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Biodegradation of Carbamazepine by *Klebsiella pneumoniae* Isolated from the Sludge of Wastewater Treatment Plant

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Background: Carbamazepine is a drug detected in wastewater, rivers and drinking water at trace concentrations and has adverse effects on humans and the environment. However, a recent study shows that physical and chemical treatments are expensive due to harmful end product generation that requires proper disposal compared to biological treatment, which is low cost and environmental friendly. This study utilised *Klebsiella pneumoniae* isolated from the sludge of wastewater treatment plant as bacteria to degrade the carbamazepine. The purpose of this study is to characterise *Klebsiella pneumoniae*, investigate the optimisation conditions such as initial concentration, pH, media and time via Response Surface Methodology (RSM) and evaluate the relationship among biodegradation, bacteria growth and enzyme activity.

Methods: The characterisation of *Klebsiella pneumoniae* was identified through Gram staining, lactose fermentation test on MacConkey agar and capsule staining. The sample contained 2 mL of *Klebsiella pneumoniae* and 18 mL of carbamazepine mixed with MSS were inserted into a universal bottle and withdrawn on day 0, 3.5 and 7. The samples were proceeded to the liquid-liquid extraction (LLE), analysis of HPLC and measurement of bacteria growth and enzyme activity. The steps were repeated for optimisation parameters of the pH (pH 5, 7 and 9) and media (MSS, MSS mixed with 5 mg/L of acetaldehyde and nutrient broth).

Results: In this study, *Klebsiella pneumoniae* was characterised as a Gram-negative bacteria with a capsule and able to ferment glucose. The 40% of carbamazepine biodegradation was achieved when *Klebsiella pneumoniae* was incubated for 3.5 days with 10 mg/L initial concentrations of carbamazepine at pH 7 in MSS with 5 mg/L acetaldehyde media. Correlation analysis showed that the aldehyde oxidoreductase activity was strongly correlated ($R^2 \approx 0.7$) with bacteria growth. However, the biodegradation of carbamazepine ($R^2 \approx 0.3$) was weakly correlated with both bacteria growth and enzyme activity.

Conclusion: In conclusion, the findings of this study indicated that the optimisation conditions are 10 mg/L initial concentrations, pH 7, MSS with 5 mg/L acetaldehyde media 3.5 days. There is a strong correlation between aldehyde oxidoreductase activity with bacteria growth.

Keywords: Biodegradation, *Klebsiella pneumoniae*, Carbamazepine

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