Efficient, Baseline Separation of Pyrethrins by Centrifugal Partition Chromatography
Alan Wong1, Vitold Ginski1, Jan A. Ginski1 1Planta Analytica LLC, 461 Danbury Rd, New Milford, CT 06776

Abstract
Pyrethrins are natural pesticides present in the oil extracted from the flowers of Chrysanthemum cinerariaefolium. These six structurally related esters are potent neurotoxins that interfere with sodium channels in neurons of insects. With low toxicity to mammals and an exceptionally safe environmental profile, there is an increasing use of the oil extract as a natural pesticide. The six pyrethrins are either of trans-chrysanthemic acid (pyrethrins I group) or pyrethric acid (pyrethrins II group). Both groups comprise pyrethin, cinerin, and jasmolin, with minute differences in the alkyl chain in the alcohol moiety.

Isolation of multi-gram quantities of all six pyrethrins in high purity is a prerequisite to synthesizing derivatives for studying toxicity and soil degradation. High hydrophobicity and close structural similarity between the individual pyrethrins within their groups make this task challenging. As a result, large quantities of these esters have not been commercially available. To facilitate the study, we have developed a two-step purification process, in which the two groups were first separated by normal phase column chromatography on silica gel. For the separation of pyrethin, cinerin, and jasmolin within each group we applied Centrifugal Partition Chromatography (CPC). We explored and successfully optimized solvent systems that were subsequently applied to achieve multi-gram scale separation. In both cases, gram quantities of individual pyrethrins in purity exceeding 99% were produced.

Experimental

Centrifugal Partition Chromatography:
Kromaton FCPC A (Rousselet Robatel, Annay, France) equipped with 1 L rotor
Waters HPLC pump model 590 for solvent delivery; 33 ml/min
Dynamax pump model SDS-200 for sample injection; 20 ml/min
Varian ProStar 701 fraction collector
Operated in ascending mode at 1500 rpm

Pyrethrins I Group:
Sovent system: SS-02 heptane-methanol-acetonitrile (6:1:2, v/v)
SS-03 heptane-MTBE-acetonitrile (8:1:5, v/v)
Sample: 8 g load of est. 65% pyrethrins I group per run; 8 runs
Result: 28.3 g pyrethrin I (1), 5.4 g cinerin I (2), 4.6 g jasolin I (3)

Pyrethrins II Group:
Sovent system: SS-12 heptane-MTBE-acetonitrile-water (8:1:5:1.5, v/v)
Sample: 8 g load of est. 60% pyrethrins II group per run; 9 runs
Result: 24.3 g pyrethyrin II (4), 4.8 g cinerin II (5), 3.2 g jasolin II (6)

Normal Phase HPLC:
System: Agilent HPLC model 1100; YMC 4.6 x 100 mm Cyano column, S-3 micron, 120 Å
Gradient: A: hexane; B: 10% THF in hexane;
2.0 ml/min; step gradient 0% B to 12% B at 5 min
Result: jasolin I (3) 4.42 min, cinerin I (2) 4.63 min, pyrethrin I (1) 4.89 min,
jasolin II (6) 7.17 min, cinerin II (5) 7.30 min, pyrethrin II (4) 7.48 min

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