# (Bio)polymeric particles for agents' encapsulation to achieve active systems for various applications

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## Introduction

Bio-based materials have great potential as carriers for various cargo transport and its controlled release. Thanks to encapsulation and/or entrapment within the matrix of a carrier material, it is possible to add active agent into these materials to control the release of the active substance. Encapsulation is an advanced modern technique of agent modification that has widespread use in the food industry, agriculture, or medicine. It can be used to protect sensitive compounds against degradation or to mask the bitter taste of active pharmaceutical ingredients or a supplement and provide controlled and targeted release of the active substance. In this study, phytochemicals, and model dyes, such as curcumin, and Nile red, respectively, were incorporated into biodegradable and biopolymeric materials (polycaprolactone, sodium alginate) under various conditions.

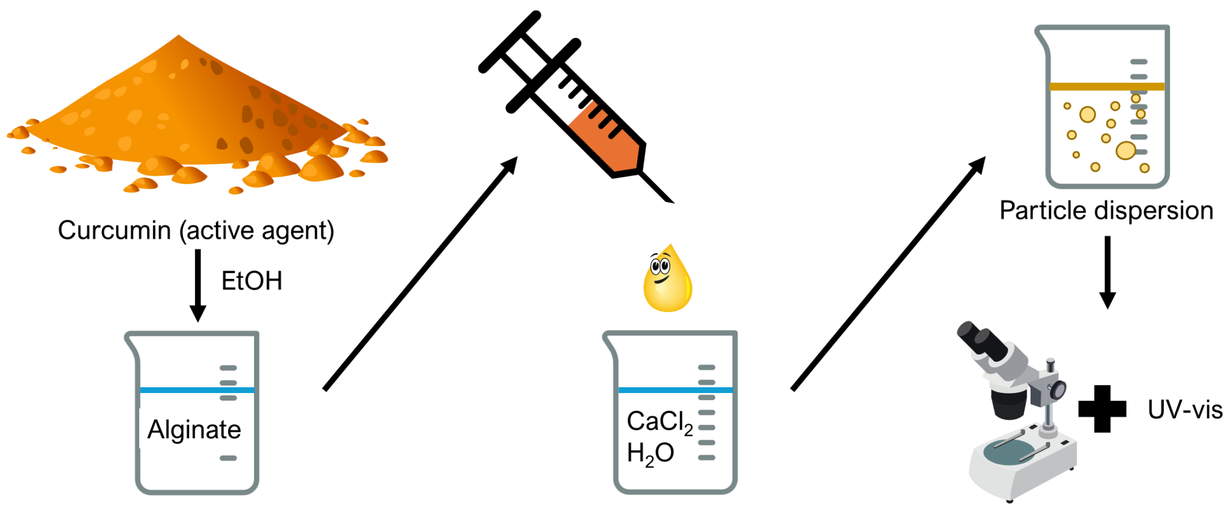
## Objectives

- Prepare alginate and polycaprolactone(PCL) capsules/wires via emulsion method; study their morphology via optical microscopy
- Determine Encapsulation efficiency for prepared capsules/wires

## Materials and Methods

Alginates:

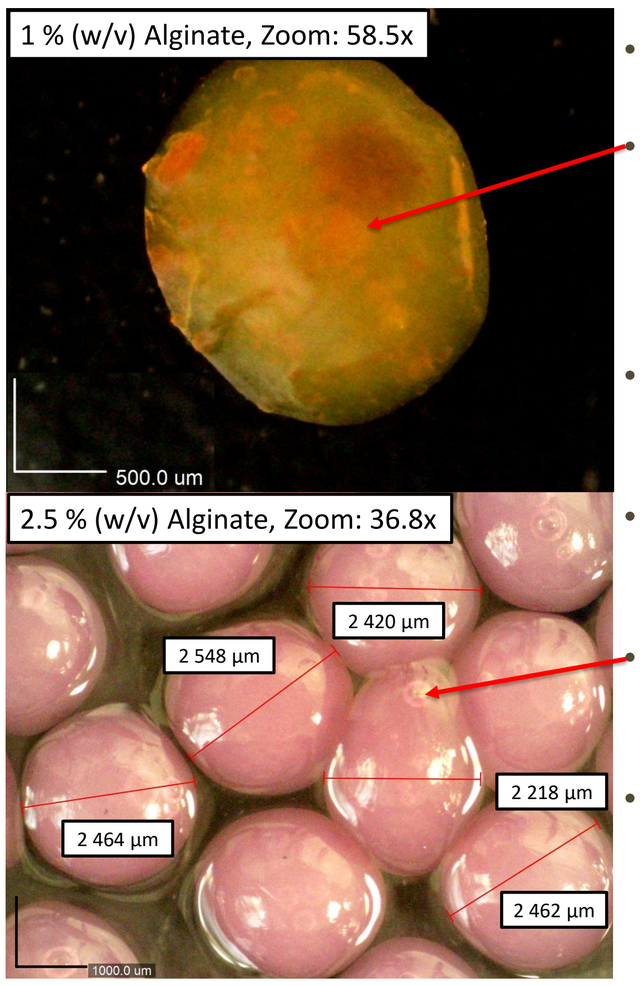
- Ethanol (p.a.) solutions were prepared (0.02 w/v curcumin, 0.0005 w/v Nile red)
- Ethanol solutions were mixed with aqueous alginate solutions (1, 2.5, 5 % w/v, demi water 0,2 µS/cm) and mixed for 1h with lab shaker (400 rpm)
- Aqueous alginate solution was slowly added with syringe into aqueous $CaCl_2$ solution (0.1 w/v) while stirring (600 rpm)
- Formed alginate capsules/wires were left to dry and analyzed via UV-vis spectrophotometry (Jasco V-730) to determine encapsulation efficiency; morphology was studied via optical microscopy (Dino-Lite)




Polycaprolactone:

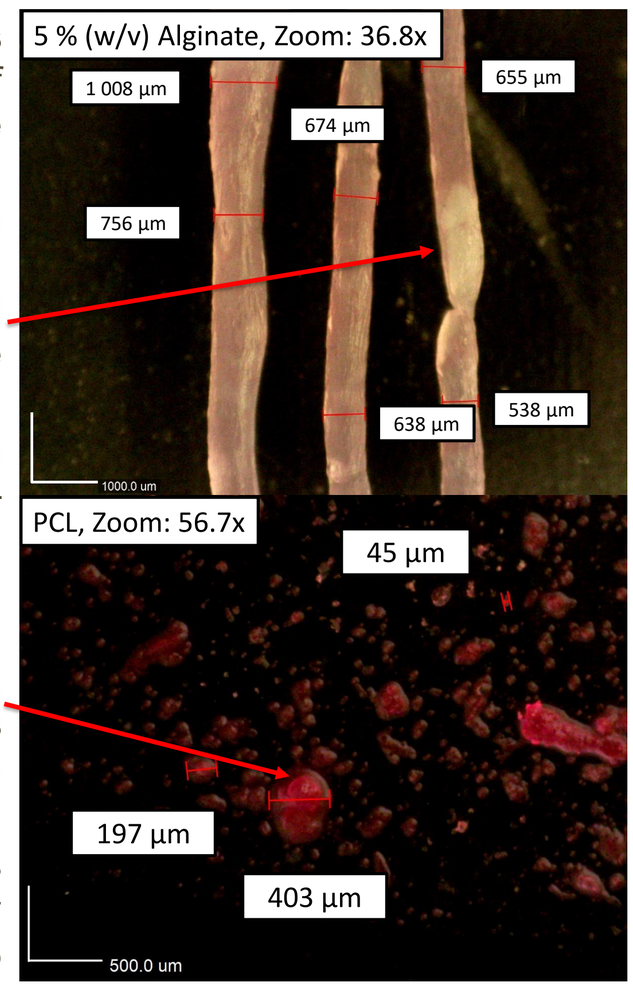
- Ethanol (p.a.) solutions were prepared (0.02 w/v curcumin, 0.0005 w/v Nile red)
- Dichloromethane (p.a.) polycaprolactone (Cellink, Mn 50,000) solution was prepared (0.01 w/v) and mixed with active agent ethanol solutions
- Dichloromethane (DCM) solution was slowly added with syringe into aqueous surfactant (Tween 80, HiMedia) solution (0.02 v/v) while stirring (600 rpm)
- Formed polycaprolactone capsules/wires were left to dry and analyzed via UV-vis spectrophotometry (Jasco V-730) to determine encapsulation efficiency; morphology was studied via optical microscopy (Dino-Lite)

## Results




- 1 % (w/v) Alginate easily formed spherical capsules
- Within the capsule, there are coagulated curcumin pockets, this coagulation is likely caused by delay between dispersion and alginate crosslinking via $CaCl_2$
- Curcumin pockets may be caused by degraded naturally occurring curcumin
- 1 and 2.5 % (w/v) alginate capsules have Nile red distributed evenly
- 2.5 % (w/v) Alginate Nile red capsules have bubbles inside, caused by the stirring process
- Particle size ranges 1,591 – 2,437; 1,975 – 2,547 µm for 1 and 2.5 % (w/v) alginate capsules respectively

- 5 % (w/v) Alginate formed protruded capsules/wires; this is caused by high viscosity of higher content of alginate in the solution
- High viscosity of 5 % (w/v) alginate causes decreased robustness of the method and formation of parts without active agent
- PCL particles were finer, with high range of particle size (<45 – 403 µm)
- PCL particles had "hollow" casing with active agent within, in contrary to coarser particles; this phenomenon causes decrease in encapsulation efficiency of finer capsules
- Encapsulation efficiency was quantitative (100 %) efficiency for alginate capsules (1, 2.5, 5 % w/v), PCL 73.8, 33.2 % for Nile red and curcumin, respectively.

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## Conclusions

- The concentration 5 % (w/v) of alginate is maximal due to high viscosity unsuitable for spherical capsules, manufacturing and distribution of active agent
- With decreasing capsule size, encapsulation efficiency decreases
- Used method provided capsules with high encapsulation efficiency and wires with high encapsulation efficiency

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