Extraction of essential oil and its fumigation toxicity against *Spodoptera litura* (Lepidoptera: Noctuidae)

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Spodoptera litura (Lepidoptera: Noctuidae) is an widely distributed polyphagous pest, with high mobility and reproductive capacity, Which is known to attack more than 120 plants, including various vegetables, cotton, and soybean. Recently, *S. litura* is gradually attaining a major pest status in different crops and regions of the globe (CABI, 2017). In China, Japan and India, its larval stages causes damage up 30% of crops each year (Ferry et al, 2004; Srinivasa et al, 2014). Chemical insecticides currently in use fail to adequately control *S. litura* in the field due to development of insecticide resistance. However, the extensive use of these synthetic insecticides agriculture has brought many problems, such as the development of pest resistance, long term persistence, secondary pest outbreak, environmental pollution, killing the natural enemies, and toxic hazards to human and other non-target organisms (Vasanthasrinivasan et al, 2016; Senthilnathan, 2013).

Essential oils are secondary metabolites that plants produce for their own needs other than for nutrition. In general, they are complex mixtures of 20-60 organic compounds, terpenoids are considered to be one of the major constituents (Bakkali et al., 2008). Many researchers have reported that the essential oil and extract exhibited good insecticidal and antimicrobial (Kumar et al., 2014). With rare exceptions, Essential oils are relatively nontoxic to mammals. They often have half-lives lower than 24 h in outdoor environments and degrade quickly, do not cause environmental pollution, and resistance to them develops slowly (Escobar-Valencia et al. 2007). In addition, essential oils are rich in sources and low in price. They are widely used in flavor and cosmetic industries (Isman 2006). More and more pest control products based on plant essential oils are emerging, the orange essential oils based on limonene has been recently registrated in the EU as a plant protection product to be used in many crops (MAPAMA, 2018).

A laboratory strain of *S. litura* were maintained at 26±2 °C with a relative humidity (RH) of 60%-70% and a 16: 8 (light: dark) photoperiod. The larvae were reared on an artificial food, which was replaced per 24 hours. Ten larvae were placed in a wide mouth bottle (250 mL). 10 μL essential oil was dripped on the filter strip (1×5 cm), and then sealed. The same amount of acetone was used as the control. The experiment was repeated three times. Mortality was recorded at 24 hours and calculated. Essential oil was prepared by Steam reflux extraction for 6 hours in laboratory.

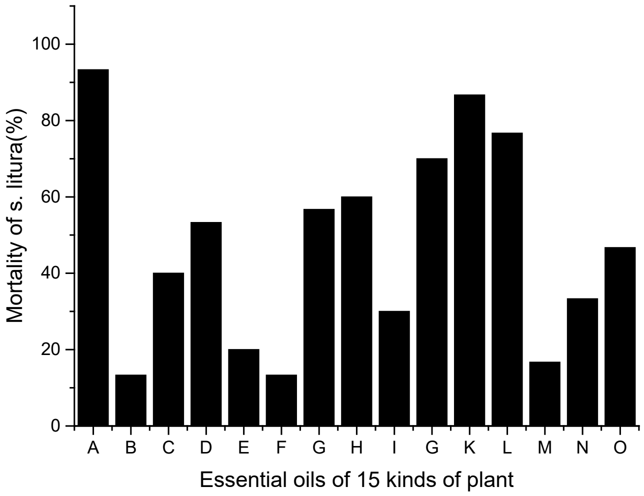

Fig. 1 The fumigating activity of 15 essential oils. A-O are Cinnamomum camphora oil, chamomile oil, geranium oil, tangerine peel oil, artemisia oil, zedoary turmeric oil, lavender oil, peppermint oil, citronella oil, cinnamon oil, lemon oil, lemon eucalyptus oil, anise oil, black pepper oil, and tea tree oil.

The results from Fig.1 showed that 15 kinds of essential oils all had fumigation activity against *S. litura*. Among them, camphor essential oil, peppermint oil, cinnamon oil, lemon oil and lemon eucalyptus oil were more than 50%, especially the fumigation activity of camphor essential oil was 93%. Within the concentration of 1-80 mg/mL, the mortality rate of *S. litura* were 6.7% to 86.7% (Fig. 2). Semi-lethal concentration was 0.105 mg/mL by Coriolis method calculation. The insecticidal constituents of *Cinnamomum camphora* oil may be a new biodegradable pesticide in future. It is possible that combination with insecticides such as pyrethroids to improve insecticide resistance of *S. litura* with degradable essential oils.

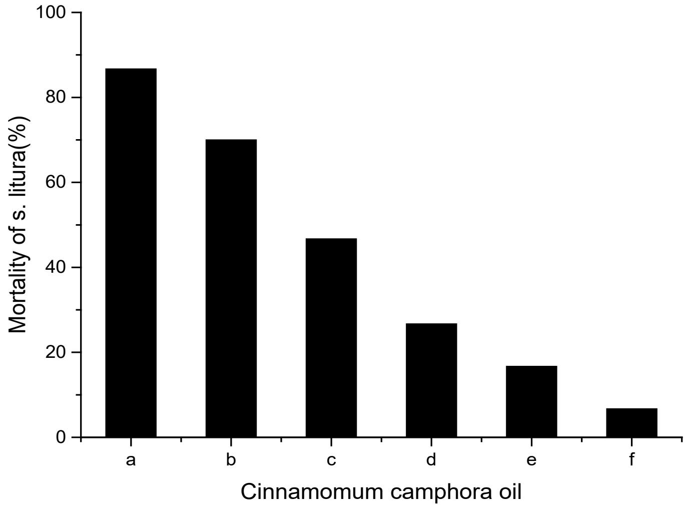

Fig. 2 Fumigation of camphor oil at different concentrations, a-f are 80 mg/mL, 40 mg/mL, 20 mg/mL, 10 mg/mL, 5 mg/mL and 1 mg/mL, respectively.

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