In vitro Study of Bioceramics From Bamboo (Bambusa blumeana) Leaf Ash and Green Mussel (Perna viridis) Shells With Silver (Ag) Coating and 3D-Printing Applications for Bone Regeneration

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In 2019, 455 million global occurrences of acute or chronic bone fracture symptoms and 178 million fractures were recorded. In the Philippines, hip fractures are projected to escalate to 175,000 by 2050. Bioglasses (BGs) are bioceramics utilized for synthetic bone substitutes. Bamboo (Bambusa blumeana) leaves and green mussel (Perna viridis) shells were utilized as sources of SiO_2 and CaO respectively. Sol-gel creates ceramics at low temperatures, which was used to develop a bioglass with a composition of 50% SiO_2- 25% CaO- 25% Na_2O. Experimental bioglasses were fired at 700 °C (EBG-700) and sintered at 900 °C (EBG-900) with a polydopamine-silver coating compared for 2-hour (EBG-700Ag2 and EBG-900Ag2) and 24-hour (EBG-700Ag24 and EBG-900Ag24) soaking periods. Ag-doped 58S bioglass samples were utilized as the control group. X-ray fluorescence spectroscopy revealed 98% purity of CaO from green mussel shells and SiO_2 from bamboo leaf ash. X-ray diffraction analysis revealed the presence of sodium calcium metasilicate in uncoated samples, with silver (Ag) confirmed in coated samples. Scanning electron microscopy (SEM) revealed the amorphous nature of EBG-700 and the crystalline structure of EBG-900 (both coated and uncoated), while Fourier transform spectroscopy (FTIR) revealed present functional groups. The growth of hydroxyapatite on bioglass surfaces after 7, 14, and 21-day immersions in a phosphate buffer solution was confirmed through SEM and Energy-dispersive X-ray spectroscopy (EDS). MTT assay results exceeded standard cell viability of >80%, with EBG-700Ag24 having cell viability of >500%. Therefore, the developed Ag-coated SiO_2-CaO-Na_2O bioglass is a highly cytocompatible, bioactive, and economical bone regenerative material.