Abstract

The excessive and inappropriate use of antibiotics as growth promoters (subtherapeutic doses) in animal production has contributed significantly to the global spread of multidrug-resistant bacteria. This rise. in drug-resistant microorganisms, which cause bacterial diseases in humans, prompted the European Union to implement a complete ban on antibiotic growth promoters (AGPs) in animal feed in 2006, as stipulated by Regulation (EC) No. 1831/2003. In response, probiotics have emerged as a promising alternative to antibiotics, offering a way to produce safe, pathogen-free food. An exciting advancement in this field is the potential to combine probiotics with prebiotics to create synbiotic formulations, which enhance the benefits of both components. New probiotic and synbiotic formulations are driving growth in the feed additives and food sectors. However, to remain competitive in the market, the production of these preparations must meet several critical criteria: (i) the use of an affordable, sustainable growth medium, (ii) a streamlined production process with fewer operational steps, and (iii) a cost-effective preservation method. Crucially, these innovations must not compromise product quality, particularly in terms of maintaining viable cell counts and ensuring product safety. This study explores the use of a highly concentrated corn flour (CF)-based medium for cultivating the probiotic strain *Lactobacillus plantarum* LOCK 0860 (now reclassified as *Lactiplantibacillus plantarum* LOCK 0860) and its use as a matrix during the final spray-drying stage of production. The research demonstrated that *L. plantarum* LOCK 0860 can efficiently utilize a wide range of mono- and oligosaccharides, as well as non-carbohydrate substrates, as carbon sources in growth media. Additionally, the strain's high heat resistance was identified as a valuable trait for thermal preservation technologies used in probiotic and synbiotic production. At every stage of the research, the proposed CF-based technology was compared to the standard method of using a liquid medium (MRS) for growing probiotic bacteria. Laboratory-scale optimization studies identified protective mixtures that maximized bacterial survival during the spray-drying process. An optimized mixture containing 2.57% monosodium glutamate and 2.43% trehalose increased bacterial survival in the CF-based process by over four times compared to the standard approach. The data collected were used to simulate industrial-scale models of the process. In these models, the probiotic preparation was further enhanced with inulin, which served as a prebiotic and a standardizing agent for live bacterial cell counts. A techno-economic analysis revealed a strong net present value (NPV), indicating high profitability for the CF-based process at a sales price of USD 5.00 per kilogram of the product. In contrast, the liquid medium (MRS) model was deemed unviable. Sensitivity analysis identified two critical factors influencing production costs and output: the price of inulin and fermentation time in the production bioreactor. These variables were found to have the most significant impact on unit production costs and the number of batches produced annually in the CF-based process model.

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