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Isolation of Oxaliplatin degrading bacteria from pharmaceutical wastewater for drug removal using single and multi-species bacterial population

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Introduction

Global production and consumption of pharmaceuticals have been increasing during recent years and therefore, their release into ecosystems is considered an emerging environmental concern . Hundreds of pharmaceuticals are annually released in aquatic and terrestrial ecosystems, which could be a major health threat for living organisms. Anticancer drugs are widely used to treat a variety of cancers and their global consumption has dramatically increased recently. Owing to the high cytotoxicity, the introduction of anticancer pharmaceuticals to the environment via pharmaceutical and hospital effluents is regarded as a major health threat for eukaryotes. Exploring bacterial cells, as prokaryotic organisms, could be a novel approach to the removal of these compounds. Therefore, in this study, we aimed to isolate and identify oxaliplatin degrading bacteria from pharmaceutical wastewater samples and to evaluate their oxaliplatin removal potential as single and multi-species systems. **Materials & Methods*:*** Pharmaceutical wastewater samples were obtained from Sobhan oncology pharmaceutical company and bacterial isolation was performed using the membrane filtration method. The inhibitory effect of the drug on the isolated bacteria was evaluated using the microdilution method in 96-well plates. The strains that were resistant to oxaliplatin were cultured in a minimal salt medium (MSM), containing oxaliplatin (0.78 mg/mL) as the sole carbon source. The strains able to grow in MSM were considered potent oxaliplatin degrading strains. Biochemical identification of the potent strains was carried out using the MICROGENA&B (England) bacterial identification kit according to the manufacturer's instructions. The oxaliplatin removal potential of each candidate strain was performed in 250 mL flasks containing MSM and oxaliplatin (0.78 mg/mL). The flasks were incubated for 21 days at 25 ˚C with shaking (120 rpm) and oxaliplatin concentration in seven days intervals were determined using High-Pressure Liquid chromatography (HPLC). Finally, the synergism of isolated strains, as multispecies bacterial population, for oxaliplatin removal was investigated.

Results and discussion

The increasing discharge of pharmaceutical compounds in ecosystems is a major environmental concern. Bacterial strains were initially isolated from pharmaceutical wastewater and the inhibitory 208 potential of oxaliplatin was evaluated by determination of MIC value. Degradation of anticancer drugs using bacterial species is a promising approach, since many anticancer agents target eukaryotic cell functions and have less cytotoxicity toward prokaryotes. Among the isolated strains, a total number of five bacterial species tolerated high concentrations of oxaliplatin and were able to grow with oxaliplatin, as the sole carbon source. Based on the biochemical identification, the isolated strains include, *Enterobacter agglomerans*, *Citrobacter youngae*, *Xenorhabdus spp*., *Bacillus licheniformis*, and *Moraxella spp*. With 52% oxaliplatin removal efficacy, *B. licheniformis* was identified as the most potent strain while the least oxaliplatin degrading potential was observed for *C. youngae* (21%). Oxaliplatin removal efficacy of *Moraxella spp., E. agglomerans,* and *Xenorhabdus spp* after 21 days of incubation was measured at 41%, 28, and 41%, respectively. Evaluation of oxaliplatin removal using the multi-species bacterial treatment showed that the treatment containing *B. licheniformis, Xenorhabdus spp, E. agglomeran* was the most potent bacterial population with oxaliplatin removal efficacy of 79% compared with the control vessel. In addition, with 60% oxaliplain removal, the treatment containing *B. licheniformis, Xenorhabdus spp*, and *Moraxella spp.* was the second most potent bacterial population for oxaliplatin degradation. Biodegradation of complex environmental pollutants using multispecies microbial populations has several benefits over single species biodegradation, including improved efficacy and further mineralization of the substrate.

Conclusion

In this work biodegradation of oxaliplatin using single and multispecies bacterial populations was investigated. Our results revealed that the bacterial strains isolated from pharmaceutical effluents could be efficiently employed for oxaliplatin removal and using a multispecies bacterial population could be considered a novel and efficient approach for the reduction of pharmaceutical pollutants from pharmaceutical wastewater.

Keywords: **anticancer drugs; bioremediation; HPLC; microbial degradation**

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