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Role of some selected organic acids on kidney stone formation and dissolution

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Kidney stone disease has attracted considerable interest among scientists as one of the most important non-communicable diseases. Approximately 20% of the population has affected by kidney stones. Kidney stones are collection of microcrystalline biomineralized materials, mainly containing calcium oxalate monohydrate (COM) or dihydrate (COD), either alone or combined. Even though the kidney stone disease is a global health issue, a few therapeutic protocols are effective to treat kidney stones. The current study investigated the effect of some selected organic acids on calcium oxalate kidney stone formation and dissolution in synthetic urine and in supper saturated solutions. The organic acids used were malic acid, parahydroxybenzoic acid, syringic acid, caffeic acid and citric acid. Aqueous solutions of $CaCl_2$ and CaC_2O_4 were combined together at pH 7.3 to prepare the calcium oxalate supper saturated solutions. To simulate the natural urine conditions for the experiments, typical standard reference artificial urine solutions were prepared. Varying amounts of individual organic acids and their mixtures (1-10 mg range) were separately added to the supper saturated and synthetic urine solutions. The crystal deposition kinetics were monitored by conductivity measurements. The formed crystals were characterized by FTIR, XRD, SEM and redox titrations to determine the structure and the morphology of calcium oxalate crystals formed. In all experiments, the formed crystals were mainly consisted of thermodynamically more stable COM. The inhibition activity of organic acid varies in the order of malic acid (3.2%) < caffeic acid (4%) < syringic acid (6.2%) < acid mixture (10%) < parahydroxybenzoic acid (10.6%) and citric acid (18.82%) in synthetic urine solutions. Parahydroxybenzoic acid showed the second highest inhibition effect compared to the known citric acid due to the formation of stable calcium salt. However, the percentage inhibition observed for acid mixtures closely represent the sum of percentage inhibition showed by individual acids (~10.0% vs 11.4%). That means acid mixtures do not exhibit synergistic behavior either in synthetic urine or in supersaturated solutions.

Keywords: calcium oxalate, organic acids, kidney stones inhibition and dissolution effect

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