Potential for Biopesticide Use of Essential Oils against the Bean Beetle, *Callosobruchus maculatus*

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Introduction

Bean beetles have been known to cause extensive damage to stored grains in tropical and subtropical areas (Rahman & Talukder, 2006).

The beetles lay their eggs on the surface of the bean and then larva burrow into the bean until adults emerge. This leaves the beans unsuitable for consumption or for use in production (Rahman &Talukder, 2006)

There is a documented case of loss of up to 100% of stored grain, which is equivalent to 30 million US dollars (Idoko &Illeke, 2020)

Current commonly used insecticides are organophosphates, such as malathion and pirimiphos-methyl (Fouad, 2013). Issues with synthetic insecticides include:

- Pest resistance
- Contamination of food and water sources
- Expensive
- Human and wildlife health risks

Methods

Oils, Cinnamon and Clove, were purchased from Sprouts and diluted with tap water using a g/mL conversion to prepare the 1% and 2% concentrations.

An even layer of mung beans was placed into 60 mm petri dishes.

Each plate was sprayed evenly with the respective treatment and allowed to evaporate for 15 minutes.
No treatment was applied to the control plates. N=20 per treatment.

4 females and 2 males placed into each plate, which was incubated at approximately 30-35º C. Beetles were allowed to reproduce and lay eggs for 48 hours.

After 48 hours, mortality and oviposition were documented, and beetles were removed.

Emergence was recorded after 5 weeks.

Fig. 1 This is an example plate set up before treatment.

Fig. 2 This is an example post plate set up containing eggs.

Objective

The purpose of this study was to assess the efficacy of clove and cinnamon essential oils as a potential biopesticide against the bean beetle, *Callosobruchus maculatus.* Three factors were used to quantify efficacy: adult mortality, oviposition, and emergence.

Results

Adult Mortality

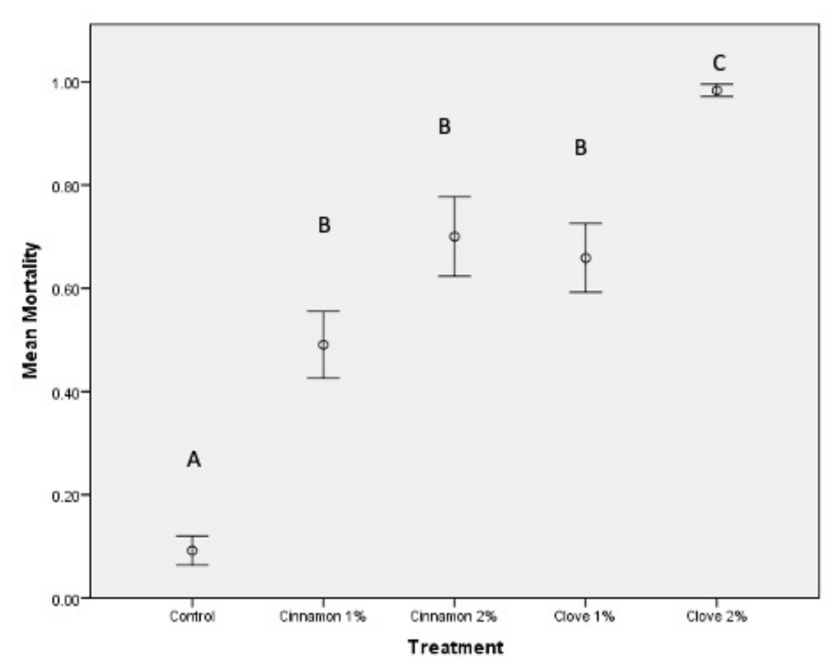

Fig. 3 All oil treatments significantly increased mortality compared to the control ($p<0.05$).

Clove 2% increased mortality significantly more than the rest of the treatments ($p<0.05$).

There was not a significant difference between cinnamon 1% and 2%, but the trend showed increased mortality ($p=0.067$).

Oviposition

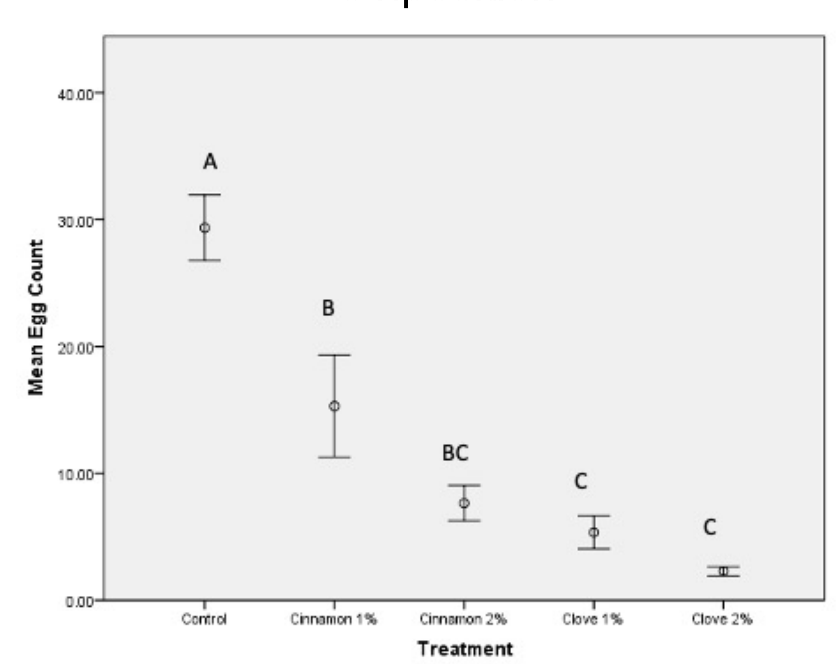

Fig. 4 All oil treatments significantly decreased oviposition compared to the control ($p<0.05$).

No difference between 1 and 2% cinnamon treatments ($p=0.14$), but the trend shows more of a decrease with 2%.

Both clove treatments significantly decreased oviposition opposed to cinnamon 1% ($p<0.05$) but were not significantly different than cinnamon 2% ($p>0.05$).

Emergence

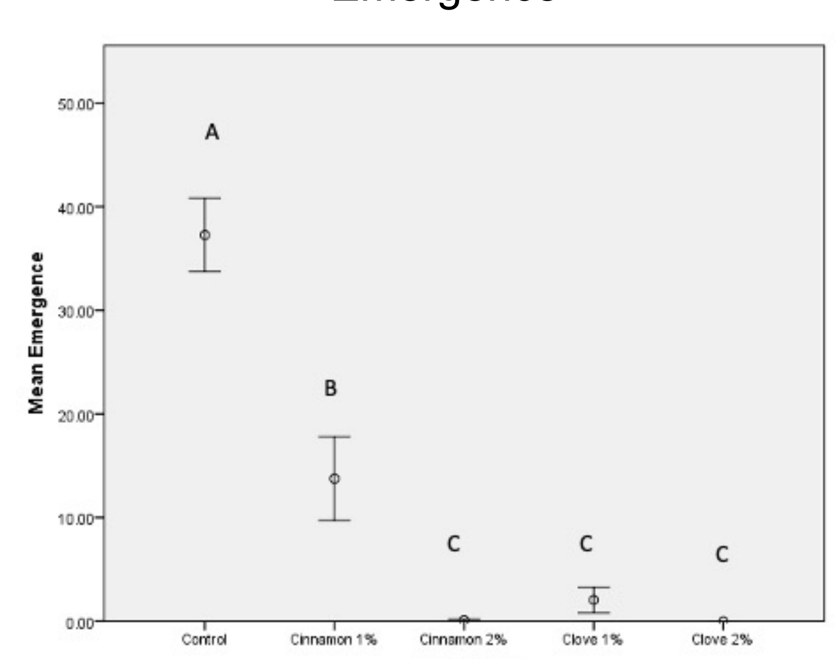

Fig. 5 All oil treatments significantly decreased emergence ($p<0.05$).

Cinnamon 1% significantly decreased emergence compared to the control ($p<0.05$), but not to the level of the other three treatments ($p>0.05$).

The other three treatments decreased emergence to very close to zero, with no significant differences among them ($p>0.05$).

*The letters on each figure represent significant differences between treatments. Treatments that share letters had no significant difference.

Conclusion

Using 1-2% concentrations of essential oils strongly affected all three efficacy parameters: mortality, oviposition, and emergence.

This suggests that there is potential for essential oils to be a low cost, efficient alternative to synthetic insecticides.

Clove, specifically 2% concentration, had the strongest effect.

Our study supports previous work that showed essential oils are effective as a potential biopesticide, and that clove was more effective than cinnamon (Soe, Ngampongsai, & Sittichaya, 2020).

Interestingly, another study suggested that the specific oil toxicity might be affected by species of beetle, as they determined cinnamon to be most effective against *Bruchidius incarnatus,* a faba bean beetle (Fouad, 2013).

Future studies are needed to assess the overall affect of essential oil treatments to the non-pest species in treatment areas.

In addition, a possible future study could be done to determine the exact concentration needed, and to assess a treatment with a mixture of plant products.

Literature Cited

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Fig. 6 & 7 Beetle populations on mung and black-eyed peas. These plates were not used during the experiment.

Acknowledgments: I would like to thank my Thesis Director, Professor Balaban Feld, and my second reader, Professor Reichert, for their support and guidance throughout this project. I would also like to thank the Integrative Biology Department for allowing use of their facilities during my research.