UNIVERSITI TEKNOLOGI MARA

THE INFLUENCE OF TZ (ZEIN + PEG+ GLY) IN BIOCOMPOSITE POLY(ε-CAPROLACTONE)/HYDROXYAPATITE/THERMOPLASTIC ZEIN VIA SOLID STATE SUPERCRITICAL CO_2 FOAMING

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ABSTRACT

This research is to study the characterization of the blended poly (ε-caprolactone) (PCL), hydroxyapatite (HA) and thermoplastic zein, (thermoplastic zein developed by mixing zein with glycerol (GLY) and poly (ethylene glycol) (PEG)) to form biodegradable porous structure and achieved via the solid state supercritical carbon dioxide ($scCO_2$) foaming technology. Characterization of the zein which is hydrophobic has been improved by mixing GLY and PEG to increase strength of zein contrast with the mixing of GLY and zein only which lead to a brittle structure. The plasticizers should have polar functional groups for effective zein plasticization, and a proper balance between polar and non-polar functional groups which is also important for plasticization efficiency. In this research area, this work reported on novel thermoplastic zein by mixing zein with (GLY and PEG) which might be a better way to synergistically improve the properties of natural polymer for foaming application. In this work, reported the process of foaming via $scCO_2$ that take place for 6h at 50˚C and pressure about 20MPa with high depressurization rate. Foams were characterized by scanning electron microscopy. Result indicated that after saturation of the polymer material with CO_2, high depressurization causes the thermodynamic instability and the formation of nucleated gas give rise to pores within the scaffold. The blended composition of $PCL_{60}/TZ_{20}/HAp_{20}$ show result of well interconnected porous structure generation compared to other bio composite material prepared. Thus, the application of TZ in biocomposite PCL/HAp/TZ give better results in generation of porous structure when foaming via supercritical carbon dioxide.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Bone tissue engineering has highlighted on the improvement of 3D scaffolds with vital and applicable porosity which it can deliver as a pillar, support and in another point of view it can coordinate the tissue reformation or restoration in native way. In forming an ideal bone scaffold, several biodegradable materials which is ceramics have been researched for bone repair and regeneration. Hydroxyapatite (HAp) is a bioactive ceramic where it is a major class of biomaterial for bone repair (Masami Okamoto, 2013).HAp consist of criteria such as biocompatible, osteoconductive and non- toxic where these prove that it has identical biological behaviour, chemical configuration and structure to native bone (Amin Shavandi, 2015). Limitation of HAp during it application are inherits brittleness, low mechanical stability which refuse it to use in large bone tissue regeneration and difficulty of shaping (Masami Okamoto, 2013). Therefore, weakness of HAp is overcome by adding synthetic polymers as inorganic filler to structure composite materials (Amin Shavandi, 2015). In order to satisfy the numerous requirements for scaffold materials using only a single material is not possible therefore, combination of synthetic polymer with HAp has been reported to be suitable way to yield porous designation that applicable for bone tissue engineering (Chuenjitkuntaworn et al., 2010). However the blending of HAp and synthetic polymer such as PCL cause a limitation, claim from literature that the presence of HAp increased the density but had no significant effect on the porosity scaffolds (Chuenjitkuntaworn et al., 2010). Therefore, approaches on the bio composite materials been studied to produce suitable materials to achieve better porosity for scaffold designation.

Polymer that available can be divided into synthetic and natural derived material. Among polymeric materials which have been used for fabrication in bone tissue engineering scaffolds, PCL has been widely selected because of its biocompatibility, suitable mechanical properties, easy processing ability and non-toxic degradation products (Zeinab Fereshteh, 2016). Studied from Neves et al. (2011) has point the obstacle of PCL as a scaffolding materials which include the nonappearance of cell recognition sites, its hydrophobicity and its approximately slower degradation.