Mesoporous Silica Based Protein Release Systems

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INTRODUCTION: Mesoporous silica nanoparticles (MSNs), such as MCM41, are effective support carriers with excellent adsorption properties and large surface areas [1-3]. Bioactive molecules like proteins, such as albumin, casein and collagen, are universally present in nature and products. Interaction of these proteins and MCM41 has not been widely explored. The aim of this study is to assess how these proteins behave in the presence of MCM41 and assess its protein release properties for the purpose of interdisciplinary applications.

METHODS: Commercial standards of ovalbumin (albumin from chicken egg white, A5378, Sigma-Aldrich), commercial collagen from rabbit skin (Type I, Sigma-Aldrich), and casein (C3400, Sigma-Aldrich) were procured. Coomassie blue dye G-250 (Acros Organics™) [0.6% (m/v) in Hydrochloric acid 0.6 M (HCl)] was used for protein quantification and was prepared in the lab. MCM41 was synthesized and calcined in a vacuum chamber at 550ºC for 6 hours, following the emulsion-condensation route reported by Cao et al [4]. The protein was extracted by 3 consecutive cycles of orbital agitation (at 27° C) and ultrasonication (at 37° C) of 1h each. Finally, the extracted protein was quantified by Bradford Assay, in the presence of Coomassie Blue solution, using BSA as standard solution (1–100 µg mL^{-1}).

RESULTS: MCM41 was characterized with SEM to X-Ray Diffraction to understand the morphological characteristics and the reflections within MCM41(Fig. 1). The protein extraction with MCM41 was compared with ordinary protein extraction in terms of a triple extraction process. As from Fig. 2, the protein supernatant was extracted three times, to procure the maximum output of extraction with and without MCM41 comparatively. After each extraction, the fractional % of protein extracted with MCM41 increases, while a decrease was observed w/o MCM41.

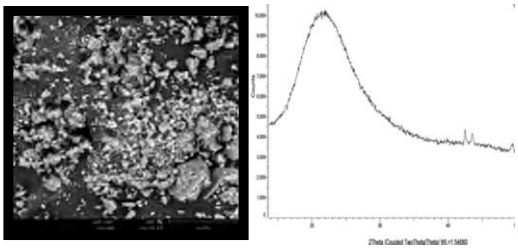

Fig. 1: SEM and XRD images of MCM41.

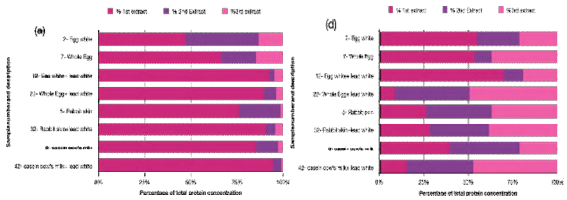

Fig. 2: Fractional % extraction (1st,2nd 3rd) a) w/o MCM41 d) with MCM41.

DISCUSSION & CONCLUSIONS: The above study shows that it is possible for MCM41 to increase protein extraction, fine-tune the sustained release of proteins, while also having a longer duration of protein recovery and a highly controlled release system. MSNs like MCM41 give a new dimension for proteomic studies.

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