The Growth Inhibition Effect of Essential Oils on *Spodoptera Litura*

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Abstract: In Thailand, the main problem of growing Chinese cabbage is the infestation of insect pests such as *Spodoptera litura* or cutworms. This research recognizes the importance of impact on agricultural products. Therefore, the objective of this research was to study the effect of star anise (*Illium verum*), turmeric (*Curcuma longa*), sweet fennel (*Foeniculum vulgare*), and holy basil (*Ocimum tenuiflorum*) essential oils in the form of inhibitors on the development of pupa and adult stages at concentrations of 0.00, 0.25, 0.50, 0.75, 1.00, and 1.25% (v/v) with 3 repetitions of the experiment. The results showed that at 0.50% concentrations of star anise, turmeric essential oils and at 1.00% concentrations of sweet fennel and holy basil essential oils, showed 100% growth inhibition effect on the pupa and adult stages, and the growth period during maturation of the pupa and the adult stage decreased, compared to the control group. So, the experimental result revealed that plant essential oils can be used as a basis for controlling the cutworms in the future.

1 INTRODUCTION

At present, agriculturists face various physical factors which affect their agricultural products, such as climate, moisture, as well as biological factors, such as pests, plant diseases, and weeds. Insect pest is the major cause of damages in agricultural products, both quality and quantity (Oliveira et. al., 2014). The main insect pests of Chinese cabbage (*Brassica chinesis*) are diamondback moth (*Plutella xylostella*), common cutworm (*Spodoptera litura*), beet armyworm (*Spodoptera exigua*), flea beetle (*Phyllotreta sinuata*), and leaf miner (*Liriomyza brassicae*), especially *Spodoptera litura,* which is one of the most economically important pests in Thailand. The Chinese cabbage can become damaged by the newly hatched larva of *Spodoptera litura*, and become more damaged when the cutworm becomes bigger. Moreover, it can spread rapidly during the year causing significant damages to Chinese cabbage production. In prevention of pests, agriculturists commonly use synthetic chemical insecticides because it's the most convenient, and effective way to eliminate all stages of pests (Aktar et. al., 2009). However, using synthetic chemical insecticides has an adverse impact on several things, including users, products, and environment (Mitra et. al., 2011) and most importantly it can also result in insecticide resistance (Sarwar and Salman, 2015). Using plant essential oils is another method to control insect pests and another way to mitigate the impact on the environment because secondary metabolites from plants have no toxicity to humans, animals, and environment, and because of its rapid decomposition, there is no toxic residue (Prakash et. al., 2008). The secondary metabolite has insecticidal, repellent effect, antifeedant, oviposition deterrent effect, and growth inhibition effect on a pest. So, this research was to investigate the growth inhibition effect of plant essential oils on *Spodoptera litura* so that it can be developed as alternatives for pest control and reduction of chemical use.

2 MATERIALS AND METHODS

2.1 Preparation of Plant Essential Oils

The pure essential oils of *Curcuma longa*, *Illicium verum*, *Ocimum tenuiflorum*, and *Foeniculum vulgare*, prepared according to principles of hazard analysis and critical control point (HACCP), were purchased from Thai-China Flavours and Fragrances Industry Co., Ltd., (Bangkok, Thailand). To obtain 0.00, 0.25,

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0.5, 0.75, 1.00 and 1.25% concentrations of essential oils, the essential oils and Tween-20 (1:1 ratio) were added into water to obtain 100 ml of diluted essential oils.

2.2 Preparation of Insect

The 2nd stage instar larvae of *Spodoptera litura* were cultured in laboratory conditions at 25°C and 12:12 light/dark cycle, and the Chinese cabbage leaves were served as their food.

2.3 Bioassay and Data Analysis

The Chinese cabbage leaves with the diameter of 3 cm were dipped into the essential oil emulsions at various concentrations as mentioned above, and water (0.00% concentration) was used for the control group. Treated leaves were put in the testing box. 10 second stage instar larvae were then released into the box. The experiment was performed in 3 replicates. Finally, the development stage and growth period of *Spodoptera litura* were observed and analyzed.

3 RESULTS

The results showed that the highest growth inhibition effect on pupae and adult stages of *Spodoptera litura* was at 0.50% concentration of star anise and turmeric essential oils, and at 1.00% concentration of the sweet fennel and holy basil essential oils (Table 1, 2). The development period of cutworm for pupa and adult stage at 0.25% concentration of star anise and turmeric essential oils was 8.33±5.77 and 9.00±0.00 days, respectively, while the average growth period of pupa and adult stage at 0.25 concentration of star anise and turmeric essential oils was 8.00 ±0.00 and 8.00±0.00 days respectively (Table 3, 4). Shorter growth period compared to the control group resulted in abnormal molting, including incomplete molt, and arrested molt cycle affecting a survival rate of *Spodoptera litura*.

Table 1: The average growth inhibition percentage of various plant essential oils against *Spodoptera litura* pupa.

Essential oils	Concentrations (%), (v/v)					
	Average growth inhibition percentage (%)					
	0 (*control*)	0.25	0.50	0.75	1.00	1.25
Star anise	0.00 ± 0.00^{Ca}	40.00 ± 0.00^{Ba}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}
Turmeric	0.00 ± 0.00^{Ca}	40.00 ± 0.00^{Ba}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}
Sweet fennel	0.00 ± 0.00^{Ea}	30.00 ± 0.00^{Db}	53.33 ± 5.77^{Cb}	60.00 ± 0.00^{Bb}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}
Holy basil	0.00 ± 0.00^{Da}	30.00 ± 0.00^{Cb}	53.33 ± 5.77^{Bb}	53.33 ± 5.77^{Bc}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}

Notes: Mean in a row followed by the same capital letter and means in a column followed by the same common letter are not significant different (P<0.05) according to Duncan's multiple range test.

Table 2: The average growth inhibition percentage of various plant essential oils against *Spodoptera litura* adult.

Essential oils	Concentrations (%), (v/v)					
	Average growth inhibition percentage (%)					
	0 (*control*)	0.25	0.50	0.75	1.00	1.25
Star anise	0.00 ± 0.00^{Ca}	50.00 ± 0.00^{Ba}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}
Turmeric	0.00 ± 0.00^{Ca}	50.00 ± 0.00^{Ba}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}
Sweet fennel	0.00 ± 0.00^{Da}	30.00 ± 0.00^{Cb}	60.00 ± 0.00^{Bb}	60.00 ± 0.00^{Bb}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}
Holy basil	0.00 ± 0.00^{Ea}	30.00 ± 0.00^{Db}	53.33 ± 5.77^{Cc}	60.00 ± 0.00^{Bb}	100.00 ± 0.00^{Aa}	100.00 ± 0.00^{Aa}

Notes: Mean in a row followed by the same capital letter and means in a column followed by the same common letter are not significant different (P<0.05) according to Duncan's multiple range test.

Table 3: The average growth period of pupa stage of *Spodoptera litura* caused by various plant essential oils.

Essential oils	Concentrations (%), (v/v)					
	Average growth period (days)					
	0 (*control*)	0.25	0.50	0.75	1.00	1.25
Star anise	9.33±5.77^{Aa}	8.33±5.77^{Bb}	0.00±0.00^{Cb}	0.00±0.00^{Cc}	0.00±0.00^{Ca}	0.00±0.00^{Ca}
Turmeric	9.33±5.77^{Aa}	9.00±0.00^{Aa}	0.00±0.00^{Bb}	0.00±0.00^{Bc}	0.00±0.00^{Ba}	0.00±0.00^{Ba}
Sweet fennel	9.33±5.77^{Aa}	9.00±0.00Aa	9.00±0.00^{Aa}	8.33±5.77^{Bb}	0.00±0.00^{Ca}	0.00±0.00^{Ca}
Holy basil	9.33±5.77^{Aa}	9.33±5.77^{Aa}	9.00±0.00^{Aa}	9.00±0.00^{Aa}	0.00±0.00^{Ba}	0.00±0.00^{Ba}

Notes: Mean in a row followed by the same capital letter and means in a column followed by the same common letter are not significant different (P<0.05) according to Duncan's multiple range test.

Table 4: The average growth period of adult stage of *Spodoptera litura* caused by various plant essential oils.

Essential oils	Concentrations (%), (v/v)					
	Average growth period (days)					
	0 (*control*)	0.25	0.50	0.75	1.00	1.25
Star anise	8.33±5.57^{Aa}	8.00±0.00^{Aa}	0.00±0.00^{Bb}	0.00±0.00^{Bb}	0.00±0.00^{Ba}	0.00±0.00^{Ba}
Turmeric	8.33±5.57^{Aa}	8.00±0.00^{Aa}	0.00±0.00^{Bb}	0.00±0.00^{Bb}	0.00±0.00^{Ba}	0.00±0.00^{Ba}
Sweet fennel	8.33±5.57^{Aa}	8.33±5.57^{Aa}	8.33±5.57^{Aa}	8.00±0.00^{Aa}	0.00±0.00^{Ba}	0.00±0.00^{Ba}
Holy basil	8.33±5.57^{Aa}	8.33±5.57^{Aa}	8.33±5.57^{Aa}	8.33±5.57^{Aa}	0.00±0.00^{Ba}	0.00±0.00^{Ba}

Notes: Mean in a row followed by the same capital letter and means in a column followed by the same common letter are not significant different (P<0.05) according to Duncan's multiple range test.

4 DISCUSSION

The results of this study were similar to the results of others research. For example, turmeric can act as growth inhibitor on *Candida krusei* and *Candida parapsilosis (*Roth et. al., 1998*)*, the turmeric extract has repellent activity and growth inhibition effect on stored grain pests (Jilani and Su, 1983), the development from pupa into adult stages of house fly was affected by Chinese star anise crude extract and the development rate of pupa and adult was less than that of the control group, and the affected pupa and adult of house fly were smaller in size than the pupa and the adult of the control group (Guntharee, 2008), turmeric reduced radial growth of Mycelia in vitro, and the turmeric product was also used for pest management in crop (Damalas, 2011), turmeric extract had insecticide property against *Schistocerca gregaria* and *Dysdercus koenigii* nymphs and had mortality effect on nymphs (Chowdhury et. al., 2000), star anise extract has insecticidal effect and causes mortality of larva and adult stages on mealworm, *Alphitobius diaperinus* (Szczepanik and Szumny, 2011), anise, lime, and tangerine oils tended to have high efficiency in controlling antifungal on *Hevea brasiliensis* and anise oil is the most effective substance in inhibiting surfaced-mold, *Penicilium sp*., and *Aspergillus niger* (Matan and Matan, 2008), and sweet fennel and pignut affected mortality on *Apis mellifera* (Abramson et. al., 2007).

5 CONCLUSION

The turmeric and star anise essential oils have high growth inhibitory potential on *Spodoptera litura*. Therefore, this study provides useful information which can be used as reference for controlling *Spodoptera litura* in the future.

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