Optimization for succinic acid production: Fractional Factorial Design (FFD) and Artificial Neural Networks (ANN).

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Succinic acid (SA) is predicted to be one of the future platform chemicals that has a broad range of industrial applications. Even though SA is advantageously produced by chemical processes that use fossil resources, there is great potential to produce it from renewable resources by microbial fermentation. The modeling is a computational toll that has been used in various biotechnological processes which it is necessary to take into account the nonlinearities inherent of the processes that have complex dynamics. Application of Artificial Neural Networks (ANN) in modeling, simulation and optimization of processes has grown considerably in recent years. The aim of this study are to determine the variables that affect in the succinic acid production by fermentative process using the strain *Actinobacillus succinogenes* (CIP 106512) through of fractional factorial design (FFD) 2^{5-1} and to evaluate different architectures of ANN's to model this process (variations of the number of neurons in the hidden layer, learning rate and activation function). To evaluate the performance of the networks were considered the squared errors of each architecture. To develop the model were used ANN's based on Multilayer Perceptron Neural Network (MLP), the networks have three layers and algorithm of backpropagation learning. The data set used for learning and to test the networks was obtained by FFD. The input layer has five neurons and output layer for one neuron. The input variables used in the ANN models were glucose (X_1), yeast extract (X_2), temperature (X_3), initial pH (X_4) and agitaion (X_5) and the output variable was succinic acid production. It was observed that the sigmoid activation function has the best performance compared to the hyperbolic tangent function. The architecture of the ANN with the mean squared error (MSE) consists of 5 neurons in hidden layer, learning rate equal 0.01 and sigmoidal activation function, so this configuration was chosen for construction of neural model. This work allowed to optimize the process fermentative of succinic acid, determining which variables most influence on the production of succinic acid and using the neural model can predict the optimal values for these variables in the range of values studied, and facilitate scale up by use the model generated.