Chapter 8

Optimization Techniques
Applications in Biochemical Engineering and Controlled Drug Delivery:
Current Practices and Forthcoming Challenges

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ABSTRACT

Before starting semi-pilot/pilot production plants for biochemical metabolites production, it is essential to optimize the fermentation media. This chapter discusses the classical and advanced techniques of media optimization. The statistical approaches save experimental time for developing processing and improving quality. Recent years have seen the growth of integrated approaches of microbial cultures. Optimization techniques such as response surface methodology, artificial neural network, genetic algorithms, differential evolution, ant colony optimization, etc. have received attention recently because of their major applications in various fields. Controlled release formulations have so many versatile applications in the field of pharmaceutical drugs that they have become important tools to apply the modern concept of therapeutic treatment. Process optimization of such formulations, mathematical modelling can play an important role. This chapter discusses various methodologies for optimization of formulation conditions for drug delivery.

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INTRODUCTION

Application of Optimization Techniques in Controlled Drug Delivery

There have been a lot of advancements, over the past few years, in the field of drug delivery. These advances can be mainly attributed to the improvement of meticulous drug discharge dosage. Most of these advances have been done in the controlled drug discharge of oral quantity, by controlling the conditions that influence drug discharge. The drug release patterns can be fined into 2 groups; i) formulations that release drug at a slow, (0 or 1st order) rate and ii) sustained release formulations that afford a first amount of dose, followed by slow (zero or first order) release of active drug (Dash et al., 2010). Sustained release formulations allow us to maintain desired drug absorption in the plasma or in any target tissue for a lengthy period of time (Langer and Wise, 1984). The specific sustained release formulations allow controlling the rate of drug release and its duration (Li and Lee, 1987). These formulations generally release only a part of the active drug initially, to achieve the active tonic concentration of the drug in a short time. After that, the drug release kinetics follows a well-defined behaviour so as to attain and maintain the desired drug concentration. Designing and developing the controlled discharge formulations needs engineers and pharmacists to work composed to produce more effective products. The procedure of modelling may allow us to predict the release kinetics without or with minimum experimental data, which is an important step to develop formulations. Also mathematical modelling might improve the quantity of certain imperative parameters such as the drug diffusion coefficient and resorting to model fitting on experimental release data. Thus, for the process optimization of such formulations, mathematical modelling is having a significant role. The development of mathematical models needs the understanding of all the factors affecting drug release kinetics (Cartensen, 1996). The mathematical models involved in drug release kinetics can be viewed as mathematical metaphors of some aspects of reality which controls the phenomena ruling the discharge kinetics (Dressman and Fleisher, 1986). Because of these general aspects, mathematical modelling is widely employed in varied fields of science and technology ranging from genetics to medicine, psychology to economy, biology, and obviously engineering. In this article we explained about the RSM, design of experiments, ANN, RBFN, GRNN methodologies for the application of drug delivery process.

Advancements of Optimization Techniques for Biochemical Production

Advancements in biochemical production require better understanding of the bioprocesses involved in biochemical production from different raw materials, agro-industrial by-products and waste streams, as well as possibility to predict the outcomes of these processes in terms of biochemical yield and substrate utilization (Olsson, 2007). Optimization of biochemical production processes is also important from the aspect of yield increase and bioprocess cost reduction. Optimization techniques such as Design of experiments (DOE), fuzzy logic (FL), Particle swarm optimization (PSO), genetic algorithms (GA), differential evolution (DE) neural networks (NN) and Multi objective optimization (MOO), could be used as a tool for biochemical production modelling and optimization. The basic characteristics and applications of ANN in modelling and optimization of biochemical production processes have been experimentally proven (Ivana et al., 2017). Figure 1 shows about the flow chart of various optimization methods.
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