Herein, we report the synthesis and evaluation of a novel family of biodegradable and elastomeric polyesters, poly(diol citrates). Poly(diol citrates) were synthesized by reacting citric acid with various diols to form a covalent crosslinked network via a polycondensation reaction without using exogenous catalysts. The tensile strength of poly(diol citrates) were as high as 11.15±2.62 MPa and Young's modulus ranged from 1.60±0.05 to 13.98±3.05 MPa under the synthesis conditions that were investigated. Elongation was as high as 502±16 %. No permanent deformation was found during mechanical tests. The equilibrium water-in-air contact angles of measured poly(diol citrates) films ranged from 15° to 53°. The mechanical properties, degradation and surface characteristics of poly(diol citrates) could be controlled by choosing different diols as well as by controlling the cross-link density of the polyester network. Various types of poly(diol citrate) scaffolds were fabricated to demonstrate their processing potential. These scaffolds were soft and could recover from deformation. In vitro and in vivo evaluation using cell culture and subcutaneous implantation, respectively, confirmed cell and tissue compatibility. The introduction of poly(diol citrates) will expand the repertoire of currently available biodegradable polymeric elastomers and should help meet the requirements of tissue engineering applications.