

Ginger essential oils-loaded nanoemulsions: potential strategy to manage bacterial leaf blight disease and enhanced rice yield

ABSTRACT

The bacterial leaf blight (BLB) caused by *Xanthomonas oryzae* pv. *oryzae* (Xoo) is one of the most serious rice diseases, causing huge yield losses worldwide. Several technologies and approaches have been opted to reduce the damage; however, these have had limited success. Recently, scientists have been focusing their efforts on developing efficient and environmentally friendly nanobactericides for controlling bacterial diseases in rice fields. In the present study, a scanning electron microscope (SEM), transmission electron microscope (TEM), and a confocal laser scanning microscope (CLSM) were utilized to investigate the mode of actions of ginger EOs on the cell structure of Xoo. The ginger EOs caused the cells to grow abnormally, resulting in an irregular form with hollow layers, whereas the dimethylsulfoxide (DMSO) treatment showed a typical rod shape for the Xoo cell. Ginger EOs restricted the growth and production of biofilms by reducing the number of biofilms generated as indicated by CLSM. Due to the instability, poor solubility, and durability of ginger EOs, a nanoemulsions approach was used, and a glasshouse trial was performed to assess their efficacy on BLB disease control. The *in vitro* antibacterial activity of the developed nanobactericides was promising at different concentration (50–125 $\mu\text{L}/\text{mL}$) tested. The efficacy was concentration-dependent. There was significant antibacterial activity recorded at higher concentrations. A glasshouse trial revealed that developed nanobactericides managed to suppress BLB disease severity effectively. Treatment at a concentration of 125 $\mu\text{L}/\text{mL}$ was the best based on the suppression of disease severity index, AUDPC value, disease reduction (DR), and protection index (PI). Furthermore, findings on plant growth, physiological features, and yield parameters were significantly enhanced compared to the positive control treatment. In conclusion, the results indicated that ginger essential oils loaded-nanoemulsions are a promising alternative to synthetic antibiotics in suppressing Xoo growth, regulating the BLB disease, and enhancing rice yield under a glasshouse trial.

Keyword: Bacterial leaf blight; Ginger essential oils; Nanoemulsions; *Xanthomonas oryzae* pv. *oryzae* (Xoo)