



UNIVERSITÀ DEGLI STUDI DI SALERNO



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Alginate hydrogels in drug delivery: from physico-chemical to technological studies of a promising polysaccharide for 3D printing applications.

Dottorando

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Abstract

Focusing the attention on the futuristic concept of personalized medicine, the Ph.D. project aimed to demonstrate the potentialities of hydrogels as a versatile feed material for the semi solid extrusion 3D printing process that could be used as pioneering production process in pharmaceutical field developing innovative and personalized drug delivery systems (DDS).

At the beginning of the activities, a preliminary literature investigation was necessary to identify the most interesting polymeric matrix with the best ratio between potential benefits and challenges. Among the large number of polymers, the alginate was selected due to its biocompatibility and peculiar gelling properties to develop innovative 3D printable inks for drug delivery systems development. The Ph.D. workflow consisted in:

- characterization of the alginate hydrogels to fulfil the printing requirements as well as optimization of all the steps of the 3D printing process;
- possibility to exploit different alginate matrix architecture to produce reproducible DDS
- production of DDS for different application, verifying the possibility to load different active ingredients and to modulate the drug content according to the patient needs.

In the first year, the attention was focused on the development of a co-axial semi solid extrusion 3D-printing process exploiting the in situ gelation at the nozzle during the extrusion. The inks involved in the co-axial process (namely alginate and crosslinking ink, respectively) were optimized to balance their flowability and the gelation requirements reaching a good resolution and reproducibility of the printing process. After the promising results of the feasibility study, in the second year of this Ph.D. program, it was investigated the possibility to apply this process in the pharmaceutical field producing floating DDS with two different APIs (i.e. propranolol hydrochloride, and ricolbendazole). Both DDS showed very interesting technological characteristics, such as the dosage flexibility or the buoyancy properties tunable varying the digital model and/or the ink composition.

Differently, between the second and the third year, the keystone exploited for the application of alginate as 3D printing toll was the modulation of the physico-chemical entanglement between alginate and calcium. In detail, thanks to several analytical technologies, a physico-chemical characterization of crosslinked alginate hydrogels was carried out to establish a protocol for the development of advanced printable alginate inks. During the visiting period at Biomaterial Institute of Friedrich-Alexander University, Erlangen-Nuremberg, under the supervision of Prof. Dr.-Ing. habil. Aldo R. Boccaccini, I expanded my expertise about analytical techniques useful for physico-chemical characterization of biomaterials, such as alginate. This knowhow improvement led to the possibility to optimize these inks adding APIs as well as functional excipients to better define and adapt the final properties of the printed DDS, from gastro-resistant to easy-to-swallow tablets.

