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Modeling and optimization of fermentation conditions for glycolipopeptide production using response surface methodology and artificial intelligence approaches

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Introduction:
Statement of the Problem: Pseudomonas aeruginosa strain IKW1 produced a biosurfactant when grown in waste frying sunflower oil-basal medium. The active compound reduced surface tension of fermentation broth to 24.62 dynes/cm at a critical micelle concentration of 20.80 mg/L. It was identified by high performance liquid chromatography and Fourier transforminfrared spectrometry as a glycolipopeptide.

Objectives:
It demonstrated considerable emulsification and foaming capabilities suggesting suitability for applications in pharmaceutical and detergent formulations. However, product yield was low, making large-scale production for recommended applications impracticable. Several researchers have reported yield improvement by strategic medium optimization approaches. Earlier, we adopted response surface methodology (RSM) for major nutrients optimization and recorded commendable yield increase.

Results:
Later on, we employed Placket-Burman design (PBD) and RSM to screen and optimize trace nutrients and obtained significant yield improvement. However, research reports indicate that artificial neural network (ANN) is a better optimization approach. Methodology & Theoretical Orientation: In this study, we optimized fermentation conditions like temperature, pH, agitation and duration using RSM, and compared results to those obtained with ANN linked with genetic algorithm (ANN-GA) and particle swarm optimization (ANN-PSO).

Conclusions:
Findings: Our results showed that the biosurfactant response model, predicted by a quadratic function of RSM, was significant ($P<0.0001$; adjusted $R2=0.9911$; $RMSE=0.034$), setting factor levels at temperature-32$\diamond$C, pH-7.6, agitation speed-130 rpm and fermentation time-66 h. Maximum glycolipopeptide concentration was 107.19 g/L with a yield (Yp/x) of 4.24. Comparative results from ANN-GA ($R2=0.9997$; $RMSE=0.055$) and ANN-PSO ($R2=0.9914$, $RMSE=0.047$) showed that model and optimized factor settings were not significantly ($P>0.05$) different from those obtained with RSM. Conclusion & Significance: This suggests that RSM, when meticulously executed, could be as good a modeling and optimization tool like neural network methods..

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