A modeling study by response surface methodology and artificial neural network on culture parameters optimization for thermostable lipase production from a newly isolated thermophilic Geobacillus sp. strain ARM

ABSTRACT

Background: Thermostable bacterial lipases occupy a place of prominence among biocatalysts owing to their novel, multifold applications and resistance to high temperature and other operational conditions. The capability of lipases to catalyze a variety of novel reactions in both aqueous and nonaqueous media presents a fascinating field for research, creating interest to isolate novel lipase producers and optimize lipase production. The most important stages in a biological process are modeling and optimization to improve a system and increase the efficiency of the process without increasing the cost. Results: Different production media were tested for lipase production by a newly isolated thermophilic Geobacillus sp. strain ARM (DSM 21496 = NCIMB 41583). The maximum production was obtained in the presence of peptone and yeast extract as organic nitrogen sources, olive oil as carbon source and lipase production inducer, sodium and calcium as metal ions, and gum arabic as emulsifier and lipase production inducer. The best models for optimization of culture parameters were achieved by multilayer full feedforward incremental back propagation network and modified response surface model using backward elimination, where the optimum condition was: growth temperature (52.3°C), medium volume (50 ml), inoculum size (1%), agitation rate (static condition), incubation period (24 h) and initial pH (5.8). The experimental lipase activity was 0.47 Uml-1 at optimum condition (4.7-fold increase), which compared well to the maximum predicted values by ANN (0.47 Uml-1) and RSM (0.476 Uml-1), whereas R2 and AAD were determined as 0.989 and 0.059% for ANN, and 0.95 and 0.078% for RSM respectively. Conclusion: Lipase production is the result of a synergistic combination of effective parameters interactions. These parameters are in equilibrium and the change of one parameter can be compensated by changes of other parameters to give the same results. Though both RSM and ANN models provided good quality predictions in this study, yet the ANN showed a clear superiority over RSM for both data fitting and estimation capabilities. On the other hand, ANN has the disadvantage of requiring large amounts of training data in comparison with RSM. This problem was solved by using statistical experimental design, to reduce the number of experiments.

Keyword: Response surface methodology; Artificial neural network; Culture parameters optimization; Thermostable lipase production; Geobacillus sp. strain