

Development of an Extended-release Insect Repellent Bio-composite by Encapsulation of *Acronychia pedunculata* Essential Oil into Tonsil 134 against *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae)

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Insect pests are a persistent threat to stored grains, leading to substantial post-harvest losses. Due to the detrimental issues of synthetic pesticides, bio-pesticides have emerged as an alternative owing to their advantages in addressing those issues. Thus, the present study aimed to develop an extended-release insect-repellent bio-composite by encapsulating *Acronychia pedunculata* essential oil (APEO) into the adsorbent tonsil 134, against the rice weevil *Sitophilus oryzae*. Test insect cultures of adult *Sitophilus oryzae* were maintained under ambient thermo-hygrometric conditions. The APEO was extracted from leaves of *Acronychia pedunculata* via hydrodistillation, and the chemical composition was analyzed through gas chromatography-mass spectrometry (GC-MS). The area preference bioassay was conducted to determine the 95% repellent concentration (RC₉₅). Subsequently, APEO content equivalent to RC₉₅ was incorporated into the adsorbent and the prolonged repellent activity of the bio-composite was assessed through the cup bioassay. The GC-MS analysis of APEO revealed thirteen major compounds, with ocimene (33.8%) being the predominant. In the area preference bioassay, a 100% repellency was observed at the highest dose after a six-hour exposure period and the RC₉₅ value was recorded as 3.62 $\mu\text{L cm}^{-2}$. The cumulative release of APEO from the bio-composite was assessed using thermogravimetric analysis, which resulted in a cumulative weight loss of 52.26% by the end of 30 days. Fourier transform infrared spectroscopy confirmed the successful incorporation of APEO into the sorbent and its extended release over 30 days. Scanning electron microscopy analysis demonstrated no significant morphological changes between the pristine tonsil and the bio-composite. The cup-bioassay resulted in a percentage repellency of 100%, >90%, and 90–80% after each 10-day exposure period within a 30-day period, which correlated with the cumulative release of APEO. Thus, APEO-based bio-composite can be effectively used as an eco-friendly method to successfully control insect-pest infestations in stored-grain food systems for a prolonged period.

Keywords: *Acronychia pedunculata*, Tonsil 134, *Sitophilus oryzae*, Extended-release, insect repellent, Prolonged repellent activity