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Protein Loaded Biomaterial Based Composite Dressings for the Treatment of Chronic Wounds

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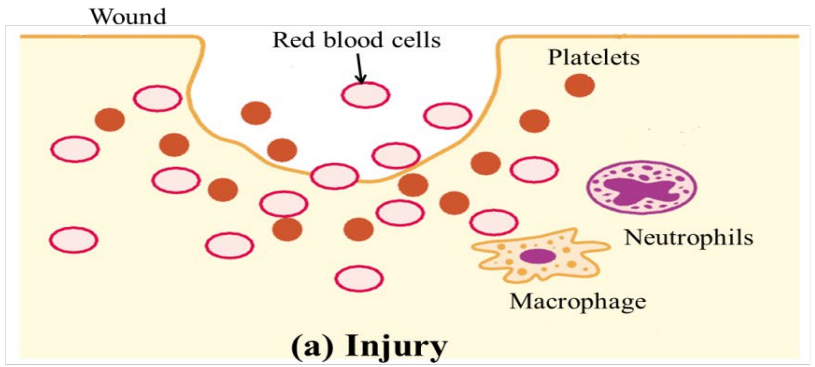
OUTLINE

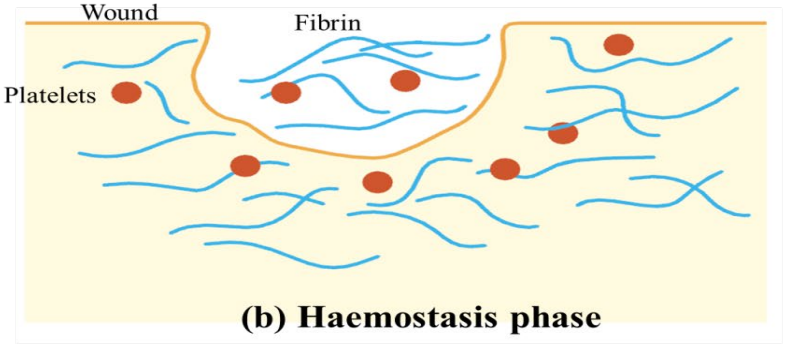
- Background
- Objectives
- Materials & Methods
- Results
- Conclusions
- Future Work

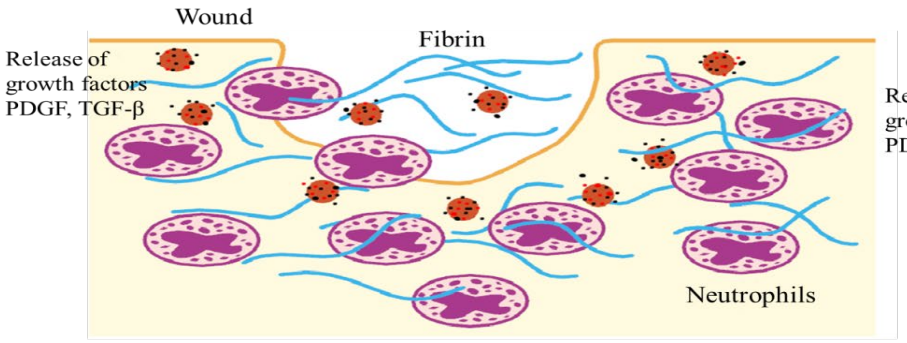
Background

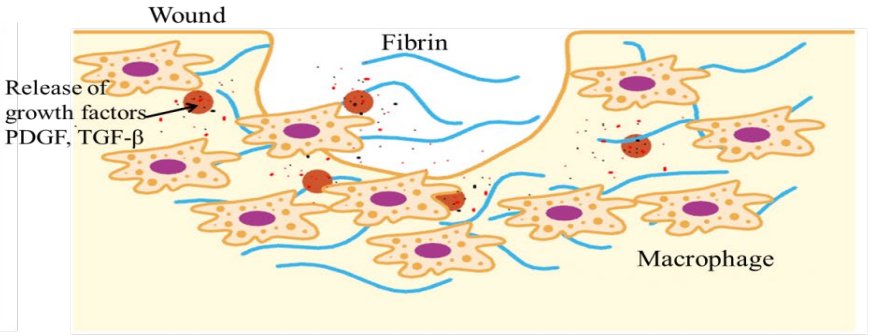
Wound healing is a ***complex process***

- Several biochemical & physiological activities
- Different stages of wound healing

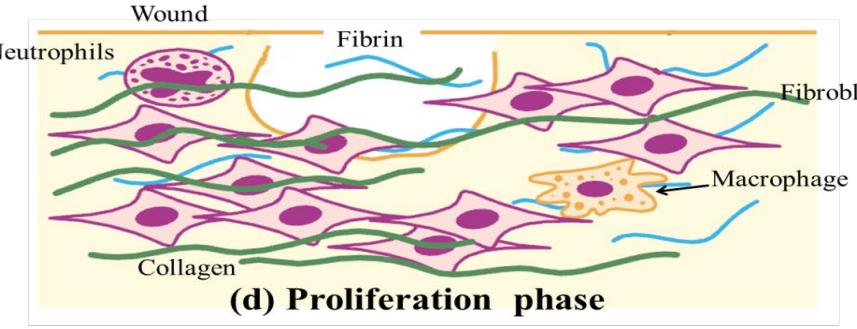


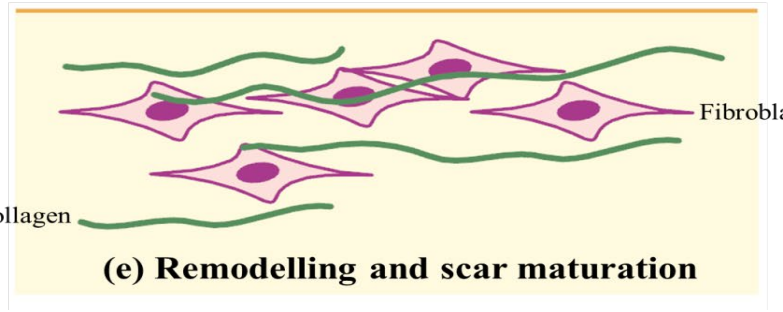






(c) Inflammatory phase





Wound Dressings

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Traditional Dressings

- Gauze
- Cotton
- Gels
- Creams

Modern Dressings

- Films
- Foams
- Hydrogels
- Hydrocolloids

- **Target only one phase of healing**
- **Biologically inactive (passive healing)**
- **Depend on normal body function to heal**
  - **Compromised in chronic wounds**

Advanced Solutions

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1. **Skin Grafts**
2. **Tissue Engineered Skin Substitutes**
   - ❖ Significant tissue loss
   - ❖ Creation of another wound (extremely painful)
   - ❖ Expert personnel required / expensive

3. **Biological Dressings (e.g. collagen)**
   - ❖ Natural skin matrix
4. **Medicated Dressings**
   - ❖ Analgesics
   - ❖ Antibiotics

Biological and medicated dressings are readily available and 'cheaper' than skin grafts and skin substitutes

Why Fish Skin Heals Faster?

- Fish skin recovers from wounds faster than humans due to higher amino acid and collagen content
- Collagen can bind to proinflammatory cytokines and balance MMP levels.
- Proline - enhances protein synthesis
- Alanine - enhances action of camosine to increase granulation.
- Hydroxyproline – improves physical and thermal stabilisation of collagen

Objectives

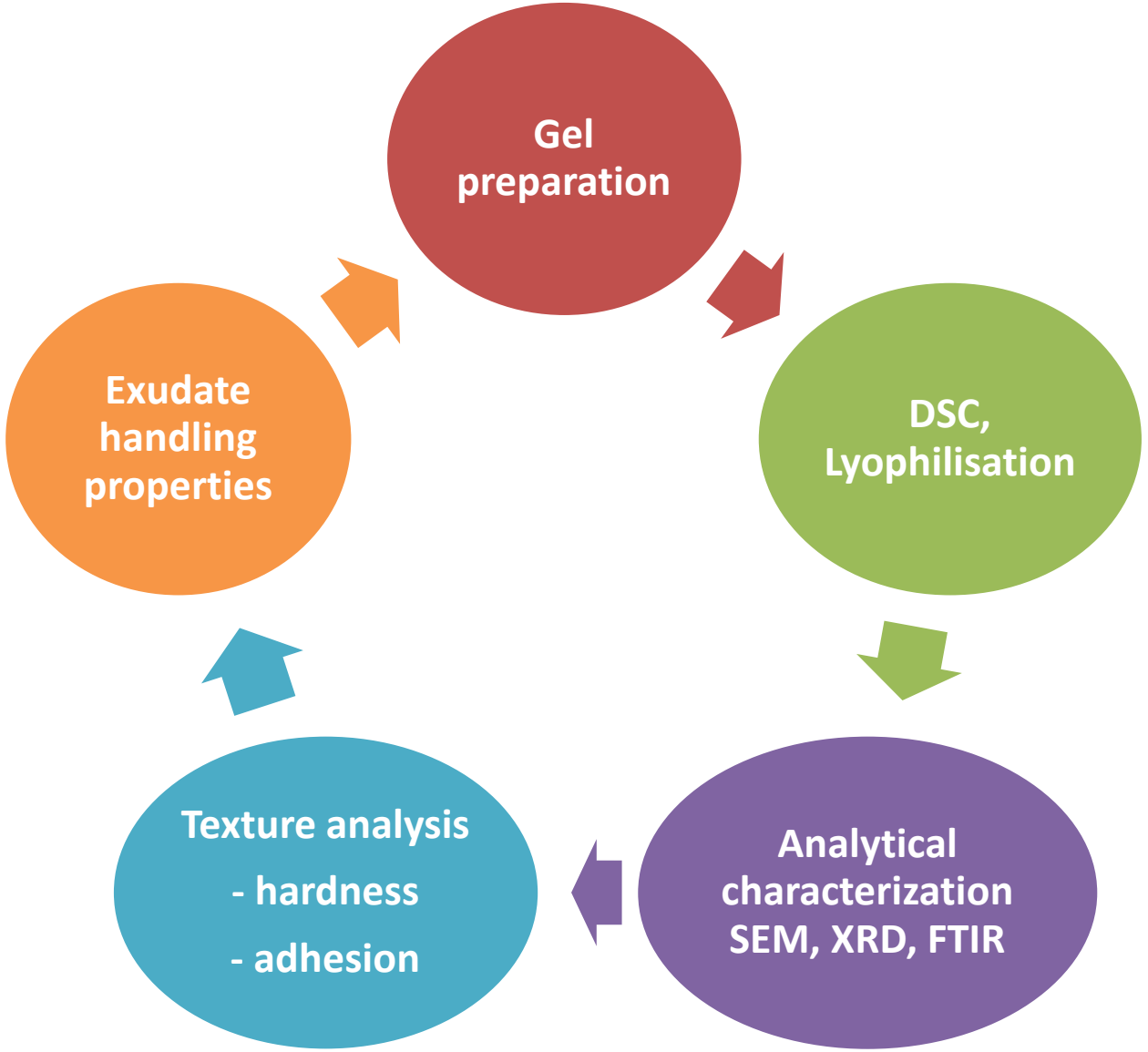
- Develop composite biological / medicated dressing based on fish skin components
- Functional characterization
- Protein delivery for potential treatment of chronic wounds

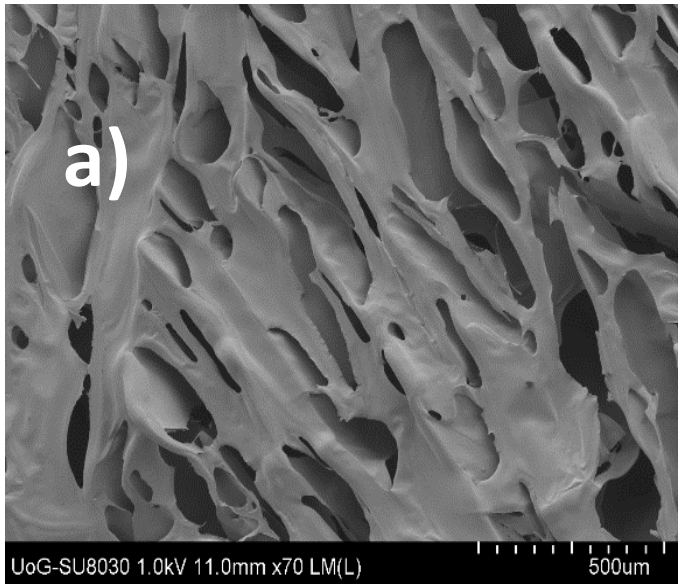
Common chronic wounds

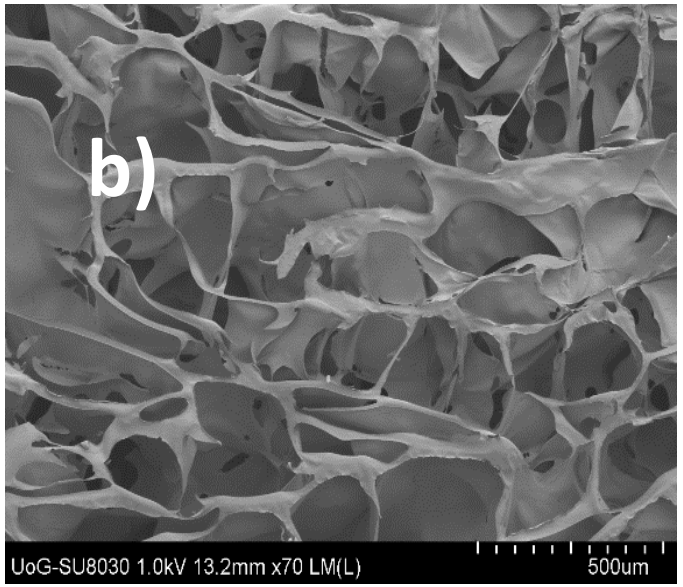
Materials

- Fish collagen (COL)
- Hyaluronic acid (HA)
- Sodium alginate (SA)
- Bovine serum albumin (BSA) – model protein

Methods







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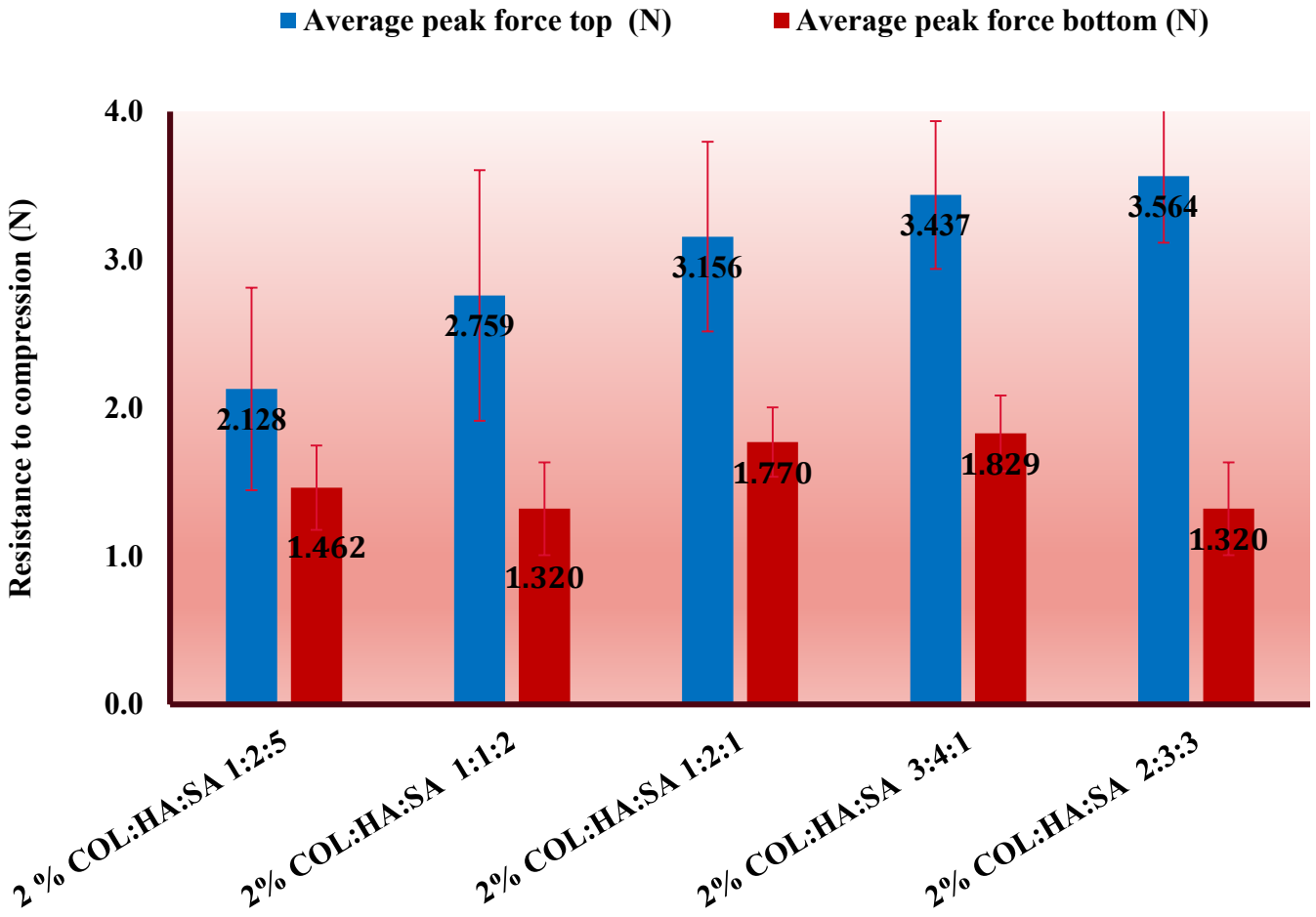
- Alginate grades with (**a**) high mannuronic (M) and (**b**) high guluronic (G) acid contents
- Showed different pore size distributions

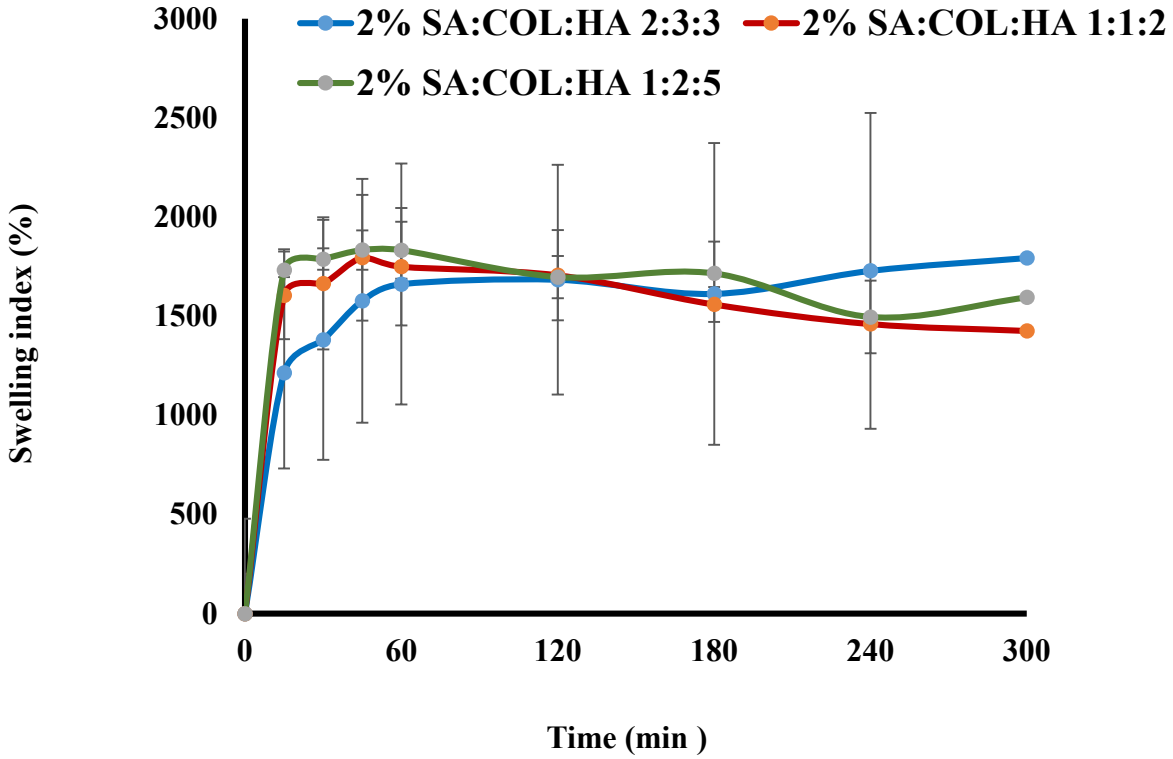
Hardness



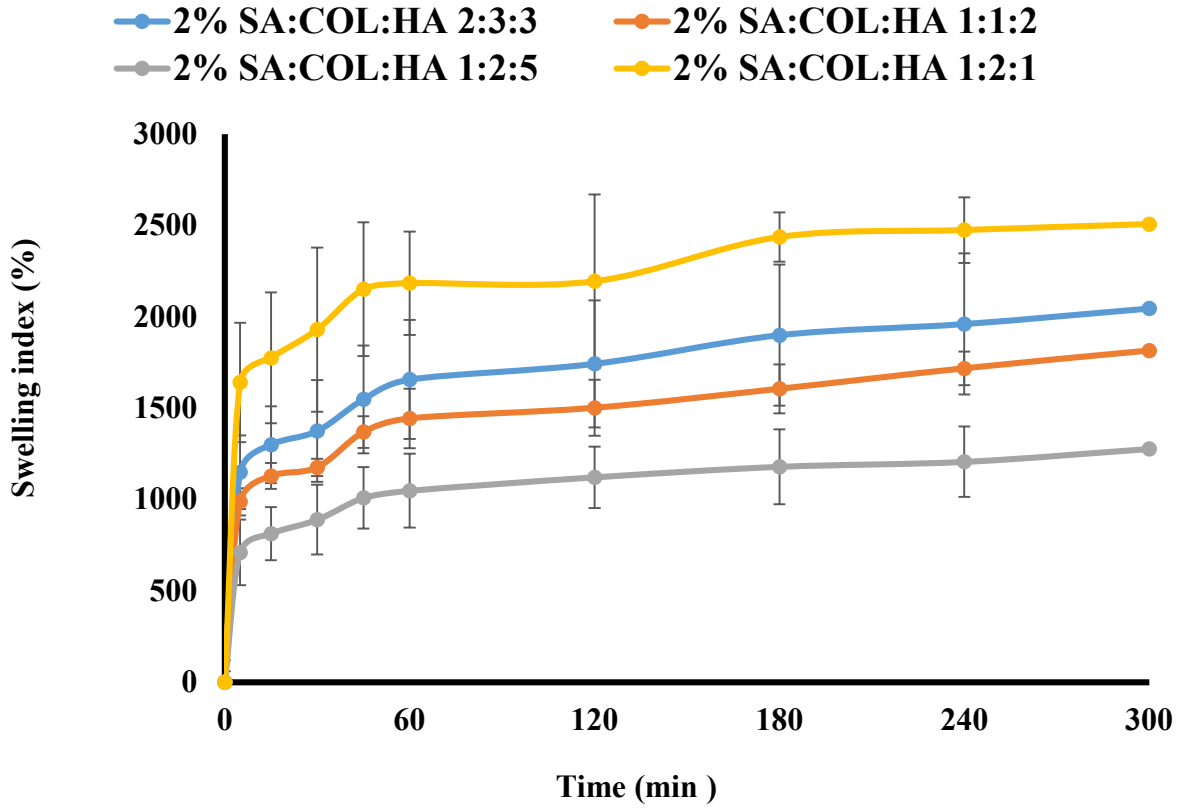
SA with high G content, (n = 3). Compressed on both sides of the wafer

- Impregnation with SA significantly improved the mechanical strength of the wafers
- Indicating interaction between SA and HA
- SA with high G content produced stronger wafers

Swelling



Wafers with high M content



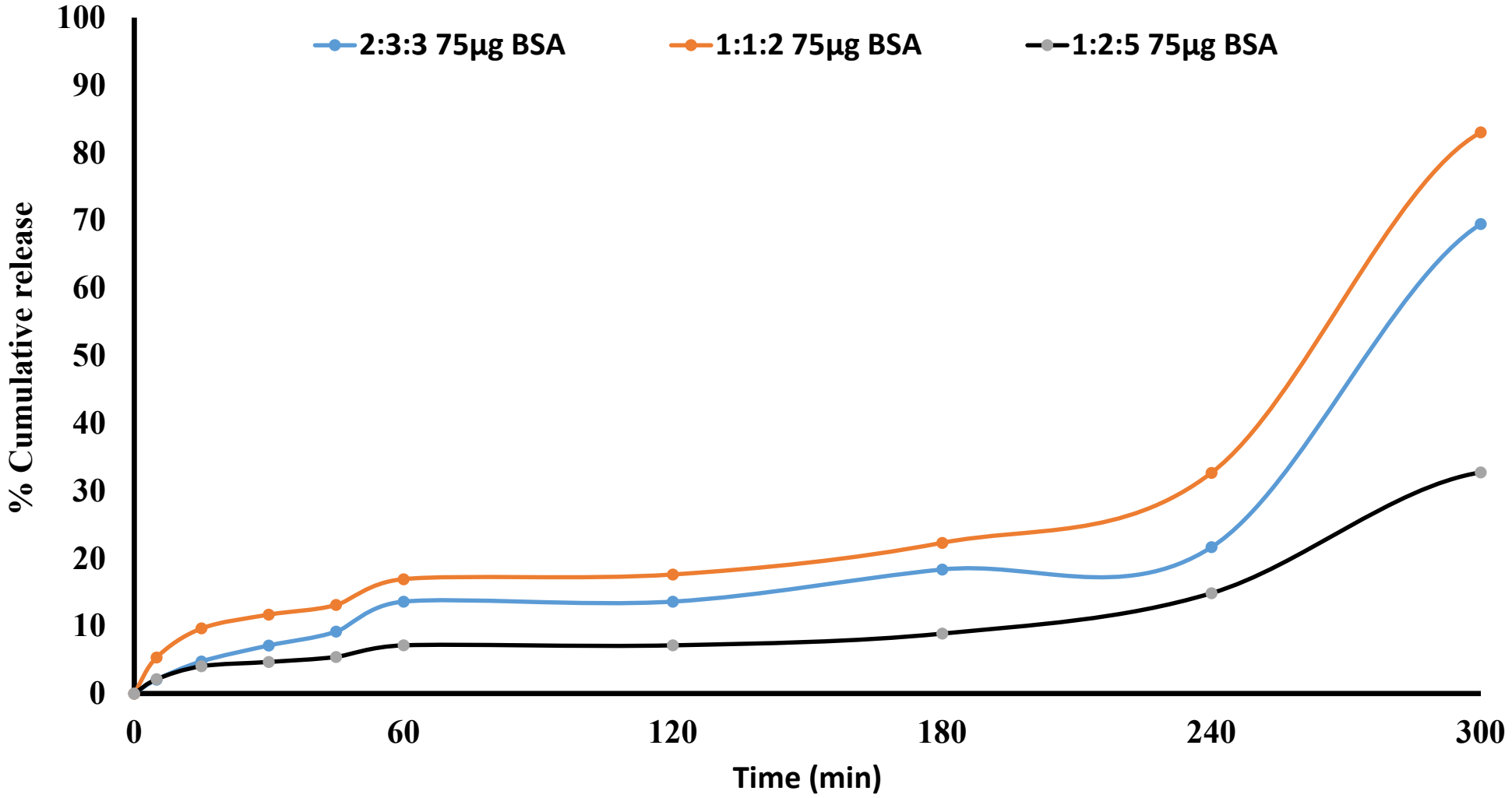
Wafers with high G content

- High G content in SA allowed wafers to swell for longer period which shows their potential application in exudative chronic wounds

Exudate Handling Properties

	High Mannuronic SA				High Guluronic SA			
Sample	Porosity (%) (±SD)	EWC (%) (± SD)	Water absorption (%) (± SD)	WVTR (g/m^2 day^{-1}) (± SD)	Porosity (%) (± SD)	EWC (%) (± SD)	Water absorption (%) (± SD)	WVTR (g/m^2 day^{-1}) (± SD)
SA:COL:HA 1:2:5	79 ± 2	86 ± 5	696 ± 267	2328 ± 22	83 ±2	88 ± 2	843 ± 210	2429 ± 53
SA:COL:HA 1:2:1	76 ± 6	89 ± 4	948 ± 382	2340 ± 35	94 ±16	94 ± 1	1382 ± 20	2183 ± 45
SA:COL:HA 2:3:3	70 ± 4	90 ± 2	956 ± 266	2354 ± 67	94 ±14	93 ± 1	1252 ± 56	2255 ± 41
SA:COL:HA 1:1:2	77 ± 3	91 ± 2	1015 ± 287	2333 ± 63	96 ±9	88 ± 2	793 ± 132	2393 ± 38

In Vitro Drug Release



Wafers containing SA with high G content

Conclusions & Future Work

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- SA with high guluronic acid is able to enhance mechanical stability and functional properties of wafers
- Composite SA: COL: HA wafers seem to have potential for the delivery of proteins to wounds
- However modification of the formulation is necessary to achieve more sustained release
- Optimised formulation will be loaded with growth factor for wound healing testing

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Thank you for your attention

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