Calcium phosphate and bioglass reinforced PLA thin film biocomposites for slow drug delivery applications

ABSTRACT:

The rise in the number of musculoskeletal disorders (MSDs) due to the increase in aging population and advancement in medical technology has led to an increasing demand for medication to prevent and treat these diseases. The development of new drugs or formulations to allow treatment of these diseases in their very early stages is only increasing. Local direct and multidelivery of medication and key minerals to support bone repair and regeneration at the defect site, from flexible degradable devices at the rate within the therapeutic window, seems to be an effective strategy. However current drug delivery vehicles are neither flexible and degradable, nor able to deliver both medication and minerals effectively. Using a simple "solution casting" method, preparation of medical devices with such potential for slow drug delivery for biomedical applications served as the research objective. Polylactic acid (PLA) and hydroxyapatite-hydrothermally converted coral were used to develop PLA thin film composites as drug delivery systems. PLA provided flexibility and biodegradability of the systems, while coralline hydroxyapatite provided a unique architecture with its porous and bioactive nature, which is suitable for drug loading and slow drug release. Two drugs, gentamicin (antibiotic) and bisphosphonate were loaded into the device and their release profiles and activities were studied for the treatment of medical-implant related infection and osteoposis respectively. The biocompatibility study on human adipose derived stem cells (hADSC) and biofilm formation behaviour of both gram-negative (Pseudomonas aeruginosa) and gram-positive bacterial (Staphylococcus aureus) were studied on PLA thin film composites loaded with gentamicin. The mechanical properties of PLA-surface treated bioglass for tissue engineering applications was also studied. An alternative conversion method of coralline materials and other natural materials such as sea mussel and ostrich eggshells to calcium phosphate materials were also evaluated. Although nanosurface bioglass treated with 1% (3-Aminopropyl) triethoxysilane (APTES) suggested effective improvement in elongation at the break of PLA/bioglass composites, they lacked the required drug release efficiency. However, the PLA thin film composites