A pioneering study on biodegradable Zn-Mn-Ca alloys for intestinal application

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Abstract There have been many studies on the perspective Zn alloys for bone implants, but few for intestinal applications. Novel Zn-0.4Mn-*x*Ca (*x* = 0, 0.05 and 0.1 wt.%) alloys are developed in this work for intestinal applications, in order to make use of proliferation effects of Mn and Ca elements on intestinal probiotics. Rat small intestinal crypt epithelial (IEC-6) cells can grow healthily on surfaces of all the alloys. Among them, the number of healthy cells on Zn-0.4Mn-0.1Ca is the largest. IEC-6 cell viabilities are over 160% (much higher than the benchmark of 75%) in 20%~100% extracts of Zn-0.4Mn-0.1Ca for 5 days. All the alloys can promote proliferation of intestinal probiotic (*Lactobacillus acidophilus*) and inhibit growth of intestinal pathogen (*Escherichia coli*). Among them, Zn-0.4Mn-0.1Ca alloy possesses greatest effect. With the increase of Ca content, the strength of the alloy increases. Zn-0.4Mn-0.1Ca alloy has the highest strength and a good plasticity among three alloys. It exhibits yield strength of 177 MPa, the ultimate tensile strength of 288 MPa, and elongation to failure of 41%. Since $CaZn_{13}$-Zn micro-cell controls corrosion rate, Zn-0.4Mn-0.1Ca with the highest volume fraction of $CaZn_{13}$ has the highest corrosion rate of 17.64 μm/year when immersed in simulated intestinal fluid for 28 days. Overall, the Zn-Mn-Ca alloys are promising candidates for intestinal implants.

Keywords Biodegradable Zn alloys; Intestinal applications; Cytocompatibility; Antibacterial ability; Corrosion behavior.