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INFLUENCE OF GALLIC ACID ON CALCIUM OXALATE PRECIPITATION

Dominik Goman¹, Bernarda Vidas^{1*,} Sara Goman¹, Silvija Šafranko², Martina Medvidović – Kosanović¹, Stela Jokić², Anamarija Stanković¹

¹J. J. Strossmayer University of Osijek, Department of Chemistry, Ulica cara Hadrijana 8/A, 31000 Osijek, Croatia ²J. J. Strossmayer University of Osijek, Faculty of Food Tecnology Osijek, Franje Kuhača 18, 31000 Osijek, Croatia

INTRODUCTION

According to the latest epidemiological studies, the prevalence of urolithiasis has been increasing for the past few decades, especially in industrialized countries, possibly due to improved standard of living and modern dietary habits. Urolithiasis is the formation of crystals in the urinary tract and is a specific form of pathological biomineralization. It is a result of physicochemical mechanisms and involves the processes of nucleation, crystal growth and aggregation. Many factors may contribute to crystallization and urinary stone formation including pH, ionic strength and the presence or absence of substances that can promote or inhibit the process.

Gallic acid (GA) or 3,4,5-trihydroxybenzoic acid is a phenolic acid widely distributed in the plant kingdom. It consists of three hydroxyl groups and a carboxylic acid group attached to a benzene ring. The bonding of the hydroxyl groups in an ortho position results in a coplanar and bent configuration, which is favorable for antioxidative activities. GA is commonly used to prevent the oxidative damage that takes place in biomolecules. The main goal of this study was to observe the effect of gallic acid on calcium oxalate precipitation. Calcium oxalates are calcium salts of oxalic acid and are the most common constituents of kidney stones. Calcium oxalates crystallize in three forms: calcium oxalate monohydrate (COM), calcium oxalate dihydrate (COD) and calcium oxalate trihydrate (COT).

MATERIALS AND METHODS





- SEM and light microscopy

The precipitation methods were based on the mixing of calcium and oxalate solutions which pH values have been previously adjusted to pH=6.50. The experiments took place inside a thermostated reactor with a capacity of 400 cm³. The experiments were performed at two temperatures 25 °C and 48 °C.

In this study, the influence of the phenolic acid addition was monitored, and the changes in the morphology, hydrate phase and reaction kinetics were observed.



Stirring using magnetic bar

48°C SYSTEMS

25°C SYSTEMS

ANALYSIS OF SELECTED SYSTEM

THERMOGRAVIMETRY



| 25°C | 1 st step | | | total 1 st step | 2 nd step | | | total 2 nd step |
|---------|----------------------|----------------------|---------------------------|-------------------------------|----------------------|----------------------|---------------------|-------------------------------|
| | <i>t</i> ₀/°C | t _{max} /°C | <i>t</i> _e /°C | ∆m / % | t₀/°C | t _{max} /°C | t _e / °C | Δ <i>m</i> / % |
| 0 GA | 65.68 | 146.36 | 196.21 | 12.29 | - | - | - | - |
| 100 GA | 42.74 | 141.38 | 197.12 | 13.47 | - | - | - | - |
| 1000 GA | 40.48 | 40.54 | 84.32 | 2.36 | 84.45 | 132.51 | 195.71 | 18.65 |

| l | СОМ | |
|-----|-----|------|
| COD |] | COM/ |
| | | |

| 48°C | 1 st step | | | total 1 st step | 2 nd step | | | total 2 nd step |
|---------|----------------------|----------------------|---------------------------|-------------------------------|----------------------|----------------------|---------------------|-------------------------------|
| | t₀/°C | t _{max} /°C | <i>t</i> _e /°C | ∆m / % | t₀/°C | t _{max} /°C | t _e / °C | Δ <i>m</i> / % |
| 0 GA | 66.58 | 144.08 | 196.95 | 11.77 | - | - | - | - |
| 100 GA | 46.08 | 140.67 | 200.87 | 12.78 | - | - | - | - |
| 1000 GA | 42.26 | 79.06 | 97.32 | 12.28 | 97.32 | 135.76 | 200.69 | 8.57 |

TGA CURVES





LIGHT MICROSCOPY / SEM



Temperature (°C)

POWDER X-RAY DIFFRACTION



20(°)

FT-IR SPECTROSCOPY



Wavenumber (cm⁻¹)



In all systems COM was the only precipitated phase.

• Size: larger crystals at higher temperature

CONCLUSIONS

- 100 GA
- COM was the dominant precipitated phase • Morphology:
 - at 25°C -> dendritic and X shape - at 48°C -> rounded hexagon

1000 GA

- At 25°C \rightarrow COD was the dominant
- precipitated phase.
 - Morphology: flower like
- At 48°C \rightarrow COM and COT mixture precipitated - Morphology: irregular and aggregated

A - Light microscopy and SEM images of samples prepared without gallic acid (0 GA) B - Light microscopy and SEM images of samples prepared with 100 mg gallic acid (100 GA) C - Light microscopy and SEM images of samples prepared with 1000 mg gallic acid (1000 GA)





