Mathematical modeling of molybdenum blue production from Serratia marcescens strain DR.Y10

ABSTRACT

The pollution of heavy metals and toxic xenobiotics has become a central issue worldwide. Bioremediation of these toxicants are being constantly carried out using novel microbes. Molybdenum reduction to molybdenum blue is a detoxification process and mathematical modelling of the reduction process can reveal important parameters such as specific reduction rate, theoretical maximum reduction and whether reduction at high molybdenum concentration affected the lag period of reduction. The used of linearization method through the use of natural logarithm transformation, although popular, is inaccurate and can only give an approximate value for the sole parameter measured; the specific growth rate. In this work, a variety of models for such as logistic, Gompertz, Richards, Schnute, Baranyi-Roberts, Von Bertalanffy, Buchanan three-phase and more recently Huang were utilized for the first time to obtain values for the above parameters or constants. The modified Gompertz model was the best model in modelling the Mo-blue production curve from Serratia marcescens strain DR.Y10 based on statistical tests such as root-mean-square error (RMSE), adjusted coefficient of determination (R^2), bias factor (BF), accuracy factor (AF) and corrected AICc (Akaike Information Criterion). Parameters obtained from the fitting exercise were maximum Mo-blue production rate (u_m), lag time (l) and maximal Mo-blue production (Y_{max}) of X (h^{-1}), Y (h) and Z (nmole Mo-blue), respectively. The application of primary population growth models in modelling the Mo-blue production rate from this bacterium has become a successful undertaking. The model may also be used in other heavy metals detoxification processes. The parameters constants extracted from this work will be a substantial help for the future development of further secondary models.

Keyword: Molybdenum reduction; Metal detoxification; Molybdenum blue; Serratia marcescens; Modified Gompertz