]	**24**	**NR**	**12**	**NR**
Duration of Use				
Leave-On	11	NR	1	NR
Rinse-Off	11	NR	8	NR
Diluted for (Bath) Use	2	NR	3	NR
Exposure Type				
Eye Area	NR	NR	NR	NR
Incidental Ingestion	NR	NR	NR	NR
Incidental Inhalation-Spray?[2,5]	5	NR	1	NR
Confirmed Spray[3]	NR	NR	NR	NR
Incidental Inhalation-Powder?[4,5]	4	NR	1	NR
Confirmed Powder[3]	NR	NR	NR	NR
Dermal Contact	19	NR	9	NR
Deodorant (underarm)-Spray?[2]	NR	NR	NR	NR
Confirmed Spray[3]	NR	NR	NR	NR
Not Spray	NR	NR	NR	NR
Hair - Non-Coloring	5	NR	3	NR
Hair-Coloring	NR	NR	NR	NR
Nail	NR	NR	NR	NR
Mucous Membrane	8	NR	8	NR
Baby Products	NR	NR	1	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 has been confirmed by the Council.
4. It is possible these products may be powders, but it is not specified whether the reported uses are powders.
5. Not specified whether a powder or a spray, so this information is captured for both categories of incidental inhalation.
6. Not listed as an INCI name; included because of similarity

a. 0.000001% in a pump hair spray.
b. 0.0025% in a propellant hair spray; 0.0025% in a pump hair spray.
c. 0.001% in a pump hair spray.
d. 0.0005% in a body and hand spray product.
e. 0.039% in a hand scrub.
f. 0.0075% in a body and hand spray product.
g. 0.00068% in a pump hair spray.

Table 13. Ingredients that are not reported to be in use

Citrus Aurantifolia (Lime)/Citrus Limon (Lemon) Fruit Water
Citrus Aurantifolia (Lime) Fruit
Citrus Aurantifolia (Lime) Fruit Water
Citrus Aurantifolia (Lime) Leaf Oil
Citrus Aurantifolia (Lime) Peel Oil
Citrus Aurantifolia (Lime) Peel Water
Citrus Aurantifolia (Lime) Seed Oil
Citrus Aurantifolia (Lime) Seed Oil Unsaponifiables
Citrus Aurantium Amara (Bitter Orange) Fruit Juice Extract
Citrus Aurantium Amara (Bitter Orange) Leaf/Twig Extract
Citrus Aurantium Amara (Bitter Orange) Peel
Citrus Aurantium Bergamia (Bergamot) Fruit Water
Citrus Aurantium Bergamia (Bergamot) Leaf Extract
Citrus Aurantium Bergamia (Bergamot) Leaf Oil
Citrus Aurantium Bergamia (Bergamot) Peel Oil
Citrus Aurantium Bergamia (Bergamot) Peel Water
Citrus Aurantium Currassuviensis Peel Oil
Citrus Aurantium Dulcis (Orange) Flower
Citrus Aurantium Dulcis (Orange) Flower/Leaf/Stem Powder
Citrus Aurantium Dulcis (Orange) Flower Wax
Citrus Aurantium Dulcis (Orange) Fruit Powder
Citrus Aurantium Dulcis (Orange) Seed Extract
Citrus Aurantium Dulcis (Orange) Seed Oil
Citrus Aurantium Dulcis (Orange) Seed Oil Unsaponifiables
Citrus Aurantium Sinensis (Orange) Fiber
Citrus Aurantium Sinensis Peel Extract
Citrus Aurantium Sinensis Powder
Citrus Clementina Fruit Extract
Citrus Clementina Juice
Citrus Clementina Peel Oil
Citrus Depressa Fruit Extract
Citrus Depressa Fruit Water
Citrus Depressa Peel Powder
Citrus Grandis (Grapefruit) Leaf Extract
Citrus Grandis (Grapefruit) Peel
Citrus Grandis (Grapefruit) Peel Powder
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 Hassaku/Natsudaidai Peel 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 Pericarp Extract
Citrus Junos Extract
Citrus Junos Fruit Juice
Citrus Junos Fruit Oil
Citrus Junos Fruit Powder
Citrus Junos Fruit Water
Citrus Junos Peel Powder
Citrus Junos Peel Water
Citrus Limon (Lemon) Flower/Leaf/Stem Oil
Citrus Limon (Lemon) Fruit Oil
Citrus Limon (Lemon) Fruit Powder
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 Water
Citrus Madurensis Fruit Juice
Citrus Medica Vulgaris Peel Oil
Citrus Natsudaidai Peel Extract
Citrus Nobilis (Mandarin Orange)
Citrus Nobilis (Mandarin Orange) Peel Powder
Citrus Paradisi (Grapefruit) Fruit Water
Citrus Paradisi (Grapefruit) Juice
Citrus Reticulata (Tangerine) Fruit
Citrus Reticulata (Tangerine) Fruit Water
Citrus Reticulata (Tangerine) Leaf Water
Citrus Reticulata (Tangerine) Peel Oil
Citrus Reticulata (Tangerine) Peel Powder
Citrus Shunkokan Fruit Extract
Citrus Shunkokan Peel Extract
Citrus Sphaerocarpa Fruit Juice
Citrus Sudachi Fruit Extract
Citrus Sudachi Fruit Juice
Citrus Sunki Peel Extract
Citrus Tachibana/Reticulata Fruit Juice
Citrus Tachibana/Reticulata Peel Oil
Citrus Tachibana/Reticulata Peel Powder
Citrus Tamurana Flower Extract
Citrus Tangelo Fruit Juice
Citrus Tangelo Fruit Powder
Citrus Tangelo Peel Powder
Citrus Tangerina (Tangerine) Fruit
Citrus Tangerina (Tangerine) Fruit Water
Citrus Tangerina (Tangerine) Peel
Citrus Tangerina (Tangerine) Peel Extract
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 Powder
Citrus Unshiu Peel Water
Citrus Unshiu Pericarp Extract
Citrus Unshiu/Sinensis/Reticulata Fruit Extract
Microcitrus Australasica Fruit Extract
Microcitrus Australis Fruit Extract

Table 14. Dermal irritation studies for Citrus-derived ingredients

Test Article	Concentration/Dose	Test Population	Procedure	Results	Reference
		NON-HUMAN			
Citrus Aurantium Dulcis (Orange) Peel Wax	100%	details not provided	MATREX in vitro toxicity testing system; details not provided	no irritation	[6,8]
Citrus Aurantium Amara (Bitter Orange) Flower Wax	neat	6 New Zealand male rabbits	primary cutaneous tolerance test ; test material applied to scarified and intact shaved skin with 2.5 cm^2 occluded patches for 24 h	moderate irritation reactions (erythema) that were totally reversible by 72 h; reactions were accompanied by minor, isolated structural modifications	[45]
either bitter orange or citrus reticulata (tangerine) leaf oil (described as "petitgrain bigarade oil")	2g/kg	2 rabbits	24-h occlusive, single dose study	slight erythema	[25]
mandarin peel oil, expressed (described as *Citrus reticulata*)	5 mg/kg	7 rabbits	24-h occlusive, single dose study	slight erythema and edema	[5]
mandarin peel oil, expressed (described as *Citrus reticulata*)	not reported	hairless mice and miniature swine; details not provided	open patch tests; details not provided	2 of 3 samples were irritating	[5]
		HUMAN			
Citrus Aurantium Dulcis (Orange) Peel Wax	100%	details not provided	48 h patch test; details not provided	no irritation	[6,8]
bergamot oil	0.3%, 2% or 15%; multiple vehicles	304 subjets at 0.3%, 30 subjects at 2%, and 29 subjects at 15%	24-72 h occlusive patch tests	no irritation at 2% or 15%, 3 ±, and 9 + reactions at 0.3%	[46]
either bitter orange or citrus reticulata (tangerine) leaf oil (described as "petitgrain bigarade oil")	0.1%, 2% or 5%; multiple vehicles	48 subjects at 0.1%, 30 subjects at 2%, and 30 subjects at 5%	24-72 h occlusive patch tests	no irritation	[46]
either bitter orange or citrus reticulata (tangerine) leaf oil (described as "petitgrain bigarade oil")	8%, vehicle not specified	25 subjects	48 h occlusive patch applied to the forearm or back	no irritation	[25]
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%	[46]
mandarin peel oil, expressed (described as *Citrus reticulata*)	8% in petrolatum	5 subjects	48 h closed patch test; details not provided	no irritation	[5]

Table 15. Sensitization studies for Citrus-derived ingredients

Test Article	Concentration/Dose	Test Population	Procedure	Results	Reference
		HUMAN			
bergamot 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	[47]
either bitter orange or citrus reticulata (tangerine) leaf oil (described as "petitgrain bigarade 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	[47]
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	[47]
either bitter orange or citrus reticulata (tangerine) leaf oil (described as "petitgrain bigarade oil")	8% in petrolatum	25 subjects	maximization study, details not provided	not sensitizing	[25]
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	[47]
mandarin oil, expressed (described as *Citrus reticulate*)	8% in petrolatum	25 subjects	maximization study, details not provided	not sensitizing	[5]
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	[47]

Table 16. Photosensitization and phototoxicity studies

Test Article	Concentration/Dose	Test Population	Procedure	Results	Reference
			ALTERNATIVE STUDIES		
bergamot oil	concentrations not reported; tested in phosphate buffered saline (PBS), ethanol, or dimethyl sulfoxide (DMSO) with samples from 4 suppliers	3T3 Balb/c fibroblasts	-3T3 neutral red uptake phototoxicity test -light source was a doped mercury-metal halide lamp, filtered with 50% transmission at 335 nm to diminish UVB	borderline phototoxic, dependent on solvent type	[48]
orange oil, including deterpenated kind	concentrations not reported; tested in PBS, ethanol, or DMSO with samples from 3 suppliers	same as above	same as above	borderline phototoxic, dependent on solvent type	[49]
lemon oil, including deterpenated kind	same as above	same as above	same as above	borderline phototoxic, dependent on solvent type	[49]
bergamot oil	up to 3.16% in water; up to 10.0% in sesame oil with samples from 4 suppliers	reconstructed human skin	-EpiDerm skin phototoxicity test -irradiated with 6 J/cm^2 in the UVA range -light source was a doped mercury-metal halide lamp, filtered with 50% transmission at 335 nm to diminish UVB	phototoxic, although no precise prediction of safe, non-phototoxic concentrations	[48]
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	[49]
lemon oil, including deterpenated kind	same as above	same as above	same as above	cytotoxicity observed with deterpneated lemon oil; potential for phototoxicity observed	[49]
			NON-HUMAN		
bergamot oil	undiluted	male albino Hartley guinea pigs, 4/wavelength tested	-test material (30 µl) was applied for 1 h to 4 sites on clipped, depilated back skin of animals -another 4 sites were treated with solvent or untreated and served as controls -after pretreatment, the skin was exposed to monochromatic light at 4 different intensities -light source was a monochromator composed of a 5kW Xenon lamp with continuously variable wavelengths 200-700 nm, with an irradiance plane at exit 0.74 mW/cm^2 ·sec at 280 nm and 1.35 mW/cm^2 ·sec at 335 nm -skin specimens excised at 24 h post irradiation and reviewed microscopically for number of sunburn cells	-exposure to UVB radiation at 280, 295, or 310 nm induced dose-dependent increases in sunburn cells, with or without pretreatment with bergamot oil; no significant differences in regression coefficients were observed between the bergamot-oil treated and control sites -exposure to UVA radiation at 325, 335, 345, 350, or 365 nm induced many sunburn cells in bergamot oil treated sites, but not in untreated sites; regression coefficients indicated that the action spectrum for bergamot-oil induced sunburn cell formation was in the range of 325-365 nm, with a peak at 335-345 nm	[50]
either bitter orange or citrus reticulata (tangerine) leaf oil (described as “petitgrain bigarade oil”)	undiluted	hairless mice or miniature swine (#/group not stated)	test material was applied, and the test sites were irradiated with UVA irradiation by blacklight or xenon lamp	not photosensitizing	[51]

Table 16. Photosensitization and phototoxicity studies

Test Article	Concentration/Dose	Test Population	Procedure	Results	Reference
bergamot oil, expressed	undiluted and diluted; 20 µl	hairless mice, 6/grp	- a single dose was applied to a 2 cm^2 area on the back; subjects were exposed to irradiation 30 min after dosing - one group was exposed to a compact-arc xenon lamp for 2 min (wavelengths <295 nm or 320-280 nm excluded) - one group was exposed to a long-arc xenon lamp for 40 min at a distance of 1 m; the weighted erythemal energy was 0.1667 W/m^2 - one group was exposed to 4 fluorescent black light lamps (UVB eliminated) for 1 h at an integrated UVA intensity of 3 W/m^2 -positive controls were treated with 0.01% 8-methoxypsoralen in methanol; negative controls with an appropriate vehicle - test sites were examined 4, 24, 48, 72, and 96 h after exposure	- a phototoxic response was observed with all three light sources - the lowest phototoxic concentration was 10%	51
bergamot oil, expressed	undiluted and diluted; 20 µl	miniature swine, 2/grp	as above	- a phototoxic response was observed with all three light sources - the lowest phototoxic concentration was 20%	51
bergamot oil, twice rectified (bergapten-free)	undiluted; 20 µl	hairless mice, 6/grp	as above	- a phototoxic response was not observed with any of the light sources	51
bergamot oil, twice rectified (bergapten-free)	undiluted; 20 µl	miniature swine, 2/grp	as above	- a phototoxic response was not observed with any of the light sources	51
lime oil, distilled (psoralen-free)	undiluted; 20 µl	hairless mice, 6/grp	as above	- a phototoxic response was not observed with any of the light sources	51
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	51
lime oil, expressed	undiluted and diluted; 20 µl	hairless mice, 6/grp	as above	- a phototoxic response was observed with all three light sources - the lowest phototoxic concentration was 15%	51
lime oil, expressed	undiluted and diluted; 20 µl	miniature swine, 2/grp	as above	- a phototoxic response was observed with all three light sources - the lowest phototoxic concentration was 30%	51
bergamot oil, twice rectified (free of furocoumarin)	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- a single dose was applied to a 2 cm^2 area on the back - 30 min after dosing, the animals were exposed to UVA irradiation by a long-arc xenon lamp for 40 min at a distance of 1 m (weighted erythemal energy was 0.1667 W/m2) or 4 fluorescent blacklight lamps for 1 h (integrated UVA intensity of 3 W/m^2)	not photosensitizing	51
grapefruit oil	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	not photosensitizing	51

Table 16. Photosensitization and phototoxicity studies

Test Article	Concentration/Dose	Test Population	Procedure	Results	Reference
bergamot oil (free of furocoumarin)	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	not photosensitizing	[51]
lime oil distilled (psoralen-free)	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	not photosensitizing	[51]
lime oil; expressed and rectified	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	not photosensitizing	[51]
lime oil Persian Florida; expressed and rectified	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	not photosensitizing	[51]
mandarin oil	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	not photosensitizing	[51]
mandarin oil, Italian	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	not photosensitizing	[51]
oil of lemon, California	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	not photosensitizing	[51]
oil of lemon, distilled	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	not photosensitizing	[51]
oil lemon petitgrain	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	not photosensitizing	[51]
oil mandarin, Italian	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	not photosensitizing	[51]
oil of tangerine	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	not photosensitizing	[51]
orange oil; cold pressed	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	not photosensitizing	[51]
bergamot oil, expressed (4samples)	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	- a phototoxic response was observed	[51]
California lemon oil	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	- a phototoxic response was observed	[51]
Italian lemon oil	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	- a phototoxic response was observed	[51]
oil lemon, Greek; cold pressed	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	- a phototoxic response was observed	[51]
oil lemon, Italian	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	- a phototoxic response was observed	[51]
oil lemon, IC	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	- a phototoxic response was observed	[51]
lime oil expressed	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	- a phototoxic response was observed	[51]

Table 16. Photosensitization and phototoxicity studies

Test Article	Concentration/Dose	Test Population	Procedure	Results	Reference
oil limes Persian	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	- a phototoxic response was observed	51
oil limes, expressed and rectified	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	- a phototoxic response was observed	51
lime oil, expressed and rectified	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	- a phototoxic response was observed	51
bitter orange oil	undiluted; 20 µl	6 hairless mice and 2 miniature swine	- as above	- a phototoxic response was observed	51
lemon fruit juice and lemon peel juice (Tahitian and Sicilian varieties)	undiluted; liberally applied	3 adult rats (strain not specified) per group	-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 -rats were placed in plastic tubes with eight orifices to allow natural sunlight through - exposure to sunlight was 2.5, 5 , 7.5, or 10 min -experiment repeated with Tahitian variety lemon peel juice with sun block SPF 45, UVA and UVB -biopsies performed for each time period for histopathological studies and photodocumentation	-phytophotodermatitis observed after 48 h after exposure to both types of peel juice -no reactions observed to peel juice without sun exposure or to sun exposure alone -minimum exposure time of 2.5 min sufficient to induce phototoxic reaction, with longer exposures causes more intense reactions -histopathological studies showed epithelial time-dependent vacuolar degeneration -sunblock diminished reaction intensity, but did not prevent it	52
lemon peel juice (Tahitian variety)	undiluted; liberally applied	4 albino rats	-epilated right half of back of rats was sprayed with peel juice -one quadrant exposed to natural sunlight for 5 min and the other for 8 min; -left back served as control -biopsies taken after 1, 2, 3, 4, 5, 6, 24, 48, and 72 h from both sides	-normal epidermis observed for first 6 time intervals on both sides -after 24 h, treated area showed keratinocyte necrosis, cytoplasmic vacuolization and spongiosis in all rats, independent of exposure time -after 48 h, erythema evident, strong vacuolization observed that progressed to sub- or intraepidermal blisters -erythema persisted after 72 h at a lesser intensity -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	53
lemon oil from multiple regional sources	20, 50, or 100% in ethanol	albino guinea pigs	- the oil was applied to the shaved back of the animals - the animals were then exposure to UVA radiation (320-400 nm, 13 J/cm^2) - erythema was evaluated 24, 48, and 72 h after irradiation - 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 - lemon oils from different regions had different phototoxicity potencies -oxypeucedanin and 5-methoxypsoralen (furocoumarins) were identified as phototoxic	54

Table 16. Photosensitization and phototoxicity studies

Test Article	Concentration/Dose	Test Population	Procedure	Results	Reference
lemon peel juice (Tahitian variety)	undiluted	4 adult rats (strain not specified)	-test material was applied to depilated skin on the right side of the animal's back, left side served as a control -animals exposed for 8 min to mid-day sunlight -biopsies performed immediately after induction and after 1 and 2 h and evaluated by transmission electron microscopy -at 24 and 48 h after induction, light microscopy performed on tissues to evaluate changes	-no histological changes observed on control sites -immediately after induction, keratinocyte cytoplasmatic vacuolization and membrane ruptures near vacuolization sties were observed -at 1 h after, desmosomal changes observed in addition to vacuolization, keratin filaments were not attached to demosomal plaques, and free demosomes and membrane ruptures were observed -at 2 h after, similar changes were observed in addition to granular degeneration of keratin	55
sweet orange peel, mesocarp, and fruit and alcohol extractions of all 3	undiluted	*Candida albicans*	-pure peel, mesocarp, and fruit were placed directly in Petri dishes inoculated with Candida -20 µl extracts of the 3 orange sources were placed on filter paper discs that were then placed directly in Petri dishes inoculated with Candida - dishes 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^2 -controls kept in dark -results noted at 24 and 48 h	-pure orange peel and orange peel extract inhibited growth (2 mm) in UV-irradiated Candida -no inhibition observed in UV-irradiated Candida exposed to mesocarp or fruit, or in controls	56
			HUMAN		
bitter orange peel oil	undiluted; 5 µl/cm^2	8 subjects	- an occlusive patch was applied to a 2 cm x 2 cm area - 1 cm site on each subject was exposed to visible light t of 20 J/cm^2 UVA - the test sites were scored after 24 and 48 h	all subjects reacted (details not provided)	18
bergamot oil	up to 10% in sesame oil and up to 1% in water from samples from 4 suppliers	5 female subjects	-2occlusive 10 mm diameter Finn Chambers on both sides of the lower back -exposure time to test material was 1 h -irradiation immediately to 1 site after patch removal at a dose of 5 J/cm^{2}as measured in the UVA range -test sites scored after 24, 48, and 72 h -light source was a doped mercury-metal halide lamp, filtered with 50% transmission at 335 nm to diminish UVB	-all subjects had positive reactions at all 3 time periods to bergamot in water at 0.1% and 0.0316% from 2 suppliers; however, no reactions were observed at 1% in water from 2 other suppliers -no reactions observed to bergamot oil in sesame oil	48
lemon oil, including deterpenated kind	up to 1% in water from samples from 3 suppliers	5 female subjects	-same as above	-phototoxic reactions concurrent with an irritation reactions were observed in lemon oil at 1% in 4/5 subjects up to 72 h after irradiation -phototoxic reactions were observed in deterpenated lemon oil at 0.1% in 2/5 subjects at 48 and 72 h after irradiation -no reactions were observed at concentrations of 0.1% or lower in lemon oil and 0.01% in deterpenated lemon oil	49

Table 16. Photosensitization and phototoxicity studies

Test Article	Concentration/Dose	Test Population	Procedure	Results	Reference
orange oil, including deterpenated 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 -no reactions were observed at concentrations of 0.1% or lower in orange oil or 0.1% and 0.01% in deterpenated orange oil	[49]
bergamot oil, expressed	undiluted and diluted; 20 µl	10 Caucasian subjects	- a single dose was applied to a 2 cm^2 area on the back - 30 min after dosing, subjects 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^2 -positive controls were treated with 0.01% 8-methoxypsoralen in methanol; negative controls with an appropriate vehicle - test sites were examined 4, 24, 48, 72, and 96 h after exposure	- a phototoxic response was observed with all three light sources - the lowest phototoxic concentration with the simulated light sources was 20%	[51]
bergamot oil, twice rectified	undiluted	10 Caucasian subjects	- a single dose was applied to a 2 cm^2 area on the back - 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) -positive controls were treated with 0.01% 8-methoxypsoralen in methanol; negative controls with an appropriate vehicle - test sites were examined 4, 24, 48, 72, and 96 h after exposure	no phototoxic response was observed	[51]
lime oil, distilled	undiluted	10 Caucasian subjects	- a single dose was applied to a 2 cm^2 area on the back - 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) -positive controls were treated with 0.01% 8-methoxypsoralen in methanol; negative controls with an appropriate vehicle - test sites were examined 4, 24, 48, 72, and 96 h after exposure	no phototoxic response was observed	[51]
lime oil, expressed	undiluted and diluted; 20 µl	10 Caucasian subjects	- a single dose was applied to a 2 cm^2 area on the back - 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^2 -positive controls were treated with 0.01% 8-methoxypsoralen in methanol; negative controls with an appropriate vehicle - test sites were examined 4, 24, 48, 72, and 96 h after exposure	- a phototoxic response was observed with all three light sources - the lowest phototoxic concentration with the simulated light sources was 30%	[51]

Table 16. Photosensitization and phototoxicity studies

Test Article	Concentration/Dose	Test Population	Procedure	Results	Reference
Citrus Aurantium Dulcis (Orange) Peel Wax	100% undiluted	11 subjects, fair skinned with skin types I-III	- 2 sites treated with 0.2 ml of the test material and 1 site was untreated; patches were occluded and applied to the back - 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). - test sites were examined 15 min, 24 h, and 48 h after irradiation	no phototoxic response was observed	[57]
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	-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 -closed patches were 1 h in duration - 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^2 - test sites were examined 8, 24, 48, 72, and 96 h after irradiation	-strong erythema (++) observed in 2 subjects with type 1 skin and strong erythema and infiltration (+++) observed in 1 subject with type I skin after48 h after irradiation and exposure to pure peel and peel extract -slight erythema observed in all 3 type I subjects after exposure to pure peel and peel extract with no sun exposure after 48 h -no reactions observed to mesocarp or fruit, either pure or extract -no reactions induced in the type II skin subject	[56]

Table 17. Case studies

Mode of Contact	Patient(s)	Indication	Reference
bergamot aromatherapy oil followed by several hours of sun exposure	54-year-old woman with Fitzpatrick skin type III	-painful, red, edematous, sharply demarcated areas with bullae and crusting on the face in a butterfly-like distribution	[58]
bergamot aromatherapy oil (6 drops) in a bath followed by 20-30 minutes UV exposure from a tanning bed	33-year-old woman	-48 h after exposure, developed increasing erythema and blistering of exposed areas -admitted to hospital burn unit with approximately 70% superficial partial thickness burns	[59]
bergamot aromatherapy oil aerosolized in a sauna followed by UVA radiation from a tanning bed	41-year-old woman with Fitzpatrick skin type II	-disseminated, painful, red, edematous, sharply demarcated areas with bullae mainly on the face, neck, arms, palms, and thighs	[58]
limeade made from the juice of Mexican limes for at least 15 min in duration; minimal sunlight exposure for 1 h while swimming outdoors	6-year-old boy	-initial presentation was marked symmetric, painful erythema of both hands that abruptly stopped at the wrists; skin had a wrinkled appearance similar of an early second-degree burn or severe contact allergy -8 h later, dramatic bullae developed over the dorsum of both hands	[60]
fresh limes used in an arts-and-crafts activity at a summer camp	12 children initially	-skin eruptions consistent with phototoxic dermatitis confined to hands, wrists, and forearms -eruptions observed as discreet and confluent polymorphous patches and linear streaks -eruptions were also macular, hyperpigmented, and nonpruritic -clinical examination of 622 children, 104 counselors, and 57 adult staff at the camp found 97 (16%) of the children, 7 of the counselors (7%), and none of the adult staff with a similar rash	[61]
fresh limes and lime juice while making salsa on vacation in the Bahamas	28-year-old male active duty sailor	-hyperpigmented macules on the dorsa of both hand and right forearm; macules were uniformly brown in color and well demarcated with minimal erythema -lesions were observed near the knuckles and between the thumb and forefinger, with guttate macules scattered along the radial right forearm -large bullous lesion also developed on the dorsum of the patient's left hand -no reactions were observed on the palms and there were no other related cutaneous mucosal lesions -based on physical examination and patient history, the patient was diagnosed with phytophotodermatitis.	[62]

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