Supporting information

Fabrication of thermo-responsive multicore microcapsules using a facile extrusion process

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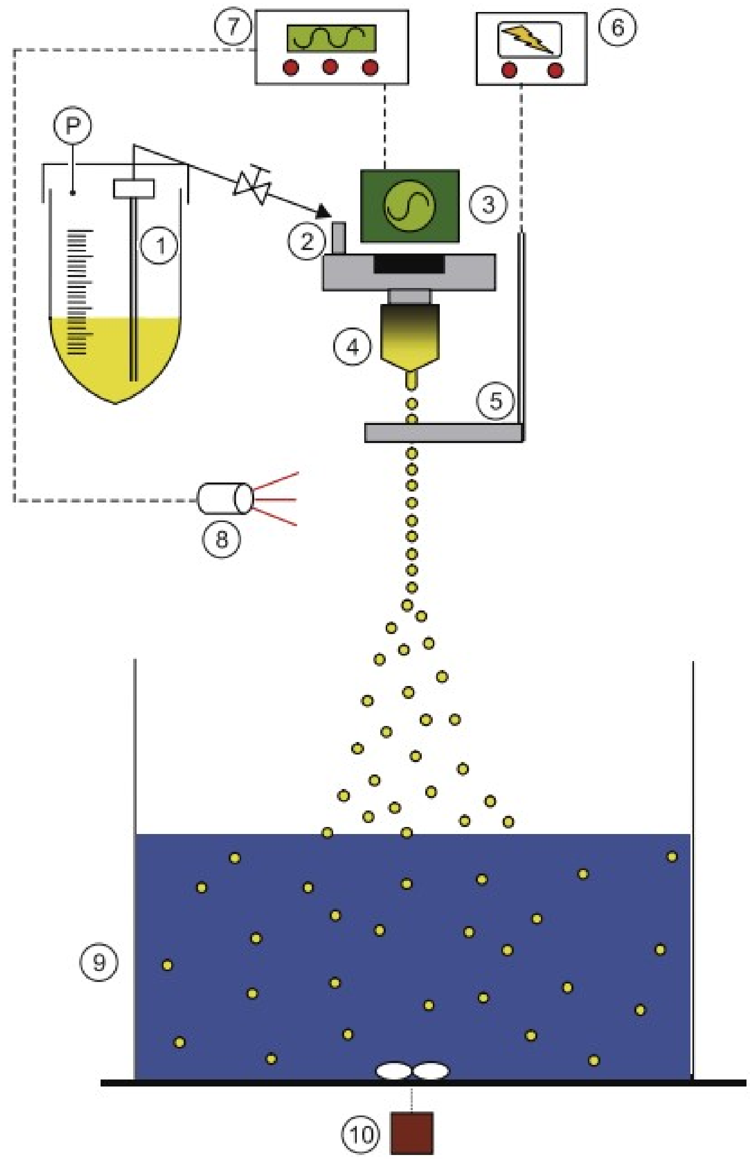

Figure 4-1: Schematic representation of the Encapsulator B-390

1. Pressure bottle
2. Bead producing unit
3. Vibration unit
4. Single nozzle
5. Electrode
6. Dispersion control
7. Vibration control
8. LED/stroboscope
9. Polymerization bath
10. Magnetic stirrer

(P) Air pressure

Figure S1: Schematic representation of the encapsulator B-390

Reference: OM_11593477_B-390_en.pdf (buchi.com)

Single nozzle procedure

A single nozzle can be used to form beads (or capsules by coacervation). The encapsulant liquid was first added to the pressure bottle connected to the encapsulator. The latter was connected to a gas tank (compressed air or nitrogen) to create pressure that would allow the liquid to flow through the tubing. The flow of the liquid could be regulated by the flow valve prior to its entrance to the bead producing unit, which in turn formed small droplets when it prilled the solution out of the nozzle. A strobe light is included in the machine to help see the individual droplets as they fall into a Petri dish or watch glass placed above the bath. Once a continuous bead chain was obtained, a voltage was applied at the electrode through which the droplets pass to prevent them from aggregating. The electrode gave them a charge, which made them repulse due to electrostatic forces and keep them from sticking together. The watch glass or Petri dish used as protection was then removed to allow the droplets to fall into a stirring hardening bath, grounded by a wire, where each drop can solidify and form a bead or capsule. The beads and capsules were interchangeably stored in water, in a refrigerator (~4 ^{o}C) or at room temperature, unless specified otherwise.

Hot prilling

Hot prilling is a type of extrusion which relies on temperature to solidify the polymer solution used. The temperature is above the melting temperature of the polymer. The type of prilling can be used with any nozzle, following a few deviations from the normal protocol. First, the polymer was loaded into a pressure bottle in a water bath and the temperature was adjusted until it was just above the melting point. The bead producing unit temperature was set to at least 10 ^{o}C above the polymer bath temperature. The temperature of the hardening bath was typically between 5-15 ^{o}C. The polymer solution should not linger in the tubing or in the bead producing unit before or in-between productions as it would clog the instrument.

Experimental conditions for formation of κ-carrageenan (κ-c) single beads (hot prilling)

Method	Single nozzle
Contents	1% K-C
Frequency	2000 Hz
Nozzle size	200 µm
Pressure and/or flow rate	600-900 mbar
Amplitude	4
Voltage	0 V
Bath	2% KCl (10 ^{o}C)
Bath conditions	30 minutes
Nozzle temperature	60 ^{o}C

Experimental conditions for formation of sodium alginate and chitosan multicore microcapsules.

Method	Single nozzle	Single nozzle (double encapsulation to produce multicore microcapsules)
Contents	1% Na-alginate	1/6 Ca-alginate beads in 1% chitosan
Frequency. (Hz)	2000 Hz	400 Hz
Nozzle size (µm)	80 µm	750 µm
Pressure and/or flow rate	60 mL/h	Manually (1000-2000 mL/h)
Amplitude	4	4
Voltage	1000 V	2000-4000 V
Bath	0.1M $CaCl_2$	1% Na-triphosphate
Bath conditions	30 min	1 hour

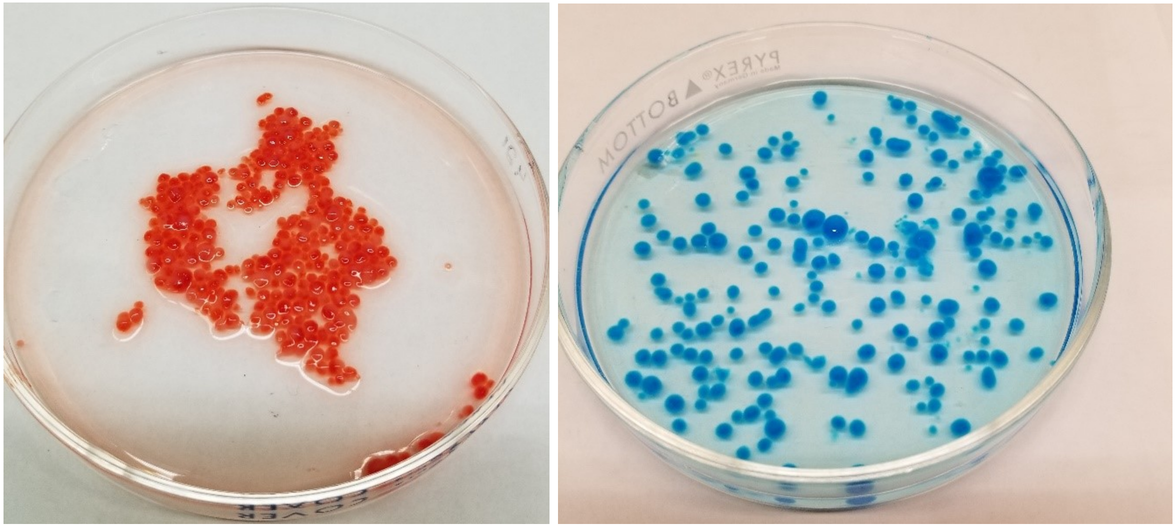

Figure S2: Red and blue κ-carrageenan (κ-c) single beads prior to multicore microcapsules formation