

IMPROVED CITRAL AND CITRONELLAL DERIVATIVES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of priority of Provisional Application Serial No. 60/638,964 filed December 22, 2004.

FIELD OF THE INVENTION

The present invention relates generally to the field of flavorings and fragrances. More particularly, the present invention relates to citral and citronellal derivatives that provide beverages and other food products, as well as perfumes and other fragrant articles with a lemony or fresh rosy scent, while at the same time overcoming the stability limitations of the native citral or citronellal compound.

BACKGROUND OF THE INVENTION

The odor profile for citronellal is sweet, floral, rosy, waxy, citrus and green. Citral (3,7- dimethyl-2,6-octadienal) is a major component of lemon smell, and has the sweet-acidulated character of natural lemon. For largely historical reasons, lemon smell has become associated with freshness and cleanliness, both in drinks and in household products, and in fragrances and flavorings, generally. Lemon drinks, whether natural or synthetic, are naturally acid, which causes rapid degradation of citral to unpleasant-smelling products like cresol. This means that the shelf life of lemonade is correspondingly short, creating an expensive logistical problem. In household products, the problem is of a different nature. In order to associate bacteriological cleanliness with the smell of lemon these products frequently use lemon-scented bleach (hypochlorite). Citral is unstable in bleach, and cannot therefore be used. Instead, its nitrile analogue, geranyl nitrile, with its less satisfactory oily-metallic lemon note has to be used.

The chemical instability of citral is largely due to the two double bonds and an aldehyde group, all of which are potentially susceptible to reaction, particularly when used in harsh environments, such as lemon-scented bleach. It would be desirable to develop citral and citronellal derivatives with improved useful lifetimes, and, preferably, improved odor intensity, while maintaining the lemon note of citral or the rosy note of citronellal. The present invention provides such citral and citronellal derivatives.

SUMMARY OF THE INVENTION

Improved fragrances and flavorings that have a longer useful shelf life than citral and citronellal are disclosed. In particular, citral derivatives that maintain the fragrance characteristics and lemony flavor of citral, and citronellal derivatives that maintain the fragrance characteristics and rosy flavor of citronellal, while lowering the allergic properties, and providing a longer shelf-life than citral or citronellal, and/or increasing the odor intensity relative to citral and/or citronellal, are disclosed. Also disclosed are methods of making the derivatives, and articles of manufacture including the derivatives.

The citral derivatives replace the aldehyde group in citral with a hydroxy group, and the citronellal derivatives replace the aldehyde group in citronellal with a hydroxy group. In one embodiment, the derivatives also replace one or both double bonds in citral or the single double bond in citronellal with a cyclopropyl, which can be unsubstituted-, or substituted with one or two lower alkyl, preferably methyl groups. The alkyl groups can optionally be substituted, for example, with electron donating groups, electron withdrawing groups, groups which increase the hydrophilicity or hydrophobicity of the molecule, and the like. The cyclopropyl group can also include, in place of a carbon atom, sulfur or oxygen.

Examples of suitable articles of manufacture include candles, air fresheners, perfumes, disinfectant compositions, hypochlorite (bleach) compositions, beverages such as

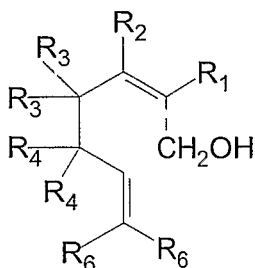
beer and soda, denture cleanser tablets as described, for example, in U.S. Patent No. 5,571,519, the contents of which are hereby incorporated by reference in their entirety, and flavored orally-delivered products such as lozenges, candies, and the like.

DETAILED DESCRIPTION OF THE INVENTION

Improved citral and citronellal derivatives, which can be used, for example, as fragrances and flavorings that have a longer useful shelf life than citral, are disclosed. The citral derivatives have a similar odor to citral, and the citronellal derivatives have a similar odor to citronellal, and the citral and citronellal derivatives also have improved physical and/or chemical properties relative to citral and citronellal. These improved properties include increased stability to high pH, low pH, improved half-life, lower likelihood of causing allergic reactions, and/or increased odor intensity.

The compounds of formulas 2-4 described herein have one or both of the double bonds of citral or the citral derivatives in Formula 1, or the double bond in citronellal replaced with a suitable three membered ring. The compounds, and mixtures thereof, are stable in various media in which citral and citronellal themselves are relatively unstable, and also have odor characteristics which are very similar to that of citral and citronellal. The odor of the compounds of Formulas 2-4, or mixtures thereof, possess the same fresh-citrus connotation as citral and/or the fresh rosy connotation as citronellal.

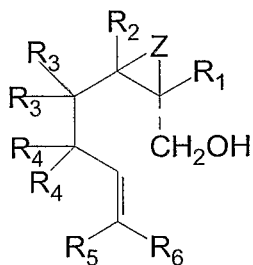
I. Improved Citral and Citronellal Derivatives



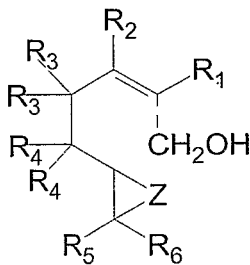
Formula 1

Formula 1 represents a citral derivative where the aldehyde group has been replaced with a hydroxy group. This type of derivative can be further modified using the chemistry described herein to replace one or both of the double bonds with appropriate ring structures, thus improving the various physical and/or chemical properties of the molecule. In Formula 1, citral would be depicted if the hydroxy group were replaced with an aldehyde group (-C(=O)H), and the values of the remaining substituents selected such that R_{1-4} are H, and R_5 and R_6 are methyl. However, R_{1-6} can be, independently, H, C_{1-5} alkyl, substituted C_{1-5} alkyl, halo, hydroxy, thiol, thioether, amine, carboxylic acid, ester, nitro, cyano, isocyano, sulfonic acid, urea, and thiourea, where the substituents on the alkyl groups are selected from halo, hydroxy, thiol, thioether, amine, carboxylic acid, ester, nitro, cyano, isocyano, sulfonic acid, urea, thiourea, and the like. In one embodiment, the double bond adjacent to the hydroxy group is saturated (i.e., to form a citronellal derivative), and the derivatives are the same but for the saturated double bond at this position.

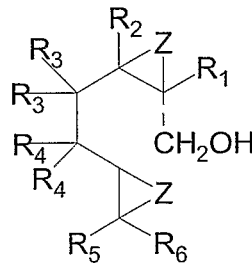
Formulas 2-4 below represent citral and citronellal derivatives as described herein, where one or both of the double bonds are replaced with a suitable three membered ring.



Formula 2



Formula 3



Formula 4

wherein:

Z is O, S, or C(R)_2 such as methyl, or C_{1-5} substituted alkyl, where R_{1-6} are as

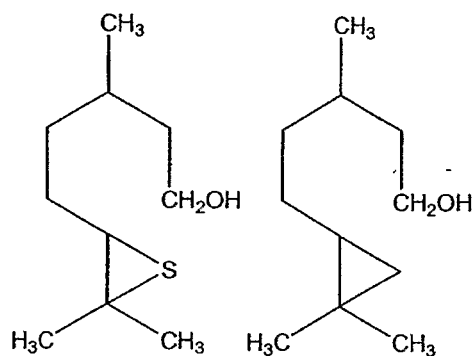
described above with respect to Formula 1, and

the dashed line indicates that the carbon to which the CH₂OH group is bound is in the R or S configuration, or exists as mixtures of the two, or the double bond to which it is bound is in the E or Z configuration.

In one embodiment of formulas 2-4, R₁₋₄ represent hydrogen, R₅₋₆ represent methyl, and Z represents C(R)₂. In this embodiment, it is preferred that one or more R groups are methyl, with the other R groups representing hydrogen.

In Formulas 2-4, where the molecule includes two Z groups, one Z can represent saturation at both carbons to which it is bound (i.e., no double bond or cyclopropane, oxirane or thiirane ring), so long as one Z is 0, S or C(R)₂.

Individual representative compounds include the following:

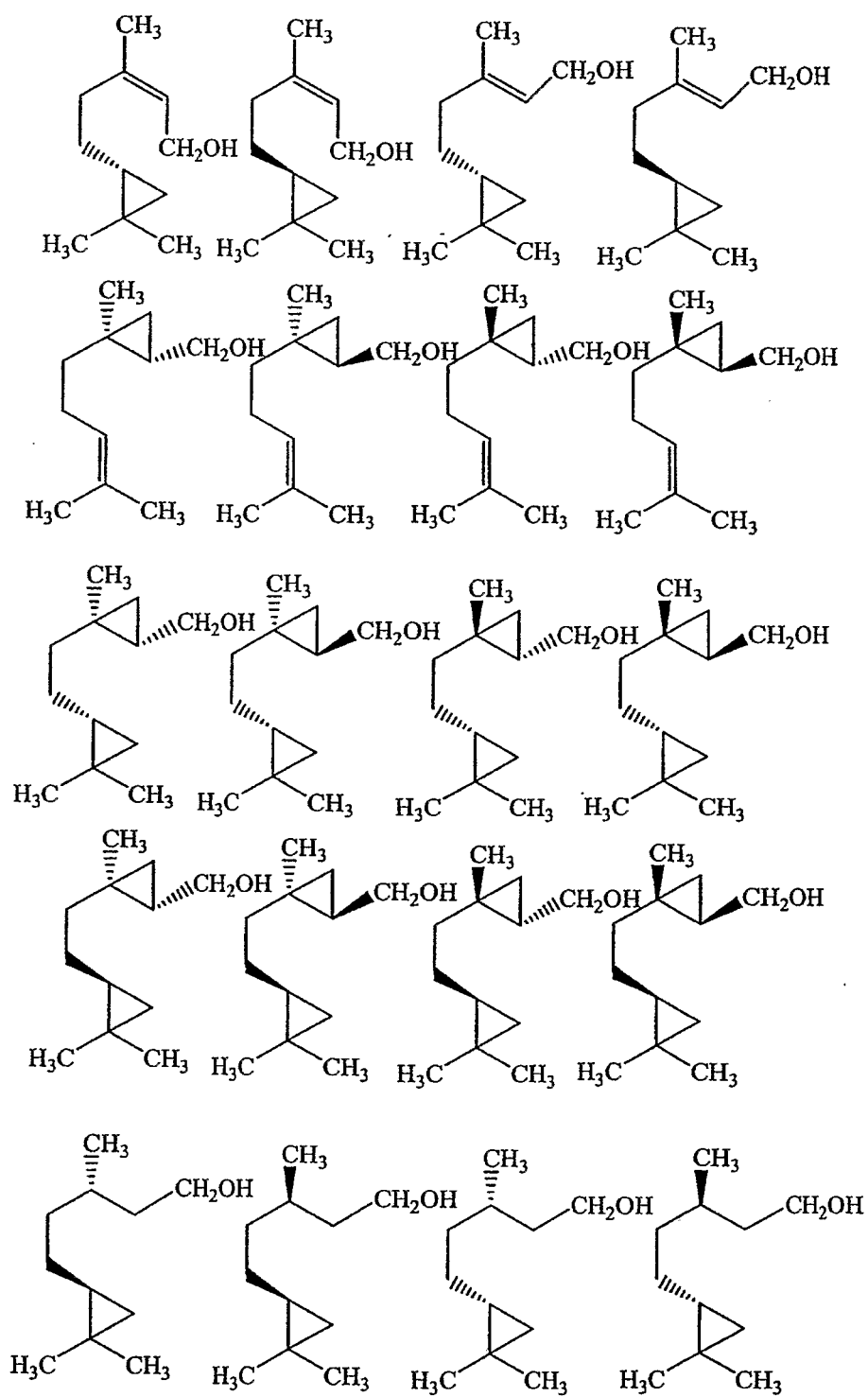


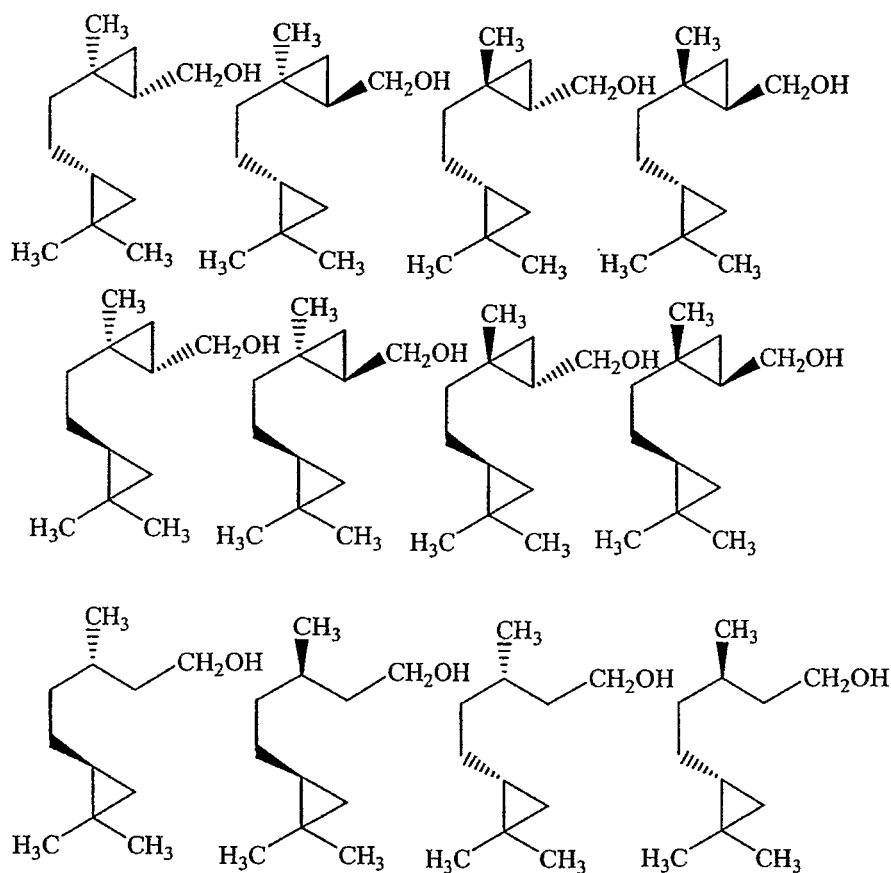
The citral and citronellal derivatives can be cyclopropanated in one or both of the positions, corresponding to the two double bonds of the molecule. With respect to citral derivatives, cyclopropanation of the double bond alpha to the hydroxy group provides four possible diastereomers, (R,R), (R,S), (S,R) and (S,S). Cyclopropanation of the double bond of the isoprene unit provides two stereoisomers for each of the E and Z isomers of the double bond alpha to the hydroxy group, for a total of four isomers. Dicyclopropanation provides eight stereoisomeric forms, including all four diastereomers from the cyclopropanation of the double bond alpha to the hydroxy group coupled with the R stereoisomer from the

cyclopropanation of the double bond in the isoprene unit, and all four diastereomers coupled with the S stereoisomer. The double bond in the isoprene unit of citronellal can also be cyclopropanated to yield two stereoisomers.

The cyclopropanation reaction can be performed to exhaustion, providing the dicyclopropanated product, or can be performed stepwise, yielding a mixture of mono and di-cyclopropanated products. The mono- and di-cyclopropanated products can be separated on the basis of different physical and chemical properties. Diastereomeric forms can be separated on the basis of different properties as well, such as different boiling points and/or crystallization conditions, as is known in the art. Stereoisomers can be isolated using known techniques, such as column chromatography using a chiral solid phase, enzymatic degradation, and reversible formation of diastereomers and separation of the diastereomeric forms, as is known in the art. The presence of the alcohol functionality permits the rapid and reversible formation of diastereomers by reaction with chiral acids to form esters, which can be hydrolyzed/saponified to reform the hydroxy group functionality. Suitable chiral acids are well known to those of skill in the art. Accordingly, should it be desired to isolate particular stereoisomers or diastereomers, it would be routine in the art to do so.

While the disclosure is not limited to the following compounds, all sixteen stereoisomeric forms of mono- and di-cyclopropanated hydroxy-citral derivatives, as well as the various stereoisomeric forms of cyclopropanated hydroxy-citronellal derivatives, are shown below. The replacement of double bonds with cyclopropane rings in other compounds will likewise often result in the formation of stereoisomers and/or diastereomers, and individual stereoisomers and/or diastereomers can similarly be isolated using conventional separation techniques. Such stereoisomers and/or diastereomers are intended to be within the scope of the invention described herein.





The cyclopropane rings can include a CH₂ moiety, or can be substituted with one or two C₁₋₅ alkyl (i.e., methyl) groups. The methyl or dimethyl analogues have a tunneling vibrational spectrum that more closely matches citral and/or citronellal than the unsubstituted cyclopropane derivatives, and has a sweeter smell than the unsubstituted cyclopropyl derivatives.

The citral derivatives described herein include derivatives in which one or both of the double bonds is replaced with a (unsubstituted, monoalkyl or dialkyl, where alkyl can be substituted or unsubstituted, and is preferably methyl) cyclopropyl group, in addition to the replacement of the aldehyde group in citral with a hydroxy group. The citronellal derivatives described herein include derivatives in which the double bonds is replaced with a (unsubstituted, monoalkyl or dialkyl, where alkyl can be substituted or unsubstituted, and is preferably methyl) cyclopropyl group, in addition to the replacement of the aldehyde group in citronellal with a hydroxy group.

II. Methods for Preparing the Citral and Citronellal Derivatives

The citral and citronellal derivatives of Formulas 2-4 can be prepared using any of the citral derivatives described above in Formula 1, or the citronellal version of Formula 1 where the double bond alpha to the hydroxy group is absent, to the extent that the synthetic route is not incompatible with any of the substituents that may be present. In one embodiment, citral (or citronellal) is used as a starting material to prepare various citral (or citronellal) derivatives described in Formulas 2-4 where R_{1-4} are hydrogen and R_{5-6} are methyl, and the aldehyde group is reduced using standard chemistry to provide the hydroxy group. Alternatively, to the extent the hydroxy group does not interfere with the cyclopropanation, oxirane or thirane chemistry, the aldehyde group can be reduced first. In one embodiment, the aldehyde is first reduced to a hydroxy group, and the hydroxy group protected using protecting groups that are not incompatible with the cyclopropanation, oxirane or thirane chemistry. In this embodiment, the protecting group can be removed after the desired ring formation is complete.

The synthesis of methyl, dimethyl or unsubstituted cyclopropane derivatives is well known to those of skill in the art, and involves, for example, bromoform reaction to form the dibromocyclopropane derivative, followed by stoichiometric reaction with methyl lithium. The hydroxy group may be protected as a ketal, a THF ether, a silyl ether, or other such protecting group during the reaction, and deprotected as desired after the reactions take place. These simple procedures yield derivatives of citral and/or citronellal with odor profiles close to citral and/or citronellal themselves, with greater potency and with far greater acid and bleach stability since the unstable features, namely the aldehyde group, and optionally, one or both double bonds, have been removed.

The same applies to epoxide (OX) and thirane (TH) rings, shown in the formulas above where Z is O or S. Not counting mixed C=C double bond replacements and stereoisomers, this generates 9 possible molecules from citral alone, all readily accessible in one or two step syntheses from citral itself by processes well known in the art, such as:

Cyclopropanyl replacement: Simmons-Smith cyclopropanation of the aldehyde or corresponding alcohol (followed by borohydride reduction of the former to give the hydroxy group).

Oxiranyl replacement: m-chloroperbenzoic acid epoxidation of the double bond (which preferably proceeds using the hydroxy group rather than an aldehyde starting material, as the borohydride reducing agent may adversely effect the oxirane ring).

Thiiranyl replacement: bromination of double bond on Amberlite, followed by S'-substitution in sodium sulfides

III. Articles of Manufacture Including the Citral and Citronellal Derivatives

The citral and citronellal derivatives can be included in virtually any article of manufacture that can include citral or citronellal , or for that matter, other lemon fragrances, whether natural or artificial. Similarly, the citronellal derivatives can be included in virtually any article of manufacture that can include citronellal, or for that matter, other rosy fragrances, whether natural or artificial. Examples include bleach, detergents, flavorings and fragrances, beverages, including alcoholic beverages, and the like. The citral and citronellal derivatives can be used in applications like soaps, shampoos, body deodorants and antiperspirants, solid or liquid detergents for treating textiles, fabric softeners, detergent compositions and/or all-purpose cleaners for cleaning dishes or various surfaces, for both household and industrial use. Of course, the use of the compounds is not limited to the above-mentioned products, as they be used in other current uses in perfumery, namely the perfuming of soaps and shower gels, hygiene or hair-care products, as well as of body deodorants, air fresheners and cosmetic preparations, and even in fine perfumery, namely in perfumes and colognes. These uses are described in more detail below.

Perfume Compositions

The compounds can be used as perfuming ingredients, as single compounds or as mixture thereof, preferably at a range of at least about 30% by weight of the perfume composition, more preferably at a range of at least about 60% by weight of the composition. The compounds can even be used in their pure state or as mixtures, without added components. The olfactive characteristics of the individual compounds are also present in mixtures thereof, and mixtures of these compounds can be used as perfuming ingredients. This may be particularly advantageous where separation and/or purification steps can be avoided by using compound mixtures.

In all cited applications, the citral or citronellal derivatives can be used alone, in combination, and/or in admixture with other perfuming ingredients, solvents or adjuvants of current use in the art. The nature and the variety of these co-ingredients do not require a more detailed description here, which, moreover, would not be exhaustive, and the person skilled in the art will be able to choose the latter through its general knowledge and as a function of the nature of the product to be perfumed and of the desired olfactive effect.

These perfuming ingredients typically belong to chemical classes as varied as alcohols, aldehydes, ketones, esters, ethers, acetates, nitrites, terpene hydrocarbons, sulfur- and nitrogen containing heterocyclic compounds, as well as essential oils of natural or synthetic origin. A large number of these ingredients described in reference textbooks such as the book of S. Arctander, *Perfume and Flavor Chemicals*, 1969, Montclair, N.J., USA, the contents of which are hereby incorporated by reference in its entirety, or its more recent versions, or in other works of similar nature.

The proportions in which the citral derivatives can be incorporated in the various products vary within a large range of values. These values depend on the nature of the article or product that one desires to perfume and the odor effect searched for, as well as on the nature of the co-ingredients in a given composition when the compounds are used

in admixture with perfuming co-ingredients, solvents or adjuvants of current use in the art.

As an example, the citral and citronellal derivatives are typically present at concentrations between about 0.1 and about 10%, or even more, by weight of these compounds relative to the weight of the perfuming composition in which they are incorporated. Far lower concentrations than those mentioned above can be used when the compounds are directly applied for perfuming the various consumer products cited beforehand.

The compounds are relatively stable in typically aggressive media for perfumes.

Accordingly, they can be used in detergents containing bleaching agents and activators such as, for example, tetraacetythylenediamine (TAED), hypohalites, in particular hypochlorite, peroxygenated bleaching agents such as, for example, perborates, etc. The compounds can also be used in body deodorants and antiperspirants, for example, those containing aluminum salts. These embodiments are described in more detail below.

Conventional Detergent Ingredients

In addition to the derivatives described herein, the compositions herein include a deterative surfactant and optionally, one or more- additional detergent ingredients, including materials for assisting or enhancing cleaning performance, treatment of the substrate to be cleaned, or to modify the aesthetics of the detergent composition (e.g., perfumes, colorants, dyes, etc.). The following are illustrative examples of deterative surfactants and other detergent ingredients.

Deterative Surfactants Non-limiting examples of synthetic deterative surfactants useful herein typically at levels from about 0.5% to about 90%, by weight, include the conventional C₁₁₋₁₈ alkyl benzene sulfonates ("LAS") and primary, branch-chain and random C₁₀₋₂₀ alkyl sulfates ("AS"), the C₁₀₋₁₈ secondary (2,3) alkyl sulfates of the formula CH₃(CH₂)_x(CH(CH₃)OSO₃⁻ M⁺) and CH₃(CH₂)_i(CH(CH₂CH₃)OSO₃⁻ M⁺)

wherein x and y are integers and wherein each of x and $(y + 1)$ is least about 7, preferably at least about 9, and M is a water-solubilizing cation, especially sodium, unsaturated sulfates such as oleyl sulfate, the C_{10-18} alkyl alkoxy sulfates ("AEx S"; especially EO 1-7 ethoxy sulfates), C_{10-18} alkyl alkoxy carboxylates (especially the EO 1-5 ethoxycarboxylates), the C_{10-18} glycerol ethers, the C_{10-18} alkyl polyglycosides and their corresponding sulfated polyglycosides, and C_{12-18} alphasulfonated fatty acid esters. If desired, the conventional nonionic and amphoteric surfactants such as the C_{12-18} ethoxylates ("AE") including the so-called narrow peaked alkyl ethoxylates and C_{6-12} alkyl phenol alkoxyates (especially ethoxylates and mixed ethoxy/propoxylates), C_{12-18} betaines and sulfobetaines ("sultaines"), C_{10-18} amine oxides, and the like, can also be included in the overall compositions. The C_{10-18} N-alkyl polyhydroxy fatty acid amides can also be used. Typical examples include the C_{12-18} N-methylglucamides. See WO 9,206,154. Other sugar-derived surfactants include the N-alkoxy polyhydroxy fatty acid amides, such as C_{10-18} N-(3-methoxypropyl) glucamide. The N-propyl through N-hexyl C_{12-18} glucamides can be used for low sudsing. C_{10-20} conventional soaps may also be used, however synthetic detergents are preferred. If high sudsing is desired, the branched-chain C_{10-16} soaps may be used. Mixtures of anionic and nonionic surfactants are especially useful. Other conventional useful surfactants are listed in standard texts. See also U.S. Pat. No. 3,664,961 to Norris.

Preferred compositions incorporating only synthetic detergents have a detergent level of from about 0.5% to 50%. Compositions containing soap preferably comprise from about 10% to about 90% soap.

Although the detergent compositions herein can include only deterative surfactants and the citral derivative(s), the compositions preferably contain other ingredients commonly used in detergent products.

Builders

Detergent builders can optionally be included in the compositions herein to assist in controlling mineral hardness. Inorganic as well as organic builders can be used. Builders are typically used in fabric laundering compositions to assist in the removal of particulate soils.

The level of builder can vary widely depending upon the end use of the composition and its desired physical form. When present, the compositions will typically comprise at least about 1 % builder. Liquid formulations typically comprise from about 5% to about 50%, more typically about 5% to about 30%, by weight, of detergent builder. Granular formulations typically comprise from about 10% to about 80%, more typically from about 15% to about 50% by weight, of the detergent builder. Lower or higher levels of builder, however, are not meant to be excluded.

Inorganic or detergent builders include, but are not limited to phosphate builders such as, the alkali metal, ammonium and allanilammonium salts of polyphosphates (exemplified by the tripolyphosphates, pyrophosphates, and glassy polymeric metaphosphates), phosphonates, and phytic acid, and non-phosphorous builders such as silicates, carbonates (including bicarbonates and sesquicarbonates), sulphates, and aluminosilicates. Non-phosphate builders are required in some locales.

Organic builders suitable for use herein include polycarboxylate builders such as disclosed in U.S. Pat. No. 3,308,067 to Diehl; U.S. Pat. No. 4,144,226 to Crutchfield and U.S. Pat. No. 4,246,495 to Crutchfield.

Soil Release Agents

Soil Release agents are desirably used in laundry detergents of the instant invention.

Suitable soil release agents include those of U.S. Pat. No. 4,968,451 to Scheibel and Gosselink: such ester oligomers can be prepared by (a) ethoxylating allyl alcohol, (b) reacting the product of (a) with dimethyl terephthalate ("DMT") and 1,2-propylene

glycol ("PG") in a two-stage transesterification/oligomerization procedure and (c) reacting the product of (b) with sodium metabisulfite in water; the nonionic end-capped 1,2-propylene/polyoxyethylene terephthalate polyesters of U.S. Pat. No. 4,711,730 to Gosselink et al, for example those produced by trans esterification/oligomerization of poly(ethyleneglycol) methyl ether, DMT, PG and poly(ethyleneglycol) ("PEG"); the partly- and fully-anionic-end-capped oligomeric esters of US. Pat. No. 4,721,580 to Gosselink, such as oligomers from ethylene glycol ("EG"), PG, DMT and Na-3,6-dioxo-8-hydroxyoctanesulfonate; the nonionic-capped block polyester oligomeric compounds of U.S. Pat. No. 4,702,857 to Gosselink, for example produced from DMT, Me-capped PEG and EG and/or PG, or a combination of DMT, EG and/or PG, Me-capped PEG and Na-dimethyl-5-sulfoisophthalate; and the anionic, especially sulfoaroyl, endcapped terephthalate esters of US. Pat. No. 4,877,896 to Maldonado, Gosselink et al, the latter being typical of SRA's useful in both laundry and fabric conditioning products, an example being an ester composition made from m-sulfobenzoic acid monosodium salt, PG and DMT optionally but preferably further comprising added PEG, e.g., PEG 3400. Another preferred soil release agent is a sulfonated end-capped type described in U.S. Pat. No. 5,415,807.

Other Optional Ingredients

The compositions herein can contain other ingredients such as enzymes, bleaches, fabric softening agents, dye transfer inhibitors, suds suppressors, and chelating agents, all well known within the art.

For purposes of defining detergent compositions of the present invention, the pH of the detergent composition is that which is measured at 1 % concentration of the detergent composition in distilled-water at 20°C. The detergent compositions herein have a pH of from about 7.1 to about 13, more typically from about 7.5 to about 9.5 for liquid detergents and from about 8 to about 12 for granular detergents.

Formulation with Detergents With or Without Conventional Perfumery Materials

While the derivatives described herein can be used alone and simply mixed with essential detergent ingredient, most notably surfactant, they can also be desirably combined into three-part formulations which combine (a) a non-fragranced detergent base comprising one or more synthetic detergents and (b) one or more of the derivatives described herein.

In formulating the present detergents, the fully-formulated fragrance can be prepared using numerous known odorant ingredients of natural or synthetic origin. The range of the natural raw substances can embrace not only readily-volatile, but also moderately-volatile and slightly-volatile components and that of the synthetics can include representatives from practically all classes of fragrant substances, as will be evident from the following illustrative compilation: natural products, such as tree moss absolute, basil oil, citrus fruit oils (such as bergamot oil, mandarin oil, etc.), mastix absolute, myrtle oil, palmarosa oil, patchouli oil, petitgrain oil Paraguay, wormwood oil, alcohols, such as famesol, geraniol, linalool, nerol, phenyl ethyl alcohol, rhodinol, cinnamic alcohol, aldehydes, such as citral, HelionaTM, alphahexyl-cinnamaldehyde, hydroxycitronellal, LilialTM (p-t-butyl-alpha-methyl-dihydrocinnamaldehyde), methylalonyl-acetaldehyde, ketones, such as allylionone, alpha-ionone, beta-ionone, isoraldein (isomethyl-alpha-ionone), methylionone, esters, such as allyl phenoxylacetate, benzyl salicylate, cinnamyl propionate, citronellyl acetate, citronellyl ethoxylate, decyl acetate, dimethylbenzylcarbinyl acetate, dimethylbenzylcarbinyl butyrate, ethyl acetoacetate, ethyl acetylacetate, hexenyl isobutyrate, linalyl acetate, methyl dihydrojasmonate, styrallyl acetate, vetiveryl acetate, etc., lactones, such as gamma-undecalactone, various components often used in perfumery, such as musk ketone, indole, p-menthane-8-thiol-3-one, and methyl-eugenol. Likewise, any conventional fragrant acetal or ketal known in the art can be added to the present composition as an optional component of the conventionally formulated perfume (c). Such conventional

fragrant acetals and ketals include the well-known methyl and ethyl acetals and ketals, as well as acetals or ketals based on benzaldehyde, those comprising phenyl ethyl moieties, or more recently developed specialties such as those described in a United States Patent entitled "Acetals and Ketals of Oxo- Tetralins and Oxo-Indanes, see U.S. Pat. No. 5,084,440. Of course, other recent synthetic specialties can be included in the perfume compositions for fully-formulated detergents. These include the enol ethers of alkyl-substituted oxo-tetralins and oxo-indanes as described in U.S. Pat. No. 5,332,725; or Schiff Bases as described in U.S. Pat. No. 5,264,615. It is preferred that the profragrant material be added separately from the conventional fragrances to the detergent compositions of the invention.

Formulation with other Special-Purpose Fragrance Delivering Compounds

Detergents including the derivatives described herein may further, optionally, if desired, contain other known compounds having the capability to enhance substantivity of a fragrance. Such compounds include, but are not limited to, the aluminum alkoxides such as isobutylaluminum diferanylate as disclosed in U.S. Pat. No. 4,055,634; or the known titanate and zirconate esters or oligoesters of fragrant materials such as those disclosed in U.S. Pat. No. 3,947,574, and U.S. Pat. No. 3,779,932, the contents of each of which are hereby incorporated by reference in their entirety. When using such organoaluminum, organotitanium or organozinc derivatives, they may be incorporated into the present formulations at their art-known levels.

Beverage Compositions

The citral and citronellal derivatives described herein can be incorporated into beverages and impart various flavorings to the beverages. The beverage composition can be a cola beverage composition, and can also be coffee, tea, dairy beverage, fruit juice drink, orange drink, lemon-lime drink, beer, malt beverages, or other flavored beverage. The beverages can be in liquid or powdered form.

The beverage compositions can also include one or more flavoring agents; artificial colorants; vitamin additives; preservatives; caffeine additives; water; acidulants; thickeners; buffering agents; emulsifiers; and or fruit juice concentrates.

Artificial colorants which may be used include caramel color, yellow 6 and yellow 5.

Useful vitamin additives include vitamin B2, vitamin B6, vitamin B12, vitamin C (ascorbic acid), niacin, pantothenic acid, biotin and folic acid. Suitable preservatives include sodium or potassium benzoate. Salts which may be used include sodium, potassium and magnesium chloride. Exemplary emulsifiers are gum arabic and purity gum, and a useful thickener is pectin. Suitable acidulants include citric, phosphoric and malic acid, and potential buffering agents include sodium and potassium citrate.

In one embodiment, the beverage is a carbonated cola beverage. The pH is generally about 2.8 and the following ingredients can be used to make the syrup for these compositions:

Flavor Concentrate, including one or more of the derivatives described herein (22.22 ml), 80% Phosphoric Acid (5.55 g), Citric Acid (0.267 g), Caffeine (1.24 g), artificial sweetener, sugar or com syrup (to taste, depending on the actual sweetener) and Potassium Citrate (4.07 g). The beverage composition can be prepared, for example, by mixing the foregoing syrup with carbonated water in a proportion of 50 ml syrup to 250 ml of carbonated water.

In another embodiment, "the beverage is a beer or malt beverage. Preferred flavorings for beer and malt beverages include lemon, lime and lemon-lime. Advantageously, the flavorings include citral derivatives in which one of both of the double bonds are replaced with a cyclopropane group, where the cyclopropane groups can, independently, be unsubstituted, or include one or two alkyl or substituted alkyl groups, preferably methyl groups. The amount of flavoring can be adjusted according to taste.

Orally-Delivered Products

Flavored food and pharmaceutical compositions including one or more of the derivatives described herein can also be prepared. The derivatives can be incorporated into conventional foodstuffs using techniques well known to those of skill in the art. Alternatively, the derivatives can be incorporated within polymeric particles, which can, in turn, be dispersed within and/or over a surface of an orally-deliverable matrix material, which is usually a solid or semi-solid substrate. When used in chewable compositions, the derivatives can be released into the orally deliverable polymeric matrix material as the composition is chewed and held in the mouth, thus prolonging the flavor of the composition. In the case of dried powders and mixes, the flavor can be made available as the product is consumed or be released into the matrix material as the composition is further processed. When two flavors are combined with the polymeric particles, the relative amounts of the additives can be selected to provide simultaneous release and exhaustion of the compounds.

In one embodiment, the flavored composition includes an orally-deliverable matrix material; a plurality of water insoluble polymeric particles dispersed in the orally-deliverable matrix material, where the polymeric particles individually define networks of internal pores and are non-degradable in the digestive tract; and one or more derivatives as described herein entrapped within the internal pore networks. The derivatives are released as the matrix is chewed, dissolved in the mouth, or undergoes further processing selected from the group consisting of liquid addition, dry blending, stirring, mixing, heating, baking, and cooking. The orally-deliverable matrix material can be selected from the group consisting of gums, latex materials, crystallized sugars, amorphous sugars, fondants, nougats, jams, jellies, pastes, powders, dry blends, dehydrated food mixes, baked goods, batters, doughs, tablets, and lozenges.

Chewing Gum

A flavorless gum base can be combined with a citral or other suitable derivative as described herein to a desired flavor concentration. Typically, a blade mixer is heated to about 110F, the gum base is preheated so that it is softened, and the gum base is then added to the mixer and allowed to mix for approximately 30 seconds. The flavored derivative is then added to the mixer and mixed for a suitable amount of time. The gum can be then removed from the mixer and rolled to stick thickness on waxed paper while warm.

Time Release Formulations

In one embodiment, the derivatives described herein are incorporated into a system which can release a fragrance in a controlled manner. These include substrates such as air fresheners, laundry detergents, fabric softeners, deodorants, lotions, and other household items. The fragrances are generally one or more derivatives of essential oils as described herein, each present in different quantities. U.S. Pat. No. 4,587,129, the contents of which are hereby incorporated by reference in their entirety, describes a method for preparing gel articles which contain up to 90% by weight of fragrance or perfume oils. The gels are prepared from a polymer having a hydroxy (lower alkoxy) 2-alkeneoate, a hydroxy (lower alkoxy) lower alkyl 2-alkeneoate, or a hydroxy poly (lower alkoxy) lower alkyl 2-alkeneoate and a polyethylenically unsaturated crosslinking agent. These materials have continuous slow release properties, i.e., they release the fragrance component continuously over a long period of time. The invention will now be illustrated with reference to the following non-limiting example.

Example 1: Preparation and Flavor Characteristics of a Cyclopropanated Citral or Citronellal Derivative

Cyclopropanation of Citral to Produce Citral-6, 7 -cyclopropane.

The following experimental was based on a well-known method for cyclopropanating olefins, and was conducted numerous times with various stoichiometric equivalents of the cyclopropanation reagents. Optimum results for synthesizing the above-identified monocyclopropanated citral derivative were obtained using the amounts shown below. Attempts to increase relative amounts of reagents resulted in the formation of a significant amount of side products. However, this reaction has not been optimized. The use of less than a stoichiometric amount of the diethylzinc and diiodomethane reactants might be advisable if the separation of citral

and citral-6,7-cyclopropane were optimized. However, since the separation was not optimized, the cyclopropanation reaction was allowed to proceed to completion. The reactions were conducted behind a blast shield due to the reported possible explosive nature of these reactions. It is believed that cyclopropanations using these reaction conditions may be problematic if the diiodomethane is added too quickly to the reaction mixture.

Citral-6,7 -cyclopropane

To an oven dried 500mL round bottomed flask was added 1,2-dichloroethane (85mL) under a nitrogen atmosphere. Diethylzinc (30mL, 1M in hexanes) was added, and then diiodomethane (15g) was introduced dropwise over 1 hour. Following stirring for 30 minutes (a white precipitate formed) citral (1.1g) was added and the reaction was stirred overnight at room temperature.

The reaction mixture was poured into a potassium carbonate solution (100mL, 20%) and then filtered through a pad of Celite® in a sintered funnel. The organic layer was separated and dried over sodium sulfate. Filtration of the drying agent, concentration and flash column chromatography with dichloromethane as eluent gave the title compound.

Reduction of the Aldehyde in Citral-6,7-cyclopropane

The citral-6,7-cyclopropane can be reacted with virtually any reagent known to reduce an aldehyde group to a primary alcohol, such as sodium borohydride and lithium hydride. These reactions tend to go to completion, particularly when a small excess of reducing agent is used. Workup typically involves adding water to quench the excess reducing agent, adjusting the pH of the solution to protonate any alkoxide that might be present, and extracting the resulting reduction product into an appropriate organic solvent. The extracts can be dried through an appropriate drying agent, such as sodium sulfate, and the solvent removed to provide the desired compound. If desired, the

compound can be purified by distillation and/or chromatography using techniques known to those of skill in the art.

Comparative Chemistry with Citronellal

The same chemistry described above can be repeated with respect to citronellal, except that, since there is only one double bond, there is only one cyclopropanation product (although different stereoisomers will be present). The cyclopropanation of citronellal can take place under substantially the same conditions as those used to cyclopropanate citral. The product can be used crude, or purified, before the aldehyde is reduced to a primary alcohol using the same (hydride or other) reducing agents.

Odor Profile of Citronellal Derivatives

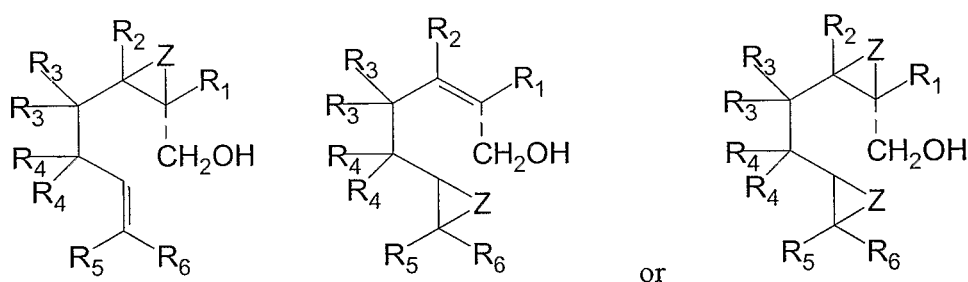
Citronellal derivatives were prepared where the double bond in citronellal was converted to a cyclopropane ring, and also to a thiirane ring, and in each case, the aldehyde group was reduced to a primary alcohol group. In both cases, the compounds had a distinct fresh rosy connotation.

Having hereby disclosed the subject matter of the present invention, it should be apparent that many modifications, substitutions, and variations of the present invention are possible in light thereof. It is to be understood that the present invention can be practiced other than as specifically described. Such modifications, substitutions and variations are intended to be within the scope of the present application.

IMPROVED CITRAL AND CITRONELLAL DERIVATIVES

Claims

1. A citral or citronellal derivative having one of the formulae:



wherein:

Z is O, S, or $\text{C}(\text{R})_2$,

R_1 - R_6 are independently, H, C_{1-5} alkyl, substituted C_{1-5} alkyl, halo, hydroxy, thiol, thioether, amine, carboxylic acid, ester, nitro, cyano, isocyano, sulfonic acid, urea, and thiourea, wherein the substituents on the alkyl groups are selected from halo, hydroxy, thiol, thioether, amine, carboxylic acid, ester, nitro, cyano, isocyano, sulfonic acid, urea and thiourea, and

the dashed line indicates that the carbon to which the CH_2OH group is bound is in the R or S configuration, or exists as mixtures of the two, or the double bond to which it is bonded is in the E or Z configuration.