Direct Chromatographic Separation of the Enantiomers of Methyl Jasmonate and Its Derivatives

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(3R,7R,9Z)-(-)-Methyl jasmonate [(+-)-JA-Me, 1] is not only an important odoriferous substance,1,2 but also in a new group of endogenous plant growth regulators.3-5 Several reports on the novel and interesting bioactivity of JA-Me and its derivatives, (+)-methyl epijasmonate [(+-)-epiJA-Me, 2], methyl dihydrojasmonate, and methyl cucurbit, have been published.6-12

The racemate of JA-Me, which is easily available from the perfume industry, has been applied to most of the physiological studies. Since different physiological effects of (+)- and (-)-JA-Me have been reported,8,13-15 separation of the two enantiomers is imperative for studies on the mode of action and metabolism of JA-Me. (+)-JA-Me has been optically resolved by liquid chromatography after conversion to the diastereo-isomeric jasmonate ketals of (-)-2,3-butanediol13 or esters of (-)-borneol.8 Little is known, however, about the optical resolution of derivatives of JA-Me. This paper describes a direct chromatographic resolution of JA-Me and its related compounds, epi-JA-Me, methyl dihydrojasmonate, and methyl cucurbit, on chiral stationary phases.

Figures 1a and b show the optical resolution of (+)-JA-Me and (±)-epiJA-Me on a Chiralpak AS column, complete optical resolution being achieved by using n-hexane-2-propanol (9:1) as the eluent. The capacity factors, K1 and k', which represent the strength of interaction between the stationary phase and enantiomer, were 1.22 and 1.76 for (+)-JA-Me, and 1.65 and 3.50 for (±)-epiJA-Me. The separation factor, ∑, which shows the optical resolving power of the chiral stationary phase, was calculated as 1.44 and 2.12, respectively. The resolution factor, Rs, which indicates the efficiency of the column, was 1.94 for (+)-JA-Me, and 5.02 for (±)-epiJA-Me. A polarimetric detector showed that the (+)-form eluted faster than the (−)-form in both cases. Four isomers of JA-Me and epiJA-Me could be resolved in one injection as shown in Fig. 1c. This method will be useful for analyzing practical materials, because epiJA-Me easily epimerizes at C-7 to form a stable trans isomer, JA-Me.16

(±)-Methyl dihydrojasmonate was also separated by a Chiralpak AS column, using n-hexane-2-propanol (98:2) as the mobile phase. The (+)-enantiomer eluted faster (tR: 9.9 min) than the (−)-form (tR: 12.3 min) by polarimetric detection. The k1, k', ∑, and Rs values were 2.32, 3.12, 1.35, and 2.72, respectively.

Fig. 1a. Chromatographic Resolution of (±)-JA-Me on the Chiralpak AS Column (250 x 4.6 mm i.d.; Daicel, Japan). The mobile phase was n-hexane-2-propanol (9:1) at a flow rate of 0.10 ml/min and at ambient temperature. The injection volume was 10 µl (5 µg).

b. Chromatogram Obtained for (±)-epiJA-Me.

c. Chromatogram Resulting an Injection of 10 µl (5 µg each) of a Mixture of (±)-JA-Me and (±)-epiJA-Me. UV detection was at 230 nm, and the other conditions are given in 1a.

Capacity factors: K1 (capacity factor for the less-retained enantiomer) = (retention time of the less-retained enantiomer – dead time)/dead time; k' (capacity factor for the more-retained enantiomer) = (retention time of the more-retained enantiomer – dead time)/dead time.

Separation factor ∑ = k'/K1.

Resolution factor Rs = 2 × (distance between the two peak positions)/(sum of the bandwidths of the peaks).
cucurbate could not be resolved by the Chiralpak AS column. This suggests that the 6-keto group of JA-Me derivatives may have interaction with the chiral stationary phase of the Chiralpak AS column through hydrogen bonding and/or dipoles.

These methods can be applied to determine the optical purity of synthetic substances for a precise evaluation of their biological activity. Direct resolution is more valuable than the resolution of diastereomeric derivatives produced by reaction with an optically active reagent in several respects.

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