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The Effect of Substitution of CaO/MgO and CaO/SrO on in vitro Bioactivity of Sol-Gel Derived Bioactive Glass

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Abstract : This study had two main aims: firstly, to determine how the individual substitution of CaO/MgO and CaO/SrO can affect the in vitro bioactivity of sol-gel derived substituted 58S bioactive glass (BG) and secondly to introduce a composition in the 60SiO₂–(36-x)CaO–4P₂O₅–(x)MgO and 60SiO₂–(36-x)CaO–4P₂O₅–(x)SrO quaternary systems (where x= 0, 5, 10 mol.%) with enhanced biocompatibility, alkaline phosphatase (ALP) activity, and more efficient antibacterial activity against MRSA bacteria. Results showed that both magnesium-substituted bioactive glasses (M-BGs) and strontium- substituted bioactive glasses (S-BGs) retarded the Hydroxyapatite (HA) formation. Meanwhile, magnesium had more pronounced effect. The 3-(4, 5dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) and ALP assays revealed that the presence of moderate amount (5 mol%) of Mg and Sr had a stimulating effect on increasing of both proliferation and differentiation of MC3T3-E1 cells. Live dead and Dapi/actin staining revealed both substitution of CaO/MgO and CaO/SrO resulted in more biocompatibility and stimulation potential of the MC3T3 cells compared with control. Taken together, among all of the synthesized magnesium substituted (MBGs) and strontium substituted (SBGs), the sample 58- BG with 5 mol% CaO/MgO substitution (BG-5M) was considered as a multifunctional biomaterial in bone tissue regeneration field with enhanced biocompatibility, ALP activity as well as the highest antibacterial efficiency against methicillin-resistant Staphylococcus aureus (MRSA) bacteria.

Keywords : apatite, alkaline earth, bioactivity, biomedical applications, Sol-gel
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