The Impact of Scale-Up and Agitation Speed in Stirred Bioreactors on the Growth Dynamics of Five *Lactobacillaceae* strains with Probiotic Potential

Obakeng Jona
Lecturer and PhD candidate, Centre for Bioprocess Engineering Research (CeBER), Department of Chemical Engineering, University of Cape Town, Cape Town, South Africa

Anna-Ursula Happel
Institute of Infectious Disease and Molecular Medicine (IDM), University of Cape Town, Cape Town, South Africa

Division of Immunology, Department of Pathology, University of Cape Town, Cape Town, South Africa

Brian Kullin
Institute of Infectious Disease and Molecular Medicine (IDM), University of Cape Town, Cape Town, South Africa

Division of Medical Virology, Department of Pathology, University of Cape Town, Cape Town, South Africa

Jo-Ann S. Passmore
Institute of Infectious Disease and Molecular Medicine (IDM), University of Cape Town, Cape Town, South Africa

Division of Medical Virology, Department of Pathology, University of Cape Town, Cape Town, South Africa

National Health Laboratory Service, Cape Town, South Africa

Susan T.L. Harrison
Centre for Bioprocess Engineering Research (CeBER), Department of Chemical Engineering, University of Cape Town, Cape Town, South Africa

Marijke A. Fagan-Endres
Centre for Bioprocess Engineering Research (CeBER), Department of Chemical Engineering, University of Cape Town, Cape Town, South Africa

Institute of Infectious Disease and Molecular Medicine (IDM), University of Cape Town, Cape Town, South Africa

Abstract:

This study explores how scale-up and agitation affect the growth of five vaginal Lactobacillaceae strains with probiotic potential for bacterial vaginosis treatment. Cultures were grown in serum bottles and stirred bioreactors (300–5000 mL), with agitation speeds ranging from 35 to 280 rpm. The 300 mL bioreactor used dual Rushton turbines and a marine impeller to assess hydrodynamic parameters like tip speed, Reynolds number, and power input. Significant agitation-dependent effects on optical density, specific growth rate, and pH were observed ($p < 0.05$). Strains showed enhanced growth rates up to 140 rpm – linked to better micro-mixing – while higher speeds led to shear-related growth inhibition. Scale-up revealed strain-specific growth shifts, with most strains benefiting from increased reactor volume through improved mixing and power input, even with consistent geometry ratios (D/T, H/T). The data suggest that while moderate agitation supports uniform and best growth, excessive mixing may inhibit growth performance. Ultimately, the study emphasises the importance of bioreactor design and agitation tuning for successful scale-up and efficient cultivation of probiotic Lactobacillaceae in industrial applications.

Keywords:

Lactobacillaceae, Probiotics, Bioreactors, Scale-Up, Agitation, Mixing.