Effects of additives on the crystallisation of solids contributing to crystal arthritis

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Crystal arthritis (CA) is a form of pathological biomineralisation where crystals form in the joints resulting in inflammation, pain and swelling. There are two major CA conditions; which are gout - associated with monosodium urate monohydrate (MSU) crystals and pseudogout or calcium pyrophosphate (CPP) deposition - associated with CPP dihydrate. These conditions are very common, especially among to >60 age group. (1) CPP deposition is associated with 2 main polymorphs (monoclinic and triclinic CPP dihydrate). However when the formations are analysed in the laboratory there is another stable polymorph, CPP tetrahydrate, which is not observed in biology. (2, 3) These crystals have limited treatments, mainly focusing on the treatment of symptoms using anti-inflammatory medication. (4)

This research looks at investigating the ways that additives can impact the formation of the crystals as growth modifiers. (5) The crystals are analysed using scanning electron microscope to analyze the appearance and aggregate formations. Fourier transformation infrared (FTIR) and x-ray diffraction (XRD), with Rietveld analysis, to analyze the signal changes on the solids formed over the period of the test. This research investigates the impact of amino acids, stereochemistry, macromolecules and carboxylic acids on the formation of these crystals.

The results show that distinct impacts are observed with amino acids present during the crystallisation of MSU with aspartic acid and lysine presenting signals in the FTIR spectra. These impacts are also seen in the XRD with distinct changes to the cell parameters and the crystallite sizes. CPP shows distinct changes in the polymorph stability when amino acids are present as well as some interesting differences with different stereochemistry when proline calixarenes are present. Finally, distinct changes were observed with the presence of charged amino acids whereby the crystallite size of the sample increased and there was a notable unit cell deformation. This work shows that amino acids are important crystal growth modifiers for minerals often formed in CA.

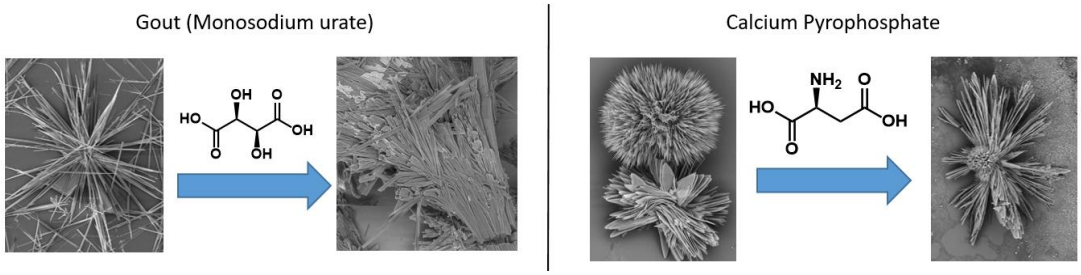

Figure 1: Example of morphological effects additives can have on the formation of CPP and MSU formation

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