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Effectiveness of medical plant essential oils on pregnant female of *Luciaphorus perniciosus* Rack (Acari: Pygmephoridae)

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Abstract

Pregnant female mushroom mites, *Luciaphorus perniciosus* Rack were fumigated with the essential oils from clove (*Syzygium aromaticum*), citronella grass (*Cymbopogon nardus*), lemon grass (*Cymbopogon citratus*) and turmeric (*Curcuma longa*). The essential oils at various concentrations from 0 to 75 $\mu\text{g}/\text{cm}^3$ in 2% Tween-20 in water were placed into 16 cm^3 glass vials and fumigated for 2 hrs at XX $^{\circ}\text{C}$. Hatching of adults mites was observed for 7 days. At 75 $\mu\text{g}/\text{cm}^3$, lemon grass and citronella grass essential oils had the highest inhibition effect, resulting in 97.3 and 95.8% mortality, respectively. Turmeric and clove essential oils were less effective and had 63.8 and 39.2% mortality, respectively. Lemon grass and citronella grass essential oils median effective concentration (EC_{50}) was 18.15 and 19.66 $\mu\text{g}/\text{cm}^3$, respectively. Whereas, turmeric and clove essential oils had EC_{50} of 41.79 and 82.09 $\mu\text{g}/\text{cm}^3$, respectively.

Keywords :

Introduction

The mushroom mite, *Luciaphorus perniciosus* Rack (Acari: Pygmeporidae) is the most important mite causing yield losses in mushroom production. This mite reduces the production of *Lentinus squarrosulus* (Mont.) Singer, *Lentinus polychrous* Le'v, *Auricularia auricular* (Bull.) Wettst. and *Flammulina velutipes* Karst. mushrooms in north and northeast Thailand (Bussaman *et al.*, 2004). Control methods for mites on farms is limited, pesticides are sometimes used at the beginning of growing period. The carbamate and organophosphate insecticides and some organic solvents employed to control this mite has limited effectiveness during the whole production cycle. The potential development for resistance to these

pesticides, with concerns about environmental damage and risks to human health has reduced their use and increased the interest in biological control of this mite (Bussaman *et al.*, 2009).

Essential oils are an alternative control method for mushroom mites because of their insecticidal, repellent or antifeedant properties. These oils have contact toxicity, are volatile and can act like fumigants offering the prospect for use in stored-product protection. Most studies have targeted post-embryonic stages and few studies have assessed the fumigant toxicity of oils against eggs of stored-product pest (Don-Pedro, 1996). Fumigant toxicity of the essential oils from *Lavandula hybrida*, *Rosmarinus officinalis* and *Eucalyptus globules* against the eggs of *Acanthoscelides obtectus* have LC₅₀ values ranging from 1.3 and 35.1 µl/l air, depending on egg age and essential oil used (Papachristos and Stamopoulos, 2003). A few reports have appeared regarding the use of crude extracts from plant for controlling *L. perniciosus* (Pumnuan *et al.* 2008) by contact. Clove and cinnamon extracts at 125 µg/cm² was very effective with more than 88.7% mortality of mite.. Dichloromethane extracts of clove and cinnamon showed the highest toxicity against *L. perniciosus* with LD₅₀ values of 34.97 and 35.57 µg/cm², respectively.

The objective of this study was to evaluate effectiveness of other medical plant essential oils on pregnant female of mushroom mite, *Luciaphorus perniciosus* Rack .

Materials and Methods

Stock culture of mushroom mite;

Colonies of *L. perniciosus* was reared on sorghum grain infested with mycelia of *Lentinus polychrous* Le'v and kept at 27.2±2°C, 70±5% RH.

Extraction of essential oils;

The essential oils tested were extracted by water distillation from the following plants; clove (*Syzygium aromaticum*), citronella grass (*Cymbopogon nardus*), lemon grass (*Cymbopogon citratus*) and turmeric (*Curcuma longa*). The distilled essential oils were stored in a refrigerator at 10°C.

Experimental treatment;

Essential oil were applied onto filter paper at 0, 0.125, 0.25, 1.25, 2.5, 12.5, 25, 50 and 75 µg/cm³ in 2% Tween-20 in water and placed into), Those treated filter papers were placed respectively into glass vials (16 cm³). Batches of 2-3 sorghum grains, which contained 20-40 *L. perniciosus* pregnant females of 2-3 day olds were then transferred to the glass vials. The adults were fumigated for 2 hrs at XX°C and the filter papers removed> The hatching of adult mites from those pregnant females were observed for 7 days.

Statistical analysis;

The experiment was designed in three completely randomized design with XX replicates. The data obtained was statistically analyzed by analysis of variance (ANOVA) and Duncan's multiple range tests (DMRT). EC₅₀ (median effective concentration) was calculated by the probit method.

Results and Discussion

Essential oil of lemon grass and citronella grass at the rate of 75 µg/cm³ had the highest inhibitory effect, resulting in 97.3±4.7 and 95.8±5.4% mortality, respectively, Whereas,

turmeric and clove essential oils showed the lower inhibitory effect, resulting in 63.8 ± 2.1 and $39.2 \pm 2.4\%$ mortality, respectively. However, at all concentrations of lemon grass and citronella grass essential oils were non-significant difference ($P > 0.05$), while turmeric and clove essential oils at the rate of more than $25 \mu\text{g}/\text{cm}^3$ showed significantly lower activity than that of other essential oils ($P < 0.05$). In conclusion, lemon grass and citronella grass essential oils had the greatest inhibitory effects with an EC_{50} of 18.15 and $19.66 \mu\text{g}/\text{cm}^3$, respectively. Turmeric and clove essential oils had an EC_{50} of 41.79 and $82.09 \mu\text{g}/\text{cm}^3$, respectively (Table 1). The adult hatching from the pregnant females in the control vial, was found after exposure 2% Tween 20 in water (Figure 1a), but adult hatching from pregnant females subjected to essential oils treatments was not found (Figure 1b).

Among four essential oils tested, lemon grass and citronella grass were the most effective to adult hatching while turmeric and clove essential oils less effective. The results obtained were similar to those observed for adults in our previous experiment, citronella grass essential oil was the most toxic fumigant to *L. perniciosus* at 12 hrs with LD_{50} of $0.82 \mu\text{l}/\text{cm}^3$, followed by black pepper, lemon grass, clove, pomelo and turmeric essential oils with LD_{50} of 0.127, 0.242, 0.295, 0.382 and $0.538 \mu\text{l}/\text{cm}^3$, respectively (Rongpol *et al.*, 2009). Clove essential oil was successful in killing *D. pteronyssinus* with 100% mortality at $1.2 \mu\text{g}/\text{cm}^3$ and had a LD_{50} of $0.092 \mu\text{g}/\text{cm}^3$ (Insung and Pumnuan, 2008).

The degree of susceptibility of *L. perniciosus* to essential oil vapours, varied with age. When toxicity of essential oil vapours is tested against eggs, the relationship between egg age and susceptibility was not considered (Huang *et al.*, 2000). Some workers have found a negative correlation between egg age and susceptibi[ity (Rahman and Schmidt., 1999). This latent toxic effect has also been reported by Gurusubramanian and Krishna (1996) for *Earias vittella* F., *Dysdercus koenigii* F. and *Helicoverpa armigera* (Hübner) after exposure of their eggs to *Allium sativum* L. volatiles. The authors attributed this chronic effect to the direct action of volatile components on the developing embryo or the neonatal larva inside the egg.

The result of this study indicated that lemon grass and citronella grass essential oils have the potential to be used as botanical acaricidal. The oils have the potential to successfully killing adult and decreased adult hatching rate. However, field application studies are still needed.

Table 1. Percentage of adult hatching rate of *Luciaphorus perniciosus* Rack after treated with various medical plant essential oils by fumigation method and EC_{50} of essential oils.

Concentrations ($\mu\text{g}/\text{cm}^3$)	Essential oils			
	Clove oil	Citronella grass oil	Lemon grass oil	Turmeric oil
0 (Control)	0.0±0.0 d	0.0±0.0 f	0.0±0.0 g	0.0±0.0 e
0.125	4.9±3.7 dA ¹	7.6±3.6 efA	9.3±6.4 fgA	12.5±9.7 dA
0.25	5.2±3.0 dB	20.5±7.3 deA	19.7±4.2 efA	22.1±8.9cdA
1.25	18.4±0.6 cA	25.1±6.8 dA	24.8±7.8 deA	30.1±7.4 bcA
2.5	19.8±4.0 cB	28.4±6.8 dAB	34.2±5.7 dA	34.9±4.5 bA
12.5	29.2±2.6 bB	68.0±11.9 cA	62.2±6.1 cA	37.1±1.9 bB
25	30.7±5.1 bC	73.0±11.1 bcA	80.1±9.2 bA	55.9±7.3 aB
50	33.8±7.9 abC	83.1±9.6 abA	83.8±6.9 bA	57.7±8.7 aB
75	39.2±2.4 aC	95.8±5.4 aA	97.3±4.7 aA	63.8±2.1 aB
ED₅₀ ($\mu\text{g}/\text{cm}^3$)	82.09	19.66	18.15	41.79
Slope	0.01396	0.04075	0.04352	0.01784
SE	0.00179	0.00267	0.00289	0.00174

¹ Mean in row with the same contact time followed by the same capital letters are not significantly different and mean in column followed by the same common letters are not significantly different at the 5% level as determined by DMRT ($P < 0.05$)



Figure 1 a: pregnant female, adult hatching after exposure in control,
b: dead pregnant female, dead hatching adults in treatment.

Conclusion

Lemon grass and citronella grass essential oils at the concentration of $75 \mu\text{g}/\text{cm}^3$ were the most effective in inhibiting hatching of *Luciaphorus perniciosus* Rack, and resulted in 97.3 and 95.8% mortality, respectively, and gave the median effective concentration (EC_{50}) of 18.15 and $19.66 \mu\text{g}/\text{cm}^3$, respectively. Turmeric and clove essential oils had EC_{50} of 41.79 and $82.09 \mu\text{g}/\text{cm}^3$, respectively. This study demonstrated the potential of using essential oils from lemon grass and citronella grass for mushroom mite control.

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