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Acaricidal and quantitative structure activity relationship of monoterpenes against the two-spotted spider mite, *Tetranychus urticae*

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Abstract

The acaricidal activity of 12 monoterpenes against the two-spotted spider mite, *Tetranychus urticae* Koch, was examined using fumigation and direct contact application methods. Cuminaldehyde and (–)-linalool showed the highest fumigant toxicity with $LC_{50} = 0.31$ and 0.56 mg/l, respectively. The other monoterpenes exhibited a strong fumigant toxicity, the LC_{50} values ranging from 1.28 to 8.09 mg/l, except camphene, which was the least effective ($LC_{50} = 61.45$ mg/l). Based on contact activity, the results were rather different: **menthol displayed the highest acaricidal activity ($LC_{50} = 128.53$ mg/l)** followed by thymol (172.0 mg/l), geraniol (219.69 mg/l) and (–)-limonene (255.44 mg/l); 1-8-cineole, cuminaldehyde and (–)-linalool showed moderate toxicity. At 125 mg/l, (–)-Limonene and (–)-carvone caused the highest egg mortality among the tested compounds (70.6 and 66.9% mortality, respectively). In addition, the effect of molecular descriptors was also analyzed using the quantitative structure activity relationship (QSAR) procedure. The QSAR model showed excellent agreement between the estimated and experimentally measured toxicity parameter (LC_{50}) for the tested monoterpenes and the fumigant activity increased significantly with the vapor pressure. Comparing the results of the fumigant and contact toxicity assays of monoterpenes against *T. urticae* with the results of acetylcholinesterase (AChE) inhibitory effect revealed that some of the tested compounds showed a strong acaricidal activity and a potent AChE inhibitory activity, such as cuminaldehyde, (–)-linalool, (–)-limonene and menthol. However, other compounds such as (–)-carvone revealed a strong fumigant activity but a weak AChE inhibitory activity.