International Journal of Science and Healthcare Research
Vol.1; Issue: 3; July-Sept. 2016
Website: www.gkpublication.in/ijshr
Review Article *ISSN: 2455-7587*

Downstream Processing in Biotechnology: Research and Studies

Sunil J. Kulkarni

Datta Meghe College of Engineering, Airoli, Navi Mumbai, Maharashtra, India.

Received: 11/06/2016 | Revised: 20/07/2016 | Accepted: 20/07/2016

ABSTRACT

Biotechnology is important solution to many synthesis issues. It offers less energy intensive, economical and easy solution to synthesis of many chemicals. The choice of substrate, enzyme and reaction conditions needs careful study. Ethanol, citric acid, lactic acid, amino acids, proteins and many other compounds are produced by biochemical pathways. It is said that 80 percent of the process cost in biotechnology goes for downstream processing. The current review summarizes research and studies on downstream processing.

Key words: Synthesis, Enzymes, reactions, activity, cost, purity.

INTRODUCTION

Synthesis of a compound by low cost, economical and environment friendly method is becoming major area of research. The high purity of product and low effluent disposal is becoming important aspect of technology. Biotechnology has potential to solve this problem to considerable extent. Many chemicals and compounds like ethanol, citric acid, amino acid, lactic acid etc. are being synthesized by using biochemical pathways. [1-5] Enzyme catalyzed reactions provide highly specific, energy efficient pathway for producing many compounds. [6-9] Immobilization of enzymes is added advantage with high thermal stability of enzymes. [10-12] It is said that downstream processing consumes 80 percent of efforts in terms of time and money in biotechnology. The research in this field is many times aimed at finding solution to the problem of downstream recovery of compounds. The current review summarizes research and studies on downstream processing.

RESEARCH AND STUDIES ON DOWNSTREAM PROCESSING

Bibi carried out an investigation on process intensification in downstream processing. [13] His work was aimed at development of highly efficient techniques for downstream processing. He polymerized selected monomers in the presence of a highly soluble cross-linking agent to produce a rigid three dimensional mega porous monolithic structure. According to him, a lower binding capacity of bio-molecules is a limitation. He tried to enhance the binding capacity by particle embedding, direct chemical synthesis or grafting (radiation-induced and chemical induced. The study carried out on parameters like surface area, charge, imprinting factor, selectivity factor, maximum capacity and maximum available binding sites indicated that the imprinted adsorbent could be conveniently utilized for the recovery of CA from cochineal extract. According to him, mass transfer resistance was a major problem. In these studies, it was observed that most of the mass transfer resistance came from pore diffusion. The resistance could be overcome by increase in bulk movement. Carstensen carried out an investigation on in situ product recovery (ISPR). [14] He studied reverse-flow diafiltration. He integrated submerged hollow-fiber membranes in the fermenter in two streams. One supplies the nutrient solution (inside out filtration), the second one extracts product solution (outside-infiltration). These were exchanged alternatively over the same membrane in a reverse-flow operation mode. He used media such as model yeast suspension, fungi fermentation broth and antibody fermentation broth. He found this process to be promising alternative for product recovery in fermentation.

Morenweiser presented a paper on downstream processing of viral vectors and viral vaccines. [15] Kunasundari and Sudesh carried out investigation on isolation and recovery of microbial polyhydroxyalkanoates. [16] They proposed biodegradable polyhydroxyalkanoate (PHA) as alternative to conventional plastic in some applications. The upstream fermentation process was a challenge. The downstream processing also is as important. The various recovery technologies are proposed for the downstream processing. These include solvent extraction, chemical digestion, enzymatic treatment and mechanical disruption, supercritical fluid disruption, flotation techniques, use of gamma irradiation and aqueous two-phase system. They reviewed all these recovery technologies. According to them it is important to keep check on cost and use of strong chemicals in downstream processing.

Kumar and Murthy studied cellulosic ethanol production. [17] They carried out studies on impact of pretreatment and downstream processing technologies on economics and energy. They performed a comprehensive techno-economic analysis for conversion of cellulosic feedstock to ethanol using some of the common pretreatment technologies. The pretreatment technologies they considered were dilute acid, dilute alkali, hot water and steam explosion. They used SuperPro Designer for developing detailed process models. They obtained ethanol yield 230 to 255 L/dry metric ton biomass for conversion. According to them there is potential to reduce the cost by increasing pentose fermentation efficiency and reducing biomass and enzyme costs. Rameshwari and Meenakshisundaram carried out studies on downstream processing of bacterial thermoplastic-polyhydroxyalkanoate. [18] The bioplactics, according to them, can be isolated by using centrifugation (cell-free extracts) or by solvent extraction (dried intact bacteria) with chloroform, trifluoroethanol, dichloroethane, propylene carbonate, methylene chloride or dichloroacetic acid.

Luthra et.al. carried out optimization of downstream process parameters using statistical approach for isolation of mycophenolic acid. [19] They optimized solvents for extraction using the one variable at a time method. They found that pH and the temperature play most vital role in the process. Kallberg et.al. carried out investigation on downstream processing of protein [20] They used multimodal chromatography. Stricter regulator demands for purity in protein call for highly effective downstream processing. They carried out review on downstream processing of protein by multimodal chromatography. In this technique, two or more physicochemical properties are used to enhance the specificity of the interactions.

CONCLUSION

Various methods for downstream processing include centrifugation, filtration, extraction, membrane separation. Requirement of high purity products with low production cost calls for efficient and cost effective downstream processing. There is potential to reduce the cost by increasing fermentation efficiency and reducing biomass and enzyme costs in case of fermentation. Similar modifications in other processes can bring about cost effective solution to downstream processing.

REFERENCES

1. Sunil J. Kulkarni, "Use of Biotechnology for Synthesis of Various Products from Different Feedstocks -A Review", International Journal of Advanced Research in Bio-Technology, 2014, 2(2), 01-03.
2. Patanjali Varanasi, Priyanka Singh, Manfred Auer, Paul D Adams, Blake A Simmons, Seema Singh, "Survey Of Renewable Chemicals Produced From Lignocellulosic

Biomass During Ionic Liquid Pretreatment", Biotechnology For Biofuels, 2013, 6(14), 2013,1-9

3. Tracy M. Carole, Joan Pellegrino,And Mark D. Paster, "Opportunities In The Industrial Biobased Products Industry", Applied Biochemistry And Biotechnology, 2004, 113-116, 871-888.
4. Veena Ramachandran, Nisha Pujari, Tanmay Matey, Sunil Kulkarni,"Enzymatic Hydrolysis for Glucose-A Review", International Journal of Science, Engineering and Technology Research, 2013, 2(10), 1937-1942.
5. Veena Ramachandran, Nisha Pujari, Tanmay Matey, Sunil Kulkarni,"Enzymatic Hydrolysis of Cassava using wheat seedlings",International Journal of Science, Engineering and Technology Research, 2014, 3(5), 1216-1219.
6. Sunil Jayant Kulkarni, "Research on Biocatalysts: A Review", International Journal of Research, 2014, 2(5), 784-788.
7. Sunil Jayant Kulkarni, "Research and Studies on Vinegar Production-A Review", Int. Journal on Scientific Research In Science And Tech., 2015, 1(5), 146-148.
8. Sunil Jayant Kulkarni, "Production of Citric Acid: A Review on Research and Studies", International Journal of Advanced Research Foundation, 2015, 2(11),17-20
9. Sunil J. Kulkarni, Nilesh L. Shinde, Ajaygiri K. Goswami, "A Review on Ethanol Production from Agricultural Waste Raw Material", Internation Journal on Scientific Reseach in Sciencce, Engineering and Technology, 2015, 1(4), 231-233.
10. Ajay Kumar Singh, Sanat Rath, Yashab Kumar, Harison Masih, Jyotsna K. Peter, Jane C. Benjamin, Pradeep Kumar Singh, Dipuraj, Pankaj Singh, "Bio-Ethanol Production From Banana Peel By Simultaneous Saccharification And Fermentation Process Using Cocultures Aspergillums Niger And Saccharomyces Cerevisiae", Int. J. Curr. Microbiol. App. Sci, 2014, 3(5), 84-96.
11. Tran Quoc Viet, Nguyen Phuoc Minh, Dong Thi Anh Dao, "Immobilization of Cellulase Enzyme in Calcium Alginate Gel and Its Immobilized Stability", American Journal of Research Communication, 2013, 1(12), 254-267.
12. Sheila Romo-Sanchez, Conrado Camacho, Héctor L. Ramirez, María Arévalo-Villena, "Immobilization Of Commercial Cellulase And Xylanase By Different Methods Using Two Polymeric Supports", Advances In Bioscience And Biotechnology, 2014, 5, 517-526.
13. Noor Shad Bibi, "Downstream process intensification by innovative material development", School of Engineering and Science, Jacobs University, 2012, 1-250.
14. Frederike Carstensen,"In situ Product Recovery from Fermentation Processes Using Reverse-Flow Diafltration", Thesis, 2013, 1,1-195,
15. R. Morenweiser, "Downstream Processing of viral vectors and vaccines", Gene Therapy, 2005, 12, 5103-5110.
16. B. Kunasundari, K.Sudesh, "Isolation and recovery of microbial polyhydroxyalkanoates", Polymer Letters, 2011, 5(7), 620-634.
17. Deepak Kumar and Ganti S Murthy, "Impact of Pretreatment and Downstream Processing Technologies on Economics and Energy in Cellulosic Ethanol Production", Biotechnology for Biofuels, 2011, 1,4-27.
18. Rameshwari, and Meenakshisundaram, M, "A Review on Downstream Processing of Bacterial Thermoplastic-Polyhydroxyalkanoate", Int. J. Pure App. Biosci., 2014, 2 (2), 68-80.
19. Umesh Luthra, Yogesh Patel, Aditi Trivedi, Dharmendra Singh," Isolation of Mycophenolic Acid by Optimization of Downstream Process Parameters using Statistical Approach", International Research Journal of Engineering and Technology, 2016, 3(3), 923-927.
20. Kristian Kallberg, Hans-Ol of Johansson and Leif Bulow, "Multimodal chromatography: an Efficient Tool in Downstream Processing of Proteins", Biotechnol. J. 2012, 7, 1-11.

How to cite this article: Kulkarni SJ. Downstream processing in biotechnology: research and studies. International Journal of Science & Healthcare Research. 2016; 1(3): 8-10.

******