

REPELLENCY OF CELERY ESSENTIAL OILS (*Apium graveolens* L.) AGAINST *Spodoptera frugiperda* (Lepidoptera: Noctuidae) IN THE LABORATORY

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Manuscript received: 22 November 2020. Revision accepted: 14 April 2021.

ABSTRACT

Repellency of celery essential oil (*Apium graveolens* L.) against *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in the laboratory. Essential oil is one of the ingredients that has repellent ability to herbivorous insects. Celery is one of plants containing essential oil which may also have the repellent ability. This study was aimed to determine the differences in the repellent ability of celery essential oils compounds that were taken from 3 different locations against *S. frugiperda* in the laboratory. This research was arranged in a factorial completely randomized design (CRD) with two factors. The first factor was the origin of the celery plants (Malang, Surabaya, and Lamongan) and the second factor was the concentration level of essential oils (1000, 2000, and 3000 ppm) which was repeated three times. The reliability test was carried out using filter paper method. The results showed that the essential oil extracted from celery originated from Malang with 3000 ppm concentration had the highest percentage level of repellency (level 5) that reached 93.33% of repellency. Location and concentration factors had no different effect on *S. frugiperda* larvae repellency. There was no correlation between location and concentration on the repellency of *S. frugiperda* larvae.

Key words: concentration, filter paper method, interaction, larvae, repellent

INTRODUCTION

Spodoptera frugiperda (Lepidoptera: Noctuidae) is one of the important insect pests of maize in Indonesia. *S. frugiperda* was first reported in West Sumatra on March 2019 (FAO, 2019). Subsequently, it was reported in Bengkulu, Lampung and West Java (Ginting *et al.*, 2020; Trisyono *et al.*, 2019; Maharani *et al.*, 2019). The damage caused by this pest could reached 100% in young maize plant (Trisyono *et al.*, 2019). Currently, application of chemical pesticides is the main alternatives used by farmers in Lamongan, East Java for controlling pest insects, including *S. frugiperda*. Chemical pesticides contain toxic and hazardous chemicals as well as persistent organic pollutants that have a negative impact on human health and the environment.

Environmentally friendly control technology using organic plant materials is an alternative that has the potential to be developed. Organic plant materials that provide direct activity against the target organism are known as botanical pesticides. Some of the advantages of plant-based pesticides such as having unique mode of action, not toxic to mammals, easily decompose in

nature so it does not pollute the environment and relatively safe for humans and pets because it has easily degraded residue, the materials can be easily found in nature, and relatively easy to make (Asmaliyah *et al.*, 2010).

Several studies reported that various types of plants could play a role as botanical pesticides. Application of lemongrass oil with a concentration of 5 mL L⁻¹ on pepper in Bangka could reduce the population and yield loss due to *Dasynus piperis* (Rohimatus & Laba, 2013). The application of plant extract of billygoatweed (*Ageratum conyzoides*), ginger (*Zingiber officinale*), galangal (*Alpinia malaccensis*), pinecone ginger (*Z. zerumbet*), gotu kola (*Centella asiatica*), lemongrass (*Cymbopogon nardus*), physic nut (*Jatropha curcas*), and turmeric (*Curcuma longa*) at a concentration of 5 mL L⁻¹ causing mortality of rhizome flies (*Mimegralla coeruleifrons*) for more than 80% (Balfas *et al.*, 2013). Spraying directly with 0.5% of plant extract of *C. longa*, *A. conyzoides*, *C. nardus* and *Syzygium aromaticum* (cloves) oil resulted in mortality of more than 80% of rhizome flies (*M. coeruleifrons*). The application of plant extract of neem and lemongrass to ginger showed ability to reduce

the population of *M. coeruleifrons* by 90% and 60%, respectively as well as reducing the number of eggs of *M. coeruleifrons* (Balfas & Sugandi, 2013).

Celery (*Apium graveolens* L.) is a plant that has potential as a botanical pesticide. This plant has a high content of active chemical compounds that is toxic to pest insects. Celery leaf extract has been reported as a contact pesticide and insect repellent (Tuetun *et al.*, 2005; Kooti & Daraei, 2017; Astuti & Khotimah, 2020). Celery leaf extract has also been reported to be able to inhibit egg laying (antioviposition) of bean beetle (*Callosobruchus chinensis* L.; Coleoptera: Bruchidae) (Darmiati, 2013). To date, there is still no information on the ability of the celery essential oil as repellent for *S. frugiperda*. This study was aimed to determine the repellency of the celery essential oils to *S. frugiperda*.

MATERIALS AND METHODS

Research Site. The research was carried out from May to November 2020. Celery plant samples were taken in three districts with different altitude, namely

Malang (1100 masl 7°31'S;111°40'E), Surabaya (25 masl, 7°21'S; 112°54'E) and Lamongan (11 masl, 7°11'S; 112°14E) (Figure 1). Repellency ability test of celery essential oils towards *S. frugiperda* was conducted at the Biology Laboratory, Universitas Billfath.

Celery Leaves Sampling. The determination of the sampling plot for celery leaf collection in each district was carried out using a purposive sampling method. Observations were made directly on the existence of celery plants in each selected district. Sampling was carried out using a line transect with a length of 110 m, measured using a rolling meter, then divided into 4 plots measuring 20 × 20 m. At each observation location 5 line transects were placed. Leaf samples were taken from the first to third leaflets, then cut, packed in plastic, labeled, and stored in a Styrofoam box (34 × 25 × 230 cm) with ice pack to keep the celery leaves fresh until extraction.

Insect Collection. The *S. frugiperda* was obtained from farmer's maize in Lamongan (Figure 2). In total,

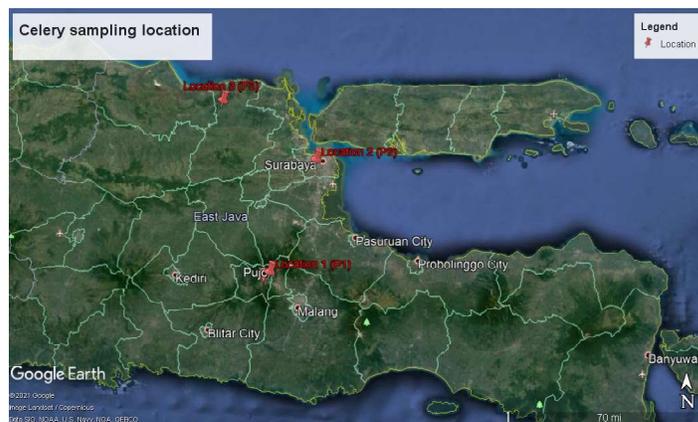


Figure 1. Celery sampling location map.



Figure 2. *S. frugiperda* sampling location map.

270 3rd instar larvae of *S. frugiperda* were taken and transported to the laboratory.

Essential Oil Extraction. The essential oil was extracted using the maceration method. Each fresh leaf was weighed 100 g with the analytical balance ATX224 to 0.01 accuracy (Shimadzu, Japan). The leaves were chopped and soaked in N-hexane pro analysis (P.A) solvent with a ratio of 1:10. The solution then stirred manually every 24 h and kept at room temperature without light exposure (in a closed and dark place) for 3 days. Then the extract was separated by filtering using filter paper and squeezed so that the pulp and filtrate were obtained. The filtrate containing oil was evaporated using a rotary vacuum evaporator at a temperature of 65–70 °C, to separate the solvent from the essential oil. The filtrate was stored in the refrigerator for 24 h to precipitate the wax. The oil on the top layer was then separated from the settling wax with a separating funnel to obtain the essential oil.

Repellency Effect of Essential Oils towards *S. frugiperda*. This study used a factorial completely randomized design (CRD) method with 2 factors and 3 replications. Factor 1: the location of celery essential oil sampling, namely, Malang (K1), Surabaya (K2) and Lamongan (K3). Factor 2: the level of essential oil concentration consists of 1000 ppm (P1), 2000 ppm (P2) and 3000 ppm (P3). The method referred to Hasyim *et al.* (2014) with modification. Investigation was carried out using the filter paper method. Each filter paper (Whatman no. 1; 22 cm of diameter) was divided into two parts. One part was dripped with celery essential oil another part was dripped by water as a control. The filter paper then dried and placed in a petri dish (15 cm of diameter). A total of 10 3rd instar larvae of *S. frugiperda* were placed in the middle of a petri dish filled with both treated and untreated filter paper. Observations were conducted at 1, 3, 6, and 24 h after treatment. The responses of *S. frugiperda* was calculated using the formula described by Hasyim *et al.* (2014):

$$R = \frac{NC - NT}{NT + NC} \times 100\%$$

R = response of *S. frugiperda*

NC = number of *S. frugiperda* larvae contained in the control

NT = number of *S. frugiperda* larvae contained in the treatment

To determine the level of response, the following criteria were used (Hasyim *et al.*, 2014):

0 = Repellency value < 0.1

1 = Repellency value 0.1–20.0%

2 = Repellency value 20.1–40.0%

3 = Repellency value 40.1–60.0%

4 = Repellency value 60.1–80.0%

5 = Repellency value 80.1–100%

Data Analysis. The data were analyzed using ANOVA followed by the Duncan Multiple Range Test (DMRT) at the 5% of significant level.

RESULTS AND DISCUSSION

The results showed that at 24 hours after treatment, most of *S. frugiperda* larvae moved to the untreated filter paper (Figure 3). This might be due to the repellent compound that is contained in the celery leaves. The celery essential oil contain D-limonene, D-selinene, Sedanolide, Terpeneol, Santalol, Selinene, Nerolidol, β pinene, dan β myrcene (Al-Asmari *et al.*, 2017). The D-limonene compound is an insecticide which acted as repellent (Luik *et al.*, 1999). The essential oils compound mode of action is by interact with the larva olfactory receptors and blocking the sense of smell (Tripathi *et al.*, 2009). The celery produced strong odor which will repel the larvae of *S. frugiperda*.

The analysis of variance result showed that the sampling location and concentration of celery essential oil had no different effect on the repellency of *S. frugiperda* larvae (Table 1). There was no correlation between sampling location and concentration of celery essential oil on the repellency of *S. frugiperda* larvae. Based on the altitude, the location of Malang has the highest level of altitude, its 1100 masl, then Surabaya 25 masl and Lamongan has the lowest altitude level of 11 masl. Table 1 showed that the highest repellency (level 5) was showed in the treatment of celery essential oil collected from Malang Regency with a concentration of 3000 ppm with the average value of response was up to 93.33%. The lowest repellency (level 3) was observed in the treatment of celery essential oil obtained from Lamongan at a concentration of 1000 ppm with the average value of response was up to 53.33%.

Celery essential oil from Malang had the higher response value when compared to the essential oil from Surabaya and Lamongan. It was possible to the differences in the chemical compound concentration which was responsible on the repellent activity. Azkiyah & Tohari (2019) reported that altitude had significantly correlated with air temperature and chemical content

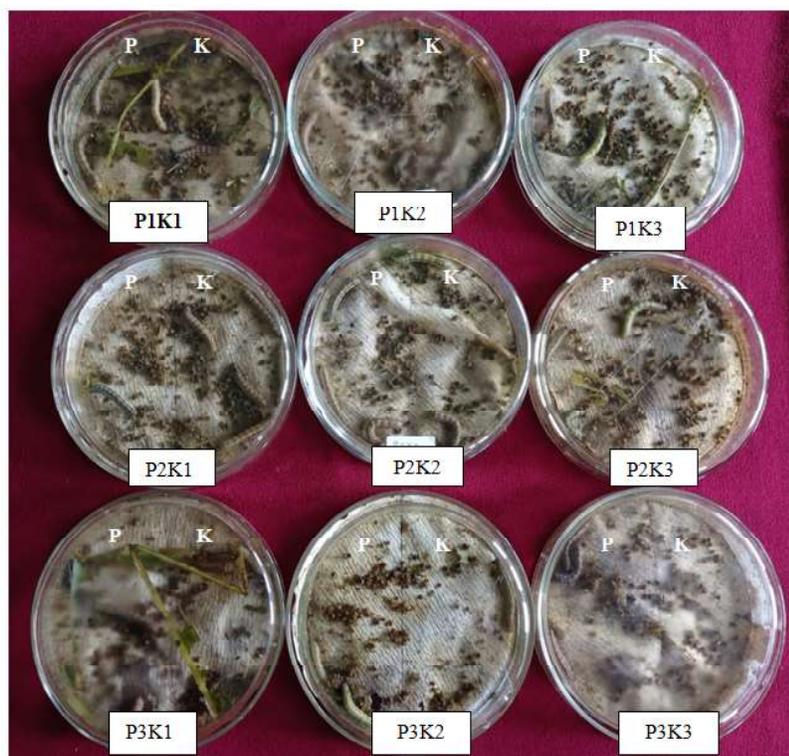


Figure 3. Observation results of *S. frugiperda* resistance testing after 24 hours. P = Treatment; K = Control; P1K1 = Malang treatment with a concentration of 1000 ppm; P1K2 = Malang treatment with a concentration of 2000 ppm; P1K3 = Malang treatment with a concentration of 3000 ppm; P2K1 = Surabaya treatment concentration of 1000 ppm; P2K2 = Surabaya treatment concentration of 2000 ppm; P2K3 = Surabaya treatment concentration of 3000 ppm; P3K1 = Lamongan treatment concentration of 1000 ppm; P3K2 = Lamongan treatment with a concentration of 2000 ppm; P3K3 = Lamongan treatment with a concentration of 3000 ppm

Table 1. The percentage and level of essential oil repellency to 3rd instar larvae *S. frugiperda* after 24 h

Treatment of essential oil	The percentage of repellency (%)	Level of response	Altitude
Malang 1000 ppm (P1K1)	66.67	4	1100 masl 7°31'S;111°40'E
Malang 2000 ppm (P1K2)	76.67	4	
Malang 3000 ppm (P1K3)	93.33	5	
Surabaya 1000 ppm (P2K1)	80.00	4	25 masl, 7°21'S; 112°54'E
Surabaya 2000 ppm (P2K2)	76.67	4	
Surabaya 3000 ppm (P2K3)	66.67	4	
Lamongan 1000 ppm (P3K1)	53.33	3	11 masl, 7°11'S; 112°14E
Lamongan 2000 ppm (P3K2)	66.67	4	
Lamongan 3000 ppm (P3K3)	73.33	4	

(total compound of stevioside and ratio of rebaudiosida A/steviosida) in *Stevia rebaudiana* plants. The chemical content of *C. manga* rhizome essential oil which was originated from lowlands had more concentration than it was from the highlands. The phenomenon was occurred

because of the lower rainfall in the lowlands than the highlands (Astuti *et al.*, 2014). Irrigation and harvesting time were also took effect on the content and composition of essential oils in celery. The irrigation could increase concentration of volatile substances of

celery compared to the unirrigated one. In Poland, celery that had been harvested in September (using irrigation system) contained more limonene than in October (without any irrigation system) (Rozek *et al.*, 2016).

The concentration of celery essentials oil also affected the larval repellency rate. The higher concentration would increase larval repellency level. Akuba *et al.* (2019) reported that celery methanol extract at the highest concentration (15%) showed optimally killed mosquito larvae. The zodea leaf extract with the highest concentration (45.87%) could reject *Tribolium castaneum* up to 96.2% (Cameron *et al.*, 2016). The botanical insecticides of Babadotan were more effective to control *S. litura* at 500 g L⁻¹ than 250 g L⁻¹ (Sari *et al.*, 2013).

CONCLUSION

Celery essential oil has the potential as a repellent against the *S. frugiperda*. The highest level of repellency from Malang with concentration 3000 ppm, and the lowest repellency from Lamongan with concentration 1000 ppm, and there is no correlation between the location and the concentration against repellency of larvae.

ACKNOWLEDGMENTS

We would like to thanks to maize farmers in Lamongan, the celery planters in Lamongan, Surabaya and Malang for allowing us to do this research.

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