International Journal of
Medicinal Chemistry & Analysis
www.ijmca.com
e ISSN 2249 - 7587
Print ISSN 2249 - 7595

CONCENTRATION IMPACT AND STRUCTURE SUITABILITY OF ACETYL SALICYLATE MOEITY (ASPIRIN) AS MULTI-FUNCTIONALIZED DRUG

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ABSTRACT

The present investigations discuss the correlation between concentrations of active acetyl salicylate moiety in the synthesized tablet and solvation rates in different pH-media. Furthermore AFM-microscopy was to visualize a real 3D-imaging of sample's surface topography .High resolution AFM-investigations indicated that crystalline aspirin has regular arrays of atomic arrangement with no violation in the bulk of aspirin.TM deflection AFM- gave us good approximation to the diffusion of grain throughout the surface topology of investigated aspirin. 3D-visualized imaging is introducing precise determination of exposure surface area interacting with dissolving agent responsible for increasing or decreasing calculated solvation rates.

Keywords: AFM-microscopy , pH-effect ,Grain , Nano-structural Features ,Deflection centers.

INTRODUCTION

The mechanism of aspirin's analgesic, anti-inflammatory and antipyretic properties was unknown through the drug's heyday in the early- to mid-twentieth century. Recently aspirin is well known and well characterized it has a direct irritant effect on gastric mucosa due to inhibition of prostaglandins and prostacyclin and thus causes ulceration, epigastric distress and haemorrhage. So as to reduce the side-effects the controlled release formulation of aspirin has to be prepared [1,2]. Chemically, aspirin is degraded by water to salicylic acid and acetic acid. Drugs in the solid state can have significant influences on a variety of physical and chemical properties [3] and it is essential to characterize the effect of moisture on these individual components [4]. Direct compression is the most efficient process used in tablet manufacturing but it requires different properties of powder such as good flowability, good compressibility, and bulk density. Many of the crystals do not exhibit these properties; hence it is necessary to improve these properties. As, Aspirin is having poor flowability and compressibility, it is necessary to increase the flowability and compressibility of Aspirin also it is moisture sensitive drug, hence there is need to avoid these major problems [5, 6].

All the problems associated with Aspirin could be overcome by the technique known as spherical crystallization, is a novel particle engineering technique by which crystallization and agglomeration can be carried out simultaneously in one step to transform drug crystals directly into a compacted spherical form and direct compression is possible. Spherical crystallization has been developed by Yoshiaki Kawashima and co-workers as a novel particulate design technique to improve processibility such as mixing, filling, tableting characteristics and dissolution rate of pharmaceuticals [7].

The synthesis of aspirin as shown involves the reaction of salicylic acid and acetic anhydride in the presence of phosphoric acid, H_3PO_4 as catalyst [8,9].

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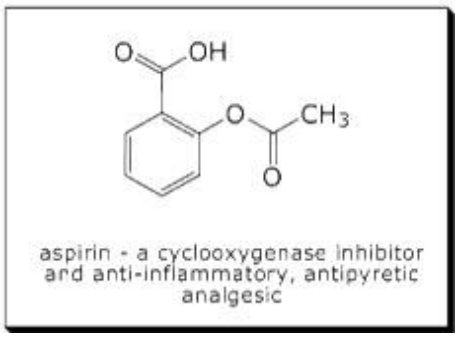
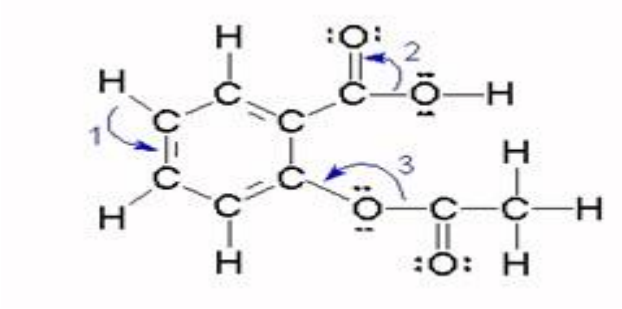




The isolation and purification of aspirin, once the aspirin is prepared it must be isolated from the reaction solution and purified.

The acetic acid and phosphoric acid are water soluble and can be removed by washing the aspirin with chilled water. Salicylic acid is only slightly soluble in water and is not completely removed in the washing step. Final purification is accomplished by the process of recrystallization. The impure aspirin is dissolved in warm ethanol. The solution is then cooled slowly, and the aspirin crystallizes out of solution leaving the salicylic acid and other impurities behind.

The major goal of the present investigations is focusing on the nano-structural features and internal microstructure suitability of crystalline aspirin as multi-functionalized drug.

EXPERIMENTAL

Synthesis of Crystalline Aspirin

Using an electronic pan balance, weigh out 2.0 g of salicylic acid and transfer it to a clean and dry 125 mL Erlenmeyer flask. 4.0 mL of acetic was added anhydride to the flask and gently swirl the flask for a minute. Carefully 3-5 drops of concentrated phosphoric acid was added. The Erlenmeyer flask was placed in a hot water bath in the hood and let it heat for 5 minutes while swirling the flask occasionally. During this time period all of the salicylic acid should dissolve. Add 30 mL of distilled water to the flask, swirl it to mix all the reagents then let it sit in the water bath for 1 minute. The water you added will convert any unreacted acetic anhydride to acetic acid. Remove the flask from the hot water bath and let it cool to room temperature. The mixture should become gummy then a clump of solid should crystallize out. Wash the flask and the collected aspirin in the funnel with two 10 mL portions of ice cold distilled water. Dry the solid crystal by pulling air through the funnel for five more minutes.

Ultra-Crystallization of Aspirin

Three equivalent weights of highly pure aspirin powders (each of 0.4 gm) were dissolved in 30 ml of warm ethanol with supporting ultrasonic instrument . The re-crystallization process was performed using gently microwave assist to avoid any traces from applied solvent. The highly pure crystals were dried in oven the forwarded for structural investigations.

Structural measurements

The X-ray diffraction (XRD): Measurements were carried out at room temperature on the fine ground samples using Cu-Kα radiation source, Ni-filter and a computerized STOE diffractometer/Germany with two theta step scan technique. Rietveld and indexing of structure were made via Full prof package and Gesas program.

Scanning electron microscopy (SEM): measurements were carried out along ab-plane using a small pieces of the prepared samples by using a computerized SEM camera with elemental analyzer unit Shimadzu (Japan).Atomic force microscopy (AFM): High-resolution Atomic Force microscopy (AFM) is used for testing morphological features and topological map (Veeco-di Innova Model-2009-AFM-USA).The applied mode was tapping non-contacting mode. For accurate mapping of the surface topology AFM-raw data were forwarded to the Origin-Lab version 6-USA program to visualize more accurate three dimension surface of the sample under investigation. This process is new trend to get high resolution 3D-mapped surface for very small area.

Solvation Rates Calculations

The solvation rates of acetyl salicylate solution were measured as time sufficient for certain weight of powder to soluble completely without sedimentation.

RESULT & DISCUSION

The crystalline aspirin sample was structurally and spectrophotometrically examined by both of X-ray diffraction as shown in Fig.1a,b and infrared spectroscopy respectively and well established as crystalline aspirin which forwarded to AFM-and SEM to investigate nano-structural features .

The analysis of SE-micrograph recorded for crystalline aspirin indicated that the grain size ranged in between 170-200 nm and no in-homogeneities observed on the grain boundaries or in between grain which refer to the quality of synthesis applying solution route[8-11]. The

blue arrows in Fig.2 display moderate to large size gains while red arrows are for small size gains.

The average of grain size was estimated from XRD data pattern applying Scherrer's formula [10] and found to be 176-199 nm . This result is fitted with grain size estimated from SEM examinations.

Fig.3_a shows AFM-nano-graph captured for crystalline aspirin applying tapping mode technique for $0.04\mu m^2$ scanned area . The analysis of AFM-nano-graph of crystalline aspirin indicated that the average grain size was found 167 nm which is consistent with those calculated from scanning electron micrograph image that reflect the quality of synthesized aspirin by using solution route technique.

As clear in Fig.3_b which describe 3D-topography of crystalline aspirin's surface no abnormal heights present on the whole scanned area 0.2x0.2 μm which reflects the quality of solution route synthesis as preparation technique for crystalline aspirin even at very small area .These results indicate that the homogeneity degree are maximum with very small ratio of impurity phases as confirmed in XRD pattern recorded for crystalline aspirin see Fig.1a .

Fig.3c shows deflection centers distribution of grain through scanned surface area $0.04\ \mu m^2$ .As clear the in figure black dots refer to grain orientation on the surface which regularly distributed in circular arrangement reflect degree of homogeneity on the material surface. Only very few numbers of grains distributed irregularly due to jamming of population during re-crystallization process which affected by heating rate and solvent applied in crystallization process [12-25]. The connections of deflection dots could be benefit to understand both of micro-structural features and conduction mechanisms within material surface's.

Fig.4 shows 3D-visualized image for crystalline aspirin with maximum heights ranged in between 0.69-0.70 μm which represented by orange-red color with ratio ~ 7% of total scanned area .The minimum depth with blue gradient color is nearly 18% recording 0.677-0.680 μm. These details of surface topography enhance us to calculate and estimate accurately the surface exposure area of the whole scanned area which is responsible fore solubility interactions with any dissolving solvent.

Fig.5 shows different salvation times of different concentration as function of hydrogen concentration (pH) .as it clear acidic medium has maximum salvation rate (i.e. minimum salvation time) while basic medium has lower salvation rates as shown in Fig.5.

The blue line displays salvation rate for acetyl salisylate solution with ($W_{aspirin}$ = 80 mg/100ml H_2O) which is fastest rate concentration with minimum salvation time while the red line represents the maximum concentration of aspirin (120 mg/100H_2O) with maximum salvation time (i.e. minimum salvation rate).

Fig 1_a. XRD pattern recorded for nano-crystalline aspirin

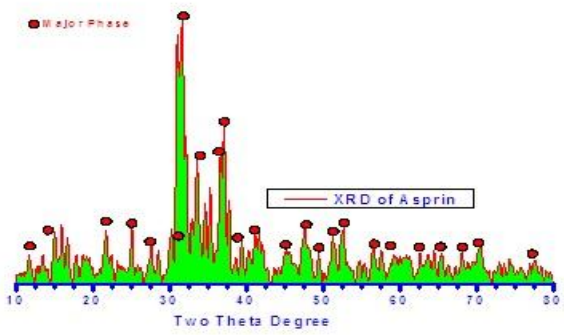


Fig 1_b. Infrared absoption spectrum of Aspirin

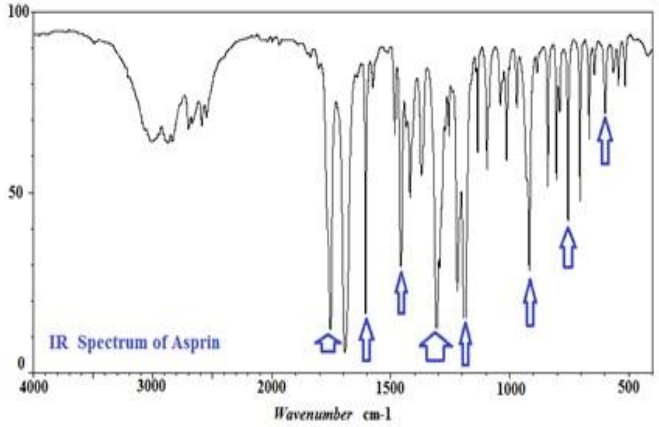


Fig 2. SE-micrograph captured for crystalline aspirin

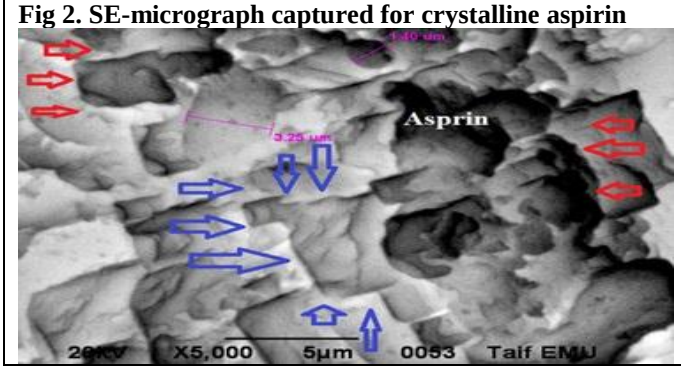


Fig 3_a. AFM-Nano-graph Tapping mode recorded for crystalline aspirin

Fig 3_b. 3D-AFM-Nanograph Tapping mode recorded for crystalline aspirin

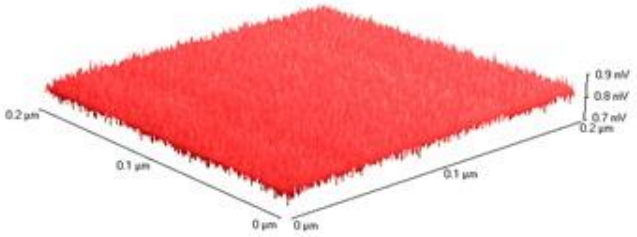


Fig 3_c. TM-deflection centers of grains in the aspirin topology

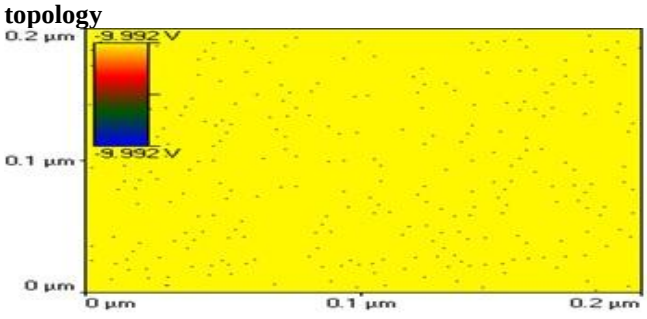


Fig 4. 3D-AFM-visualized real-imaging of aspirin using tapping non-contact mode

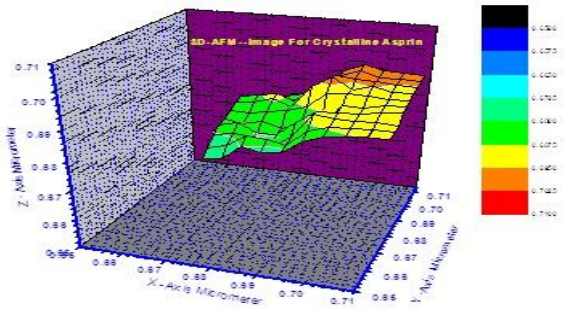
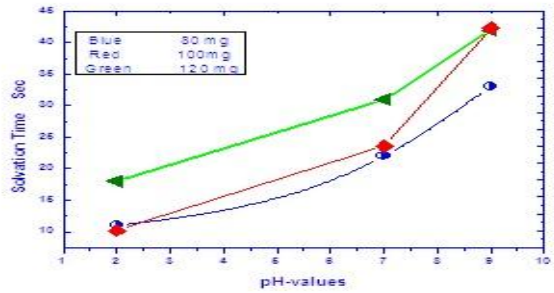


Fig 5. Solvation time in seconds versus pH-hydrogen concentrations



CONCLUSION

The conclusive remarks can be summarized in the following points. The topology of aspirin surface acts important role in its solubility rate.

- The lower concentration of aspirin the higher solvation rate.
- Crystalline aspirin have 3D-regular array net of aspirin decreasing steric hiderence problem as organic molecule .
- 3D-AFM-visualized imaging introduced sharp informative conclusions about the inernal layered structure of nano-array of crystalline aspirin within narrow scanned area reach to 0.01 μm^2 .

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