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New Drug Carrier for Slow Release: 5-Fluorouracil Formulation in Nanoporous Biogenic Mg-calcite from Blue Crab Shell

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Study Overview

The demand for more effective drugs, has put targeted drug delivery to the forefront of scientific innovation. Owing to its unique properties, the biogenic calcite from wasted blue crab shells is as a new drug carrier for 5-fluorouracil (5-FU). The drug solution has been loaded in the powdered biogenic material and further pelleted in tablets. The slow release of the drug from the tablet was investigated by tracking the surface enhanced Raman scattering (SERS) signal of the tablet solution in a series of time dependence experiments.

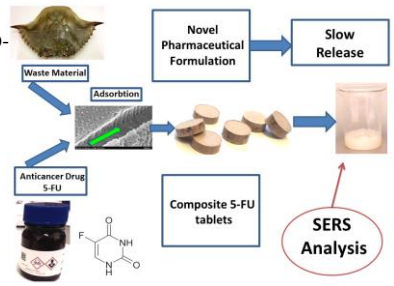

Figure 1. Graphical sketch of the experiments performed. [1]

Biogenic Powder Characterization

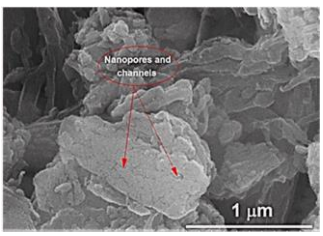

Figure 2. SEM images of the blue crab carapace powder. [1]

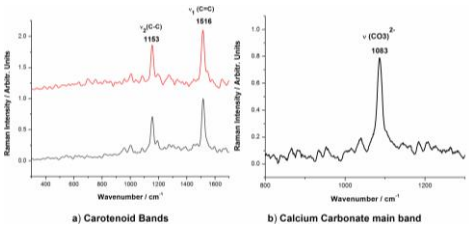

Figure 3. Raman spectra of carapace powder showing the carotenoids preservation in powdered biogenic material (calcite). [1]

5-FU Characterization

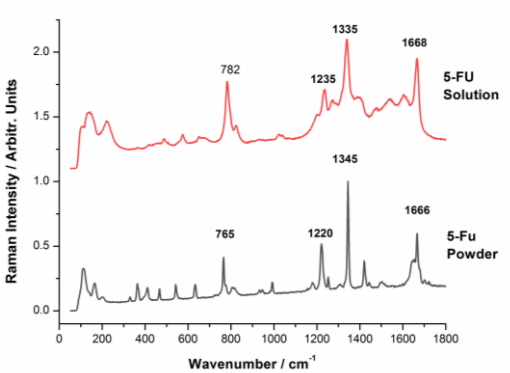

Figure 4. Micro-Raman of 5-FU powder (lower) compared to the SERS signal of the 5-FU solution (0.02 μg/ml) on AgNPs. [1]

Tablets Characterization

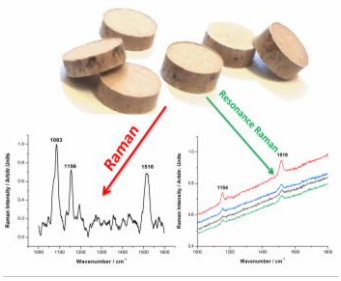

Figure 5. Images of the novel composite drug tablets and their raw Raman spectra collected from tablet surface. [1]

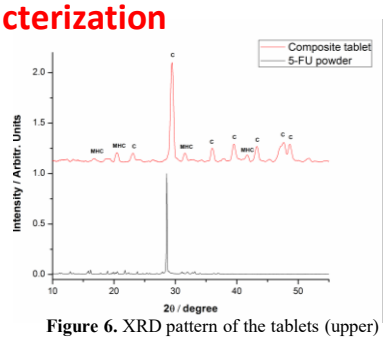

Figure 6. XRD pattern of the tablets (upper) revealing the crystalline calcite signal (marked with C on the graph) as well as monohydrocalcite signal (marked with MHC on the graph) and the pure 5-FU powder (lower). [1]

Slow Release of 5-FU from the Composite Tablets

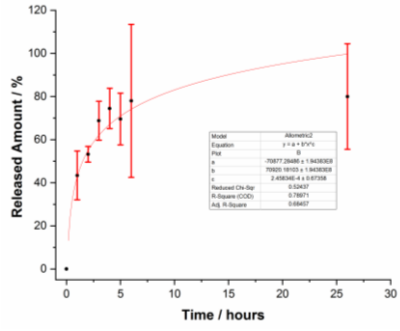

Figure 7. Released amount of FU from the tablet as a function of time. [1]

The amount released was quantified and plot against the time, with the 5-FU released given as percentage of the total amount of drug contained in the tablet. No 5-FU release could be detected in the first hour of the experiment, however after the first hour, the released amount had built up to an average of approximately 40%, suggesting a slow release in the first hour but insufficient to surpass the detection limit. The release process continued over the next few hours, reaching a total amount of approximately 80% released in 6 hours. After the 6th hour, the release process had seemingly ceased, as the concentration of 5-FU in the solution was roughly the same after one day

Conclusions and Outlook

The present work is proof that the biogenic calcium carbonate from the shell of the Atlantic Blue Crab has a great potential to be used as a drug carrier. Moreover, it also demonstrates that SERS can be used as a feasible method to study the release process of substances, such as the anticancer drug 5-FU, loaded in biogenic calcite particles. The use of the blue crab shell as a drug carrier presents numerous advantages compared to other classical formulations. The loading process is relatively simple, and the shell needs minimal physical preparation (powdering) prior to its loading with drug solution, making possible the preparation of a large number of composite tablets in a short time period.

References

[1] Lazar, G.; Nekvapil F.; Hirian R.; Glamuzina, B.; Tamaș, T.; Barbu-Tudoran, L. and Cinta Pinzaru, S. Novel Drug Carrier: 5-Fluorouracil Formulation in Nanoporous Biogenic Mg-calcite from Blue Crab Shell—Proof of Concept. Accepted Manuscript, ACS Omega, 2021.