ABSTRACT

Lactic acid production and its polymerization to polylactide (PLA) using renewable resources have recently gained advancement in the field of biomedical science. It hailed as a promising technology to combat the alarmingly rising environmental, economical and technological issues of concern. PLA due to its good processability and biocompatibility always have fascinated researchers in the clinical sector, yet its high degree of hydrophobicity and absence of reactive groups cause steric hindrance and impeded biofunctionalization of PLA surface for cell attachment.

The present work is a comprehensive study of microbial fermentation of carbohydrate rich renewable resources carried out at a laboratory scale. Lactic acid fermentation with *Lactobacillus amylophilus* GV6 was studied under various conditions using statistical approach. The highest lactic acid concentrations were 46.71, 154.63, and 665.22 g/L, for cheese whey, potato waste and fruits of *Zizyphus oenophlia* respectively were achieved using statistical optimization. When extended to large scales, *Zizyphus oenophlia* being the most amenable substrate demonstrated appropriate predictability and holds promises for greater applicability in the process for the current purpose.

Moreover, a novel and simple platform technology was employed for separation of lactic acid lucratively from *Zizyphus oenophlia*, based on ion exchange chromatography. The selected ion exchangers were Amberlite IRA 96 and Amberlite IR 120; wherein Amberlite IRA 96 retained the lactic acid from the broth while washing away other anions. Maximum binding capacity of the resin was found to be 210.46 mg lactic acid/g bead. After the simple two step purification process, the purity of lactic acid improves up to 99.17% having yield of 98.9%. Upon characterization, formation of only levo ratatory form of lactic acid confirms its easy metabolism by the human system.

Finally, polymer was synthesized from purified LA obtained from *Zizyphus oenophlia* and humic acid simply by employing direct polycondensation reaction. Optimization of different condition for polymer synthesis was performed and series of characterizations were explored using different techniques to prove its superior characteristics as compared to pure PLA.

Lastly, designing, development and characterization of a novel PLA-HA scaffold produced from *Zizyphus oenophlia* has been endeavored with a modified heat molding coupled with porogen-leaching method. Subsequently, the prepared scaffolds were subjected to characterization which illustrated incorporation of hydrophilic moieties, improved degree of hydrophilicity, characteristic surface properties and reduced roughness index as compared to the pristine PLA. The porous scaffold achieved high level of interconnectivity due to improved porosity above 90%. Additionally, biocompatibility test was performed using HaCaT cell line which illustrated more than two fold increment in cell concentration signifying the cell attachment and its well growth on the surface of the scaffold. Thus, the study instigated the use of novel biopolymer as an excellent matrix for biocompatible tissue engineering application.

Keywords: *Zizyphus oenophlia; Lactobacillus amylophilus* GV6*;* Humic acid; Lactic acid fermentation; Scaffold fabrication