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Antifeedant and repellent properties of natural and synthetic compounds against the rice weevil, *Sitophilus oryzae* (Coleoptera: Curculionidae) and the pulse beetle, *Callosobruchus maculatus* (Coleoptera: Bruchidae): perception, biological and behavioral contexts.

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Antifeedant and repellent properties of natural and synthetic compounds against the rice weevil, *Sitophilus oryzae* (Coleoptera: Curculionidae) and the pulse beetle, *Callosobruchus maculatus* (Coleoptera: Bruchidae): perception, biological and behavioral contexts.

Abstract

The objective of this study was to evaluate the potential of four commercially available essential oils (EOs) (cumin, mandarin, marigold and better orange) and three oil components (citranellol, geraniol and linalool) and one insecticide (Deltamethrin) against two of the most common stored grain pests in storage facilities in Egypt; the rice weevil, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) and the pulse beetle, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae). In addition, the purpose of this study was to compare the antennal morphology, types of sensilla, and their distribution of *C. maculatus* and *S. oryzae* in order to better understand the repellent and antifeeding responses of these stored grain pests to botanical insecticides. The chemical composition of EOs was determined by gas chromatography/ mass spectrometry (GC-MS). Results obtained showed that, principal compounds of bitter orange, mandarin, cumin and marigold EOs were limonene (85.47%), tricarbonyl [methyl 6-vinylidenehepta 2,4-dien-1-oate]iron (52.8%), propanal (26.07%) and α-terthienyl (8.79%), respectively. Deltamethrin possessed the highest contact toxicity against both insects when compared with the other EOs. Mandarin and bitter orange EOs were the most toxic against *S. oryzae* after two and five days post exposure with LC_{50} values of 8974 and 1752.7 ppm, respectively. Bitter orange and mandarin EOs exhibited highest contact toxicity against *C. maculatus* after two and five days post exposure with LC_{50} values of 1138.5 and 14 ppm, respectively. Combined mixtures of EOs were more toxic to *S. oryzae* and *C. maculatus* than single EO treatments. The monoterpenoid geraniol was the most toxic compared to either linalool or citronellol five days post exposure of *C. maculatus* and *S. oryzae*. All EOs inhibited the emerged progeny and reduced the seed weight loss. Bitter orange EO and the monoterpenoid citronellol at the highest concentration showed the strongest antifeedant effect on *S. oryzae*. The oil components had the highest repellent activity against both *S. oryzae* and *C. maculatus* than that of crude EOs. Percent of repellent increased with the increasing of concentration through the period of experiment, treated grain bioassay obviously demonstrated higher repellent activity than filter paper bioassay. Three

types of sensilla were recognized on the antennae of *C. maculatus* including sensilla trichodea, Böhm bristles (BB) and sensilla chaetica (Sc). Seven types of sensilla were found on *S. oryzae* antennae including two types of sensilla trichoidea (ST1 and ST2), two types of sensilla chaetica (Sch1 and Sch2), two types of sensilla basiconica (Sb Type 1 and 2) and sensilla gemmiformia.

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