แมลงวันคอกสัตว์ (Diptera: Muscidae): การสำรวจชนิดและการทดสอบพิษทางสัมผัสของน้ำมันตะไคร้หอมและน้ำมันกานพลู

Stable flies (Diptera: Muscidae): a Survey of Species composition and contact toxicity test of citronella and clove oils

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บทคัดย่อ: แมลงวันคอกสัตว์เป็นแมลงดูดเลือดศัตรูสำคัญทางปศุสัตว์ งานวิจัยนี้มีวัตถุประสงค์เพื่อสำรวจชนิดและจำนวนของแมลงวันคอกสัตว์ด้วยกับดักสี และการทดสอบพิษทางสัมผัสของน้ำมันหอมระเหยต่อแมลงวันคอกสัตว์จากฟาร์มเลี้ยงโคและแพะของภาควิชาสัตวศาสตร์ คณะทรัพยากรธรรมชาติ มหาวิทยาลัยสงขลานครินทร์ จังหวัดสงขลา ผลการศึกษาพบว่า แมลงวันที่ดักได้จากฟาร์มโคจำนวน 4,720 ตัว มากว่าจากฟาร์มแพะซึ่งมีจำนวน 1,290 ตัว พบแมลงวันคอกสัตว์ 3 ชนิด ชนิดที่พบมากที่สุดคือ *Stomoxys calcitrans* (79.00% และ 77.13%) รองลงมาคือ *Stomoxys indicus* (3.24% และ 1.01%) และ *Haematobi*a spp. (2.88% และ 3.14%) ในฟาร์มโคและฟาร์มแพะ ตามลำดับ ผลการทดสอบพิษทางสัมผัสทั้งจำนวนแมลงวันที่หงายท้องและตายสูงสุดจากน้ำมันหอมตะไคร้หอมที่ความเข้มข้น 2.5% (หงายท้อง 100% และตาย 90%) ในสภาพห้องปฏิบัติการ จึงสรุปได้ว่าน้ำมันหอมตะไคร้หอมมีศักยภาพในการใช้เป็นสารเพื่อควบคุมแมลงวันคอกสัตว์ได้ แต่ต้องมีการศึกษาในระดับชนิดและพื้นที่จริงต่อไป
คำสำคัญ: แมลงวันคอกสัตว์, กับดักวาวัว, พิษทางสัมผัส, น้ำมันหอมระเหย, ประเทศไทย

ABSTRACT: Stable fly is a hematophagous insect pest for livestock. The objectives of current research were to survey a species composition of fly by Vavoua trap and to evaluate the contact toxicity of essential to stable fly in cattle and goat farms of Animal Science Department, Faculty of Natural Resources,Prince of Songkla University, Songkhla, Thailand. This study found a total number of fly collections were 4,720 in cattle farm and 1,290 in goat farm. Three species of stable flies were identified with the percentage according to the species- *S. calcitrans* (79.00% and 77.13%), *S. indicus* (3.24% and 1.01%), and *Haematobia* spp. (2.88% and 3.14%), in the cattle and the goat farms, respectively. For the tarsal contact test, higher percent KD and mortality (100%KD and 90%mortality) of S. calcitrans were seen at 2.5% of citronella oil under laboratory condition. This study designated that citronella are moderate effective to control the stable flies under the laboratory condition. Eventually, field applications should be considered for trial in near upcoming study.
Keywords: Stable fly, Vavoua trap, contact toxicity, essential oil, Thailand

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Introduction

Stable flies are blood-feeding fly, sources of economic loss in the livestock industry and strongly impact pests for wildlife. The bite causes pain and annoyance to the livestock, leading to the loss of blood, weight, and lactation (Cambell, 2001; Showler and Osbrink, 2015). An estimation of economic loss in the United States caused by stable flies was 1 billion US dollars per year (Taylor and Berkebile, 2008). They are implicated as a mechanical carrier and biological vectors in the transmission of several pathogens (Baldacchino et al. 2013).

Synthetic insecticides are used as a common method in the livestock industry to control arthropod parasites. The inappropriate usage of insecticides is a really serious issue for a decade. This has leading to the insecticide contamination in the environment, besides increases the insecticide resistance phenomenon within the target and non-target insect pest populations (Brito et al. 2018; Tainchum et al. 2018).

Strategy to get rid or slowdown from insecticide resistance problem is the use of botanical insecticides. Plant derivatives have been used in order to be alternative insecticide or repellent. Actually, botanical-based insecticides and repellents were greatly performed against arthropod pests for over two centuries (Zhu et al., 2011). Particularly it is a common use for integrated pest management practice due to easily biodegrade to the nontoxic products, which are less harmful to non-target organisms and environment (Isman, 2006). Previously, catnip oil (20 mg dosage) showed the greatest toxicity against adult stable flies with rapidly knock-down time in only 7 minutes (Zhu et al. 2016). Lemongrass oil was effective to repel stable flies (Baldacchino et al. 2013). However, to ensure the great result of the implementation of essential oils against insect pests, several key information are needed, such a species of insect pest, type of essential oil and concentration. Therefore the purposes of this study were to survey species composition of stable flies and to evaluate the toxicity of two plant essential oils to this insect at Songkhla, Thailand.

Materials and Methods

Species composition

Stable flies were collected at the dairy cattle and goat farms of the Department of Animal Science, Faculty of Natural Resources, Prince of Songkla University, Hat Yai, Songkhla. Thailand. The four Vavoua traps (Laveissiere and Grebaut, 1990) were placed for fly's collection and observed every 1 hour from 7.00-18.00 hr. Two-day trapping collections were performed in every month during the period of 3 months (January-March 2017). The specimen was individually preserved in 95% ethyl alcohol and morphological species identification of stable fly was done based on the morphological keys (Tumrasvin and Shinonaga, 1978; Zumpt, 1973). Temperature and relative humidity were recorded during a period of study to analyze a correlation between insect abundance and climatic factors.

Insecticidal toxicity test

Adult stable flies were captured by the sweeping net prior to rearing in insect cage (30*30*30 cm) and feeding honey drop and water cotton ball (Tainchum et al. 2018). Two essential oils of citronella,

Cymbopogon nardus (L.) (Poales: Poaceae) (Ruen Sa Mun Pai herbal shop, Supanburi) and clove, Syzygium aromaticum (Myrtales: Myrtaceae) (L.B. Science Limites Partnership, Songkhla) were used for the test. The five concentrations (0.5, 1.0, 1.5, 2.0 and 2.5%) of both essential oils were selected for toxicity test against stable flies. Absolute ethyl alcohol was used for negative control and solvent. All solutions were treated on filler papers (Whatman no.1, size 10 X 10 cm) and dried at room temperature for 24 hours before testing. The tarsal contact test according to the procedure of WHO cone test was performed. Five stable flies were introduced for 30 minutes for tarsal contact on essential oil-treated filter paper under WHO cones (WHO, 2006). Each concentration was replicated 6 times. A number of knockdowns (KD) flies have recorded at 60 minutes and mortality was recorded 24 hours post-treatment.

Data analyses

Descriptive data analyses for number of fly caught by species, hour and collection site were calculated. Pearson's correlation analyze was used to examine the interaction between the number of stable flies and ambient temperature. Data were analyzed with a level of significance set at 0.05% ($P< 0.05$), using an IBM SPSS statistical package (ver. 23.0, SPSS, Chicago, IL).The knockdown and mortality of stable flies to each botanical essential oil estimated on the following WHO revised criteria (WHO, 2006).

Results

Species composition

Numbers of flies collected from the cattle and the goat farms of Animal Science Department, Faculty of Natural Resources Prince of Songkla University from January to March 2017 were shown in Table 1. Flies were more abundant in the cattle farm than in the goat farm. A total number of 4,720 flies were collected in cattle farm, comprising 79% of S. calcitrans, 3.24% of S. indicus and 2.88% of Haematobia sp., respectively, whereas 1,290 flies were caught in goat farm, comprising 77.13% of S. calcitrans, 1.01% of S. indicus and 3.41% of Haematobia sp., respectively (Table 1). Data from all collection period were combined to determine the correlation between S. calcitrans abundance and measured environmental variables. Results indicated that mean number of S. calcitrans collected were not correlated with both temperature ($r = -0.25$, $P = 0.43$) and relative humidity ($r = 0.25$, $P = 0.44$).

Insecticidal toxicity test

The increasing concentration of essential oils produced a significant increase in the KD and mortality when the stable fly adults were exposed for 60 min and 24 h, accordingly. Percent KD of the stable fly was completely 100% at 2.00% and 2.50% of citronella and the same concentration caused 40 and 70% when exposed to clove oil. The highest mortality of stable fly after 24h exposure to 95% mortality from 2.5% of citronella and 50% mortality from 2.5% of clove (Table 2). It indicates that citronella oil was more toxic to S. calcitrans than clove oil.

Table 1 A survey of top five biting and non-biting fly species by Vavoua traps for both cattle and goat farms in Songkhla during January-March 2017.

Species	Cattle		Goat	
	No	%	No	%
Stomoxys calcitrans	3,729	79	995	77.13
Stomoxys indicus	153	3.24	13	1.01
Haematobia spp.	136	2.88	44	3.41
Parasarcophaga spp.	499	10.57	64	4.96
Musca spp.*	203	4.3	174	13.49
Total	4,720	100	1,290	100

* Three species of *Musca* is counted (*Musca autumnalis*, *Musca crassirostris,* and *Musca domestica)*

Table 2 Percent knockdown and mortality of *S. calcitrans* at 60 min and 24h after exposure to citronella and clove oils by using contact toxicity test (n=30).

Essential oils		Concentrations					
		Control	0.50%	1.00%	1.50%	2.00%	2.50%
Citronella *Cymbopogon nardus*	KD (%)	0	15.00	71.43	52.63	100.00	100.00
	Mortality (%)	0	15.00	38.10	42.10	61.10	95.00
Clove *Syzygium aromaticum*	KD (%)	0	5.00	15.00	35.00	40.00	70.00
	Mortality (%)	0	5.00	5.00	15.79	35.00	50.00

Discussion

The Vavoua trap collection of stable fly for 3 months survey was similarly previous reports in Thailand (Tumrasvin and Shinonaga, 1978; Masmeatathip et al. 2006, Muenworn et al. 2010). Stomoxys calcitrans is the most prevalence species and commonly found in dairy farm, followed by S. indicus. The number of stable fly in this study was seen in a goat farm greatly lower than dairy cattle farm. As the conclusion of Muenworn et al. (2010) that the different number of fly collection was found in different population, areas, seasons, and time.

The result from the bioassay test in this study indicated that higher mortality of stable fly was seen in a higher concentration of citronella than clove, even similar concentration. The previous report demonstrated that citronella was effective for repelling the stable flies for several hours, but repellency action was gradually diminished after 17 h and preventing from stable fly feeding for 12 h after mixed with lemongrass oil (Showler, 2017). Clove buds and clove leaves at 0.5 mg/cm2 can protect the human hand from stable fly bites for 3.25–3.5 h after applied. Longer protection time was seen when combining the clove oils with tamanu oil gave protection closely

to DEET (Showler, 2017). A combination of oil is showed that causes the greater effective to control stable fly than the single essential oil.

Conclusion

Two species of Stomoxys- S. calcitrans, and S. indicus, and Haematobia spp. were found in Songkhla, Thailand. The most abundant species of biting fly in Vavoua trap collection was S. calcitrans. This study designated that 2.5% of citronella was moderate effective to control the stable flies, Songkhla's populations under the laboratory condition. However, field applications for protection of livestock animals from stable flies biting and disease transmission should be considered in near upcoming study.

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