Potential of core- shell hydrogel microcapsule as an efficient tool for use in modular tissue engineering

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Introduction

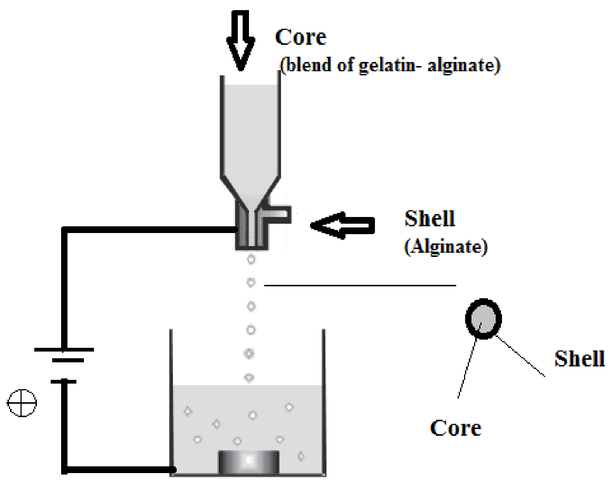
- Modular tissue engineering is emerged as a new approach to construct engineered complicated tissues.
- Applicability and easy fabrication of cell microcapsulation candidate it as building block in this approach.
- Gelatin because of existence of high RGD peptides in structure, can be used as a modifier for alginate hydrogel to improve biocompatiblity and biodegradablity of alginate hydrogel.

Aim of study

- Aim of the work was to utilize a simple one-stage technique for generating core-shell microcapsules which offers numerous attractive features for manufacturing multi applicable cell-laden hydrogel microcapsule for modular tissue engineering.

Experimental Set-Up

- A core tube inter diameter is varied 0.2-0.45 mm and a shell tube inter diameter is 0.9 mm.
- Electro spraying with co-axial nozzle was applied to produce uniform core- shell microcapsule in one stage .



Material

- Gelatin (type A, from porcine skin, bloom 300), alginic acid sodium salt (Medium viscosity) for hydrogel preparation was obtaind from Sigma-Alderich, Germany. Calcium chloride and barium chloride 100 mM used as cross linker was purchased from Merck.

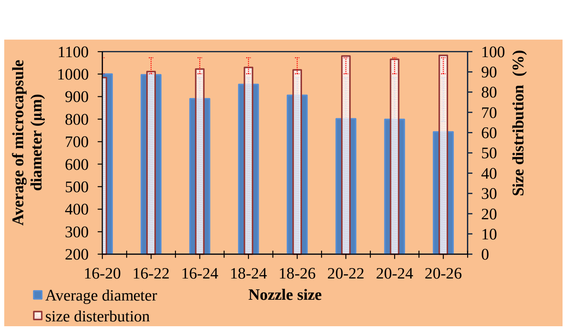
Analysis method

- Core and shell diameter was measured by analysis of image of microscope by image J software.
- MTT assay and hemocytometer cell counting method were applied for evaluation cell viability and proliferation.

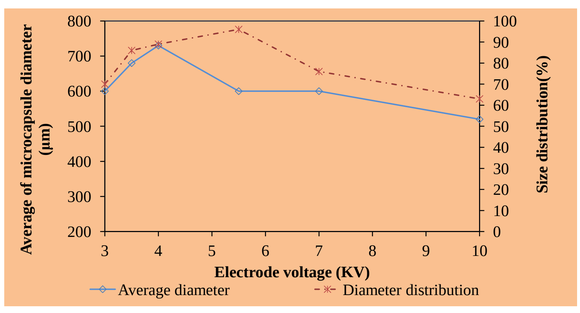
Results

- Some of important operation factors such as diameter of nozzles, voltage, flow rate of extrusion, and distance of gelling bath and nozzle were considered to produce uniform microcapsule.

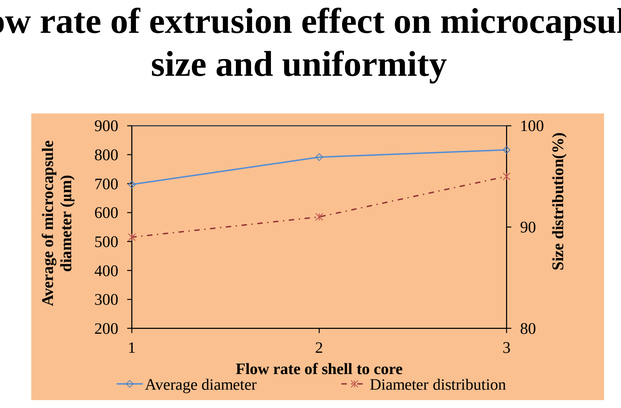
Diameter of nozzles effect on microcapsule size and uniformity



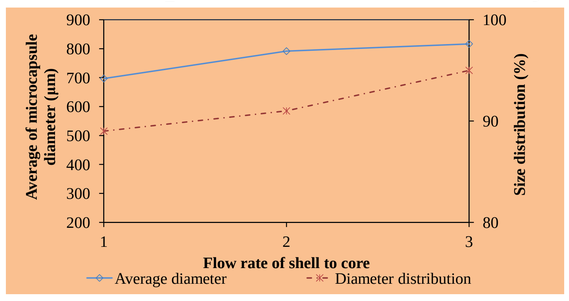
Voltage effect on microcapsule size and uniformity



Flow rate of extrusion effect on microcapsule size and uniformity



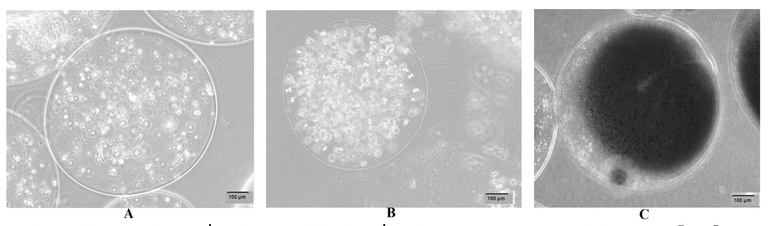
Nozzle distance to gelatin bath effect on microcapsule size and uniformity



Conclusions

- Increasing the flow rate of core to shell decreased shell thickness while uniformity of microcapsules was improved.
- The size of microcapsules decreased by rising voltage and reducing flow rate of core and shell extrusion.
- Flow ratio of 4, applied voltage of 5.5 KV and distance of 2.5 cm could produce the uniform microcapsules with average diameters of 800 and 700 for shell and core, respectively.
- Cell growth analysis using osteoblast cells cultured by initial cell density 1.5 million cells/ml in the cores depicted a 12.9-fold increase after 14 days.
- The core- shell microcapsules improved microenvironment for adherent cell expansion.
- The present study demonstrated that core- shell microcapsules have high potential for using in tissue engineering bottom- up approach as building block for manufacturing organs and complicated tissue.

Culture of 1.5 $\times 10^6$ MG63 cells in Core- shell microcapsule



A. 1st Day, B. 7th Day. C. 14th Day , View: 10. Scale bar 100 µm.

Acknowledgments

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