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A mathematical model to investigate the antimicrobial activity of Ceylon high-grown green tea and black tea against human pathogenic bacteria and yeast species

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Ceylon tea has a great demand worldwide and considered as one of the finest tea in the world. Green and black tea are the widely consumed types of tea in general. Tea has many biologically active compounds, and these antimicrobial agents can inhibit the growth of human pathogenic microorganisms. This research focused to derive an appropriate mathematical model to investigate the antimicrobial activity of high-grown green tea and black tea against selected human pathogenic bacteria (*Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus subtilis*) and three yeast (*Candida*) species. The behaviour of the model solutions was analysed graphically and the antimicrobial activity of tea for a given concentration can be found using this model. First, descriptive analysis was carried out to analyse the basic characteristics of the experimental data. Then, using the Interpretative/ Breakpoint criteria provided in the Performance standards for antimicrobial disk susceptibility tests; CLSI, the antimicrobial effects were further discussed. Those results revealed that there was a difference between the two tea varieties and the antimicrobial activity was higher in green tea. Interaction between the two independent variables (tea type, concentration) on the dependent variable (diameter of the inhibition zone) was analysed using the two-way ANOVA test. The results revealed that interaction between two independent variables on the dependent variable was significant in all tested bacteria and yeast species except in *Candida tropicalis*. Then the most suitable mathematical model was developed, model parameters were calculated using experimental data, and values were predicted for the inhibition area of each species of microorganism for both tea varieties independent of each other. The model accuracy was examined using MAD (mean absolute derivation), RMSE (root mean square derivation), and MAPE (mean absolute percentage error) values and using histograms for residuals. The findings showed that the experimental data fitted and agreed with the model. The analytical output of the model was implemented using MATLAB (2018a) and it demonstrated experimentally observed antimicrobial activity. The model can be used to describe the antimicrobial activity of high-grown green tea and black tea at a given concentration against the tested bacteria and yeast species. Further, results revealed that the concentration of tea is directly proportional to the antimicrobial activity up to a certain point, respective to each microorganism, and thereafter no such correlation was observed.

Keywords: Black & Green tea, Inhibition population, Logistic Growth Model, MAPE, Two-way ANOVA