

Title In vitro and in vitro activity of eugenol oil (*Eugenia caryophyllata*) against four important postharvest apple pathogens

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Abstract

The activity of eugenol oil was evaluated in vitro and in vivo against four apple pathogens namely *Phlyctema vagabunda*, *Penicillium expansum*, *Botrytis cinerea* and *Monilinia fructigena*. The minimum inhibitory concentration (MIC) of eugenol incorporated in malt extract agar medium was found to be 2 mg ml^{-1} . Mycelial growth of the four test pathogens was completely inhibited when treated with $150 \mu\text{l l}^{-1}$ of volatile eugenol whether at 4 or 20 °C. Conidia of *P. vagabunda*, *P. expansum*, *M. fructigena* and *B. cinerea* suspended for 2 min in eugenol solution at 2 mg ml^{-1} heated to 50 °C germinated at rates of 19, 37, 38 and 39%, respectively. Three different eugenol formulations (Tween 80, ethoxylate and lecithin) were tested for their in vivo efficacy against the tested pathogens on apples. Ethoxylate- and Tween 80-eugenol formulations applied at room temperature were ineffective in reducing disease incidence. When heated to 50 °C, both formulations induced phytotoxicity on apple surface and caused cuticle damages as revealed by scanning electronic microscopic observations. A mixture of eugenol at 2 mg ml^{-1} and soy lecithin at 50 mg ml^{-1} suppressed the phytotoxic symptoms produced by eugenol on apples and reduced the disease incidence of *P. expansum*, *P. vagabunda*, *B. cinerea* and *M. fructigena* to less than 7, 6, 4 and 2% respectively after 6 months of storage at 2 °C. The application of heated lecithin-formulated eugenol could become a successful alternative to the traditional fungicides used in postharvest disease management of apple fruit.