Pengaruh penambahan graphite, graphene oxide, dan carbon nanotube terhadap karakteristik fisikokimia perancah chitosan/hyaluronic acid/hydroxyapatite untuk aplikasi rekayasa jaringan = Effect of graphite, graphene oxide, and carbon nanotubes on the physicochemical characteristics of chitosan/hyaluronic acid/hydroxyapatite scaffolds for tissue engineering applications

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Abstrak

Osteoartritis merupakan penyakit kronis yang ditandai dengan kemunduran tulang rawan dan menyebabkan kekakuan, nyeri, dan gangguan pergerakan. Strategi rekayasa jaringan tulang menggunakan perancah dapat menjadi alternatif yang menjanjikan untuk regenerasi jaringan tulang yang rusak. Penelitian ini bertujuan untuk fabrikasi dan karakterisasi perancah dengan material chitosan (CS), hyaluronic acid (HA), hydroxyapatite (Hap) dengan kombinasi penambahan graphite (Gr), graphene oxide (GO), dan multiwalled carbon nanotube (MWNCT) untuk aplikasi rekayasa jaringan tulang. Dalam penelitian ini, dilakukan sintesis GO dan fungsionalisasi kimia dari material Gr dan MWNCT. Fabrikasi perancah dilakukan dengan metode freeze drying. Seluruh kelompok perancah dilakukan karakterisasi SEM dan FTIR, uji tekan dan porositas, uji swelling, wettability, dan laju degradasi. Fabrikasi perancah dibagi menjadi empat kelompok yaitu CS/HA/HAp, CS/HA/HAp/GO, CS/HA/HAp/f-Gr, dan CS/HA/HAp/f-MWNCT dengan ukuran diameter 1 cm, tinggi 1,5 cm, dan luas permukaan luas permukaan 4,71-6,28 cm2. Keseluruhan perancah memiliki ukuran pori yang bervariasi dan terdistribusi pada permukaan. Berdasarkan hasil FTIR, perancah mengandung gugus fungsi O-H, C=O, C-O-C, amida I, amida II, dan fosfat (PO43-). Pada uji kekuatan tekan, keseluruhan perancah memiliki CS/HA/HAp memiliki kekuatan tekan dan young modulus yang serupa dengan cancellous bone sebesar 5,76-6,14 MPa dan 3,95-471 MPa. Perancah memiliki laju porositas dengan rentang 13,8- 86,6%. Perancah memiliki kemampuan wettabiliy yang baik dengan rentang persentase 726-1069%. Rasio swelling perancah berada pada rentang 25,2-39,3%. Laju degradasi perancah cukup terkontrol dengan rentang 16,7-35,5%. Berdasarkan seluruh hasil karakterisitik, perancah CS/HA/HAp dengan penambahan GO merupakan kandidat terkuat sebagai perancah ideal pada penelitian ini. Perancah GO mempunyai karakteristik yang berada diantara perancah kontrol dan perancah f-MWNCT/f-Gr.

.....Osteoarthritis is a chronic disease characterized by the deterioration of cartilage and causes stiffness, pain, and impaired movement. The bone tissue engineering strategy using scaffolds can be a promising alternative for the regeneration of damaged bone tissue. This study aims to fabricate and characterize scaffolds with chitosan (CS), hyaluronic acid (HA), hydroxyapatite (Hap) with a combination of addition of graphite (Gr), graphene oxide (GO), and multiwalled carbon nanotubes (MWNCT) for tissue engineering applications. In this study, GO synthesis and chemical functionalization of Gr and MWNCT materials were carried out. Scaffolding was done by freeze drying method. All groups of scaffolds were characterized by SEM and FTIR, compressive and porosity tests, swelling, wettability, and rate of degradation tests. Scaffolding was divided into four groups, namely CS/HA/HAp, CS/HA/HAp/GO, CS/HA/HAp/f-Gr, and CS/HA/HAp/f-MWNCT with a diameter of 1 cm, height 1, 5 cm, and a surface area of ââ4.71-6.28 cm2.

The entire scaffold has varying pore sizes and is distributed over the surface. Based on the results of FTIR, the scaffold contains functional groups O-H, C=O, C-O-C, amide I, amide II, and phosphate (PO43-). In the compressive strength test, all scaffolds having CS/HA/HAp had similar compressive strength and young modulus with cancellous bone of 5.76-6.14 MPa and 3.95-471 MPa. Scaffolds have porosity rates in the range of 13.8-86.6%. Scaffolds have good wetability with a percentage range of 726-1069%. The swelling ratio of the scaffolds was in the range of 25.2-39.3%. The rate of degradation of the scaffold was quite controlled with a range of 16.7-35.5%. Based on all the characteristic results, the CS/HA/HAp scaffold with the addition of GO was the strongest candidate as the ideal scaffold in this study. The GO scaffold has characteristics that are between the control scaffold and the f-MWNCT/f-Gr scaffold.