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Comparison of the antibacterial and antibiofilm Activities of selected Jordanian honeys

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Abstract

Honey is a natural product that has been widely used for its therapeutic effects. Honey is effective against pathogenic bacteria in inhibiting planktonic antibiotic sensitive strains and antimicrobial resistant organisms. The purpose of this study was to evaluate and compare the antibacterial activity of Jordanian honeys (Sidr and Jabali) with Manuka honey against *Staphylococcus aureus (S. aureus)* and *Escherichia coli* (*E. coli).* The antibacterial and antibiofilm activities were evaluated using agar well diffusion assay, minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC), growth curve, time-kill curve, microtiter plate assay and reverse transcription polymerase chain reaction (RT-qPCR). Agar well diffusion assay showed that Sidr and Jabali honey had antibacterial activity at 20% and 25% (w/v) respectively compared with Manuka at 20% (w/v) against both bacteria. The MIC values for Manuka and Sidr honey was 20% (w/v) and 25% (w/v) for Jabali against *S. aureus* and *E. coli.* The MIC_{50} values for both Manuka and Sidr honey was 20% (w/v) and 25% (w/v) for Jabali honey against *S. aureus*

and *E. coli*. Whereas, the MIC_{90} values against *S. aureus* were 25% (w/v) for both Manuka and Sidr honeys and 50% (w/v) for Jabali Honey. While the MIC_{90} values against *E. coli* were 50% (w/v) for both Manuka and Sidr honeys and 75% (w/v) for Jabali honey. The MBC values for Manuka and Sidr honey were 25% (w/v) and 50% (w/v) for Jabali honey against *S. aureus* and *E. coli*. The growth curve of *S. aureus* and *E. coli* was reduced after exposure to all the tested honeys at MIC. In time-kill curve assay, *S. aureus* cells were significantly ($P<0.05$) decreased to 4.5-Log_{10}, 4-Log_{10}, 3.34-Log_{10} after incubation with Manuka, Sidr, Jabali honeys respectively compared to untreated. Meanwhile after *E. coli* cells treated with Manuka, Sidr and Jabali honeys, the number of cells was significantly ($P<0.05$) decreased to 4.7-log_{10}, 4-log_{10} and 3.6-Log_{10} reduction respectively compared to untreated. The lowest concentration 20% (w/v) of all the tested honey was able to inhibit and eradicate *S. aureus* and *E. coli* biofilms. The RT-qPCR analysis showed that the range of gene expression of *argF, purC, pykA, fabG, scdA, adh* and *menB* in *S. aureus* was between 4.8-6.3-fold, 3.9-5.9-fold and 3.5-5.6-fold after exposure to Manuka, Sidr and Jabali honey respectively. In addition, the range of gene expression of *yifO (bsmA), rpoS, ycfR (BhsA), tnaA* and *evgA* in E. *coli* was between 4.6-6.3-fold, 4.1-5.8-fold and 4-5.4-fold after exposure to Manuka, Sidr and Jabali honey respectively. Among the all-tested honeys, Manuka showed the highest total antibacterial activities against both bacteria. This study demonstrated that Sidr and Jabali honey has antibacterial and antibiofilm activities compared with Manuka honey. This study revealed that Sidr and Jabali honey inhibits both of *S. aureus* and *E. coli* planktonic and biofilm through the downregulation of genes required for cell envelope stability and motility.

Keywords: Antibacterial activity, Honey, *E. coli*, *S. aureus*, Gene expression, Virulence genes.