

PREPARATION, PHYSICOCHEMICAL, ANTIOXIDATANT, ANTIBACTERIAL AND BIOCOMPATIBILITY STUDIES OF GELLAN GUM-CURCUMIN-TANNIC ACID HYDROGEL AS BIOACTIVE WOUND DRESSINGS

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Introduction

- Global wound care spending: **\$24.2 billion** in **2023**, forecasted to grow to **\$40.2 billion** by **2032** [1]
- Wound dressings: **Advanced**, Surgical & Traditional
 - To accelerate wound healing
 - Minimise risk of infections
 - Prevent secondary injury upon removal

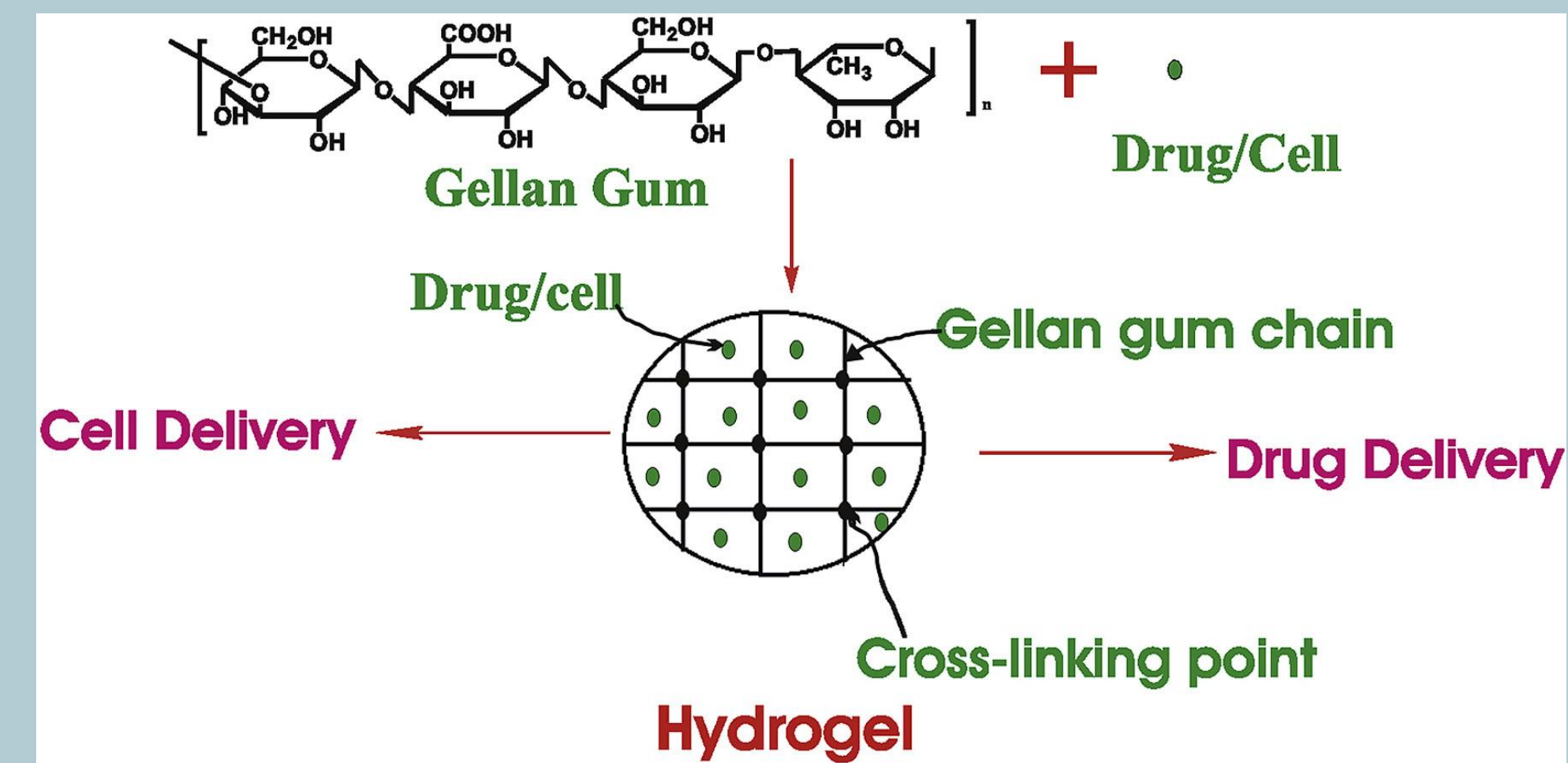


Figure 1: Gellan gum-based hydrogel in drug delivery. [2]

Objective

- To prepare gellan gum hydrogels containing curcumin and tannic acid via ionic gelation and lyophilisation
- To examine the physicochemical properties, antioxidant activity, antibacterial activity and biocompatibility of gellan gum hydrogels containing curcumin and tannic acid

References

- Wound care market analysis, statistics, and future forecast [Internet]. 2025 [cited 2025 Sept 20]. Available from: <https://www.skyquestt.com/report/wound-care-market>
- Das M, Giri TK. Hydrogels based on gellan gum in cell delivery and drug delivery. Journal of Drug Delivery Science and Technology. 2020 Apr;56:101586. doi:[10.1016/j.jddst.2020.101586](https://doi.org/10.1016/j.jddst.2020.101586)
- ISO 10993-5. Biological evaluation of medical devices – Part 5: Tests for *in vitro* cytotoxicity: International Standard; 2009.

Methodology

Part 1: Preparation of gellan gum hydrogels containing curcumin and tannic acid

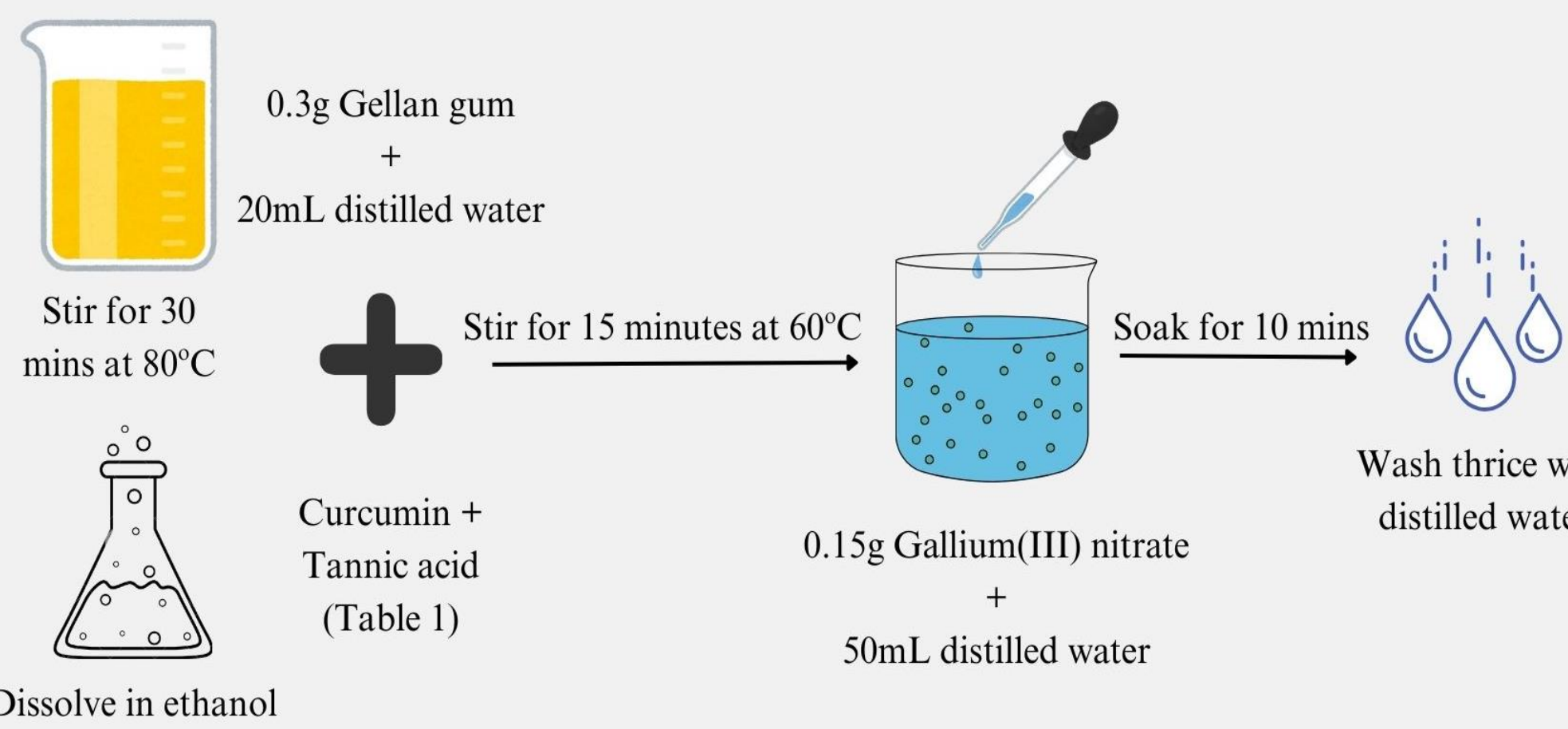


Table 1: Formulation of hydrogels.

Sample	GG (wt%)	Ga (mg/mL)	C (phr)	T (phr)
GG (blank 1)	100	0	0	0
GG-Ga (blank 2)	100	3	0	0
GG-Ga/Cur0.5-TA0.5	100	3	0.5	0.5
GG-Ga/Cur1-TA1	100	3	1	1
GG-Ga/Cur2-TA1	100	3	2	1
GG-Ga/Cur1-TA2	100	3	1	2
GG-Ga/Cur2-TA2	100	3	2	2

*GG = Gellan gum, Ga = Gallium(III) nitrate, Cur = Curcumin, TA = Tannic acid, phr = parts per hundred resin of gellan gum

Part 2: Characteristics of gellan gum hydrogels containing curcumin and tannic acid

Physicochemical properties

- ATR-FTIR spectroscopy
- Scanning electron microscopy (SEM)
- Drug content analysis
- Gel fraction determination
- Swelling analysis
- In vitro* drug release study
- Degradation analysis

Antioxidant activity

Antibacterial properties

Cytocompatibility

Results

1. ATR-FTIR Spectroscopy

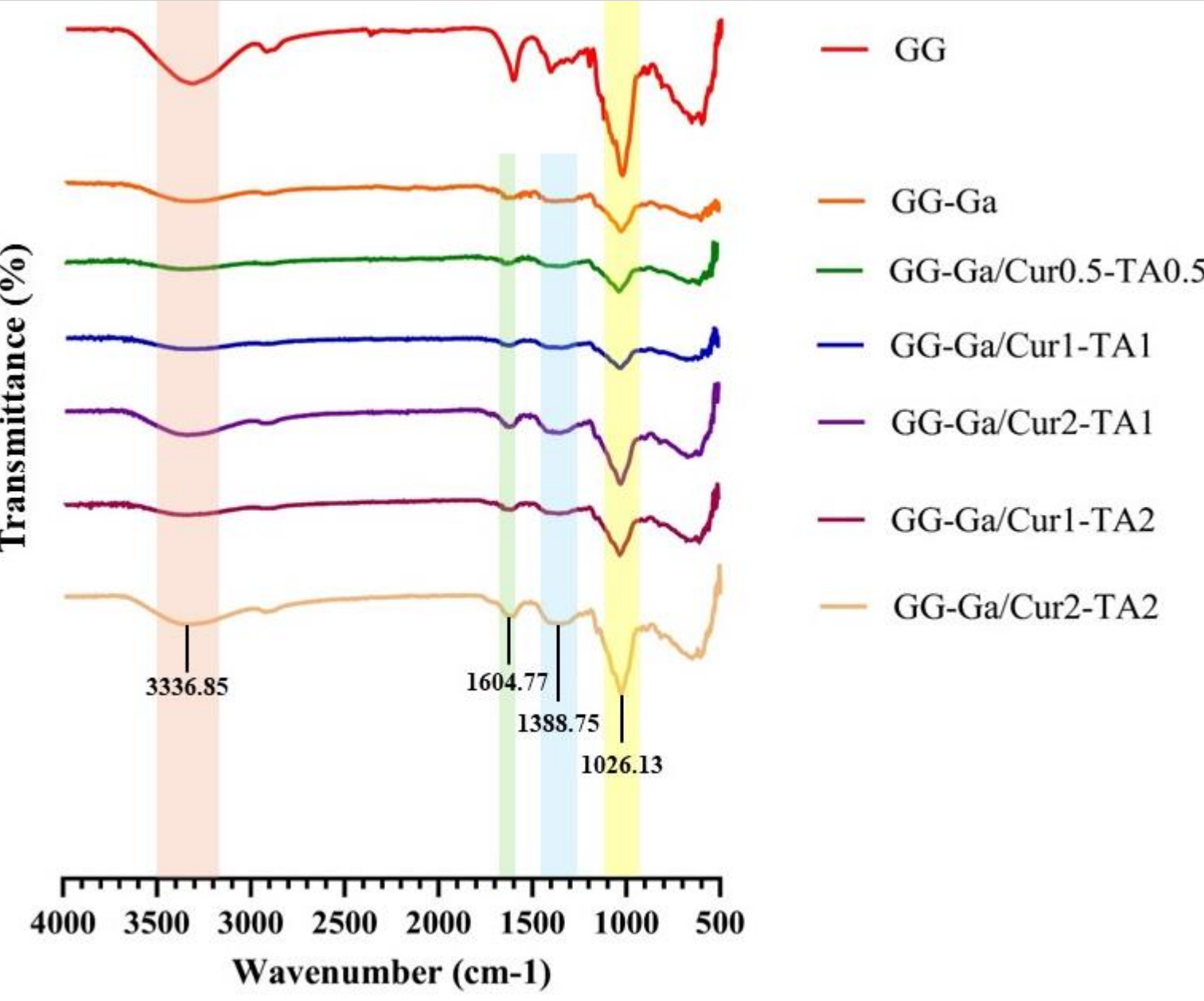


Figure 2: FTIR spectra of hydrogel scaffolds.

2. Scanning electron microscopy

GG, GG-Ga	Smooth surfaces without cracks
GG-Ga/Cur-TA	Increased surface roughness

3. Gel fraction analysis

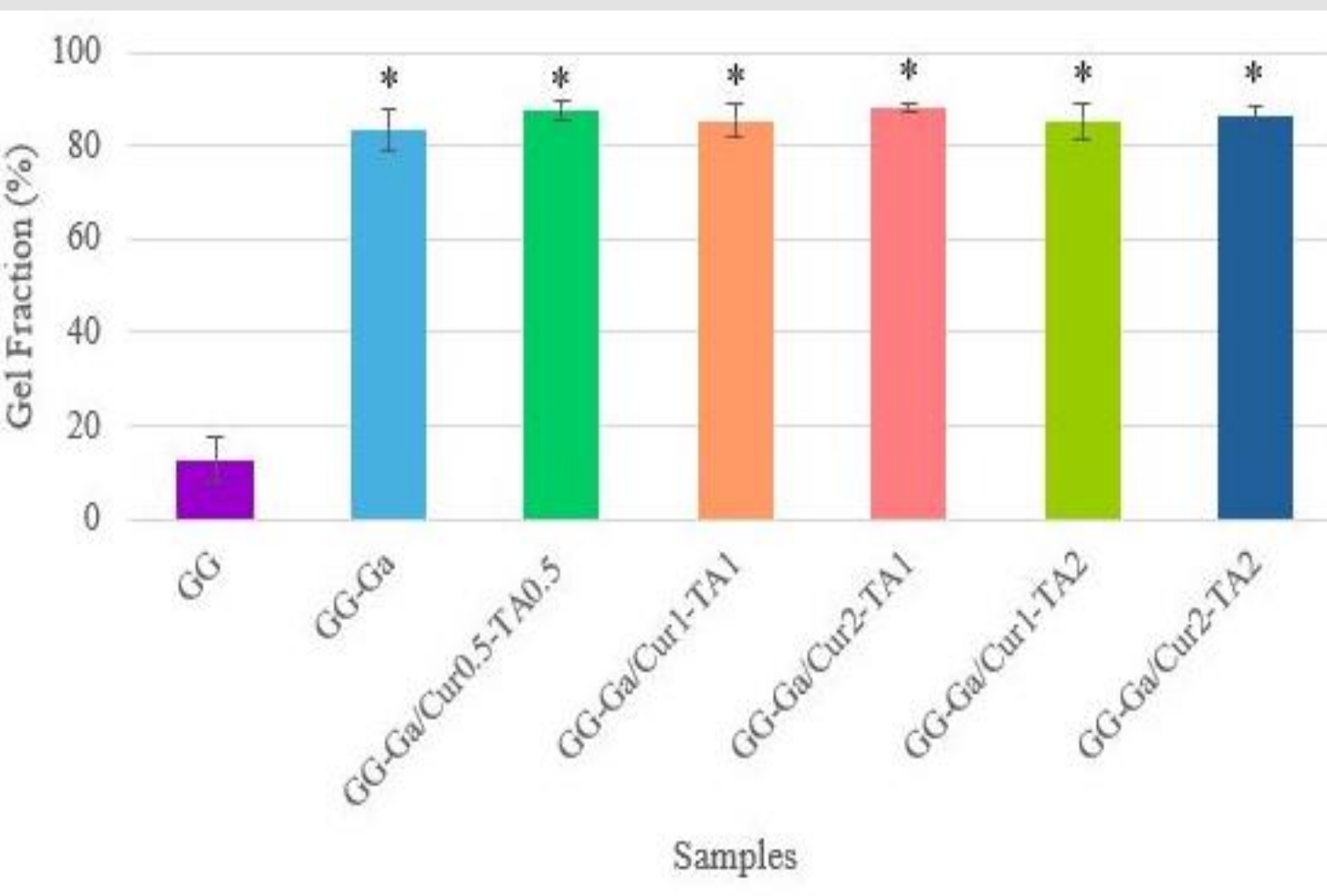


Figure 3: Gel fraction of hydrogel scaffolds, where *p ≤ 0.05 in comparison to GG sample.

→ Cur & TA did not inhibit crosslinking

Functional groups

O-H stretching vibration

Interpretation

Originated from GG and TA
Increase with TA concentration
→ Hydrogen bond

C=O and stretching vibration

Originated from GG, Cur, TA
→ Ester linkage

N=O stretching vibration

Successful incorporation of Ga →
Ionic bond

C-O stretching vibration

Originated from GG
Increase with Cur and TA content
→ Ester bond

5. Swelling analysis

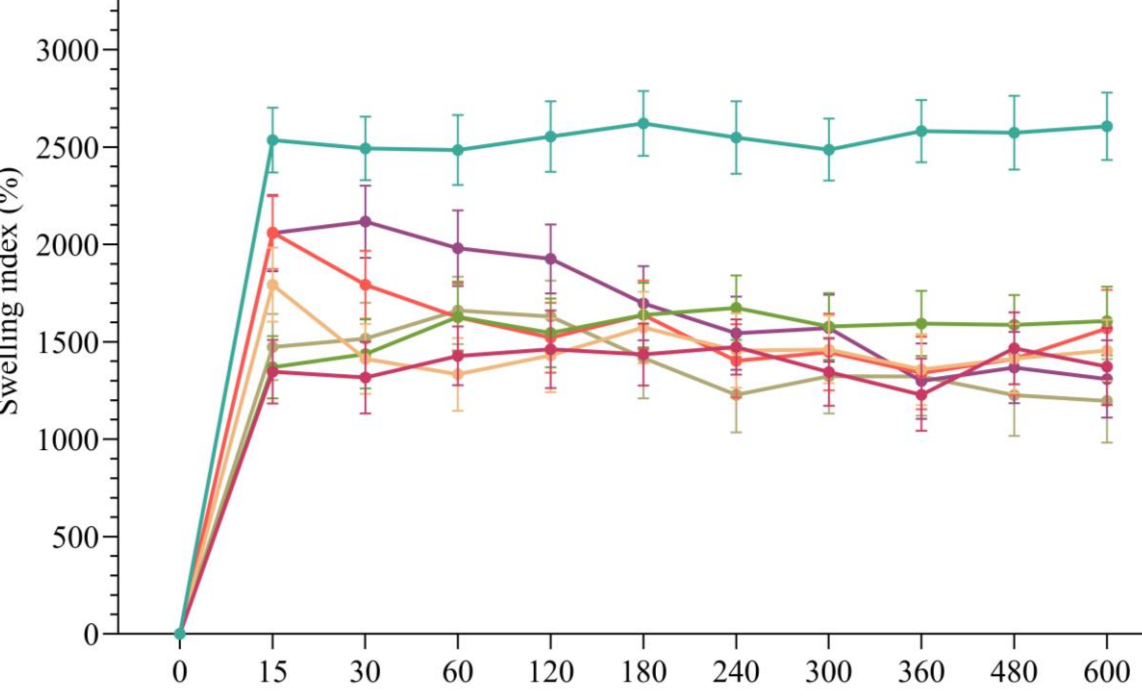


Figure 4: Swelling index of hydrogel scaffolds in 10 hours.

7. *In vitro* release study

0 – 9 hrs	Initial immediate release
9 – 120 hrs	Sustained release

8. Antioxidant activity

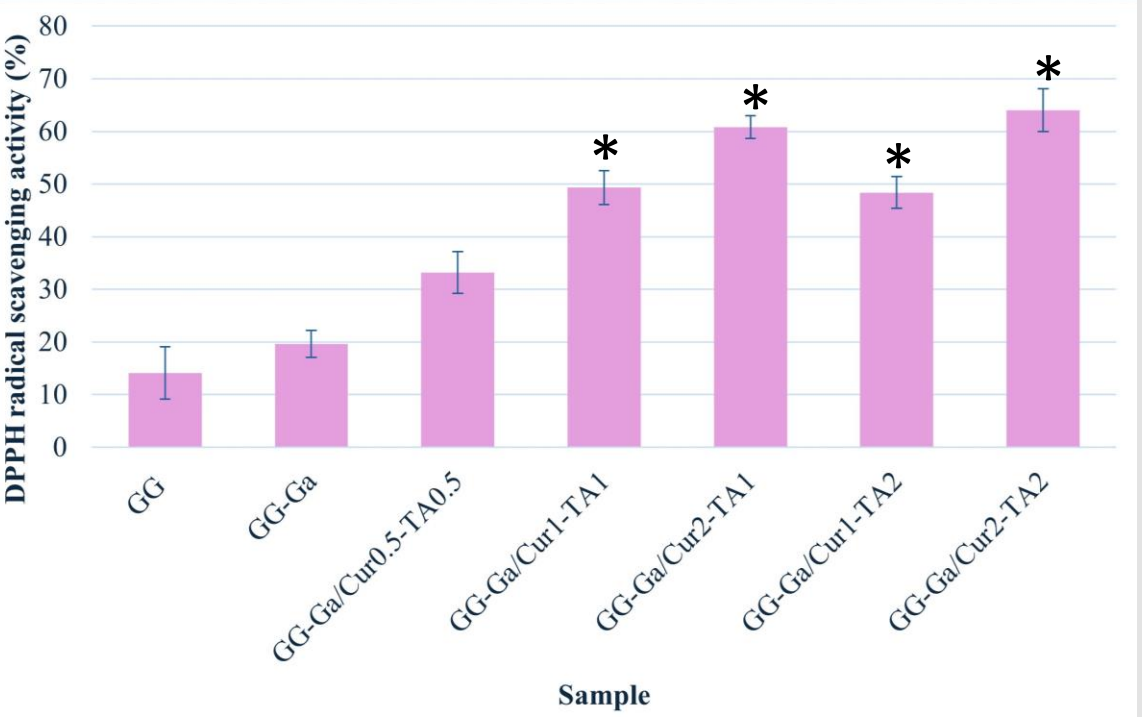


Figure 6: DPPH radical scavenging activity of hydrogel scaffolds, where *p ≤ 0.05 in comparison to GG sample.

9. Antibacterial activity

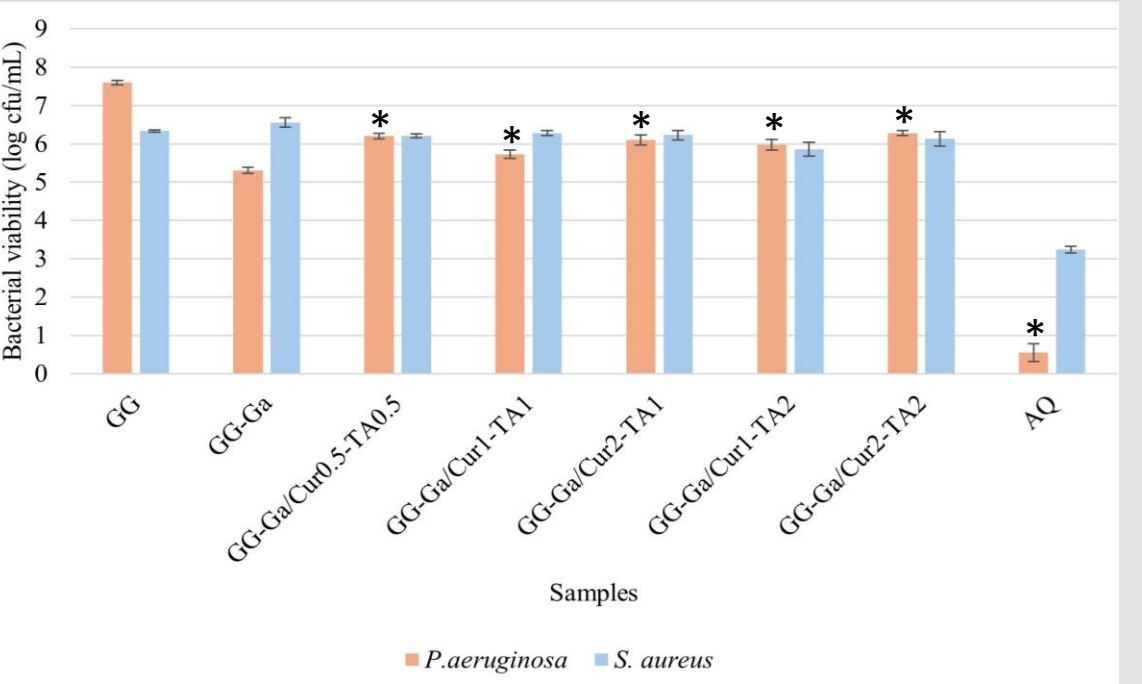


Figure 7: Bacterial viability of *P. aeruginosa* ATCC 27853 and *S. aureus* ATCC 43300 when exposed to scaffolds, GG: Negative control; AQ: Positive control where *p ≤ 0.05 in comparison to the GG sample.

10. Cytocompatibility analysis

All GG-Ga/Cur-TA scaffolds achieved >70% HaCaT cell viability up to 3 mg/mL → Cytocompatible according to ISO 10993-5 standard [3]

Conclusion

Curcumin and tannic acid were successfully encapsulated into gellan gum hydrogels via ionic gelation and lyophilisation. The resulting hydrogels were non-toxic, exhibited improved structural stability, degradation, sustained drug release, antioxidant and antibacterial properties