

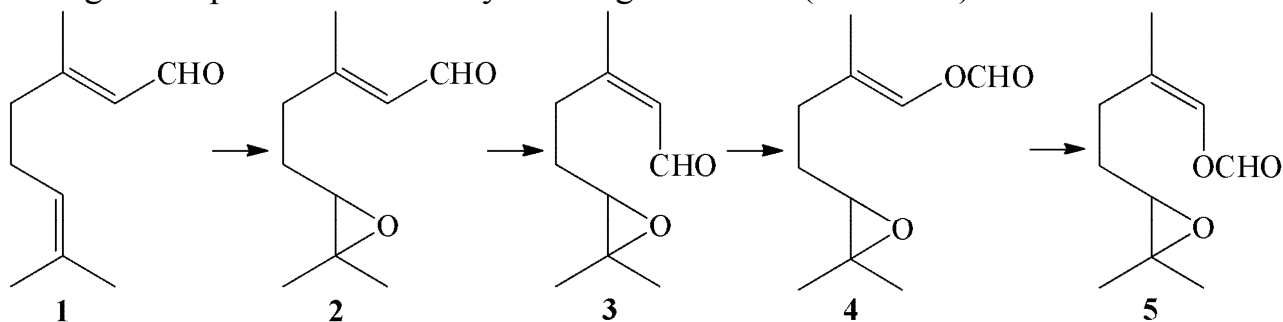
## OXIDATION OF CITRAL WITH PEROXY ACIDS OR HYDROGEN PEROXIDE

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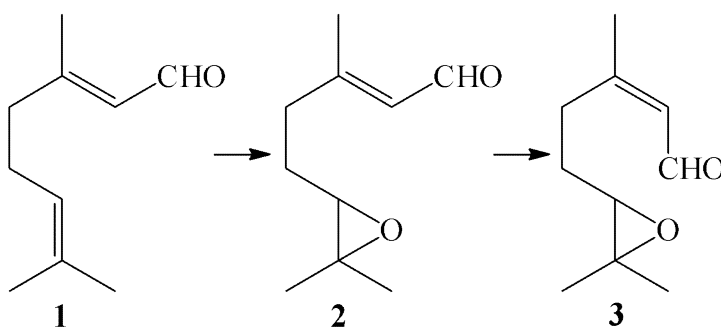
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Citral is an excellent example of a simple polyfunctional molecule, possessing two differentiable alkenes, one of which is conjugated to an aldehyde. Citral is naturally a mixture of the *E* isomer geranial and the *Z* isomer neral. Treating of citral (1) with peracetic acid in CH<sub>2</sub>Cl<sub>2</sub> at the present anhydrous Na<sub>2</sub>CO<sub>3</sub> provide 6,7-derivatives of geranial (*cis*-citral) (2) and neral (*trans*-citral) (3). Alongside these epoxides formed (*E*)-(4) and (*Z*)-(5) 2,6-dimethyl-5,6-epoxy-1-heptenyl formates arising from epoxidation and Bayer-Williger reaction (Scheme 2).



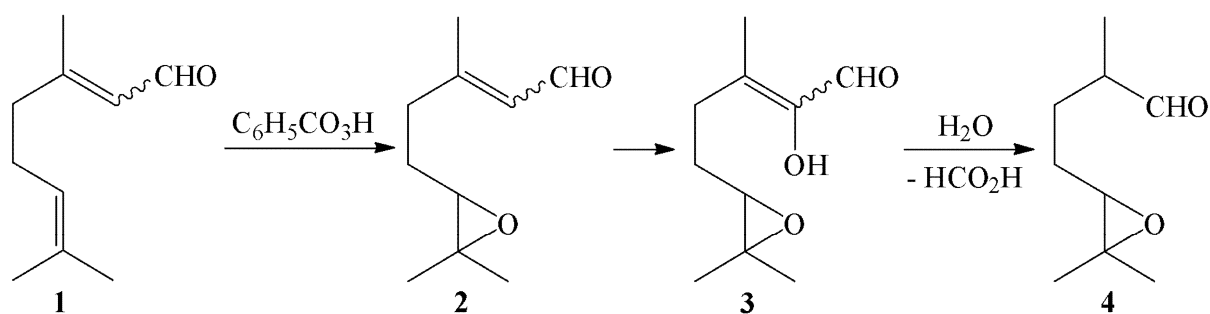
**Scheme 1** Oxidation of citral with peracetic acid in chloroform

By oxidation of Citral (1) with *m*-chloroperoxybenzoic acid in chloroform at room temperature was obtained a mixture of *E*- and *Z*-epoxides at 2 and 3 at a ratio of 60 : 40 in an overall yield of about 60%, while no other products were detected (Scheme 2).



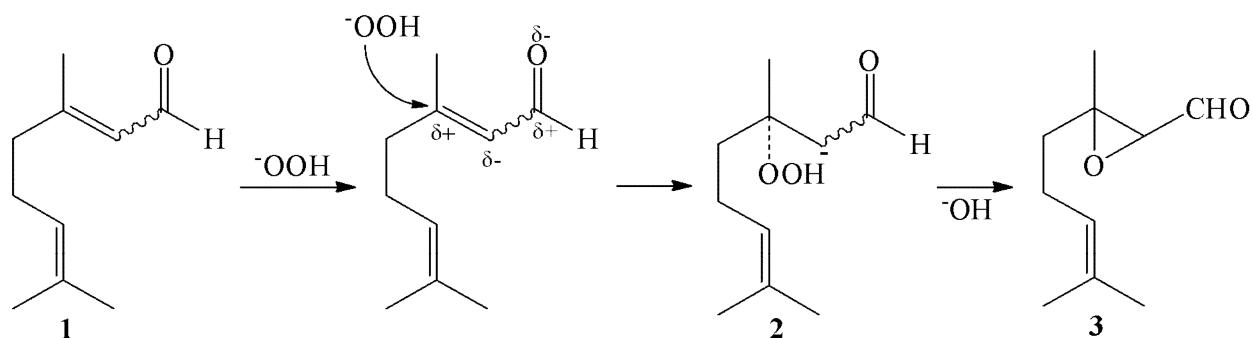
**Scheme 2** Mechanism for the oxidation of Citral with *m*-chloroperoxybenzoic acid in chloroform

Prilezhaev established that Citral (1) is first epoxidized and then converted through the stage of ester formation into a lower aldehyde (4) (Scheme 3).



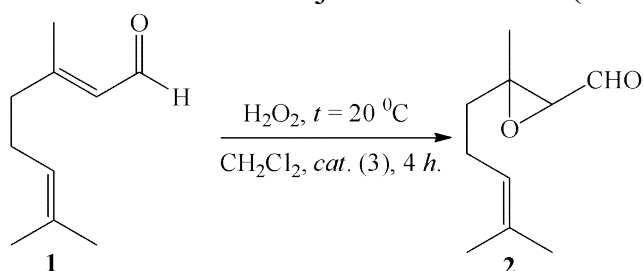
**Scheme 3** Mechanism for the electrophilic epoxidation of Citral using perbenzoic acid

This same alkene can be oxidized selectively to give epoxycitral upon treatment with alkaline hydrogen peroxide under interphase catalysis conditions (benzene and a catalytic amount of triethylbenzylammonium chloride (*TEBA*)). The yield of 2,3-epoxy-3,7-dimethylocten-6-al reaches 70-77%. The oxidation reaction summarized in Scheme 4 it features a catalyst (sodium hydroxide) that deprotonates hydrogen peroxide to increase its nucleophilicity. The intermediate enolate then forms an epoxide through breaking the weak O-O bond and regeneration of the sodium hydroxide catalyst.



**Scheme 4** Mechanism for the nucleophilic epoxidation of Citral using hydrogen Peroxide and Catalytic Sodium Hydroxide

Epoxycitral may be less familiar than the others, but it is a mite pheromone with significant anticancer activity. (2*R*,3*R*)-2,3-Epoxy-3,7-dimethyl-6-octenal [(2*R*,3*R*)-epoxyneral] was identified as the female sex pheromone from an acarid mite, *Caloglyphus* sp. (Astigmata:Acaridae). Epoxidation of citral (1) (3:2 E:Z ratio was used) under the standard conditions in the presence of a catalyst (3) gave the sex pheromone (2) in 73% yield and 85% of the ajor diastereomer (Scheme 5).



**Scheme 5** Mechanism for epoxidation of Citral using hydrogen peroxide and as a catalyst -[bis(3,5-bis(trifluoro-methyl)phenyl)trimethylsilyloxymethyl]pyrrolidine (3)