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Mycology, Plant Protection, Essential Oils

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Colletotrichum acutatum is a significant pre- and postharvest pathogen worldwide. Symptoms of anthracnose can occur on several fruits and other crops such as strawberry, sweet and sour cherry, apple, almond, papaya, blueberries, mango, tamarillo and loquat fruit. In our survey in vitro effectiveness of essential oils were tested against mycelial growth and conidial germination of *Colletotrichum acutatum*. Antifungal activity of essential oils was compared by poisoned agar technique using three different oil concentrations. Three fungicides were also involved as controls. Considerable differences were observed in effectiveness at different concentrations. Mycelial growth of *Colletotrichum acutatum* was completely inhibited in 0.1% concentration by the essential oil of anise, basil, clove, fennel, palmarosa and spearmint. At the lowest tested concentration (0.01%) thyme and cinnamon oil caused complete inhibition. Concerning conidial germination at 0.1% concentration rosemary, palmarosa, clove, thyme, spearmint, Indian lemongrass, basil, fennel and anise oils were effective. These essential oils yielded better results than fenhexamid active agent applied in field dose. In case of thyme and cinnamon oil, complete fungistatic activity has been observed at the lowest dilution, as in case of tebuconazole and mancozeb containing fungicides. Essential oils giving good efficacy against the fungus were selected for further in vivo experiments. Some essential oils might be promising source of a biological fungicide, applied directly before harvest or during postharvest.

ESSENTIAL OILS IN PLANT PROTECTION AND POSTHARVEST CONTROL OF *COLLETOTRICHUM ACUTATUM*

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Figure 1. Anthracnose of sour cherry
(Photo: Petróczy, 2012)

INTRODUCTION

Anthracoze causes significant damage on sour cherry (Fig. 1.) and on strawberry (Fig. 2.) in Hungary. The pathogen caused epidemics and unexpected losses of fruit production in the past few years, because the chemical control proved to be unsuccessful. The symptoms caused by *Colletotrichum acutatum*. Only few fungicides are allowed to apply 7-10 days before harvest, so the usage of plant extracts and essential oils in plant protection got into the focus of interest in the past years.



Figure 2. Anthracnose of strawberry
(Photo: Tóth, 2012)

MATERIALS AND METHODS

Isolates of *Colletotrichum acutatum* were originated naturally infected sour cherry (cv. 'Újfehértói fürtös'; origin: Soponya, Hungary; year of isolation: 2011) and (cv. 'Asia'; origin: Lajosmizse, Hungary; year of isolation: 2012) strawberry fruits.

Essential oils

During evaluation of the effectiveness of essential oils on *C. acutatum*, anise (*Pimpinella anisum*), basil (*Ocimum basilicum*), bergamot (*Aetheroleum bergamottae*), camphor (*Cinnamomum camphora*), cinnamon (*Cinnamomum aromaticum*), citronella (*Cymbopogon nardus*), clove (*Syzygium aromaticum*), coriander (*Coriandrum sativum*), cubeba (*Litsea cubeba*), fennel (*Foeniculum vulgare*), Indian lemongrass (*Cymbopogon citratus*), lavender (*Lavandula angustifolia*), niaouli (*Melaleuca viridiflora*), orange blossom (*Citrus sinensis*), palmarosa (*Cymbopogon martinii*), patchouli (*Pogostemon* sp.), rosemary (*Rosmarinus officinalis*), sage-muscat (*Salvia sclarea*), spearmint (*Mentha spicata*) and thyme (*Thymus vulgaris*) essential oils were selected. Antifungal activity was tested in three dilutions (1%, 0.1% and 0.01%).

In vitro antifungal activity

Agar dilution (poisoned agar plate) method was applied for testing antifungal activity of essential oils against mycelial growth and conidial germination. In addition, three fungicides Teldor 500SC (fenhexamid), Orius 20EW (tebuconazole) and Dithane M45 (mancozeb) were employed as chemical controls in the assay.

RESULTS AND DISCUSSION

In case of agar dilution technique method, great differences were observed in effectiveness among essential oils at different concentrations (Fig. 3., 4.). Between the two isolates relevant differences were not noticed.

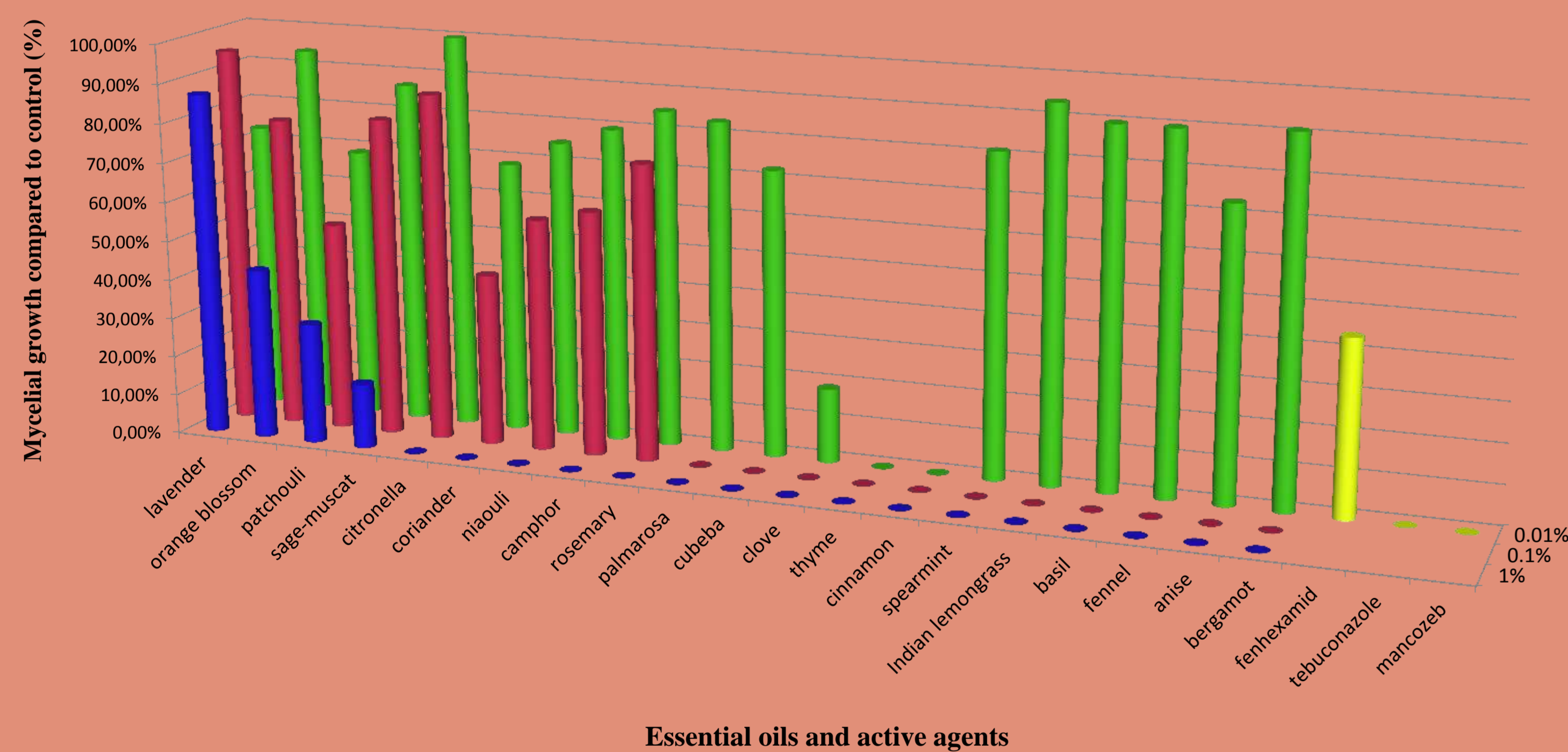


Figure 3. Antifungal activity of 19 essential oils (in 1, 0.1, 0.01% dilutions) and 3 active agents (fungicides in practical dose, as control) against mycelial growth of *Colletotrichum acutatum*

Concerning mycelial growth of *Colletotrichum acutatum* almost all oils in a 1% concentration caused total inhibition. At 0.1% dilution the efficacy of citronella, coriander, niaouli, camphor and rosemary decreased significantly. The EC_{90} value was under 0.1% in case of palmarosa, cubeba, clove, thyme, spearmint, Indian lemongrass, basil, fennel, anise and bergamot. At the tested lowest dilution only essential oil of cinnamon and thyme inhibited totally the mycelial growth of the fungus. Thyme oil at 0.01% was as effective as tebuconazole and mancozeb active agents (Fig. 3.).

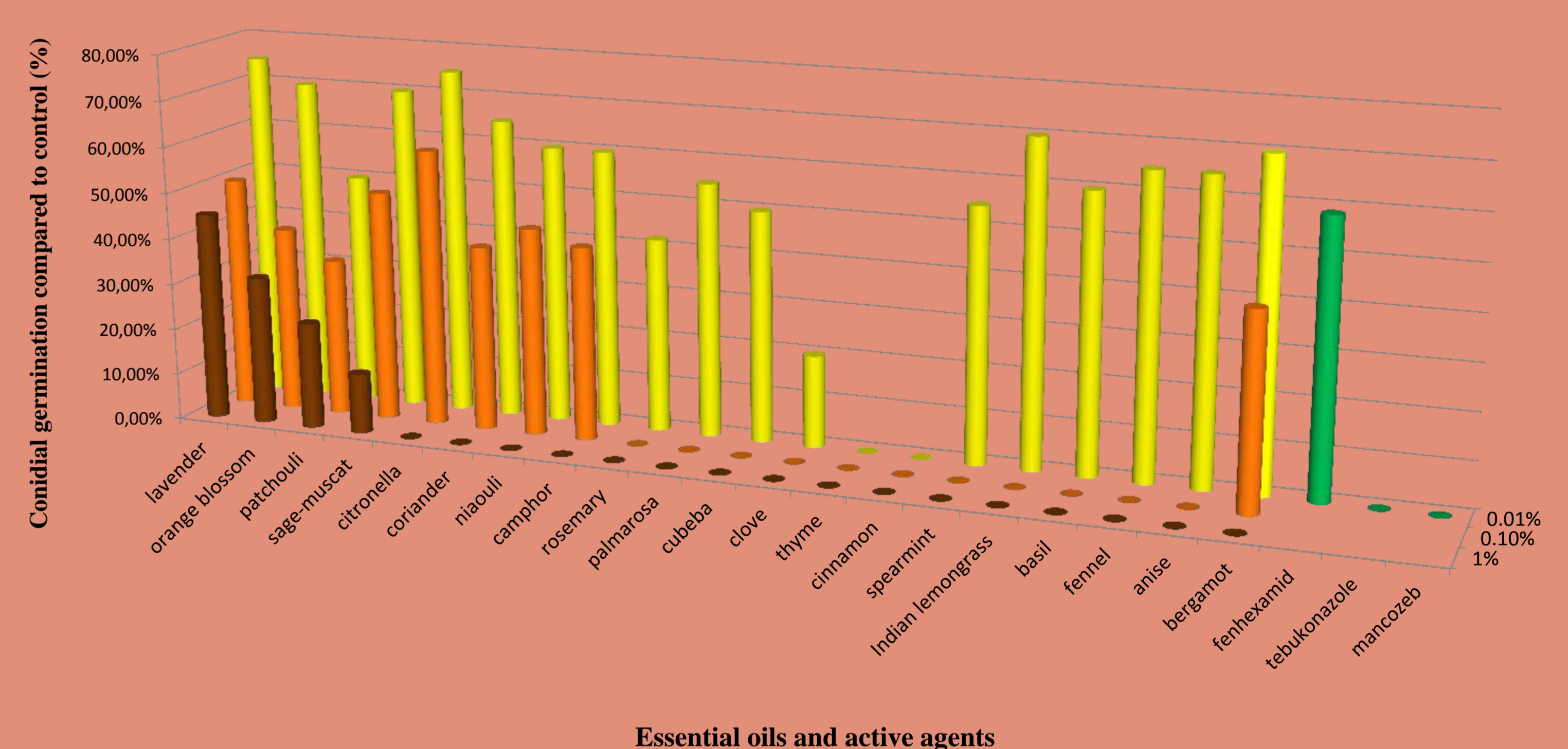


Figure 4. Antifungal activity of 19 essential oils (in 1, 0.1, 0.01% dilutions) and 3 active agents (fungicides in practical dose, as control) conidial germination of *Colletotrichum acutatum*

Essential oils of lavender, orange blossom, patchouli inhibited less the germination of conidia. EC_{90} values were between 1% and 0.1% in case of sage-muscat, citronella, coriander, niaouli, camphor and bergamot oils. At 0.1% concentration rosemary, palmarosa, cubeba, clove, thyme, spearmint, Indian lemongrass, basil, fennel and anise held back the conidial germination during 14 days observation. In case of cinnamon and thyme oil, complete fungistatic activity has been observed at the lowest dilution, like tebuconazole and mancozeb containing fungicides, so the EC_{90} value is below 0.01% (Fig. 4.).

In vivo effectiveness of essential oils was evaluated at Sósút. Twelve-year-old cherry trees (cv. 'Érdi bőtermő') were treated with the mixture of cinnamon and thyme. Essential oils were sprayed three times against the fungus: at the beginning of fruit growth (0.75 l/ha), during fruit growth and at the beginning of ripening (1l/ha). Treatments were evaluated before the harvest. Three trees were selected from every row. Efficacy was concluded by the frequency of infected fruits. By low infection rate, the treatment with essential oils was slightly less effective than the standard fungicide control (Fig.5.).

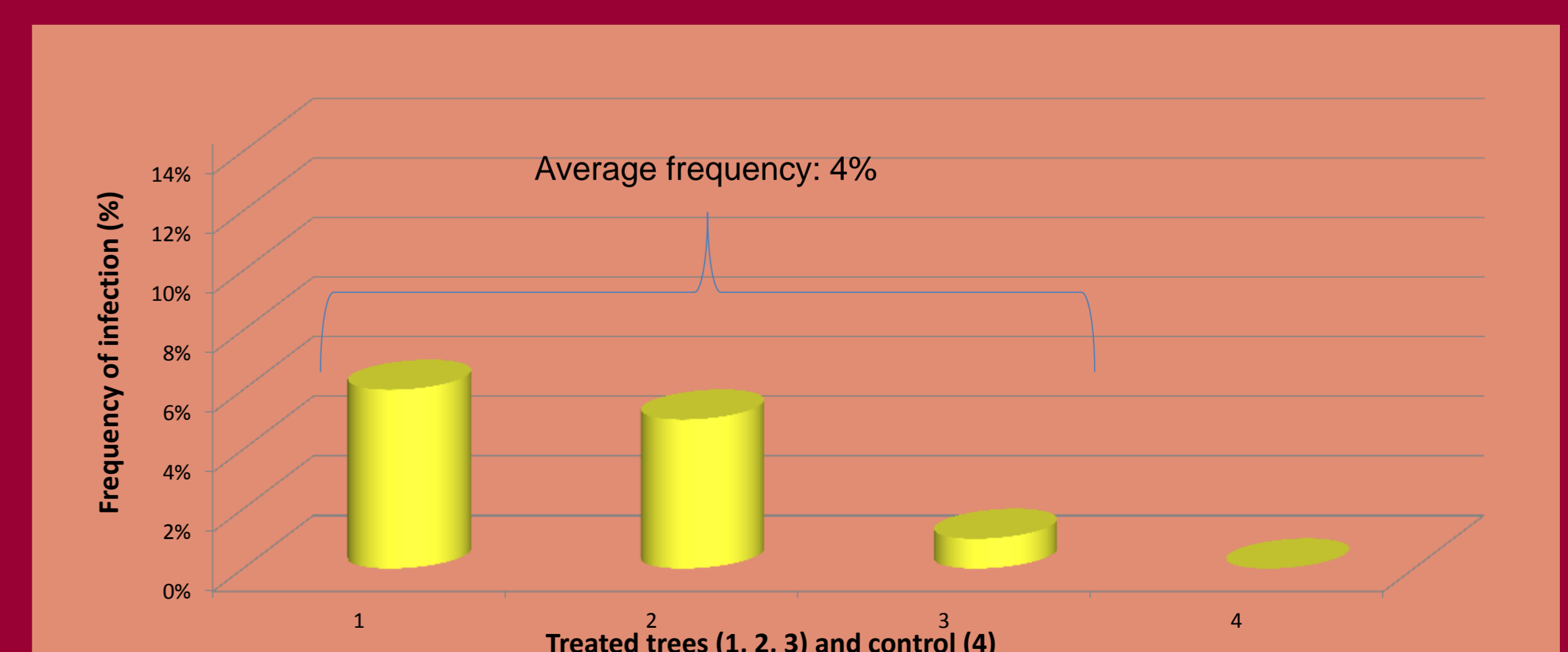


Figure 5. *In vivo* effectiveness of cinnamon and thyme oil mixture against sour cherry anthracnose

ACKNOWLEDGEMENTS

The project was funded by OTKA-PD100425, TÁMOP- 4.2.1./B-09/1-KMR-2010-0005, TÁMOP- 4.2.2./B-10/1-2010-0023 and TÁMOP 4.2.4.A/1-11-1-2012-0001 „National Excellence Program” grants.