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Detection of molecular changes induced by antibiotics in *Escherichia coli* using vibrational spectroscopy

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ABSTRACT:

This study aimed to test Raman(400-1800 cm^{-1}) and Infra-red (1900-500 cm^{-1}) spectroscopies followed by statistical analysis (principal component analysis) to detect molecular changes induced by antibiotics (ampicillin, cefotaxime – cell wall synthesis inhibitors, tetracycline – protein synthesis inhibitor, ciprofloxacin – DNA synthesis inhibitor) against*Escherichia coli* TOP10. In case of ampicillin and cefotaxime, a decrease in protein bands in both Raman (1240, 1660 cm^{-1}), and IR spectra (1230, 1530, 1630 cm^{-1}), and an increase in carbohydrate bands (1150, 1020 cm^{-1}) in IR spectra were observed. Tetracycline addition caused an increase in nucleic acid bands (775, 1478, 1578 cm^{-1}), a sharp decrease in phenylalanine (995 cm^{-1}) in Raman spectra and the amide I and amide II bands(1630, 1530 cm^{-1}) in IR spectra, an increase in DNA in both Raman (1083 cm^{-1}) and IR spectra(1080cm^{-1}). Regarding ciprofloxacin, an increase in nucleic acids (775, 1478, 1578 cm^{-1}) in Raman spectra and in protein bands (1230, 1520, 1630 cm^{-1}), in DNA (1080 cm^{-1}) in IR spectra were detected. Clear discrimination of antibiotic-treated samples compared to the control was recorded, showing that Raman and IR spectroscopies, coupled to principal component analysisfordata, could be used to detect molecular modifications in bacteria exposed to different classes of antibiotics. These findings contribute to the understanding of the mechanisms of action of antibiotics in bacteria.

Key words: Raman spectroscopy, Infra-red spectroscopy, *Escherichia coli*, antibiotics

1.Introduction

Antibiotics have been widely used for prevention and treatment of infectious diseases in humans and animals. However, their overuse has led to antimicrobial resistance among a wide range of infectious bacteria which become an increasing public health threat at global level (1) (2) (3) (4) (5) (6). According to recent statistics antibiotic-resistant infections currently involve about 700,000 deaths per year in the world (7). Among measures needed to tackle this complex and multi-faceted problem, rapid and accurate detection of antibiotic resistant bacteria is important to guide appropriate and efficient therapeutic treatments.