Inhibitory effect of plant essential oil on the biological activity of *Ralstonia solanacearum*

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Bacterial wilt is a common plant bacterial disease. It is known as one of the most harmful soil-borne diseases in the world because of its wide distribution and host range. Although the direct economic loss caused by bacterial wilt is incalculable, the global loss of a crop potato is as high as $1 billion. The disease was very prevalent in tropical developing countries. It often broken out in South America, North America and Asia, causing great harm to agricultural production (Mansfield et al., 2012). Bacterial wilt was first reported at the end of the 19th century, later, it was found in tobacco, tomatoes, potatoes and peanuts. In 1896, Smith identified Bacillus Solanaceae as the pathogen of *Solanaceae* bacterial wilt, such as potatoes and tomatoes. In the following 100 years, the pathogen was named *Pseudomonas solanacearum* and *Solanum solanacearum*. It was not until 1995 that it was officially renamed *Ralstonia solanacearum*, or *Ralstonia solanacearum*. The physiological characteristics of *Ralstonia solanacearum* population are obviously differentiated (GuoQing., 2011). The outbreak of bacterial wilt of mulberry will cause irreversible harm to sericulture production. At present, domestic research on *Ralstonia solanacearum* strains which can infect mulberry trees mainly focuses on the detection and diagnosis of pathogenic bacteria, physiological races and biotype analysis, etc. Molecular identification of strains and their subtaxonomic status in the complex system of strains have not been reported (Xue et al., 2017). Once the outbreak of *Mulberry Bacterial Wilt* occurs, it will cause immeasurable losses to mulberry trees. Therefore, it is very important to find a suitable bacteriostatic agent.

Plant essential oils, also known as volatile oils, essential oils or aromatic oils, were small volatile aromatic compounds extracted from flowers, leaves, stems, roots and fruits of Chinese herbs and spices. Although, the content of essential oils was low and complex, with the maturity and advancement of detection technology, the detection of essential oils was developing towards the direction of high efficiency, rapid and combined use of various technologies. Many studies had shown that the antimicrobial mechanism of plant essential oil was that essential oil and its components act on the cell membrane of microorganisms, which damages the membrane structure of microorganisms, increases the membrane breathability of microorganisms, led to the leakage of intracellular ions and inclusions (Moreira et al., 2005), or damages the enzyme system of microorganisms, leading to cell death (Carson et al, 2002., and Lambert et al., 2001). As a new type of cold sterilization technology, plant essential oil has many advantages, such as broad antimicrobial spectrum, obvious antimicrobial effect, low residual toxicity and no drug resistance. In addition, the aroma and oil solubility of vegetable essential oils can also play a better bacteriostatic effect. Therefore, vegetable essential oil as a new type of antimicrobial agent has great potential for development.

The control of plant bacterial wilt has always been a worldwide problem. In this experiment, the bacteriostatic effects of 10 essential oils, including Geranium oil, rose oil, citronella oil, tea tree oil, patchouli oil, Lavender oil, cinnamon oil, and some essential oils at 0.1ml/L, 0.01ml/L and 0.001ml/L, were tested. According to Sanchez and other methods (Sanchez-Maldonado et al., 2011), the mixed solution of solvent solution and CPG liquid medium was used as blank control. The absorbance at 600 nm was determined by enzyme labeling instrument and recorded as T0. After adding suspension solution to culture, the absorbance at 600 nm was determined again and recorded as TF. The antimicrobial activity was expressed as inhibition percentage. formula of computation: In the formula, $T0_{Sample}$ and TF_{Sample} respectively represent the OD600 value before and after culture after adding the bacterial suspension of the sample solution; $T0_{Blank}$ and TF_{Blank} respectively represent the OD600 value before and after culture after adding the bacterial suspension of the solvent solution. Then, three kinds of essential oils were selected randomly, and the antimicrobial concentration of three kinds of essential oils were screened, including cedar oil, camphor oil and mint oil.

The results showed that when the concentration of cedar oil was 0.1ml/L, the bacteriostasis rate was 69.10%; when the concentration was 0.01ml/L and 0.001ml/L, the bacteriostasis rate was 57.31% and 7.49%, respectively. When the concentration of *cinnamomum camphora* oil was 0.1ml/L, 0.01ml/L and 0.001ml/L, the bacteriostasis rate was relatively similar, which was 40.03%, 40.37% and 36.32%, respectively. When the concentration of peppermint oil was 0.1ml/L, the highest bacteriostatic rate was 62.48%, the lowest was 55.85% when the concentration was 0.01ml/L, and the lowest was only 4.65% when the concentration was 0.001ml/L. Of course, the antibacterial concentration of these essential oils still needs to be explored.

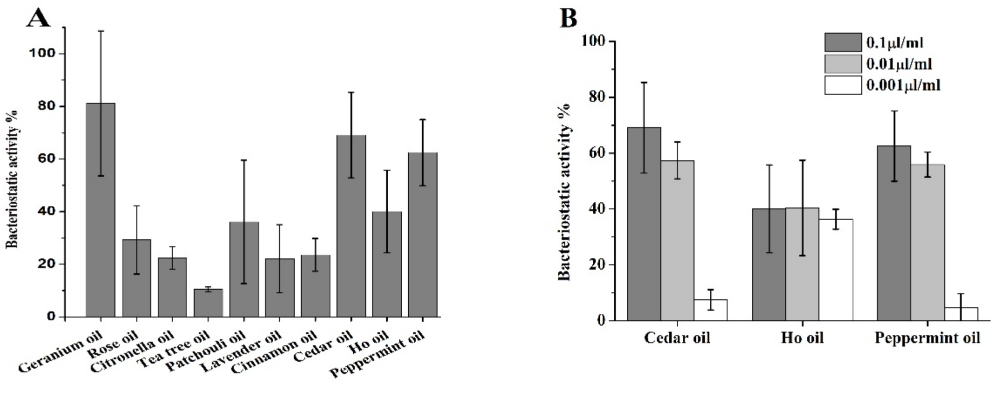

Figure 1 The antibacterial activities of essential oils. (A) The antibacterial activity of 10 essential oils with a concentration of 0.1ml/L; (B) The antibacterial activities of the three selected essential oils, cedar oil, linalool oil and peppermint oil, at the concentrations of 0.1ml/L, 0.01ml/L and 0.001ml/L

The composition of the three essential oils determines the antibacterial effect of the three essential oils. In cedar, the main component of leaf essential oil is monoterpenoids. Stem essential oils, by contrast, contain mainly sesquiterpenoids. In terms of bioactivities, the leaf essential oil showed antibacterial activity and the stem essential oil showed anti-melanogenesis activity (Nakagawa et al., 2016). The main component of ho oil was linalool, which has antibacterial effect on common bacteria. The volatile oil of menthol contains antimicrobial and antiviral components such as menthol, menthol acetate, limonene and menthol (Yajuan et al., 2016). Therefore, these three essential oils have certain antibacterial effects.

The antimicrobial concentration of these three kinds of essential oils should be further analyzed and the antimicrobial concentration of other kinds of essential oils should be further explored.

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