Enhance the bacterial nitrate reductase production using mathematical and statistical model to formulate the affordable silver nanoparticle for the production of nanofinished fabric

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Keywords: Nitrate reductase, silver nanoparticles, Antibacterial, nonosilver

Nitrate reductase (NR) is well-known for formulate of the silver nanoparticles (AgNPs). The specific characteristics with defined high concentration are necessary to achieve the maximum yield of AgNPs to meet the industrial requirement. Each bacterial cell has its unique characteristics to produce the variable quantity of NR enzyme. To standardized the quantitative production of the NR enzymes, the conventional OVAT strategy used in media engineering since last few decades but due to its single dimensional task and laborious method, it does not explain interaction effects among the variables on the enzyme production process. The present study was conducted to overcome these limitations. The response surface methodology (RSM) based primary screening was performed using a statistical model to screen the 4 media component out of 5 responsible for the enzymes production and growth of Ornithinibacillus californiensis using Plackett-Burman design (PBD). Total 13 experiments were conducted separately based on PBD. The positive values of the regression coefficient and Lower P values indicated the rejected null hypothesis, so linear model fit into the conducted study. The levels of the 4 significant variables, i.e., Glucose, Yeast extract, Casein hydrolysate, and KNO3 were further optimized using 30 experiments generated by Central Composite Design (CCD). The optimized media offered the 121 fold enhancement in NR production. Favorable analysis of variance, less P-values and model terms for both responses were found significant. Thus the experimental verification of the model was performed successfully. The crude enzyme produced by optimized media was applied for the formulation of the AgNPs. AgNPs were characterized by the UV-Vis spectrophotometry, DLS with zeta potential, SEM-EDX, XRD, and TEM. Stable, confined-size, circular, crystalline and functionalized AgNPs were formulated using 4mM AgNO3 at the 60C temperature after 30 minutes. Antibacterial properties of AgNPs were also tested against the 10 human pathogens. So based on the AgNPs functionality; finally, the nanosilver coated cotton fabric was developed using the colloidal AgNPs and nanocoating was verify by SEM and FTIR. The study provides the prototype to develop the affordable biosynthesis of AgNPs and development of the surgical antimicrobial cotton.