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2,889,340

UNSATURATED DIALKYL SUBSTITUTED 2,3-EPOXYACID ESTERS

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No Drawing. Application July 2, 1956 Serial No. 595,099

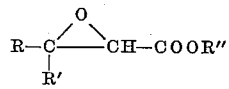
7 Claims. (Cl. 260—348)

This invention relates to esters of aliphatic poly-substituted 2,3-epoxyacids or glycidic acids wherein one or more of the substituents is unsaturated. The invention further relates to methods of producing such esters.

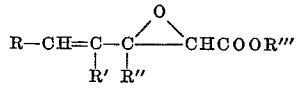
In our copending application Serial No. 595,059, filed July 2, 1956 which has been abandoned, we have described new aliphatic poly-substituted aldehydes. The preferred methods described for producing such aldehydes include process steps wherein esters of aliphatic poly-substituted 2,3-epoxyacids are formed. As pointed out in our copending application Serial No. 595,095, fixed July 2, 1956 which has been abandoned, the esters of epoxyacids having saturated alkyl substituents possess characteristic odors and flavors which render them useful in the production of perfumes or perfumed products and flavoring agents.

It has further been discovered that if one or more of the aliphatic radicals in the compound is unsaturated, the odor and flavor characteristics of the compound are markedly enhanced and frequently differ considerably from those of the corresponding saturated compound.

The compounds of the present invention are therefore aliphatic poly-substituted alkenyl-2,3-epoxyacid esters, or aliphatic alkyl, alkenyl-2,3-epoxyacid acid esters. If desired, the aliphatic group of the ester may also be unsaturated. Accordingly, the compounds of the present invention may be said to have the composition represented by the following formula



where R and R′ are aliphatic groups and at least one of them is unsaturated and R″ is an aliphatic group which may be either saturated or unsaturated. The preferred compounds of the present invention are disubstituted in the 3 or beta position and the alkenyl group is a branched chain group as represented by the formula



where R, R′ and R″ are alkyl or alkenyl groups. Such compounds may be called aliphatic 3,4-dialkyl-2,3-epoxy-4,5-enoic acid esters. Unsaturation may also occur in the alcohol moiety of the ester group.

The principal object of the present invention is to provide a new class of compounds consisting of esters of aliphatic polysubstituted 2,3-epoxyacids containing at least one alkenyl radical.

Another object of the invention is to provide new compounds characterized by their pronounced odor or flavor and consisting of unsaturated aliphatic-polyalkyl-2,3-epoxyacid esters.

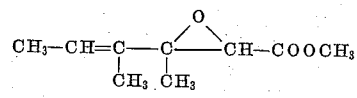
A particular object of the invention is to produce esters of aliphatic 3,4-dialkyl-2,3-epoxy-4,5-enoic acids.

The compounds of the present invention vary considerably in odor in that some possess a fruity odor, others have a berry-like odor, while still others have what may be described as an herb-like or woody odor. The development of such odors is quite unexpected in glycidates containing only aliphatic substituents. The particular odor developed in any compound is found to depend largely upon the nature and location of the various alkyl and alkenyl groups present. The aliphatic group of the ester has an important influence upon the character of the odor. However, in all cases it appears that the intensity of the odor is materially increased and its character modified when one or more of the substituents of the acid is unsaturated. In particular, the olefine linkage between the carbon atoms 4 and 5 has been found to exert a marked effect upon the odor properties of the compound. Thus while the methyl - 3,4-dimethyl-2,3-epoxy-hexanoate has a pronounced and useful berry-like odor, the corresponding unsaturated compound methyl-3,4-dimethyl-2,3-epoxy-4-hexenoate has a characteristically stronger and somewhat different odor. The geranyl and citronellyl esters of the foregoing acids indicate similar properties in that the esters of the saturated acid are substantially odorless, whereas the esters of the unsaturated acid possess strong mocha or caramel-like odors.

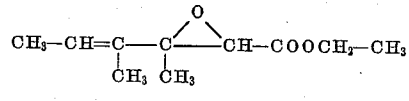
The alkyl groups which may be present in the unsaturated 2,3-epoxyacid ester compounds can be varied greatly. Among the alkyl groups which may be present are methyl, ethyl, propyl, isopropyl, butyl, isobutyl, pentyl, hexyl, and the like as well as their various branched chain isomers. In general, however, the alkyl groups usually contain from 1 to 4 carbon atoms.

Typical of compounds of the class to which this invention relates are the following:

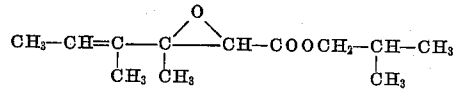
Methyl-3,4-dimethyl-2,3-epoxy-4-hexenoate which has a berry-like odor and may be represented by the formula



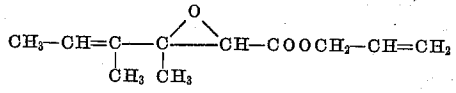
Ethyl-3,4-dimethyl-2,3-epoxy-4-hexenoate has a berry-like odor and the formula



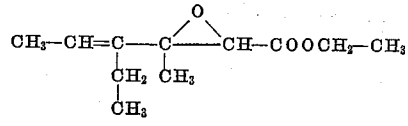
Isobutyl - 3,4-dimethyl-2,3-epoxy-4-hexenoate has an odor which may be described as maple-walnut and is represented by the formula



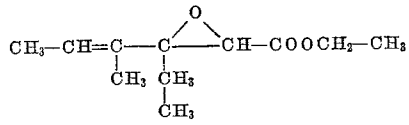
Allyl-3,4-dimethyl-2,3-epoxy-4-hexenoate has a pungent fruity odor and may be represented by the formula



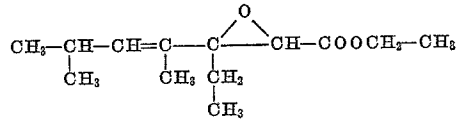
Ethyl - 3 - methyl-4-ethyl-2,3-epoxy-4-hexenoate has a berry-like odor and is represented by the formula



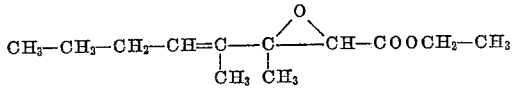
Ethyl-4-methyl-3-ethyl-2,3-epoxy-4-hexenoate has the odor of licorice and the formula



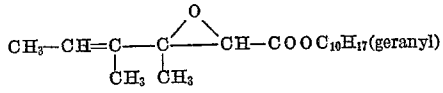
Ethyl-4,6-dimethyl-3-ethyl-2,3-epoxy-4-heptenoate has a woody odor and the formula



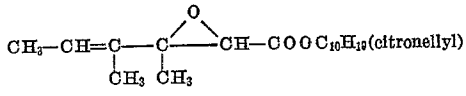
Ethyl-3,4-dimethyl-2,3-epoxy-4-octenoate possesses an herb-like odor. It has the following formula



Geranyl - 3,4 - dimethyl-2,3-epoxy-4-hexanoate has a strong mocha odor and may be identified by the formula



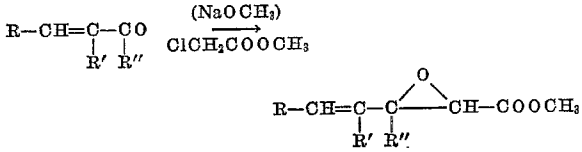
Citronellyl - 3,4-dimethyl-2,3-epoxy-4-hexanoate has a powerful caramel-like odor and the formula



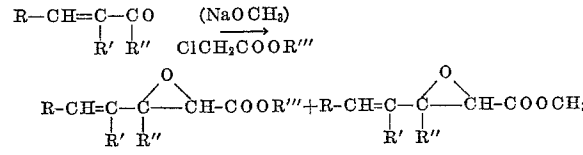
The unsaturated glycidates of the series to which this invention relates may be prepared by reacting an appropriately alpha substituted alpha, beta-unsaturated ketone with an ester of chloracetic or bromacetic acid in the presence of an alkaline condensing agent such as sodium, sodium methylate or other sodium alkoxides, sodium amide, and the like. For convenience and ease of handling it is preferable to employ anhydrous sodium methylate as the condensing agent but satisfactory results may be obtained with the other agents described. If a specific ester is desired and a sodium alkoxide is used as the condensing agent, then the chloracetic acid ester must be derived from the same alcohol as the alkoxide. Otherwise, a mixture of both esters of the glycidic acid will be obtained. Such mixtures are sometimes preferable, particularly when blended odors are desired. However, in many cases where the boiling points of the esters differ sufficiently from each other, it is possible to separate them from such mixtures by fractional distillation. It is also possible to convert a lower alkyl ester of the glycidic acids of this invention to a higher boiling ester by a trans-esterification procedure in which, for example, the methyl ester is heated with another alcohol in the presence of a catalyst such as sodium, anhydrous sodium methylate, and the like with elimination of methanol and formation of the new ester.

The reactions by which products of the present invention are produced may be represented by the following equations:

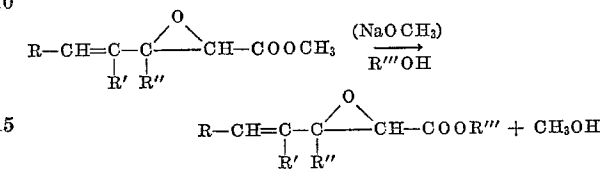
(1)



(2)

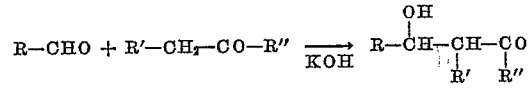


(3)

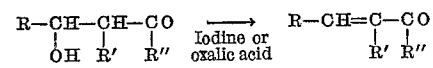


The alpha substituted alpha-beta-unsaturated ketones required for the preparation of the compounds of this invention are not commercially available but may be prepared by the reaction of an aliphatic aldehyde with an aliphatic ketone containing at least four carbon atoms. The resulting hydroxy ketone may then be dehydrated to the desired alpha substituted, alpha, beta, unsaturated ketone with for example iodine or anhydrous oxalic acid. Reactions which may be used in producing the unsaturated ketones employed in the preferred method of producing the compounds may be represented in the following equations:

(4)



(5)



Either alkaline or acid condensing agents may be used and in general, the alkaline agents are preferred. However, in carrying out the reactions of Equation 4 or 5 above, if R is such that the aldehyde has a branched chain in the alpha position and R″ of the ketone is methyl, an acid condensing agent is preferred in order to assure attack of the aldehyde upon the methylene group of the ketone.

In order to illustrate typical procedure which may be employed in accordance with the present invention, the following examples are cited.

Example 1

968 gms. of acetaldehyde were added with stirring at 0–5° C. in 6 hrs. to a mixture of 4752 gms. methyl ethyl ketone and 33.6 gms. potassium hydroxide dissolved in 166 gms. methanol. After stirring for one hr. at 0–5°, 40 gms. oxalic acid was added and the precipitated potassium oxalate removed by filtration. The unreacted methyl ethyl ketone was then distilled out to 94° C. (pot temp.=156°). After cooling to 100° C., an additional 40 g. oxalic acid was added and the mixture again distilled to give 2080 g. crude product (plus some water) distilling from 80–170° C. The water was separated and the product redistilled to give 1276 g. 3-methyl-3-pentene-2-one distilling at 137–142° C.

1176 gms. 3-methyl-3-pentene-2-one and 2083 gms. methyl chloracetate were cooled to −10° C. and 1037 g. anhydrous sodium methylate added in portions with cooling and stirring during four hours while not permitting the temperature to go above 0° C. The temperature was then slowly raised to about 30° C. in about 3 hrs. and the mixture allowed to stand overnight. The mixture was again heated gradually to reflux temperature and maintained at reflux for about one hour. After cooling to about 30°, about 60 g. of acetic acid were added until acid to blue litmus paper. Then 600 g. wa-

ter were added, the oil layer was separated and the product distilled. Unreacted ketone plus other by-products were recovered in the fraction distilling from 45° C. to 100° C. at 20 mm. pressure. Then 1030 g. of methyl 3,4-dimethyl-2,3-epoxy-4-hexenoate was obtained distilling from 83–111° C. at 5 mm. pressure. Upon redistillation the bulk of this material distilled from 87–97° C. at 5 mm. pressure.

Example II

98 gms. 3-methyl-3-pentene-2-one and 73.5 g. ethyl chloracetate were cooled to about −10° C. and a solution of 13.8 g. sodium in 205 g. ethanol was added in about one hour with cooling and stirring while keeping the temperature below 0° C. The temperature was allowed to rise to about 25° C. and after stirring for 2 hrs. again heated to reflux (85° C.) and maintained at that temperature for 1 hr. 162 g. ethanol was then removed by distillation until temperature of reaction mixture reached about 100° C. The mixture was cooled to about 30° C. and 1 g. acetic acid added (until acid to blue litmus paper) followed by 500 g. water. The oil layer formed was separated and distilled. Unreacted ketone plus other by-products were recovered in the fraction distilling from 51° C. to 77° C. at 20 mm. pressure and then 40.4 g. ethyl 3,4-dimethyl-2,3-epoxy-4-hexenoate was obtained distilling from 114° C. to 128° C. at 20 mm. pressure. On refractionating this material the bulk of it distilled at 60–70° C. at 2 mm. pressure.

Example III

76.6 gms. methyl-3,4-dimethyl-2,3-epoxy-4-hexenoate was heated with 157 g. allyl alcohol and 2.34 g. anhydrous sodium methylate. The temperature of the mixture was gradually raised to 120° while distilling out 145 g. of a mixture of methanol and allyl alcohol. The residual material in the flask was then cooled to about 25° C. and treated with about 100 g. of 3% acetic acid and about 65 g. benzene. The benzene layer was separated and after removing the solvent the residual oil was distilled in vacuo. There was obtained 47 g. of the allyl ester of 3,4-dimethyl-2,3-epoxy-4-hexenoic acid distilling at 104–8° C. at 5 mm. pressure.

Example IV

51 g. methyl 3,4-dimethyl-2,3-epoxy-4-hexenoate, 88.9 g. isobutyl alcohol and 1.4 g. anhydrous sodium methylate as catalyst were heated in a flask fitted with a fractionating column while distilling out the methanol formed in the reaction. As the temperature of the mixture was raised from about 98° to 125° C. there was obtained 52.8 g. distillate consisting of a mixture of methanol and isobutanol and distilling from 67° C. to 108° C. Cooled the reaction mixture to about 25° C. and added 1.6 g. acetic acid until acid to blue litmus paper, followed by 200 cc. saturated salt solution. Separated the oil layer and distilled. Obtained 47 g. distilling from 121° C. to 134° C. at 10 mm. pressure which on redistillation gave 38.9 g. isobutyl 3,4-dimethyl-2,3-epoxy-4-hexenoate distilling at 95–97° C. at 2 mm. pressure.

Example V

51 g. methyl 3,4-dimethyl-2,3-epoxy-4-hexenoate, 138.8 g. geraniol, and 1.9 g. anhydrous sodium methylate as catalyst were heated at about 100° C. in vacuo in a flask fitted with a fractionating column until methanol ceased to be evolved. The excess geraniol was then removed by distillation and the residual material in the flask cooled to about 25° C., treated with dilute acetic acid until acid to blue litmus paper, and extracted with benzene. The benzene was then removed by distillation and the crude product distilled to give geranyl 3,4-dimethyl-2,3-epoxy-4-hexenoate distilling at 140–142.5° C. at 0.6 mm. of pressure. The product had a pronounced mocha-like odor.

Example VI

51 g. methyl 3,4-dimethyl-2,3-epoxy-4-hexenoate was reacted with 141 g. citronellol and 1.9 g. anhydrous sodium methylate according to the general procedure of Examples IV and V to give citronallyl 3,4-dimethyl-2,3-epoxy-4-hexenoate distilling at 136–7° C. at 0.5 mm. of pressure. This material had a strong caramel-like odor.

Example VII

According to the general procedure of Example I, isobutyraldehyde was reacted with diethyl ketone and the product dehydrated (in this case with iodine instead of oxalic acid) to give 4,6-dimethyl-4-heptene-3-one. The material distilled at 74–78° C. at 15 mm. pressure.

721 g. 4,6-dimethyl-4-heptene-3-one was reacted with 894 g. methyl chloracetate and 444 g. anhydrous sodium methylate according to the general procedure of Example I to give 440 g. methyl 4,6-dimethyl-3-ethyl-2,3-epoxy-4-heptenoate distilling from 100° to 103° at 5 mm. pressure.

Example VIII

When 4,6-dimethyl-4-heptene-3-one was reacted with ethyl chloracetate and anhydrous sodium methylate, a mixture of the methyl and ethyl esters was obtained from which the ethyl ester was separated by careful fractionation. It distilled at 77° C. to 80.5° at 2.4 mm. pressure.

Example IX

3-methyl-3-heptene-2-one was prepared (according to the general procedure of Example I) by the condensation of n-butyraldehyde with methyl ethyl ketone followed by dehydration of the hydroxy ketone (in this case with iodine instead of oxalic acid).

309.3 g. 3-methyl-3-heptene-2-one was reacted with 425 g. methyl chloracetate and 212 g. anhydrous sodium methylate according to the general procedure of Example I to give 311.4 g. methyl-3,4-dimethyl-2,3-epoxy-4-octenoate distilling from 106° C. to 110° C. at 5 mm. pressure.

Example X

Reaction of 3-methyl-3-heptene-2-one with ethyl chloracetate and anhydrous sodium methylate gave a mixture of the methyl and ethyl esters from which the ethyl ester was obtained by careful fractionation. It distilled at 68–72° C. at 1.1 mm. pressure.

Example XI

3-ethyl-3-pentene-2-one was prepared (according to the general procedure of Example I) by the condensation of acetaldehyde with methyl propyl ketone followed by dehydration of the hydroxy ketone (in this case with iodine instead of oxalic acid). The material distilled at 153–9° C.

449 g. 3-ethyl-3-pentene-2-one was reacted with 286 g. ethyl chloracetate and 136 g. anhydrous sodium methylate according to the general procedure of Example I. 122.2 g. of a mixture of the methyl and ethyl esters of 3-methyl-4-ethyl-2,3-epoxy-4-hexenoic acid was obtained distilling at 108–117° C. at 10 mm. pressure. Careful fractionation gave the ethyl ester distilling at 69.5–74.5° C. at 2.3 mm. pressure.

Example XII

4-methyl-4-hexene-3-one was prepared (according to the general procedure of Example I) by the condensation of the acetaldehyde with diethyl ketone followed by dehydration of the hydroxy ketone (in this case with iodine instead of oxalic acid). The material distilled at 161° C.

112.1 g. 4-methyl-4-hexene-3-one was reacted with 71.5 g. ethyl chloracetate and 33.9 g. anhydrous sodium methylate according to the general procedure of Example I to give 56.4 g. of a mixture of the methyl and ethyl esters of 4-methyl-3-ethyl-2,3-epoxy-4-hexenoic acid distilling from 113° to 123° C. at 20 mm. pressure. Careful

fractionation of this material gave the ethyl ester distilling from 69° to 71.5° at 2.3 mm. of pressure.

While numerous typical compounds of the series to which this invention relates have been specifically referred to or described above, and preferred methods described for producing such compounds, it will be apparent that many other compounds embodying the present invention may be produced. Moreover, it is pointed out that the odor of the compounds varies over a wide range in both character and intensity depending upon the type, location and the relative positions of the various substituents in the carbon chain as well as those of the ester group. Those compounds having relatively high boiling points ordinarily possess less odor and accordingly compounds containing no more than about 20 carbon atoms are preferred for most purposes. However, even the higher boiling compounds and those containing more than 20 carbon atoms may be used as blending agents or modifiers in perfumes and perfumed products.

It will also be evident that the unsaturated ketones used in the preferred methods of procedure described may be produced or obtained in any suitable way and it is possible that the epoxyacid esters themselves may be produced by methods other than those herein described.

In view thereof it should be understood that the particular compounds referred to above and the methods for their production described in the various examples cited hav been chosen for the purpose of indicating the general nature of the invention and are not intended to limit the scope thereof.

What we claim is:

1. Lower alkyl-3,4-dimethyl-2,3-epoxy-4-hexenoates.
2. Lower alkenyl-3,4-dimethyl-2,3-epoxy-4-hexenoates.
3. Methyl-3,4-dimethyl-2,3-epoxy-4-hexenoate.
4. Citronellyl-3,4-dimethyl-2,3-epoxy-4-hexenoate.
5. Isobutyl-3,4-dimethyl-2,3-epoxy-4-hexenoate.
6. Ethyl-4-methyl-3-ethyl-2,3-epoxy-4-hexenoate.
7. Ethyl-3,4-dimethyl-2,3-epoxy-4-octenoate.

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