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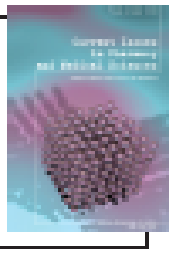

# Flow rate effect on partially modified potato starch microspheres formation process

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ABSTRACT

Natural biopolymers are the most likely choice for biomedical applications, and starches can be considered the best materials for such applications. This comes from the fact of their natural origin and their high biodegradable behavior. Native starches have weak hydrogen bonding and a leaching behavior – making it a candidate for drug delivery application. Still, to make starch useful as a drug delivery carrier, this hydrogen bonding must be strengthened. In this work, native sweet potato starch was used, and the hydrogen bonding between starch molecules was enhanced by introducing glycerol as a hydrogen bonding source and sodium alginate (SA) as a thickener. This blend was tested by means of FTIR and DSC, and based on the test results, improved hydrogen bonding had taken place. Furthermore, potato starch microspheres were successfully produced at different flow rates. In the work, a microfluidic capillary device was harnessed to form microsphere generating total flow rates ranging between (0.00031 and 0.00054) $cm^3$/sec. Herein, a starch/sodium alginate/glycerol mixture was used as a dispersed phase and PVA+tween 80 was used as continuous phase. At high flow rates (0.00062-0.00054) $cm^3$/sec, the microspheres took an oval shape. At flow rates (0.00034-0.000048) $cm^3$/sec, the microspheres took a spherical shape. At very low flow rate (0.00031) $cm^3$/sec, the microspheres shell was weak and caused core oozing. In this work, starch microspheres were successfully formed with diameter ranging from (151-263) μm.

## INTRODUCTION

Two types of difficulties arise when working with biopolymer solutions; the phase diagrams are not universally established and need to be redrawn for any new sample, and immiscibility of synthetic polymers in organic solvents is based on the Flory-Huggins lattice theory (FH) [1]. Polymer microspheres are one of the most common coating types in medicament manufacture and hold several advantages, including encapsulation for many types of drugs such as small molecules, proteins and nucleic acids and are easily administered through a syringe needle [2].

Starches are composed of α-d- glucose with the general chemical composition of $(C_6H_{10}O_5)_n$ and consist of two different polysaccharide molecules (the linear amylose and the highly branched amylopectin). As starch granules are exposed to hot water they swell, lose their crystallinity and leach amylose as they absorb water. As amylose content increases in starch, its swelling ability will decrease, and gel formation will be poor. To improve starch's ability to dissolve in water, chemical and physical modification processing methods produce functional groups that include cross-linked, oxidized, acetylated, hydroxypropylated, partially hydrolyzed molecules. The modification process help strengthen the hydrogen bonding that enhances the ability of starch to form stable gels without leaching [3-5].

Sodium alginate forms hydrogen bonding with water and inter/intra-molecular hydrogen bonding within sodium alginate itself. These bonds break up upon heating, making sodium alginate pass through three states: hydrogen bonded with water → hydrogen bonded with O5 → relatively free, this confirms the existence of inter/intra-molecular hydrogen bonds relating to hydroxyl groups in sodium alginate chains [6]. Besides the strong hydrogen bonding between starch and sodium alginate, low concentrations of glycerol decrease mobility of starch molecules because of the increasing hydrogen bonding that enhances intermolecular interaction [7].

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