

European Directive Fragrances in Natural Products

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Information on the presence of European Directive fragrance (EUF) allergens in plants and foods is important for numerous reasons. If an individual is allergic to an EUF and is avoiding fragrance, it is possible that they may still be exposed to the allergen in a natural product. In addition, because many of these allergens are also found in foods, it is possible that ingestion of a food containing the allergen may induce systemic contact allergy. Finally, individuals with lip dermatitis may react to contact with foods that contain the allergen. In this article, we have used the data available to identify which plants and foods contain EUF. When available, concentrations of EUF in natural products are provided. The goal of this article is to narrow down the list of botanicals to avoid for specific EUF allergies.

The European Directive requires that all cosmetic products sold in Europe should have a list of the presence of 26 specific fragrance ingredients (European Directive fragrance [EUF]) known to cause contact allergy. In the United States, there is no similar labeling law; however, many products (especially hair products) have been following the European Directive voluntarily. Some of the EUFs are artificially produced. However, most are also found naturally in various plants and foods.

Information on the presence of these fragrance allergens in plants and foods is important for several different reasons. First, if an individual is allergic to an EUF and is avoiding fragrance, it is possible that they may still be exposed to the allergen in a natural product. In addition, because many of these allergens are also found in foods, it is possible that ingestion of a food containing the allergen may induce systemic contact allergy. Finally, individuals with lip dermatitis may react to contact with foods that contain the allergen.

A patient with fragrance allergy will commonly be advised to avoid botanical fragrances. However, there is a paucity of information in the medical literature regarding which botanicals contain EUF. Furthermore, the concentration of EUF in botanicals is rarely specified and in some cases may be below the threshold necessary to induce contact allergy.

In this article, we have used the data available to identify which plants and foods contain EUF. When available, concentrations of EUFs in natural products are provided. The goal of this article is to narrow down the list of botanicals to avoid for specific EUF allergies.

METHODS

Online resources were used to identify which plants and foods contain each of the EUF ingredients. Using this information, summary tables were compiled listing specific natural substances and foods to avoid for each EUF.

Synthetic Fragrances in the European Directive

Eight of the 26 EUF ingredients are synthetic, and we found no evidence for the presence of any of these in natural products. These fragrances include α -isomethyl ionone, amyl cinnamaldehyde (amyl cinnamal), amyl cinnamyl alcohol, benzyl cinnamate, butylphenyl methylpropional (lilial), hexyl cinnamaldehyde (hexyl cinnamal), hydroxyisohexyl-3-cyclohexene carboxaldehyde (Lyrall), and methyl heptin carbonate. There do not seem to be any specific natural products that would need to be avoided by individuals sensitive to these. However, for lip dermatitis or suspected systemic contact allergy, hexyl cinnamal has been used in fruit and honey flavorings.¹ Amyl cinnamal has a jasmine-like odor and is used in fruit and walnut flavorings.¹

Cinnamic Aldehyde

Cinnamic aldehyde occurs in cinnamon, cassia (Chinese cinnamon), hyacinth, myrrh, rose, patchouli, and in the fungus *Stereum subpileatum*.² It is the compound that gives cinnamon its characteristic flavor and odor.³ Cinnamon bark oil is around 90% cinnamic aldehyde.³

Cinnamic Alcohol

Cinnamic alcohol is found in esterified form in cinnamon and balsam of Peru.⁴ It has also been reported to be found in hyacinth, daffodil, and benzoin.⁵ Cinnamic alcohol is used in fruit and brandy flavorings.⁵

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Cinnamic Aldehyde and Cinnamic Alcohol Avoidance Recommendations

These 2 compounds are closely related, and it is recommended that individuals allergic to these substances avoid cinnamon, cassia, balsam of Peru, benzoin, hyacinth, myrrh, rose, patchouli, and daffodil in topical products. For lip dermatitis or suspected systemic contact allergy, avoidance of cinnamates can be accomplished using a modified balsam of Peru avoidance diet.⁶ Cinnamates are found in cinnamon, cassia, citrus peel, tomato, anise, bay leaves, and basil.⁶ These foods are often added to sweets (especially chocolate, cinnamon, and artificial fruit flavors), curry, condiments, pickles, pâté, perfumed teas or tobacco, beer, wine, gin, vermouth, brandy, and spiced liquors.⁶

Eugenol

Clove leaf oil and cinnamon leaf oil may contain more than 90% eugenol.⁷ Eugenol is primarily extracted from clove plants,⁸ but it is also found in basil,⁹ cinnamon,⁶ *Cinnamomum tamala*,¹⁰ dill,¹¹ lemon balm,¹² nutmeg,¹³ bay leaves,¹⁴ vanilla,¹⁵ anise, and oregano.¹⁶ All of these are found in topical products with the exception of *Cinnamomum tamala* and lemon balm, which are not currently found in products listed in the Contact Allergy Management Program (CAMP) database.¹⁷

Isoeugenol

Isoeugenol is extracted from essential oils, especially clove oil and cinnamon,¹⁸ and can also be synthesized from eugenol.⁷ Ylang-ylang (*Cananga odorata*), sandalwood, jonquil (narcissus), nutmeg, mace, basil, dill seed, gardenia, petunia, calamus, savory, tuberose, and tobacco all contain isoeugenol.¹⁸ All of these are found in topical products with the exception of petunia, calamus, savory, tuberose, and tobacco, which are not currently found in products listed in the CAMP database.¹⁷ *Gardenia* (not typically thought of as a common allergen) is found in some topical products in CAMP.¹⁷ Isoeugenol can also be found in some nonalcoholic drinks and baked goods¹⁸ and is used in the manufacture of vanillin.¹⁹

Eugenol and Isoeugenol Avoidance Recommendations

In topical products, ylang-ylang, sandalwood, narcissus, clove, cinnamon, basil, nutmeg, mace, bay leaf, vanilla, anise, oregano, dill, allspice, and *Gardenia* should be avoided. Tobacco smoking should be avoided. For lip dermatitis or suspected systemic contact allergy, avoidance of eugenol and isoeugenol can be accomplished using a modified balsam of Peru avoidance diet.⁶ Foods that should be avoided include basil, cinnamon, nutmeg, mace, bay leaves, vanilla, anise, oregano, dill, allspice, and tomato.⁶ The foods are also often added to curry, sweets (including chocolate, cinnamon, and vanilla), condiments, pickles, pâté, perfumed teas or tobaccos, beer, gin, vermouth, whiskey, and spiced liquors.⁶

Moss Allergens

Oakmoss absolute (*Evernia prunastri*) and tree moss (*Pseudevernia furfuracea*) are *Evernia* lichens.¹ Individuals who are allergic to these allergens should avoid lichens. There is no evidence for the presence of these allergens in any other natural substances. However, for lip dermatitis or suspected systemic contact allergy, oakmoss absolute is used in fruit, honey, and spice flavorings,¹ and these should be avoided.

Coumarin

Coumarin is a component of cassia cinnamon (often used as a substitute for natural cinnamon) and used as an aroma enhancer or vanilla substitute.^{20–22} Tonka bean (*Dipteryx odorata*),^{1,20} vanilla grass (*Anthoxanthum odoratum*),²² sweet woodruff (*Galium odorata*),²⁰ mullein (*Verbascum* spp), sweet grass (*Hierochloa odorata*), melilot (*Melilotus* species),²⁰ deer's-tongue (*Panicum clandestinum*), and sweet clover (Fabaceae species) also contain coumarin. Tonka bean, clover (Fabaceae species), some *Galium* species, some *Melilotus* species, and some *Panicum* species are in topical products in CAMP.¹⁷ Avoidance of these plants, cinnamon, and cassia in topical products is recommended. For lip dermatitis and avoidance of systemic contact allergy, avoidance of cinnamon and cassia is recommended. Coumarin is also added to some pipe tobaccos and alcoholic drinks.²⁰

Limonene

The most common source for limonene is extraction from orange rinds,²³ and it is most commonly found in the rinds of citrus fruit.²⁴ The percentage of limonene in several natural oils has been reported—lemon oil (67%), *Verbena* (13%), and citronella grass (4%).²⁵ It occurs in smaller concentrations in other essential oils including eucalyptus, lavender, rosemary, caraway, peppermint, tea tree oil, and turpentine.²⁶ All of these ingredients are found in topical products in CAMP, and avoidance is recommended.¹⁷ D-Limonene is used as a flavoring ingredient for citrus flavor and can be found in nonalcoholic beverages (31 ppm), ice cream, ices (68 ppm), candy (49 ppm), baked goods (120 ppm), gelatins and puddings (48–400 ppm), and chewing gum (2300 ppm).²⁶ Citrus and citrus flavors should be avoided for lip dermatitis and avoidance of systemic contact allergy. If this is not sufficient to yield clinical results, avoidance of rosemary, caraway, and peppermint can be added.

Farnesol

Farnesol is a naturally occurring component in ylang-ylang, jasmine, and rose oil²⁷ and is distilled from the flowers of these plants.²⁸ It is also in other essential oils including tolu balsam, cassia, rose, musk ambrette, citronella, neroli, *Cyclamen*, lemon-grass, star anise, tuberose, and linden flower.^{1,29,30} All of these

ingredients except tuberose are found in topical products in CAMP and should be avoided.¹⁷ Jasmine, cassia, lemongrass, and anise are possible sources of exposure for lip dermatitis and should be avoided to prevent systemic contact allergy. Farnesol is also an additive in cigarettes.⁷

Citral

Citral is found in lemon myrtle (90%–98%), lemongrass (75%–85%), lemon tea tree (80%), may cheng (*Litsea cubeba*) (65%–74%), *Verbena* (approximately 35%), and *Melissa* (11%).²⁵ It is also found in lime oil, lemon oil, grapefruit oil, orange oil, peach oil, ginger, lemon balm, and neroli oil.^{1,31} All except lemon tea tree and lemon myrtle are in CAMP and should be avoided.¹⁷ It is also present in the oils of *Litsea citrata*, *Ocimum gratissimum*, *Lindera citriodora*, *Calyptranthes* particulate, and petit grain,⁷ none of which are in CAMP.¹⁷ Regarding lip and systemic contact allergy, citral is used primarily as lemon flavoring in foods, beverages, and candies,³¹ but it is also used in other fruit, spice, ginger, and vanilla flavorings.¹ Avoidance of lemongrass, citrus fruits, peaches, and ginger is also recommended.

Linalool

Linalool is found in ho leaf (80%–90%), bois de rose (*Dalbergia rosewood*) (65%–90%), coriander (60%–80%), linaloe (30%–70%), sweet basil (30%–50%), lavandin (30–40%), lavender (20%–50%), *Mentha citrata* (20%–50%), spike lavender (20%–40%), neroli oil (44%), petit grain (20%–30%), bergamot (10%–30%), clary sage (10%–25%), ylang-ylang (10%–15%), geranium oil (8%–15%), sweet marjoram (3%), laurel leaf (2%), rosemary (2%), lime (0.5%), chamomile (0.3%), and anise (0.2%).³² Ho leaf, bois de rose, linaloe, lavandin, *Mentha citrate*, spike lavender, and petit grain are not currently found in CAMP; however, other varieties of rosewood were found.¹⁷ Trace amounts are in acacia, cassia, clove, cumin, and nutmeg.³² It has been detected as a component of several types of fruits including pineapple guava, some nectarines, apricots, plums, some peaches, oranges, some apple juice, and Korean chamchwi in small amounts.³² Over 200 species of plants produce linalool mainly from the families Lamiaceae (mints, scented herbs), Lauraceae (laurels, cinnamon, rosewood), and Rutaceae (citrus fruits) but also from birch trees and other plants, from tropical to boreal climate zones including grapefruit, cocoa, ginger, tea, coriander, cassia, *Cinnamomum tamala*, *Ocimum basilicum*, *Solidago chilensis*, *Artemisia vulgaris* (mugwort), and *Humulus lupulus* (hops).^{1,7} It has also been found in some flavorings.⁷ Linalool is used in mint and fruit flavorings (especially citrus).^{1,32}

Linalool is so prevalent that complete avoidance is difficult. However, because percentages of linalool are available, a practical approach would be to avoid all of the plants in which linalool is present in a greater than 5% concentration. This would require avoidance of coriander, basil, lavender, bergamot, sage, ylang-ylang, and *Geranium* in topical products and coriander, basil,

and sage in foods for lip and systemic contact allergy. Avoidance of artificial mint and fruit flavorings (especially citrus) would also be reasonable. If this is not sufficient, avoidance of marjoram, bay leaf, rosemary, lime, chamomile, and anise would be a reasonable next step.

Citronellol

Citronellol is found in lemon eucalyptus (20%), citronella grass (14%),²⁵ citrus fruits, rose, lemongrass, basil, eucalyptus, *Geranium*, muscatel sage, and sandalwood.^{1,7,33} It is used in fruit and floral flavorings and as an insecticide.¹ Avoidance of these exposures is advised. For lip and systemic contact allergy, avoidance of citrus, lemongrass, basil, and sage would be reasonable.

Geraniol

Geraniol is found in rose, palmarosa, and citronella.^{7,34} It occurs in smaller quantities in *Geranium* and lemon.⁷ These substances should be avoided in topical products. Geraniol is also used in fruit flavorings such as peach, raspberry, grapefruit, red apple, plum, lime, orange, lemon, watermelon, pineapple, and blueberry.³⁴ Avoidance of lemon and artificial fruit flavorings is reasonable for lip dermatitis and avoidance of systemic contact allergy.

Benzyl Alcohol

Benzyl alcohol is produced naturally by many plants and is commonly found in fruits and teas. It is also found in a variety of essential oils including jasmine, hyacinth, and ylang-ylang.^{1,7,35} It is often found in ylang-ylang oil in a 6% concentration.³⁶ Data were not found on the full array of plants containing benzyl alcohol, and avoidance of all botanicals is recommended until further data are available. Benzyl alcohol is used in fruit, nut, honey, vanilla, root beer, muscatel, and liquor flavorings.¹ For lip dermatitis, avoidance of these flavorings, fruit, and tea is recommended and worth trying; however, more data are needed to give optimal recommendations.

Benzyl Salicylate

Benzyl salicylate is found in some edible fruits (up to 5 mg/kg), green tea (1–30 mg/kg), and black tea (1–15 mg/kg). It is used as a flavoring substance in some foods and beverages in concentrations up to 400 mg/kg and in chewing gum (1254 mg/kg).⁶ It is often used in peach and floral flavors.¹

Hydroxycitronellal

Hydroxycitronellal is prepared from (+)-citronellal and has also been reported to occur in essential oils; however, no specific data were found. It is also an additive in cigarettes.⁷ It has a lily-like odor.¹

Anisyl Alcohol

Anisyl alcohol is found in vanilla pods and in anise seed. It is also an additive in cigarettes.⁷

Benzyl Benzoate

Benzyl benzoate is found in the plants *Kaempferia rotunda* and *Zingiber cassumunar* (members of the ginger family).^{37,38} It also occurs naturally in balsams Tolu and Peru, tuberose flowers, hyacinth, *Narcissus jonquilla*, *Dianthus caryophyllus*, and ylang ylang.³⁹ In foods, it can be used as a flavoring agent for its balsamic odor (reminiscent of almond) and sharp, pungent taste.³⁹

Finding Safe Fragranced Products for Patients Allergic to Certain Fragrances

Theoretically, it is possible to find fragranced products that are likely to be safe for some patients allergic to fragrance. If a patient's test result is positive to a specific EUF but negative to the usual fragrance screening mixes and the other EUFs, it may only be necessary for the individual to avoid the one specific fragrance that was positive on patch testing. To find a safe fragrance product for this individual, it is necessary that the product is following the European Directive (as indicated by the presence of 2 or more EUFs on the label), but it must not contain the specific one to which the patient is allergic. However, it is important that the chosen product is also free of natural substances that contain the allergen. The information aforementioned can be used for this purpose.

SUMMARY

It is important that individuals allergic to EUF ingredients avoid related natural substances and foods to obtain an optimal clinical outcome. In addition, many of these fragrance substances are also found in foods, and it is possible that ingestion of a food containing the allergen may induce systemic contact allergy. Finally, individuals with lip dermatitis may react to contact with foods that contain the allergen.

In addition, it is theoretically possible to find fragranced products that are likely to be safe for patients allergic to specific EUF ingredients. Any product following the European Directive labeling laws that does not contain the specific EUF to which the patient is allergic and related natural substances is very likely to be tolerated.

Since this article was initially written, a landmark article on fragrance allergy reviewing the opinion of the European Scientific Committee for Consumer Safety was published.⁴⁰ The article lists 29 natural extracts for which there are data sufficient to establish these as established or likely contact allergens. However, there are currently over 6000 botanical ingredients in the American Contact Dermatitis Society's CAMP database.¹⁷ For most of these botanicals, there are no data (positive or negative) available because patch testing has not been performed for these substances.

Therefore, the list of botanical allergens is likely to increase as more data become available. Botanicals containing EUF are prime candidates for future study because these botanicals contain established EUF allergens. However, the presence of EUF alone does not establish a botanical as a sensitizer because the amount of EUF in a botanical may be below the threshold necessary to cause contact allergy. Nevertheless, until more data are available, it is logical that individuals allergic to a specific EUF avoid botanicals that contain the specific EUF.

There are several limitations to this study. More conclusive studies in scientific journals regarding which natural substances contain EUF are needed. In addition, the literature does not indicate the concentration for many of these substances found in natural products. Therefore, it is possible that some of these natural products do not contain enough of the EUF ingredient to induce contact allergy in normal usage or consumption. However, the information aforementioned limits the number of botanicals and foods that need to be avoided for most EUFs in the case of allergy. Additional information on the amount of EUF in specific foods is needed along with data on the threshold of these substances needed to cause allergic contact dermatitis in order to shorten the list of substances to avoid further.

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