

Expression of heat-shock protein genes in *Apis mellifera meda* (Hymenoptera: Apidae) after exposure to monoterpenoids and infestation by *Varroa destructor* mites (Acari: Varroidae)

ABSTRACT

Heat shock proteins (*hsps*) protect proteins in eukaryotic cells from damage. Expression of *hsps* in insects subject to different environmental stimuli is poorly characterized. Here, levels of expression of the *hsps* genes (*hsp40*, *hsp70*, and *hsp90*) were recorded in *Apis mellifera* Linnaeus (Hymenoptera: Apidae) workers after exposure to sublethal concentrations of thymol, eucalyptol, α -pinene, *trans*-anethole, diallyl disulfide and infestation with *Varroa* mites. Our results show a dose-dependent up-regulation in the levels of all the *hsps* tested after the bees were treated with thymol, eucalyptol and α -pinene. Although these up-regulated expressions were statistically significant for *hsp70* and *hsp90* when the bees were treated with thymol and eucalyptol, they were not significant when treated with α -pinene. In addition, significant down-regulated expressions of the *hsp* genes were recorded in the diallyl disulfide treatment. The transcriptions of all the *hsps* tested were significantly down-regulated when pupae were infested with different numbers (0-5) of *Varroa* mites. Thus, it is likely that *hsps* can be used as biomarkers of survival when honey bees are under toxic and pathogenic stress, but this needs to be confirmed.

Keyword: Apidae; *Apis mellifera meda*; Honey bee; Gene expression; Heat shock protein; Stress; Survival; *Varroa destructor*