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Evaluation of the active compound and antibacterial activity of a *Salvia rosmarinus* extract against pathogenic bacteria

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Abstract

When bacteria attach to the human body, they have many defense mechanisms. These mechanisms pose a global health risk. Medicinal plants can be used to control such bacterial attack mechanisms. The aim of this study was to assess the antimicrobial potential of an aqueous extract of *Salvia rosmarinus* and other plant extracts against some clinical bacterial isolates. The antimicrobial activity against Gram-positive and Gram-negative bacteria (*S. aureus*, *E. coli*, *P. aeruginosa*, *Proteus* spp., and *Klebsiella* spp.) was determined by using the agar well diffusion method. When compared to an alcoholic extract, the aqueous extract of *Salvia rosmarinus* inhibited the studied bacterial isolates with greater efficiency.

KEYWORDS

antibacterial activity, herb extracts, *Salvia rosmarinus,* pathogenic bacteria, FTRI technique

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1. INTRODUCTION

A number of factors has hampered the production of antibacterial agents. Of them, bacterial resistance to antimicrobials has resulted in the latter losing their inhibitory effectiveness against bacteria [1]. The identification of the biologically active compounds responsible for the medicinal properties is a critical requirement for quality control [2]. Antimicrobial plant extracts are of interest to clinical microbiologists [3]. *Salvia rosmarinus* leaves and flowers have long been used in conventional medical treatments and beauty products. They are also used in food as flavoring agents [4]. The current study was designed so as to evaluate the antimicrobial activity of *Salvia rosmarinus* against clinical bacterial isolates. Moreover, Fourier-transform infrared (FTIR) spectroscopy was used in order to detect important compounds

of *Salvia rosmarinus*, as well as to detect some virulence factors that can be inhibited by the plant's extract.

2. MATERIALS AND METHODS

Bacterial isolates: The herein assessed bacterial isolates were provided by the Department of Biology of the University of Babylon (one sample for each isolate, collected from patients with severe urinary tract infection), and were identified by manual biochemical tests. The bacterial isolates were *S. aureus*, *E. coli*, *P. aeruginosa*, *Proteus* spp., and *Klebsiella* spp. isolates.

Plant extract: This experiment was conducted in 2023 at the University of Babylon's Environmental Research and Studies Center. Herbal samples were collected from local markets, and included *Laurus nobilis*, *Punica granatum*, and *Salvia rosmarinus*, while the parts used were the leaves, the peels, and leaves, respectively [5].

Agar diffusion assay: The standard agar diffusion assay was used for the undertaking of the antibacterial assay [6].

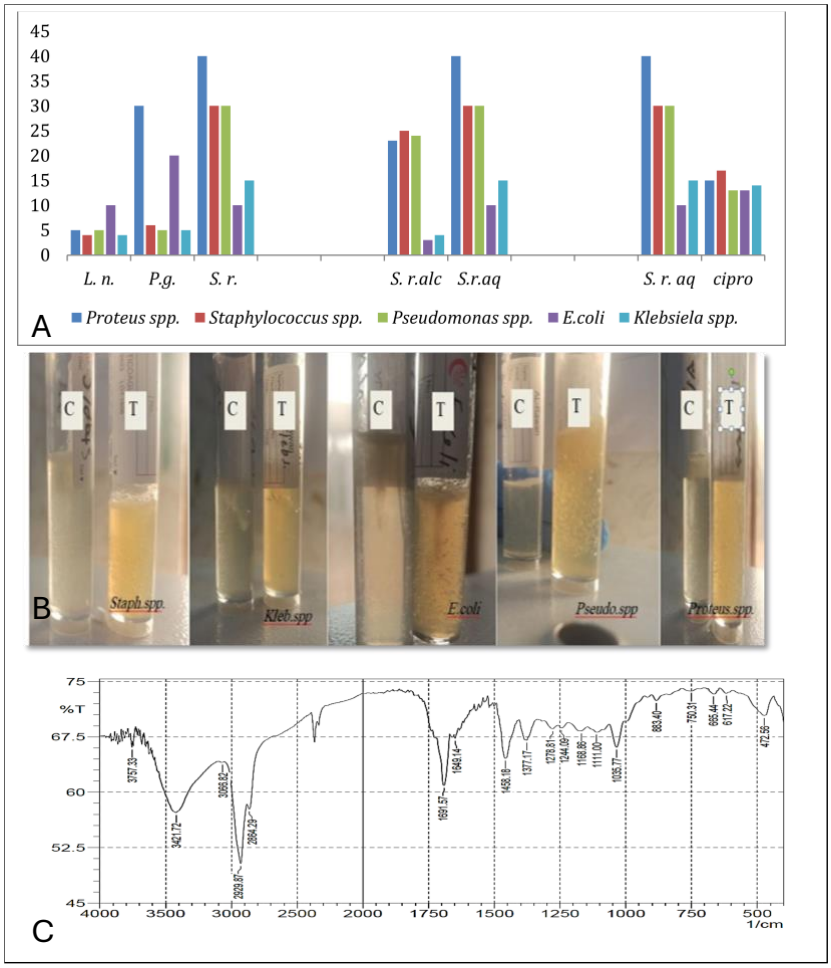

Figure 1. Antibacterial action of herbal plant extracts and antibiotics against clinical bacterial isolates (y-axis: zone of inhibition, in mm; abbreviations used: alc, alcoholic extract; aq, aqueous extract; cipro, ciprofloxacin; Ln: *Laurus nobilis*; Pg, *Punica granatum*; Sr, *Salvia rosmarinus*). (**B**): Activity of the aqueous extract of *Salvia rosmarinus* against the motility of bacteria. (**C**): Fourier-transform infrared spectrum of the rosemary extract.

3. RESULTS AND DISCUSSION

In the current study, after the preparation of the extracts of the studied herbals plants, a comparison was made so as to see which was more effective in inhibiting the pathogenic bacterial isolates caus-

ing urinary tract infection. Figure 1A shows how the aqueous extract of *Salvia rosmarinus* inhibited the studied isolates mentioned with high efficiency, and inhibited bacterial movement compared to the control treatment. The extract exhibited high efficiency in comparison to the antibiotic ciprofloxacin. Our results revealed that the alcoholic and aqueous extracts from specific plants can successfully inhibit the development of pathogenic organisms. Aqueous extracts of various plants have been shown to yield significantly more potency than alcoholic extracts of the same plants [7]. These findings contradict several previous studies that suggested that the alcohol extract has more efficacy against bacteria than the aqueous one. Thus, these chemical compounds can affect multiple target sites resistant to bacterial cells [8]. The *Salvia rosmarinus* extract inhibited more effectively the bacterial motility, while other extracts were less effective (Figure 1B). An FTIR scan of the herbal plant extract was conducted in the infrared region so as to detect the function groups present in the composition of the prepared extract. The band at 3,421.72 cm^{-1} was attributed to the stretching vibration of the phenolic hydroxyl group, while the aromatic C-H stretching exhibited a lane at about 3,066.82 cm^{-1}. The C-H stretching vibrations of the methoxyl group exhibited two bands at 2,929.87 and 2,864.29 cm^{-1}, while the bands at 1,691.57 and 1,649.14 cm^{-1} were attributed to the stretching vibration of the C=O group. Moreover, the asymmetrical stretching vibrations of the C-O-C connection in the C-O stretch, in addition to esters or phenolic hydroxyl, exhibited two bands at 1,278.81 and 1,244.09 cm^{-1}. Finally, three bands were attributed to ethoxyl: 1,168.6, 1,111.0, and 1,035.77cm^{-1} (Figure 1C).

4. CONCLUSION

Our study shows how the aqueous extract of *Salvia rosmarinus* can inhibit the studied bacterial isolates with great efficiency. In addition, it explains how this efficiency could be attributed to the influencing of one of the virulence factors, which is the motility factor.

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CONFLICT OF INTEREST STATEMENT
The authors declare no conflicts of interest.

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