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NANOCOCRYSTALLIZATION OF UREA:4-HYDROXYBENZOIC ACID USING SONOCHEMICAL METHODS

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With the increase in global population, agriculture plays a vital role bounding to consume larger quantities of slow-release fertilizers. Urea is a widely used fertilizer with higher water solubility; crystal engineering has recently gained interest towards the cocrystallization of urea to overcome the premature decomposition of urea. The study focuses on the cocrystallization and nanococrystallization of urea:4-Hydroxybenzoic acid (4-HBA) and their characterization using powder X-ray diffraction (PXRD), fourier transform Iifrared (FT-IR), scanning electron microscopy (SEM) and thermogravimetric analysis (TGA) and optimize the sonication process to improve the quality of nanococrystals. Urea:4-HBA 1:2 cocrystal was synthesized using the liquid -assisted grinding method with acetonitrile and reduced the particle size using the sonochemical method (optimum frequency: 35-40 kHz, Time: 30 minutes) with the employment of hexane, stearic acid, and sodium dodecyl to obtain nanococrystals. The 1:2 ratio was confirmed in the crystallinity data in the Cambridge Structure Database. Successful cocrystallization and nanococrystallization were confirmed by PXRD and FT-IR analysis. PXRD patterns revealed the presence of a new crystalline phase, which is different from the starting compounds. The presence of new peaks in FT-IR spectra validated the formation of new bonding interactions in the cocrystal. SEM micrographs revealed the presence of irregular particles less than 500 nm, despite the presence of agglomerates. Nanococrystals with surfactants demonstrated a smooth surface compared with those without surfactants. TGA highlighted that cocrystal and nanococrystal had improved thermal stability than the parent material (around 150-160 °C). This study represents valuable insights into forming cocrystals and nanococrystals using urea, emphasizing the importance of selecting surfactants sonication parameters for synthesizing urea nanococrystals. Further research with high frequency sonication would improve the properties of nanococrystals, and the effectiveness of the urea nanococrystal could be identified using a soil release study.

Keywords: Cocrystallization, Liquid assisted grinding (LAG), Nanococrystallization, Sonochemical method, Urea:4-hydroxybenzoic acid