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## Second Article

<b>Article title</b>	Bio-organic fertilizers promote yield, chemical composition, and antioxidant and antimicrobial activities of essential oil in fennel ( <i>Foeniculum vulgare</i> ) seeds
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### Abstract

The aromatic fennel plant (*Foeniculum vulgare* Miller) is cultivated worldwide due to its high nutritional and medicinal values. The aim of the current study was to determine the effect of the application of bio-organic fertilization (BOF), farmyard manure (FM) or poultry manure (PM), either individually or combined with *Lactobacillus plantarum* (LP) and/or *Lactococcus lactis* (LL) on the yield, chemical composition, and antioxidative and antimicrobial activities of fennel seed essential oil (FSEO). In general, PM + LP + LL and FM + LP + LL showed the best results compared to any of the applications of BOF. Among the seventeen identified FSEO components, trans-anethole (78.90 and 91.4%), fenchone (3.35 and 10.10%), limonene (2.94 and 8.62%), and estragole (0.50 and 4.29%) were highly abundant in PM + LP + LL and FM + LP + LL, respectively. In addition, PM + LP + LL and FM + LP + LL exhibited the lowest half-maximal inhibitory concentration (IC<sub>50</sub>) values of 8.11 and 9.01  $\mu\text{g mL}^{-1}$ , respectively, compared to l-ascorbic acid (IC<sub>50</sub> = 35.90  $\mu\text{g mL}^{-1}$ ). We also observed a significant ( $P > 0.05$ ) difference in the free radical scavenging activity of FSEO in the triple treatments. The in vitro study using FSEO obtained from PM + LP + LL or FM + LP + LL showed the largest inhibition zones against all tested Gram positive and Gram negative bacterial strains as well as pathogenic fungi. This suggests that the triple application has suppressive effects against a wide range of foodborne bacterial and fungal pathogens. This study provides the first in-depth analysis of Egyptian fennel seeds processed utilizing BOF treatments, yielding high-quality FSEO that could be used in industrial applications.