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கொழும்புப் பல்கலைக்கழகம்  
UNIVERSITY OF COLOMBO

# Multi-Population Microencapsulated Topical Analgesic System Targeting Sustainable Pain Management

R. N. W. Mudiyanseleage<sup>1</sup>, U. Godakanda<sup>1</sup>, R. M. de Silva<sup>1</sup>, K. M. N. de Silva<sup>1</sup>, P. Perera<sup>1</sup>  
Department of Chemistry, Faculty of Science, University of Colombo, Sri Lanka



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## INTRODUCTION

- Chronic-pain management is constrained by opioid dependence, systemic NSAID toxicity, and the burst, short-lived action of conventional topical creams.
- Transdermal co-delivery bypasses first-pass metabolism: capsaicin, a TRPV1 agonist that desensitises nociceptors, paired with methyl salicylate, a salicylate-releasing counterirritant.
- Gelatin–gum acacia complex coacervation encloses both actives, the electrostatic biopolymer wall governing diffusional release.
- Four graded wall thicknesses (0.5:0.5 → 2:2) tune the membrane diffusion path length, staging release from rapid onset to sustained.
- Delivered from a thermoreversible Pluronic F-127 gel, a natural-product, opioid-sparing route to accessible care (SDG 3).

## AIM

- To develop a single thermosensitive gel of graded-wall microcapsules co-delivering capsaicin and methyl salicylate against both neuropathic (TRPV1) and inflammatory pain for sustained, dual-action relief from natural, low-cost resources.

## OBJECTIVES

- Extract capsaicin from local Scotch Bonnet peppers (*Capsicum chinense*) and pair it with methyl salicylate.
- Co-encapsulate both actives by gelatin–gum acacia complex coacervation into four populations of graded wall thickness (0.5:0.5 → 2:2).
- Confirm encapsulation and characterise the microcapsules (FTIR, XRD, GC-MS, encapsulation efficiency).
- Evaluate controlled release and bioactivity (DPPH antioxidant; protein-denaturation anti-inflammatory assays).
- Formulate into a thermosensitive Pluronic F-127 gel and assess sol - gel behaviour for patient-friendly delivery.

## METHODOLOGY



dried & ground



Figure 1 : Scotch Bonnet peppers (*Capsicum chinense*): (a) fresh, (b) dried and crushed for Soxhlet extraction.

## CHARACTERIZATION

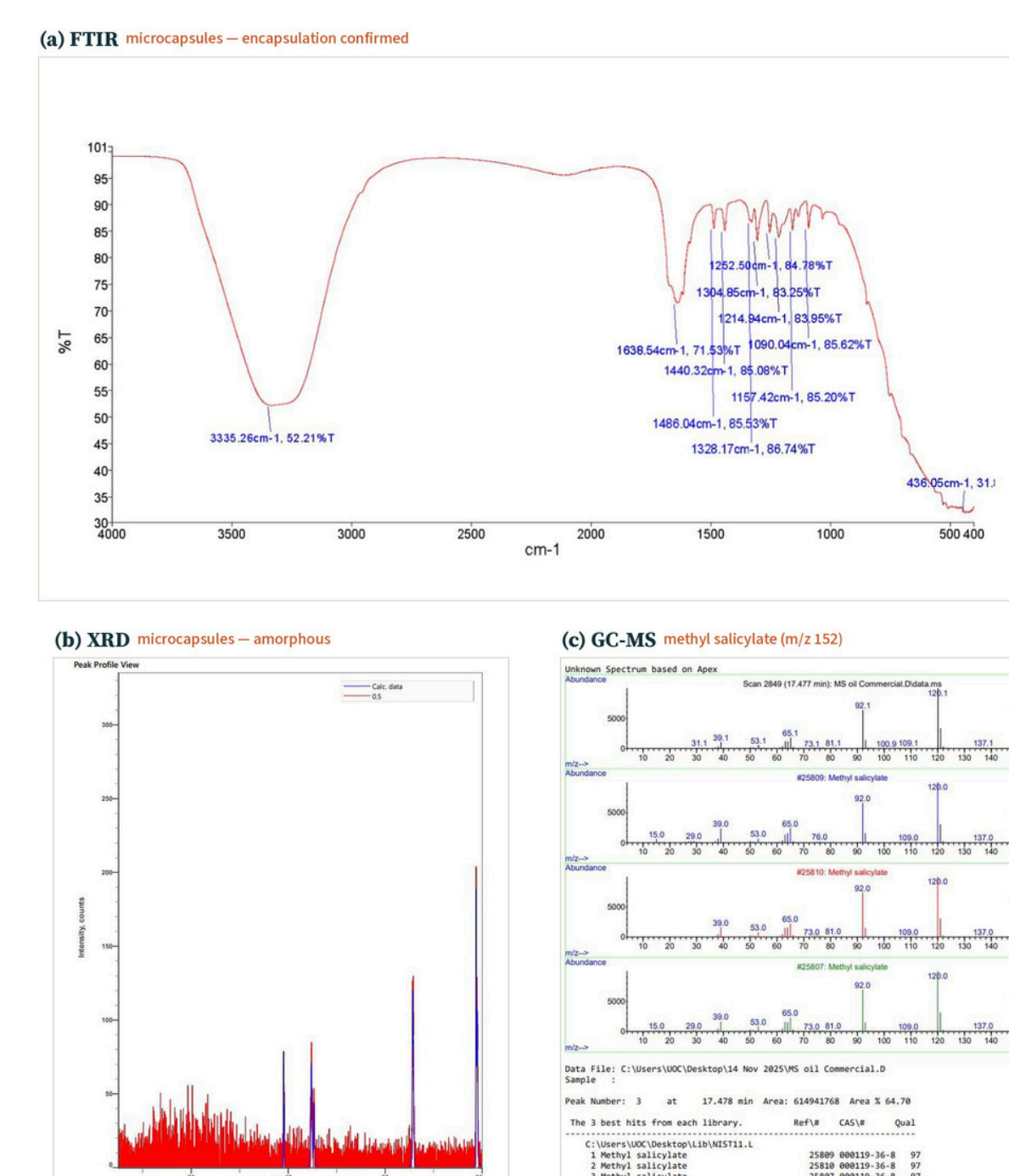


Figure 2 : Microcapsule characterisation: (a) FTIR confirming encapsulation, (b) XRD showing amorphous drug dispersion, and (c) GC-MS identifying methyl salicylate

## RESULTS



Figure 3 : Batch performance vs. wall thickness (B1–B4, 0.5:0.5 → 2:2): (a) DPPH scavenging (↓ 53.9→30.0%, controlled release), (b) encapsulation efficiency (↑ 52.7→60.4%), (c) drug loading (479, 475, 429, 431 mg g<sup>-1</sup>).

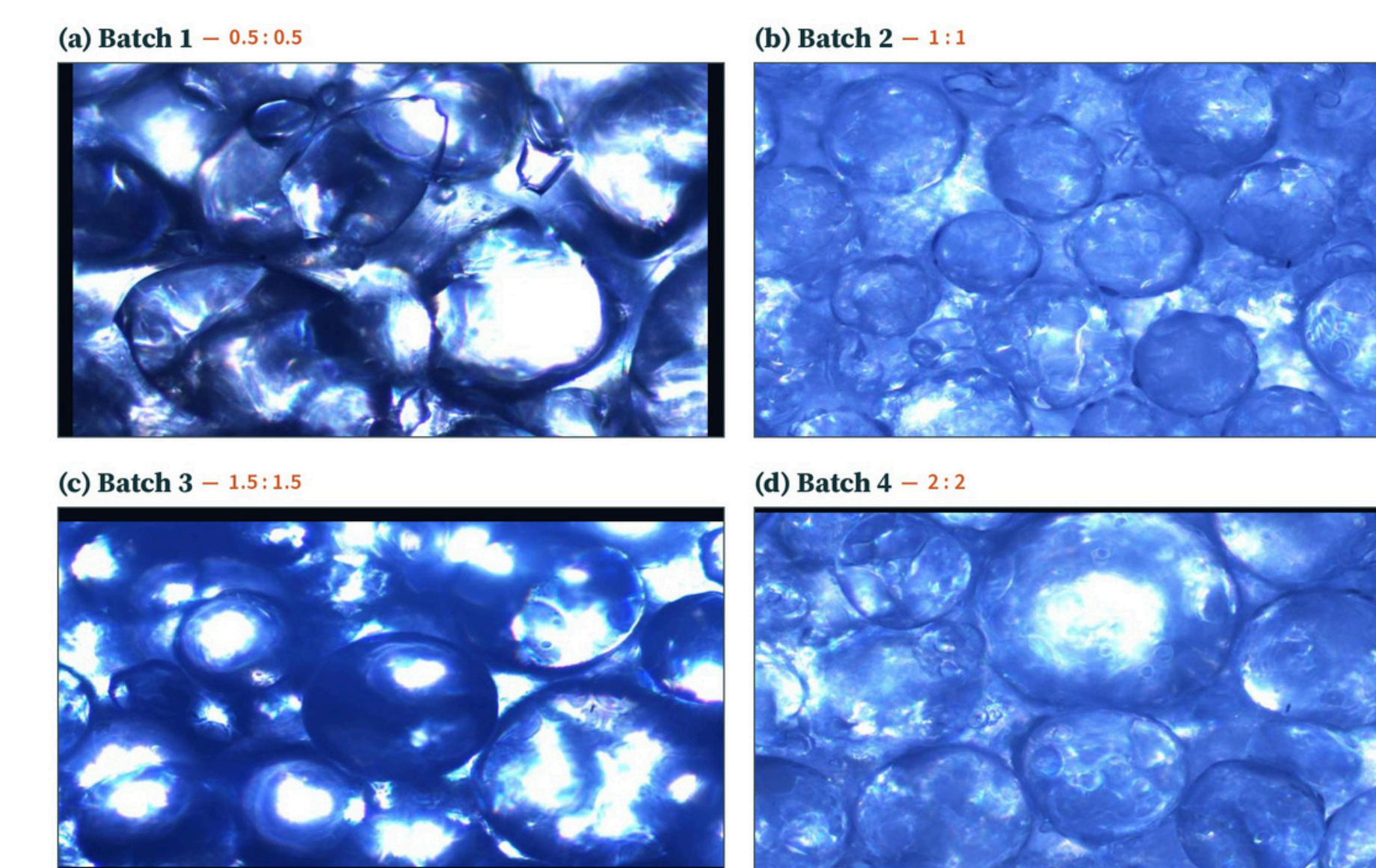


Figure 4 : Fluorescence microscopy (×40) of microcapsules: (a) Batch 1 (0.5:0.5), (b) Batch 2 (1:1), (c) Batch 3 (1.5:1.5), (d) Batch 4 (2:2).

## CONCLUSION

Gelatin–gum acacia complex coacervation successfully co-encapsulated capsaicin and methyl salicylate (EE: 52.7–60.4%; drug loading: 429–479 mg g<sup>-1</sup>) across four wall-thickness populations, achieving staged dual-analgesic release confirmed by FTIR, XRD, and DPPH assays. The resultant Pluronic F-127 thermosensitive gel provides an opioid-sparing, natural-product transdermal platform targeting both neuropathic and inflammatory pain in alignment with SDG 3.

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