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Biological effectiveness and chemical characteristics of Black Pepper (*Piper nigrum*) corn essential oil-loaded nanoemulsions against *Tribolium castaneum* (Herbst); stored grain insect pest.

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INTRODUCTION & AIM

- Postharvest losses, particularly those caused by insect infestations during storage, pose a significant challenge to global agricultural productivity.
- Among the major insect pests, Coleoptera, especially *Tribolium castaneum*, is responsible for considerable damage.
- While synthetic insecticides are commonly used, they have harmful environmental and health effects.

- This has led to increased interest in botanical alternatives, such as essential oils (EOs), though their instability limits industrial use.
- Recent research highlights that nanoemulsions can enhance EO stability and efficacy.

- This study focuses on developing a *Piper nigrum* essential oil-based nanoemulsion (PNEO/NE) as an effective botanical insecticide against *T. castaneum*.

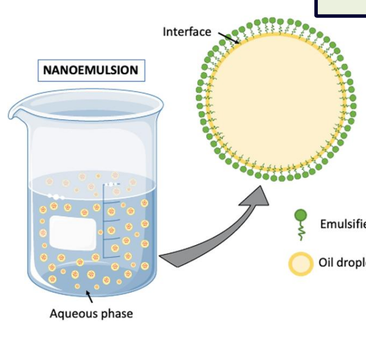
METHOD

CHARACTERIZATION OF PNEO/PNNEs

- GC-MS analysis of PNEO
- Droplet size evaluation of PNNEs
- Zeta potential evaluation of PNNEs
- Physiochemical and Thermodynamic stability of PNNEs

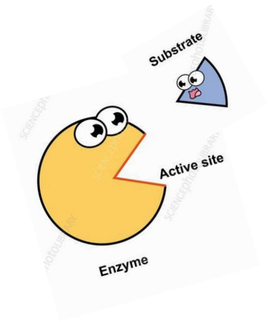
BIO-ASSAYS

- Topical Application
- Fumigation
- Repellency



ENZYME ASSAYS

- Reduced Glutathione (GSH)
- Oxidized Glutathione (GSSG)
- Catalase
- Peroxidase
- Acetylcholinesterase



RESULTS & DISCUSSION

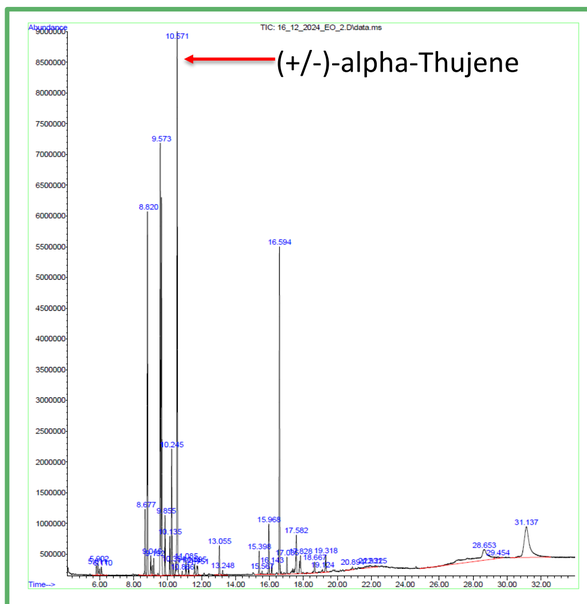
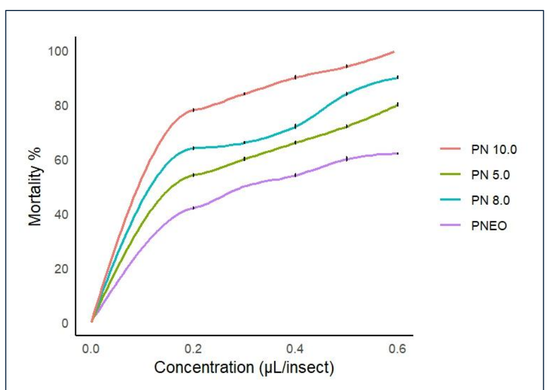


Figure 01: GC-MS spectrum of PNEO

Table 01:Droplet size, PDI and Zeta Potential of PNNEs

PNEO : Tween 80 Ratio	Droplet Size (nm)	PDI	Zeta potential (mV)
1:5	11.66	0.210	-10.65
1:8	10.5	0.153	-17.87
1:10	9.58	0.130	-11.27

Tween 80 ratio ↑ Droplet size ↓



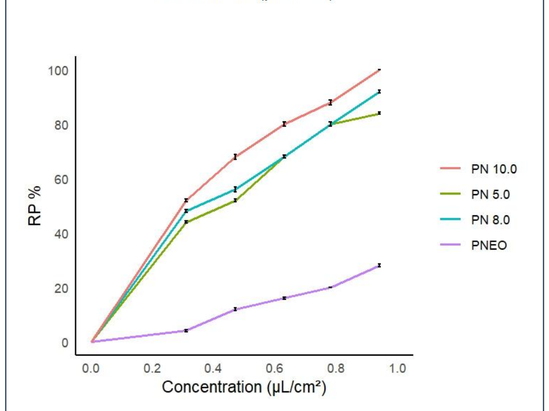
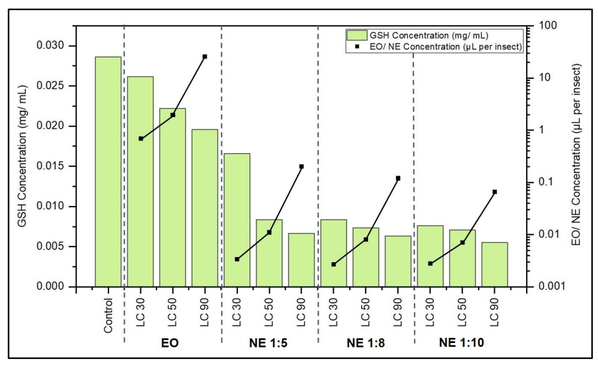
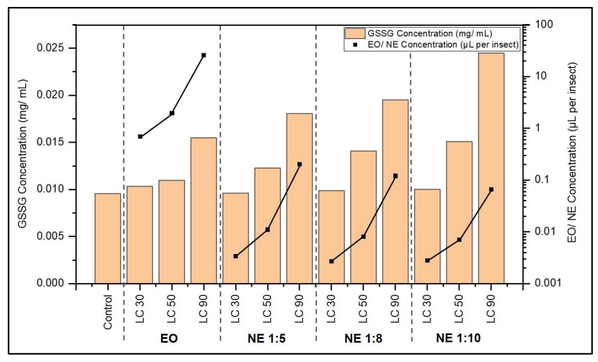
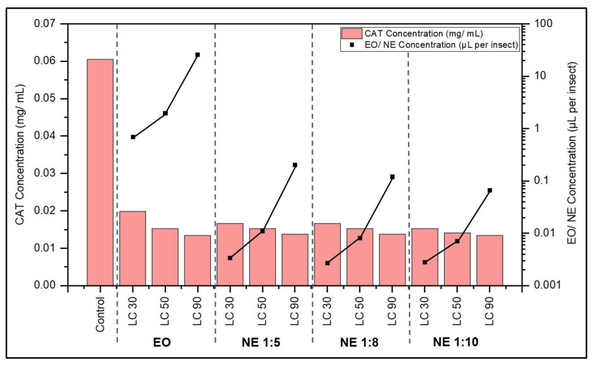


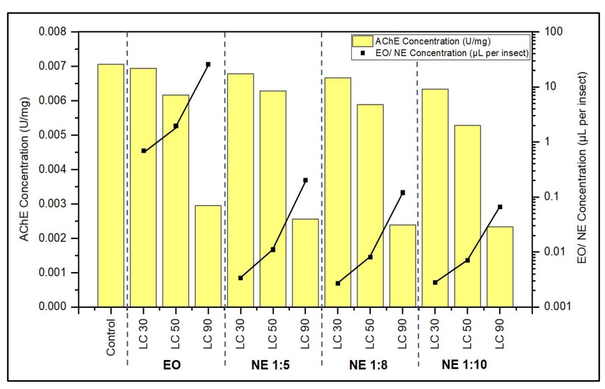
Figure 02: Mortality Percentage (top) and Repellency Percentage (bottom) of PNEO and PNNEs against *T. castaneum.*

Mortality & and Repellency % have got increased from PNEO to 1:5, 1:8 and 1:10 PNNEs









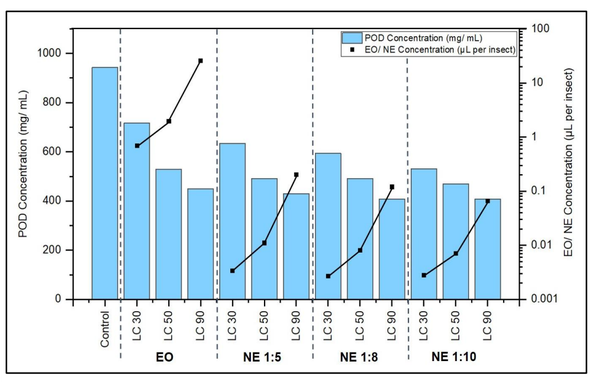


Figure 03: Effect of PNEO and PNNEs towards the fluctuation of GSH (green), GSSG (orange), Catalase (pink), Peroxidase and Acetylcholinesterase (yellow) of *T. castaneum.*

CONCLUSION

- The application of PNEO and NES proved to be more effective than PNEO alone, as shown by contact, fumigation, and repellency bioassays against *T. castaneum*.
- The toxicity and repellency of PNEO/NEs was affected by its droplet size.
- The concentrations of non-enzymatic GSH and enzymatic CAT, POD, and AChE activity in *T. castaneum* were found to be depleted after treatment with PNEO and PNEO/NEs.

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Rajkumar, V., Gunasekaran, C., Christy, I. K., Dharmaraj, J., Chinnaraj, P., & Paul, C. A. (2019a). Toxicity, antifeedant and biochemical efficacy of Mentha piperita L. essential oil and their major constituents against stored grain pest. *Pesticide Biochemistry and Physiology*, *156*, 138–144. https://doi.org/10.1016/j.pestbp.2019.02.016