(106)

Development of Zeolite Based Repellent Formulations for the Sustained-Release of *Ruta graveolens* Essential Oil against *Sitophilus zeamais*

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Abstract

Essential oils (EOs) and their derivatives are considered to be greener alternative means for controlling many harmful insects, which have been used in stored-product insect pest control for centuries. However, application of EOs turns out to be limited, because of their rapid volatilisation associated with low stability. The present study was sought with the objective of developing aroma delivery formulations, for the slow release of *Ruta graveolens* EO, using biodegradable zeolite matrix as the release retardant of EO, to be applied as a repellent against *Sitophilus zeamais* for an extended period of time. The EO was isolated from the leaves of *R. graveolens* via hydrodistillation under laboratory conditions and incorporated into zeolite mineral matrix, at a weight ratio of 1:3, producing 300 mg of the powder formulation. The powder formulation was then evaluated for repellent potential against *S. zeamais* for an extended time period, characterised via analytical techniques of Scanning Electron Microscopy (SEM) and Thermogravimetric Analysis (TGA) and performed pre-compression assessments. For more convenient application purposes, a tablet was produced from the EO-zeolite powder blend by direct compression method, for which repellent and post-compression assessments were performed. Both powder and tablet aroma delivery systems of *R. graveolens* EO exhibited effective control on *S. zeamais* producing over 90% repellent activities for a prolonged time period of 90 days. Characterisation studies confirmed better incorporation of the EO to the parent zeolite matrix and high degrees of thermal stability of the formulation. Pre-compression assays elicited effective flow properties of the powder formulation to be compressed in the production of tablets and post-compression assays of resultant tablets depicted excellent handling properties for its commercial exploitation to be used in the integrated insect pest management programs.

Keywords: *Sitophilus zeamais, Ruta graveolens,* Essential oil, Sustained-release formulations