The Effect of Static Magnetic Field on Crystal Growth of Struvite

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Abstract- In the present work, Struvite crystal one of the crystalline components of urinary stone also referred as infectious stone, which occurs in female are grown by single diffusion gel method in the presence of magnetic field of different strength such as 0, 0.1, 0.2 Tesla for constant pH, density and concentration of the solution at room temperature. Rate of nucleation, yield and morphology of grown crystal are studied. The crystals are characterized by using XRD and FTIR method.

Keywords: Struvite Crystal growth, Single Diffusion Method, XRD, FTIR.

INTRODUCTION

Struvite is composed of Ammonium Magnesium Phosphate Hexahydrate (MgNH4PO4.6H2O). The process of Struvite crystals growth has been studied by different researchers. Struvite stones were studied by Griffith (Griffith, 1978). Growth and Characterization of Struvite crystals was also studied by Chauvan (Chauvan et al., 2008). Growth inhibition of Struvite crystals in presence of Herbal Extract Boerhaavia Diffusa Linn was studied by Chauvan (Chauvan et al., 2009). Growth inhibition of Struvite crystals by the aqueous root extract of rotula aquatica was studied by Chauvan (Chauvan et al., 2011). Influence of Drugs on the formation of Struvite Urinary Calculi was studied by Bindu (Bindu et al., 2012). Growth, spectral, structural and mechanical properties of Struvite crystal grown in presence of sodium fluoride was studied by Suguna (Suguna et al., 2012). We have now studied the effect of static magnetic field on growth of Struvite crystal for constant pH, density, temperature and rate of nucleation yield and morphology of crystal are studied. The grown crystals are characterized by using XRD and FTIR method.

EXPERIMENTAL GROWTH

The A.R. grade chemicals used for study of Struvite crystal growth are Sodium Meta Silicate (SMS), Acetic Acid (glacial), Ammonium Dihydrogen Phosphate (ADP), Magnesium Acetate, Distilled water. Borosilicate Glass Test tubes of diameter 2.5cm and length 15 cm. Entire procedures carried out in dust free and quiet environment.

Gel Setting and Struvite crystal growth in gel media:
The gel preparation and gel setting is done by preparing stock solution by dissolving Sodium Meta Silicate powder in double distilled water and shaking this solution well. The solution is filtered and kept in clean flask. This solution was mixed with glacial acetic acid for pH value 6.5 and with specific gravity 1.04 gm/cc. This solution of sodium Meta silicate mixed in 2.0M concentration of Ammonium Dihydrogen Phosphate solution in the ratio 1:1 and allowed to set for 48 hours at room temperature.

Static Magnetic field set up:
An Electromagnets (EMU-50) of 7.5 kg placed at 10mm air gap with flat pole pieces (50 mm diameter) is used to apply magnetic field strength as shown in figure 1. The magnetic field strengths were varied by using appropriate current to the coils and it is measured by Gauss meter. After setting the gel, 2.5M concentration of magnesium Acetate solution is poured slowly and gently around corners of test tubes over set gel. Then four Test tubes were kept in Electromagnets (EMU-50) one by one for exposure of steady magnetic field strength of 0.1 Tesla (Core coil current 1.46 Amperes) for different time periods 30min., 60min., 90min. and 120min. Similar procedure was repeated for magnetic field exposure of 0.2 Tesla (Core coil current 2.93 Amperes) at room temperature. The test tubes were tighten using cork and kept in a quiet and vibration free condition for 120 hours. The following chemical reaction took place.

\[
\text{NH}_4\text{H}_2\text{PO}_4.\text{2H}_2\text{O}+\text{(CH}_3\text{COO)}_2\text{Mg}.4\text{H}_2\text{O} \\
\rightarrow \text{NH}_4\text{MgPO}_4.6\text{H}_2\text{O}+2\text{CH}_3\text{COOH}
\]

Fine Struvite crystals were observed in test tube at the centre of upper gel region and some at the bottom as shown in figure 2. Then crystals were collected from test tubes on filter paper for weighing.
Crystal Yield Analysis:
Yield of Struvite crystals grown are given in Table no.1. and plotted in figure 3.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Magnetic field in Tesla</th>
<th>Time in Minutes</th>
<th>Yield of Struvite Crystal after 120 hours in gm at pH 6.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1.55</td>
</tr>
<tr>
<td>2</td>
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<td>3</td>
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<td>7</td>
<td>0.2</td>
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</tr>
<tr>
<td>8</td>
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</tr>
<tr>
<td>9</td>
<td>0.2</td>
<td>120</td>
<td>1.48</td>
</tr>
</tbody>
</table>

Table 1. Crystallization of Struvite in 2.0M Ammonium Dihydrogen Phosphate.

Crystal Characterization Analysis:
XRD and FTIR Studies were conducted to characterize the crystals grown in silica gel media.

Diffractometer Philips PW1840 crystallizes in Orthorhombic structure with cell parameters as follows:
a=6.945Å, b=11.208Å, c=6.135Å, β=90.0°

FTIR Analysis:
The FTIR spectrum of Struvite crystal is confirmed by recording with FTIR-BUSY-6100 JASCO spectrometer in a scan range (4000 cm⁻¹ - 400 cm⁻¹). The FTIR analysis of Struvite crystal grown as shown in Figure 4.
RESULTS AND DISCUSSIONS:

The photographs of Struvite crystals grown are shown in figure 2. The morphology of Struvite Crystals observed as dendrite and is in good agreement with result published. The powder XRD pattern shown in figure no. 4 of Struvite crystal confirmed and results are in good agreement with results reported in literatures (Chauvan, etal, 2008; Bhagat etal 2014). Also FTIR analysis pattern shown in figure no.5 of Struvite crystal confirmed and results are in good agreement with results reported in literatures (Chauvan,etal 2008; Bhagat etal 2014). FTIR pattern obtained for crystal for crystal grown under exposure of magnetic field at the nucleation time exhibits more % transmittance for magnetic field strength 0.1 T than 0.2 T. The difference of % transmittance found decreased and depth of %transmittance dip at frequency 2355.64 cm⁻¹ is found increased as exposure time is increased. Rate of nucleation observed reduced and Size of crystals decreased with increasing strength of magnetic field but number of crystals found increased.

Yield of Struvite crystals grown are given in table no.1 and plotted in figure 3 is found slightly increased as influence of increasing magnetic field. Overall yield found less as compared to without exposure of magnetic field.

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REFERENCES


