Influence of surfactants on crystal form of mefenamic acid

Kaival P., Kulkarni P.K., Mudit Dixit* and Ashwini G. Kni

Department of Pharmaceutics, J.S.S College of Pharmacy, J.S.S University, Mysore-570015, India

*Corresponding author: Tel.: +91-9886778640, 09035508450
E-mail: muditdixit911@yahoo.com

Abstract:

Mefenamic acid is an anti inflammatory and poorly water-soluble drug. Since the drug powder can stick to any type of surface, and is not easy to handle in granulation and tabletting process, it is more desirable to recrystallize the mefenamic acid in such that powder exhibits acceptable micromeric properties, improved solubility and dissolution, to facilitate tabletability for a stable and reproducible dosage form. Mefenamic acid exists in two polymorphic forms (Form I and Form II). Aim of the work was to study the influence of surfactants on crystal forms of mefenamic acid. Crystallization of mefenamic acid was carried out using N, N-dimethylformamide. During crystallization, the cationic, nonionic and anionic surfactants were added. Crystals were characterized by infrared spectroscopy, differential scanning calorimetry (DSC), scanning electron microscopy (SEM) and X-ray diffraction (XRD) patterns. Powder was evaluated for micromeritic, compressional and dissolution characteristics. The FT-IR spectra of mefenamic acid of commercial sample and that of prepared crystals did not show any changes in peaks. Thermogram exhibited single characteristic endothermic peak for all crystals. XRD studies revealed that there was no change in the crystal form of mefenamic acid during the crystallization process. SEM studies indicated that surfactants altered the size and shape of crystals. Prepared crystal of mefenamic acid in presence of benzalkonium chloride exhibited enhanced drug release than other crystals. Crystal growth and crystal size could be controlled by appropriate selection of surfactant and its concentration. In conclusion, use of surfactant during crystallization improved micromeritic, compressional and dissolution properties of mefenamic acid.

Keywords: Mefenamic acid; Surfactants; Compressional properties; Dissolution; Polymorphism; Crystals
**Introduction**

Pharmaceutical drugs exist in different crystal forms [1]. A crystalline solid is characterized by a definite external and internal structure. The external structure and polymorphic state refers to the internal structure of a crystal [2]. Polymorphism, which is the definite arrangement of molecules within a solid, has been known to influence various physicochemical and biological properties of a crystalline moiety [3]. However, crystal habit has been paid scant attention. Crystallization is commonly employed as the final step for purification of a drug [4]. Use of different solvents and processing conditions may alter the polymorphic state and/or habit of the purified drug, leading to variation in raw material characteristics [4]. In addition, crystal habit influences flowability, packing, compaction, syringability, stability and dissolution characteristics of a drug powder [5]. There are a variety of reasons for such changes in crystal morphology which largely depends on how the crystallization of the drug is conducted, the nature of solvent(s) employed, the condition of pressure, temperature, cooling rate, agitation, use of surfactants, co-solvents and presence of other solutes and ions. Though the polymorphs are chemically identical, they exhibit different physicochemical properties like melting point, x-ray diffraction pattern, differential scanning calorimetry, solubility etc. These physicochemical properties further affect the biological properties of drug molecules. Therefore, it becomes necessary to identify the factors which alter the crystal habit of a drug and to assess the modifications of the properties of the drug altered by them. The use of adjuvants in pharmaceutical formulations has shown to affect the crystalline properties of drug materials and consequently alter the pharmaceutical performance criteria such as dissolution, equilibrium solubility, compressibility and stability [5]. The capacity of surfactants in solubilizing the drugs depends on numerous factors such as chemical structure of the surfactant, chemical structure of the drug, temperature, pH and ionic strength [6]. Although surfactants have a wide usage in development of dosage forms, earlier studies have shown their effects on crystalline properties of drugs and subsequently the pharmaceutical performance of the drug [6]. The process of crystallization depends on achieving three conditions in succession; a state of super saturation (super cooling in the case of crystallization form a melt), formation of nuclei and growth of crystals or amorphous particles [7, 8]. The internal structure of a drug can affect the bulk and physicochemical properties, which range from flow ability to chemical stability. The relationship between the external shape of the crystal and its internal structure can be confirmed by determination of the crystal structure. Crystal habit is influenced by the degree of supersaturation, nature of crystallizing solvents, rate of cooling, presence of co-solutes, surfactants, co-solvents and absorbable foreign ions etc. The morphology of a crystal depends on crystal habit, which in turn reflects the internal structure. The crystal habits can influence by several pharmaceutical characteristics related to physical shape and nature of the crystals like suspension syringeability and tableting behaviour [9, 10].

The present study was carried out to investigate the influence of surfactants on crystal form of mefenamic acid. Mefenamic acid is a non-steroidal anti inflammatory drug and widely used as an anti pyretic, analgesic and anti rheumatic drug. It has been reported that mefenamic acid has two polymorphs, Forms I and II. Form II exhibited higher solubility than Form I in several solvents [11, 12, 13]. Surfactants are known to influence the crystal growth and crystal habits. Presence and concentration of surfactant during crystallization can change the size and shape of the crystals [14, 15]. Mefenamic acid exhibits poor flow, a high tendency of adhesion and shows poor dissolution properties. Various methods are employed to improve the micromeritic properties and bioavailability of mefenamic acid such as prodrugs of mefenamic acid, complexation, solid dispersion, solvent deposition, coating and granulation. It is a poorly water-soluble drug, sticking to any type of surface, and is not easy to handle in granulation and tabletting process. It is more desirable to crystallize the pure drug in presence of surfactant that exhibits good micromeritic properties, improves the solubility and dissolution. To facilitate tabletability, and develop a stable and reproducible dosage form, the study was investigated the influence of surfactants on
crystal form of mefenamic acid.

Materials and Method

Mefenamic acid (gift sample from Blue cross laboratories Ltd., Nashik), sodium lauryl sulfate (SLS), Tween 80, benzalkonium chloride and dimethylformamide (Loba cheme Ltd.) were used.

Preparation of mefenamic acid crystals

Supersaturated solution of mefenamic acid was prepared by adding excess amount of drug in N,N-dimethylformamide, heated to 50°C for 10 min and filtered it. The supersaturated solution was added to 5 mL of different types of surfactants (Table 1). Solutions were kept in refrigerator for 24 h and the crystals were collected by vacuum filtration.

Characterization of prepared crystals

Solubility studies of mefenamic acid in different solvents

The solubility of mefenamic acid in ethyl acetate, acetone, dimethylformamide, ethanol, methanol and hexane was determined at room temperature. An excess amount of prepared crystals was weighed and placed in a 50-mL screw capped vial. Fifty milliliters of each of solvents was added to vials and were tightly capped. The vials were shaken for 24 h. The concentration of mefenamic acid dissolved was measured at 286 nm, after filtering through Whatman filter paper no. 1.

Differential scanning calorimetry (DSC)

DSC curves of commercial sample and prepared crystals were measured by a differential scanning calorimeter (Shimadzu, Kyoto, Japan).

Fourier Transform-Infrared Spectroscopy (FT-IR)

The FT IR spectral measurements (Shimadzu 8400, USA) were taken at ambient temperature. FT-IR spectra were obtained by powder diffuse reflectance on FT-IR spectrophotometer.

X-ray analysis

The powder x-ray diffraction (PXRD) patterns of commercial sample and prepared crystals were recorded using an automated x-ray diffractometer (Siemens D5000, Munich, Germany).

Scanning electron microscopy (SEM)

The surface morphology of the commercial sample and prepared crystals was examined using a scanning electron microscope (Shimadzu SSX-550, Japan).

Evaluation of prepared crystals

Particle size determination

Particle size of commercial samples and prepared crystals were determined by microscopic method.

Apparent bulk density and tapped density

Apparent bulk density was determined by pouring the samples i.e. commercial sample and crystals in bulk

<table>
<thead>
<tr>
<th>Surfactant</th>
<th>Concentration (mM)</th>
<th>Type of surfactants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tween 80</td>
<td>0.01</td>
<td>Non ionic</td>
</tr>
<tr>
<td>Sodium lauryl sulfate</td>
<td>0.82</td>
<td>Anionic</td>
</tr>
<tr>
<td>Benzalkonium chloride</td>
<td>6.30</td>
<td>Cationic</td>
</tr>
</tbody>
</table>
into a graduated cylinder. Weight of sample and initial volume were noted. Tapped density was determined by placing a graduated cylinder containing a known mass of powder on a tap density apparatus (Electro lab, Mumbai). Samples were tapped until no further reduction in volume of the sample was observed.

Angle of repose (θ)

Fixed funnel method was employed. A funnel secured with its tip at a given height above the graph paper that was placed on a flat horizontal surface. Powder or agglomerates was carefully poured through the funnel until the apex of the conical pile just touches the tip of the funnel. The radius and height of the pile were then determined. The angle of repose (θ) for the samples was calculated as \(\tan(\theta) = \frac{\text{height}}{\text{radius}}\).

Compressional properties

Tensile strength

Tensile strength of crystals was determined by compressing 500 mg of crystals using hydraulic press at 500, 1000, 1500, 2000, 2500 and 3000 lb/in\(^2\) for 1 min. The compacts were stored in a desiccator for overnight to allow elastic recovery. The thickness and diameter were measured for each compact. The hardness of each of compacts was measured using Pfizer hardness tester. The tensile strength (\(\sigma\)) of the compact (lb/in\(^2\)) was calculated using following equation, \(\sigma = \frac{2F}{\pi Dt}\); where \(F\), \(D\) and \(t\) are hardness (lb), compact diameter (inch) and thickness (inch) respectively.

Heckle’s equation

Mefenamic acid commercial sample and prepared crystals were compressed at compaction pressures of 0.5, 1, 1.5, 2, 2.5 and 3 tons for 1 min using a hydraulic press. The densification behaviour of powders was studied using Heckle’s equation. In \((1/1-D) = KP + A\); where D is the relative density of compressed powder bed at applied pressure P, K is the slope of the straight liner portion of the Heckle plot and the reciprocal of K is the mean yield pressure (\(P_y\)).

Dissolution studies of prepared crystals

Drug release studies were carried using dissolution tester (Electro lab, Mumbai). Samples were placed in 900 mL of dissolution medium (phosphate buffer pH 7.2) at 37°C using USP dissolution apparatus II (paddle method) with paddle rotating at 100 rpm. An aliquot of medium was withdrawn at pre-determined time intervals (20 min) and an equivalent amount of fresh medium was added. The samples were suitably diluted with dissolution medium before analysis. Drug concentrations were measured by spectrophotometrically (Shimadzu 1600, Japan) at 286 nm. Data were collected in triplicate.

Results and Discussion

Solvents play an important role in crystallization. They provide some solubilizing capacity so that concentrated solution can be formed. Supersaturated solution of drug is necessary in crystallization as it promotes nucleation process and subsequent packing pattern in crystal. Hence selection of solvent for crystallization is extremely important. Solubility of mefenamic acid is high in dimethyl formamide (DMF) as compared to other solvents (Table 2). Hence dimethylformamide was chosen as solvent for crystallization of mefenamic acid.

<table>
<thead>
<tr>
<th>Solvents</th>
<th>Solubility (µg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethyl acetate</td>
<td>155.4</td>
</tr>
<tr>
<td>Acetone</td>
<td>550.1</td>
</tr>
<tr>
<td>Dimethylformamide</td>
<td>672.6</td>
</tr>
<tr>
<td>Ethanol</td>
<td>528.0</td>
</tr>
<tr>
<td>Methanol</td>
<td>497.1</td>
</tr>
<tr>
<td>Hexane</td>
<td>108.1</td>
</tr>
</tbody>
</table>
increased solubility than the commercial sample in water and in phosphate buffer. Recrystallized mefenamic acid in presence of benzalkonium chloride showed better solubility than other prepared crystals (Table 3) which could be due to the higher HLB value of benzalkonium chloride. In general higher the HLB value of solvents, higher the hydrophillicity of solvents.

The DSC thermograms of mefenamic acid commercial sample and prepared crystals respectively are presented in Fig. 1. The DSC thermograms showed a sharp single endothermic peak for all the prepared mefenamic acid crystals. This one step melt might be due to only one crystal form (Form II), which formed during the crystallization process, thus indicating that mefenamic acid did not under go any crystal modification during the crystallization. The temperature range of the endothermic peak of all the mefenamic acid crystals lied in the range of 230°C to 240°C. Melting points showed slight variation as the nature of the crystals might have been affected by the presence of surfactant. The mefenamic acid commercial sample (F1) melted at 233.79°C with enthalpy of 171.4 J/g. The melting endotherm for prepared crystals occurred at 233.15 to 233.79 (F2, F3, F4 & F5) with decreased enthalpy of 127.2 to 160.9 J/g (F2, F3, F4 & F5) indicating all the prepared crystals decreased crystallinity.

All the crystals have exhibited general characteristic peaks. Changes in IR spectra could be due to minor distortion of bond angles, or even a result of the presence of a solvent of crystallization or presence of surfactants. Following characteristic bands were observed from the spectra (Fig. 2).

Table 3 Solubility of mefenamic acid at 25°C (mean ± S.D., n = 3)

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Water (µg/ml)</th>
<th>Phosphate buffer pH 7.2 (µg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1; mefenamic acid commercial sample</td>
<td>510.00 ± 1.03</td>
<td>14400.00 ± 0.29</td>
</tr>
<tr>
<td>F2; recrystallized mefenamic acid from dimethyl formamide</td>
<td>580.00 ± 1.08</td>
<td>18500.00 ± 0.24</td>
</tr>
<tr>
<td>F3; recrystallized mefenamic acid in presence of Tween 80</td>
<td>680.00 ± 1.04</td>
<td>26700.00 ± 0.15</td>
</tr>
<tr>
<td>F4; recrystallized mefenamic acid in presence of sodium lauryl sulfate</td>
<td>740.00 ± 0.84</td>
<td>30600.00 ± 0.27</td>
</tr>
<tr>
<td>F5; recrystallized mefenamic acid in presence of benzalkonium chloride</td>
<td>840.00 ± 0.93</td>
<td>39500.00 ± 0.35</td>
</tr>
</tbody>
</table>

Figure 1 DSC thermograph of mefenamic acid (F1 = Mefenamic acid commercial sample, F2 = Recrystallized mefenamic acid from dimethyl formamide, F3 = Recrystallized mefenamic acid in presence of Tween 80, F4 = Recrystallized mefenamic acid in presence of sodium lauryl sulfate, F5 = Recrystallized mefenamic acid in presence of benzalkonium chloride)
The X-ray diffraction patterns were obtained for commercial sample and recrystallized mefenamic acid in presence of benzalkonium chloride (F5). The peak patterns are reported in Fig. 3. The X-ray powder diffraction measurements showed no difference in crystal form of commercial sample and recrystallized mefenamic acid in presence of benzalkonium chloride. The d values and relative intensities were comparable. In general, for two forms of crystals, when the patterns (i.e. peak positions) are identical they have the same internal structure, whereas if the patterns are different, then the crystals have different internal structure and are polymorphs. Here the commercial sample and recrystallized mefenamic acid in presence of benzalkonium chloride exhibited spectra with similar peak position (2θ values). Therefore, the formation of different polymorphs of mefenamic acid during crystallization in presence of surfactants was ruled out.

The scanning electron micrographs of commercial sample and prepared crystals of mefenamic acid are

Figure 2 FT-IR spectra of mefenamic acid (F1 = Mefenamic acid commercial sample, F2 = Recrystallized mefenamic acid from dimethylformamide, F3 = Recrystallized mefenamic acid in presence of Tween 80, F4 = Recrystallized mefenamic acid in presence of sodium lauryl sulfate, F5 = Recrystallized mefenamic acid in presence of benzalkonium chloride)

Figure 3 X-ray diffraction spectra of mefenamic acid (F1 = Mefenamic acid commercial sample, F5 = Recrystallized mefenamic acid in presence of benzalkonium chloride)
shown in Fig. 4. In the commercial sample, smaller particles are adhered to the larger particles and exhibited wide particle size distribution. While all crystalline samples showed cubic shaped particles and agreed with Form-II of mefenamic acid. SEM studies indicated that there was no crystal growth in absence of surfactant, and by using different types of surfactants, size and shape of crystals were altered.

Table 4 shows the different micromeritic properties of mefenamic acid commercial sample and prepared crystals. The differences in the bulk densities may be related to their markedly different crystal habits, leading to different contact points, frictional and cohesive forces between the crystals. Recrystallized mefenamic acid (F2-F5) exhibited higher packing ability than commercial sample (F1), due to lower surface area and wider particle

![Mefenamic acid commercial sample](image1)
![Recrystallized mefenamic acid without surfactant](image2)
![Recrystallized mefenamic acid in presence of SLS](image3)
![Recrystallized mefenamic acid in presence of Tween 80](image4)
![Recrystallized mefenamic acid in presence of benzalkonium chloride](image5)

Figure 4 SEM photograph of mefenamic acid
Table 4 Micromeritic properties of mefenamic acid commercial sample and prepared crystals (mean ± S.D., n = 3)

<table>
<thead>
<tr>
<th>Micromeritic properties</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle size (µm)</td>
<td>4-8</td>
<td>13-16</td>
<td>18-20</td>
<td>22-25</td>
<td>30-32</td>
</tr>
<tr>
<td>Angle of repose (°)</td>
<td>32.63</td>
<td>31.54</td>
<td>29.61</td>
<td>28.35</td>
<td>27.05</td>
</tr>
<tr>
<td>Tapped density (g/mL)</td>
<td>0.517 ± 0.008</td>
<td>0.504 ± 0.006</td>
<td>0.482 ± 0.003</td>
<td>0.467 ± 0.005</td>
<td>0.454 ± 0.004</td>
</tr>
<tr>
<td>Bulk density (g/mL)</td>
<td>0.612 ± 0.006</td>
<td>0.604 ± 0.009</td>
<td>0.592 ± 0.004</td>
<td>0.582 ± 0.006</td>
<td>0.571 ± 0.005</td>
</tr>
<tr>
<td>Carr’s index (%)</td>
<td>21.66</td>
<td>21.08</td>
<td>20.84</td>
<td>20.12</td>
<td>19.91</td>
</tr>
<tr>
<td>Huisner’s ratio</td>
<td>1.38</td>
<td>1.33</td>
<td>1.26</td>
<td>1.13</td>
<td>1.04</td>
</tr>
<tr>
<td>Porosity (%)</td>
<td>20</td>
<td>29</td>
<td>35</td>
<td>37</td>
<td>40</td>
</tr>
</tbody>
</table>

F1 = Mefenamic acid commercial sample, F2 = Recrystallized mefenamic acid from dimethylformamide, F3 = Recrystallized mefenamic acid in presence of Tween 80, F4 = Recrystallized mefenamic acid in presence of sodium lauryl sulfate, F5 = Recrystallized mefenamic acid in presence of benzalkonium chloride

Figure 5 Tensile strength of mefenamic acid versus compression pressure (F1 = Mefenamic acid commercial sample, F2 = Recrystallized mefenamic acid from dimethylformamide, F3 = Recrystallized mefenamic acid in presence of Tween 80, F4 = Recrystallized mefenamic acid in presence of sodium lauryl sulfate, F5 = Recrystallized mefenamic acid in presence of benzalkonium chloride)

size distribution of crystals. The smaller crystals might have settled in voids between larger particles. Angle of repose is able to provide gross measurements of the flowability of crystals. Most free flowing materials have angle of repose less than 40°. Powders with angles greater than 50° have flow problems. Commercial sample exhibited higher angle of repose than prepared crystals that could be due to the irregular shape and small size of crystals, which put hurdles in the uniform flow of crystals from funnel. The compressibility index is a simple and fast method for estimating flow of powder. Carr’s showed the relationship between the compressibility index and flowability. Powders with compressibility above 40% exhibit poor flow properties. Flow rates are in agreement with morphology and bulk density data in that prepared crystals with low bulk density exhibit better flow properties.

Compressibility of the prepared crystals was determined on the basis of the tensile strength of the compact. Prepared crystals of mefenamic acid exhibited superior compressibility characteristics compared to commercial crystals. It could be due to the fact that during the process of compression, fresh surfaces are formed by fracturing. Surface freshly prepared by fracture enhanced the plastic interparticle bonding, resulting in a lower compression force required for compressing the prepared crystals under plastic deformation as compared to that of single crystal (Fig. 5). Mefenamic acid crystals prepared in presence of benzalkonium chloride (F5) show higher tensile strength compared to other prepared crystals, hence are suitable for tabletting.

Heckle’s profiles of commercial sample and
prepared crystals are shown in Fig. 6, and characteristic values of $P_Y$, $D_A$, $D'_0$ and $D'_B$ and elastic recovery are reported in Table 5. At early compression phase below 25 MPa, the compression of prepared crystals began at lower relative density, while the initial rearrangement phase without pressure increase for commercial sample. This corresponded to different $D'_0$ values. $D'_B$ was greater for prepared crystals and indicated a greater brittle fracture tendency of these materials. Elastic recovery was relatively high for a brittle material, but it should be noted that tablets survive the decompression phase and show no sign of capping. Prepared mefenamic acid crystals exhibited higher porosity as compared to commercial sample, hence require lower compression force for compressing under plastic deformation compared to commercial sample.

Dissolution studies were conducted using USPXXIV dissolution test apparatus Type II as per the monograph for mefenamic acid. The dissolution profile is shown in Fig. 7. The dissolution profiles of mefenamic acid exhibited better dissolution behaviour for prepared crystals than commercial sample. The reason for this faster dissolution could be linked to the presence of surfactant. The drug release in the order of: prepared crystals with surfactants (F3-F5) > crystals without surfactant (F2) > commercial sample (F1). While in case of prepared crystals in presence of surfactants the drug release in the order of recrystallized mefenamic acid in presence of benzalkonium chloride > recrystallized mefenamic acid in presence of sodium lauryl sulfate > recrystallized mefenamic acid in presence of Tween 80. Recrystallized mefenamic acid in presence of

### Table 5: Heckle’s parameters and elastic recovery of mefenamic acid (mean ± S.D., n = 3)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_Y$</td>
<td>68.50 ± 4.02</td>
<td>68.52 ± 3.55</td>
<td>68.61 ± 3.95</td>
<td>69.20 ± 3.65</td>
<td>69.4 ± 5.15</td>
</tr>
<tr>
<td>$D'_0$</td>
<td>0.573 ± 0.006</td>
<td>0.493 ± 0.049</td>
<td>0.494 ± 0.045</td>
<td>0.495 ± 0.052</td>
<td>0.496 ± 0.008</td>
</tr>
<tr>
<td>$D_A$</td>
<td>0.712 ± 0.002</td>
<td>0.713 ± 0.027</td>
<td>0.715 ± 0.003</td>
<td>0.723 ± 0.024</td>
<td>0.728 ± 0.004</td>
</tr>
<tr>
<td>$D'_B$</td>
<td>0.138 ± 0.005</td>
<td>0.188 ± 0.004</td>
<td>0.191 ± 0.028</td>
<td>0.204 ± 0.003</td>
<td>0.229 ± 0.012</td>
</tr>
<tr>
<td>Elastic recovery (%)</td>
<td>4.78 ± 0.25</td>
<td>4.79 ± 0.49</td>
<td>4.80 ± 0.31</td>
<td>4.82 ± 0.48</td>
<td>4.83 ± 0.45</td>
</tr>
</tbody>
</table>

*F1 = Mefenamic acid commercial sample, F2 = Recrystallized mefenamic acid from dimethylformamide, F3 = Recrystallized mefenamic acid in presence of Tween 80, F4 = Recrystallized mefenamic acid in presence of sodium lauryl sulfate, F5 = Recrystallized mefenamic acid in presence of benzalkonium chloride.*

**Figure 6**: Heckle’s profile of mefenamic acid versus compression pressure (F1 = Mefenamic acid commercial sample, F2 = Recrystallized mefenamic acid from dimethylformamide, F3 = Recrystallized mefenamic acid in presence of Tween 80, F4 = Recrystallized mefenamic acid in presence of sodium lauryl sulfate, F5 = Recrystallized mefenamic acid in presence of benzalkonium chloride)
benzalkonium chloride gave better drug release compared to other prepared crystals, possibly due to the higher HLB value of benzalkonium chloride.

**Conclusion**

Mefenamic acid crystals prepared using different surfactants exhibited improved micromeritic properties and compression properties. DSC, FT-IR and XRD study results showed that there is no change in the crystal structure of mefenamic acid during the crystallization process. Prepared mefenamic acid crystals showed increased solubility and dissolution properties. They are in the order of i.e., recrystallized mefenamic acid in presence of benzalkonium chloride > recrystallized mefenamic acid in presence of sodium lauryl sulfate > recrystallized mefenamic acid in presence of Tween 80 > recrystallized mefenamic acid without surfactant > commercial sample.

**Acknowledgement**

The authors express thanks to, Principal, J.S.S. College of Pharmacy and to J.S.S. Mahavidhyapeetha, Mysore for providing research facilities.

**References**


