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Outline

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- ***Motivation***
- ***Wound Dressings***
- ***Starch-based Blends***
- ***Fabrication of Starch-Based Blends***
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- ***Results and Discussion***
- ***Conclusion***

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Biodegradable and Transparent PVA/Starch-based Composite Films for Wound Dressing Applications

PVA

Starch

DI Water

Citric Acid

Glycerol

Abstract

These days, due to the rapid expansion of plastics (polystyrene and nylon) in various applications, such as biomedical materials, packaging, transport, industry, and agriculture, and global warming, replacing some of those materials in multiple purposes such as wound dressings with biodegradable starch-based films is a step forward in addressing the environmental issues. Due to mechanical debriding of tissues, traditional dressings like gauges are counterproductive and end up causing painful wound trauma during dressing procedures. The development of transparent wound dressing films enables a moist healing environment with enhanced bacterial impermeability.

The performance of polyvinyl alcohol/starch/citric acid (PVA/St/CA) based composite film for wound dressing applications is addressed in this work. A fixed composition of PVA , starch, and glycerol during casting temperature (70-80^{o}C) were implemented, and different Citric Acid concentrations (0.5 to 2g) was investigated during the development of composite film solution casting. Prepared samples have been characterized by swelling index, solubility dependent biodegradability, tensile strength (TS). The film also exhibits enhanced combinations of the water vapour transmission rate and antibacterial efficiency against the bacterial flora (various bacteria existent in the air). As an extra benefit, such materials are easily degraded in water for up to seven days with a minute footprint. A potential candidate for wound dressing applications has been inferred from the biodegradable PVA/St/CA films with all these useful features.

Keywords: Wound Dressing, Biodegradable, Starch, Citric Acid, Polyvinyl Alcohol.

Motivation

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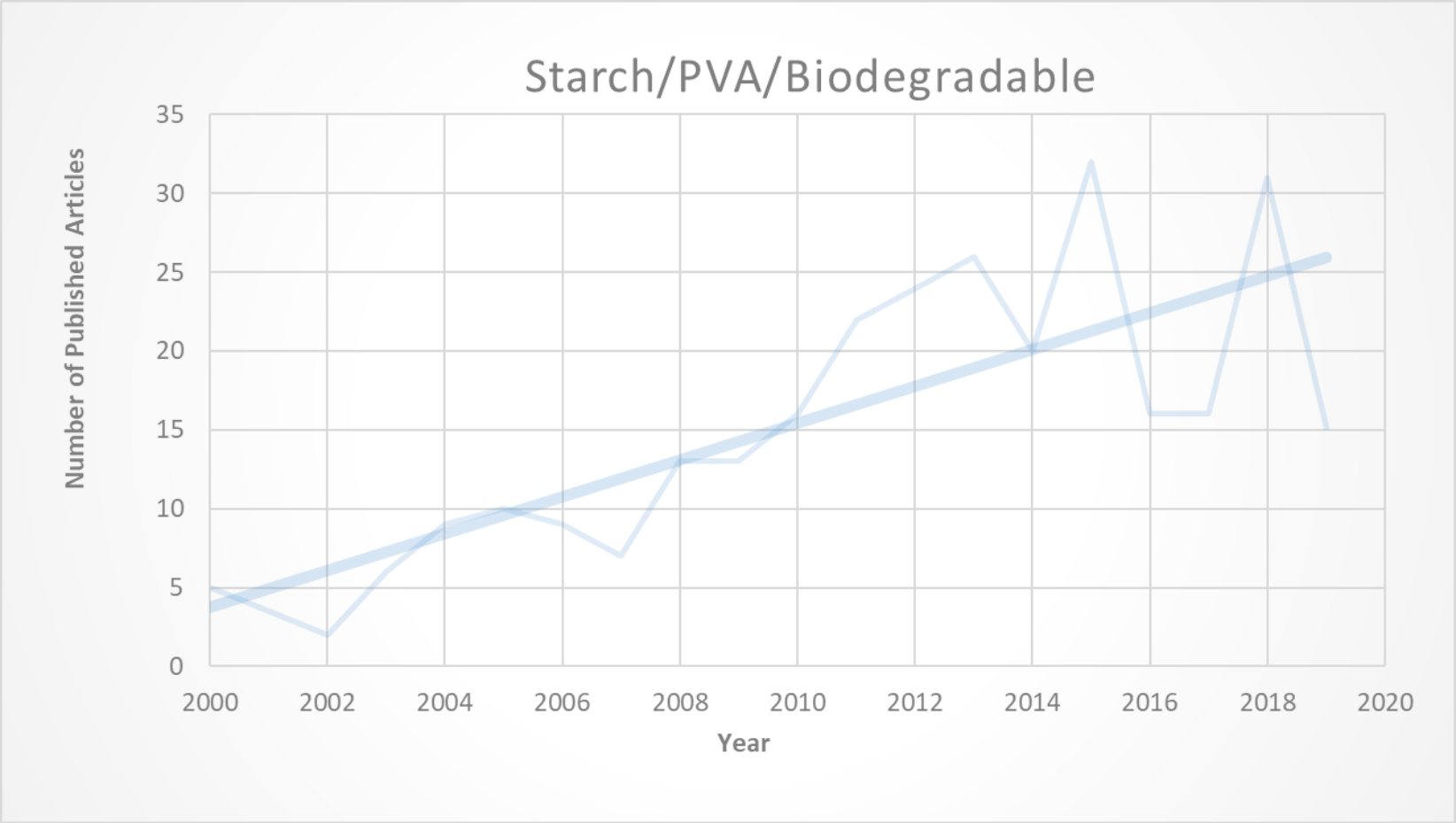
Motivation Cont'd



The increase on biodegradable starch/PVA blends literature for two decades [Engineering village data base]

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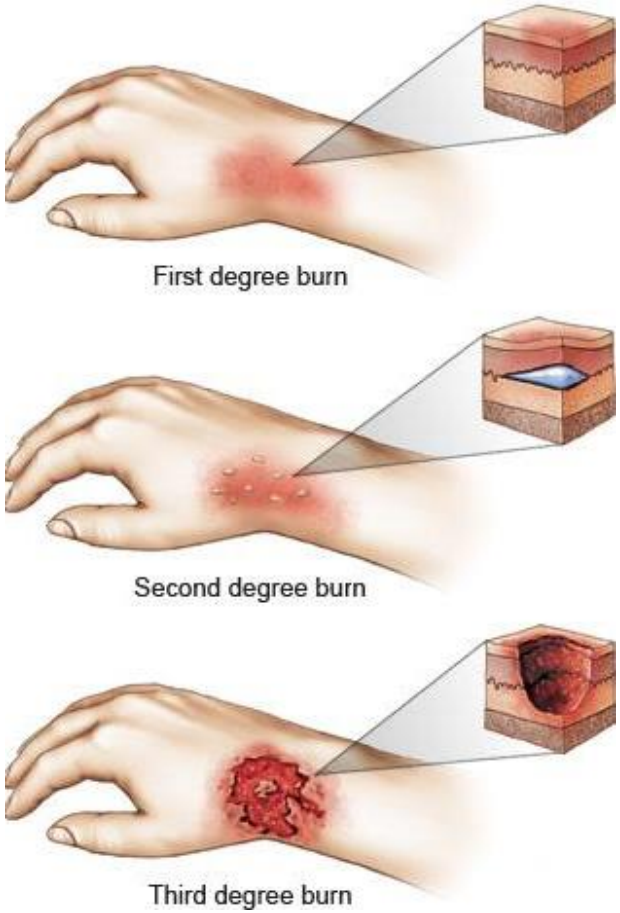
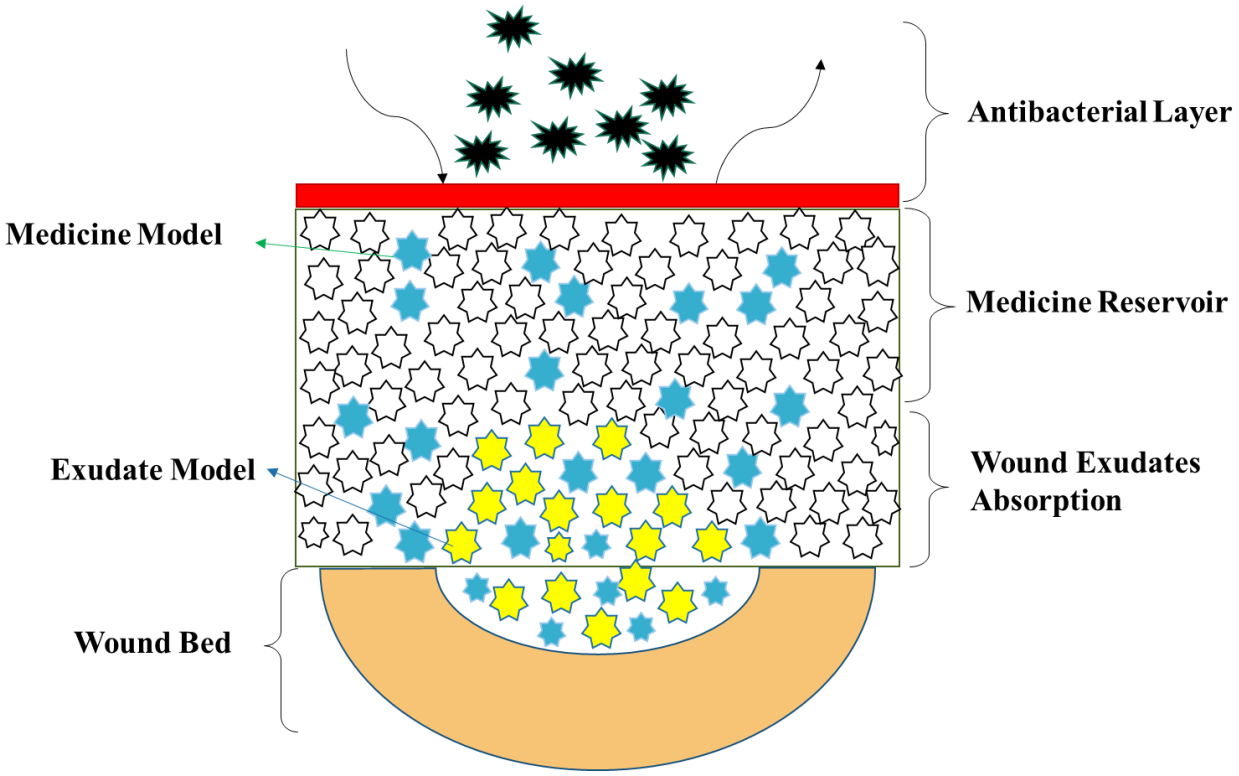
Motivation Cont'd



❖ Statics is provided by **World Health Organization (WHO)**

- An injury to the skin or other organic tissue primarily caused by heat or …
- In 2004, nearly **11 million people** worldwide were burned severely enough to require medical attention
- In 2008, over 410 000 burn injuries occurred in the United States of America, with approximately 40 000 requiring hospitalization
- For **2000 children**, direct costs of care for patients with burns in the United States of America exceeded **211 million US$**

Wound Dressings



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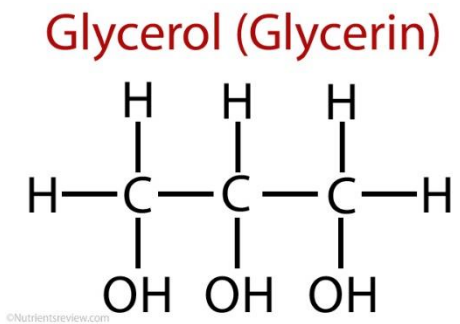
Starch-Based Blends

- Starch (potato, corn, …)
- Polyvinyl alcohol (PVA)
- Deionized water
- Citric acid
- Glycerol



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Fabrication of Starch-Based Blends

- Dissolving PVA (10 min, 80-90°C)
- Adding water-starch solution (10min)
- Adding citric acid and glycerol
- Hot plate
- Spinning rod
- Beaker
- Oven (30 min, 95°C)
- Leveled glass surface

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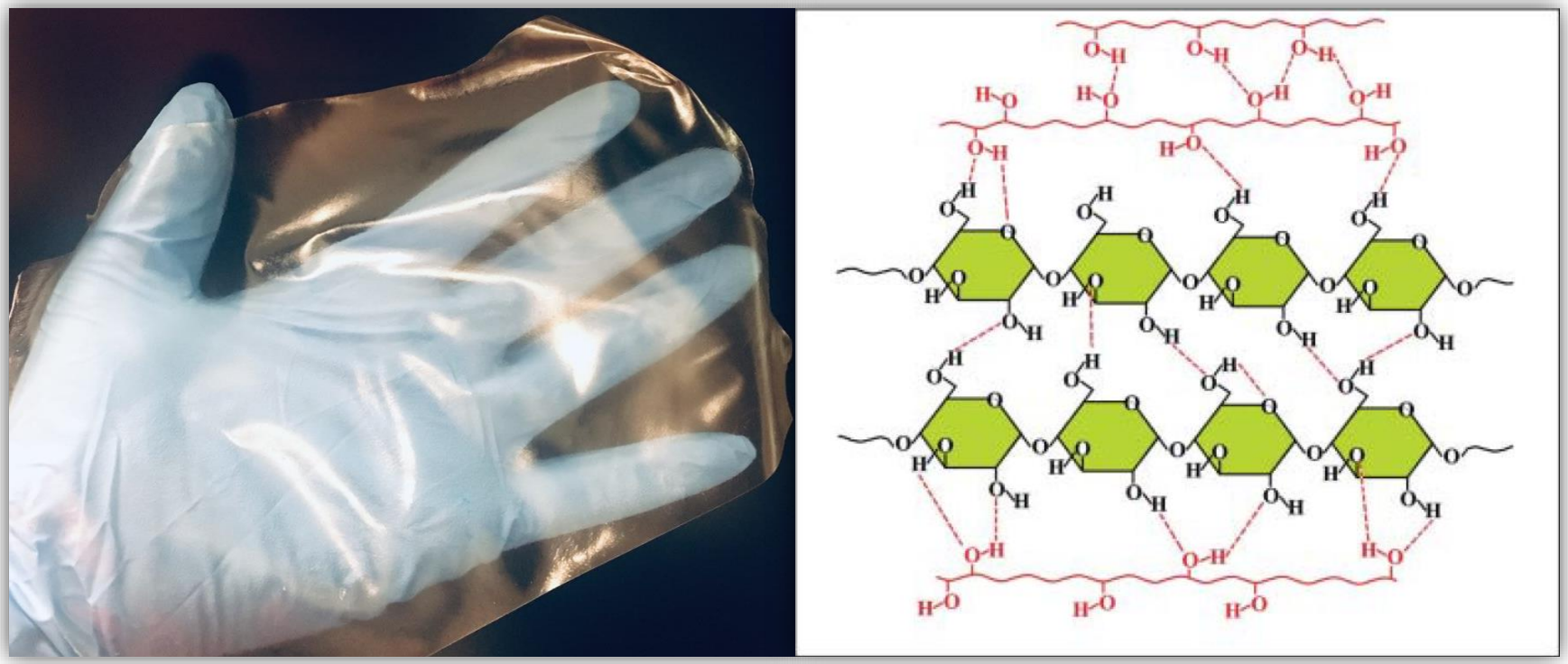
Fabrication of Starch-Based Blends



Teodorescu M, Bercea M, Morariu S. Biomaterials of Poly (vinyl alcohol) and Natural Polymers. Polymer Reviews. 2018;58(2):247-87.

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Expected Significance

- Environmentally-friendly
- Biodegradable
- Cost-effective
- Disposable
- Easy to fabricate
- Portable
- Boost the healing Process
- Appropriate porosity
- Provide UV protection
- Sufficient mechanical properties

- Antibacterial material
- Prevent local pain
- Transparent
- Flexible

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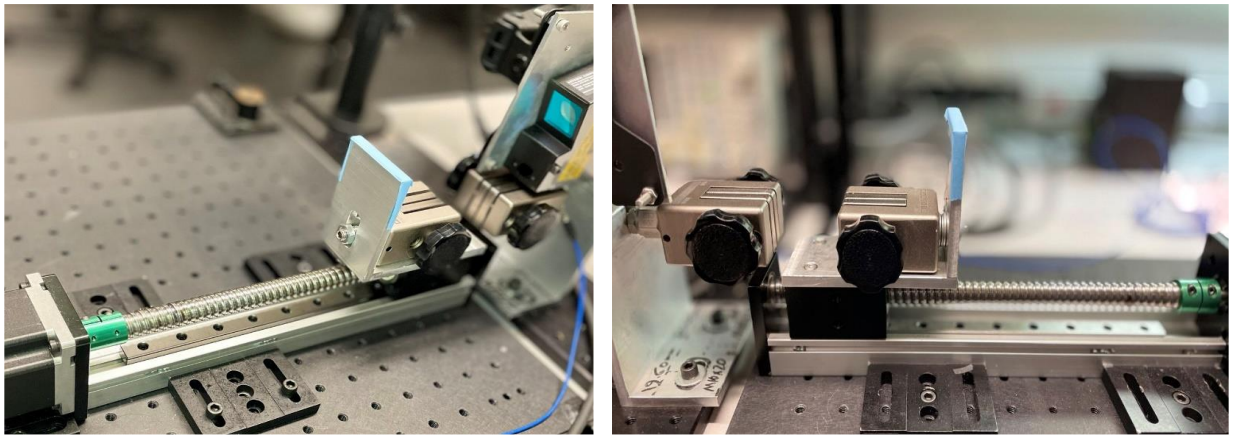
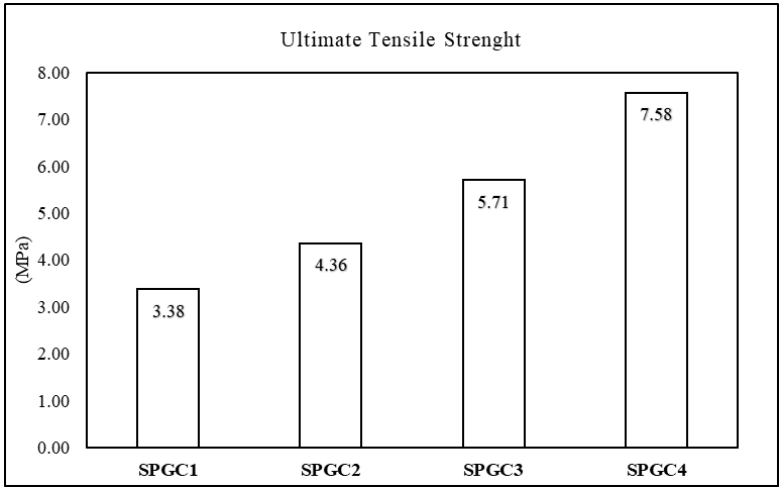
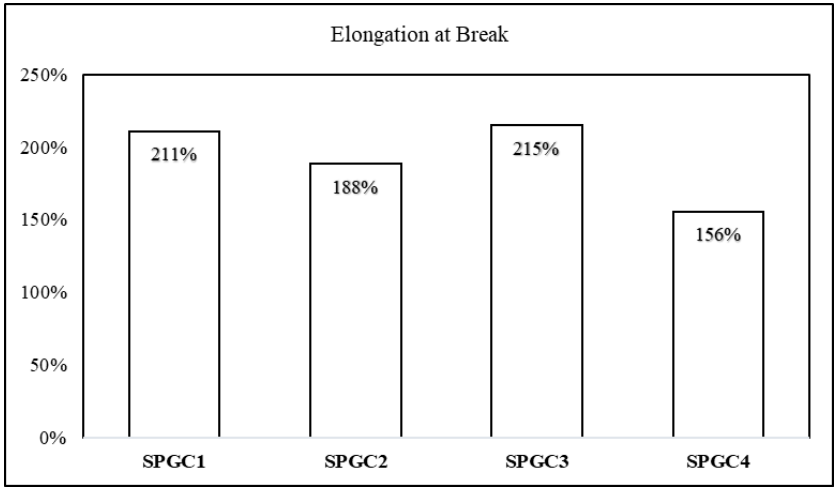
Results and Discussion

Tensile Strength & Elongation at Break:



Tensile Strength and Elongation Measuring Device





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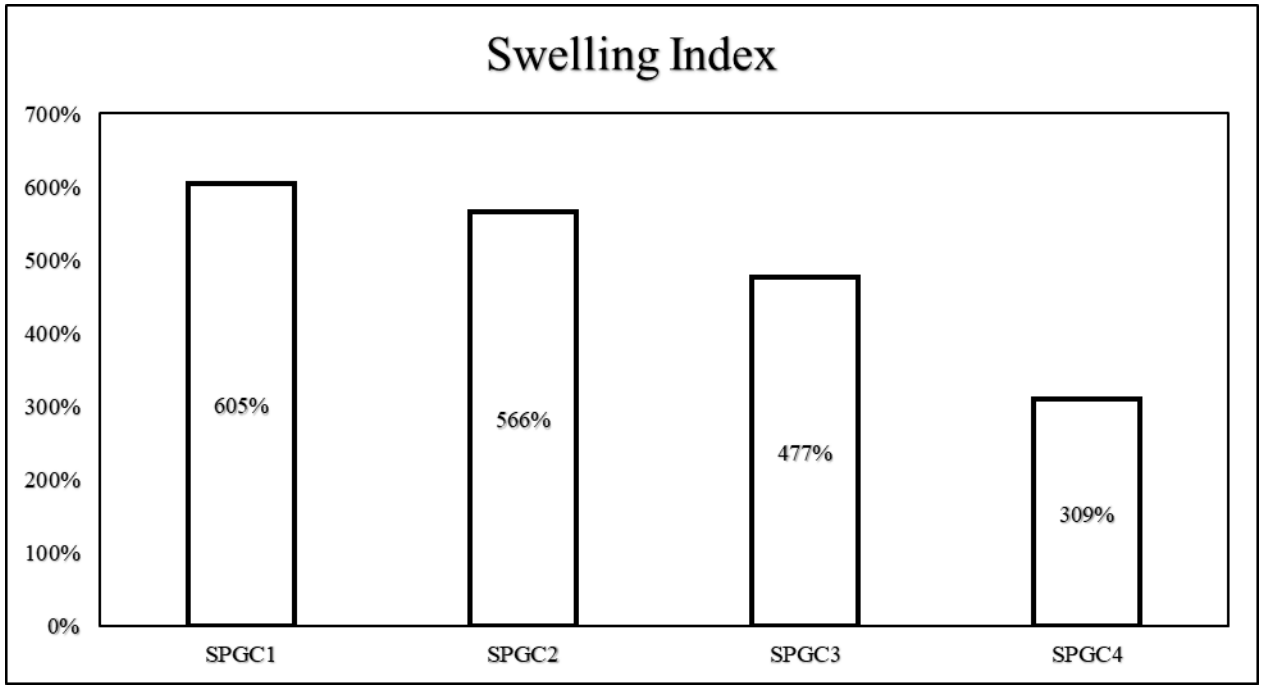
Results and Discussion

Swelling Index (SI)

- The film capacity to absorb the wound exudates
- One of the most important properties for a dressing material
- SI% could be evaluated using this expression: $\mathrm{SI} = \frac{W_s}{W_0} \times 100\%$
- The effect of different Citric Acid concentrations from 0.5 to 2 g are shown below:



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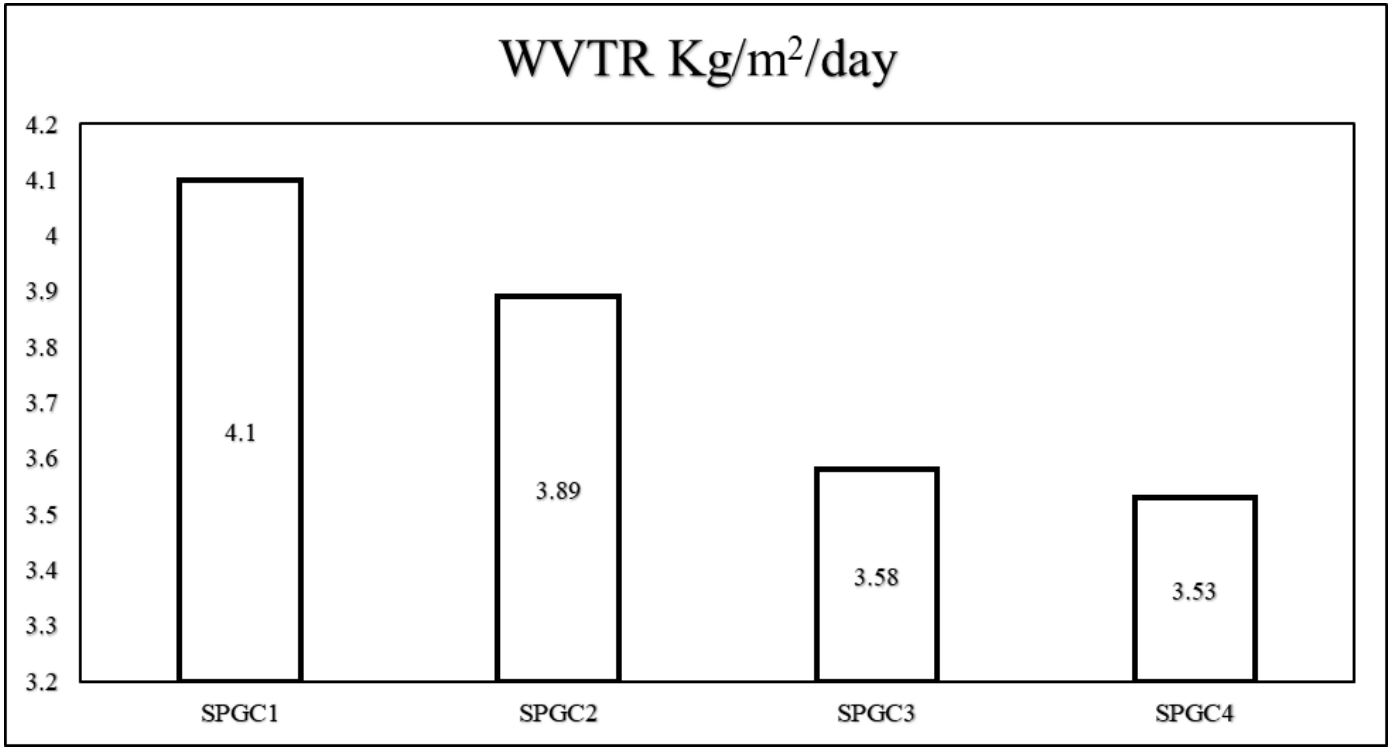
Results and Discussion

Water Vapour Transmission Rate (WVTR):

- A beneficial characteristic of wound dressings to provide a local **moist environment** for proper wound healing.
- A low value leads to the accumulation of wound exudates.



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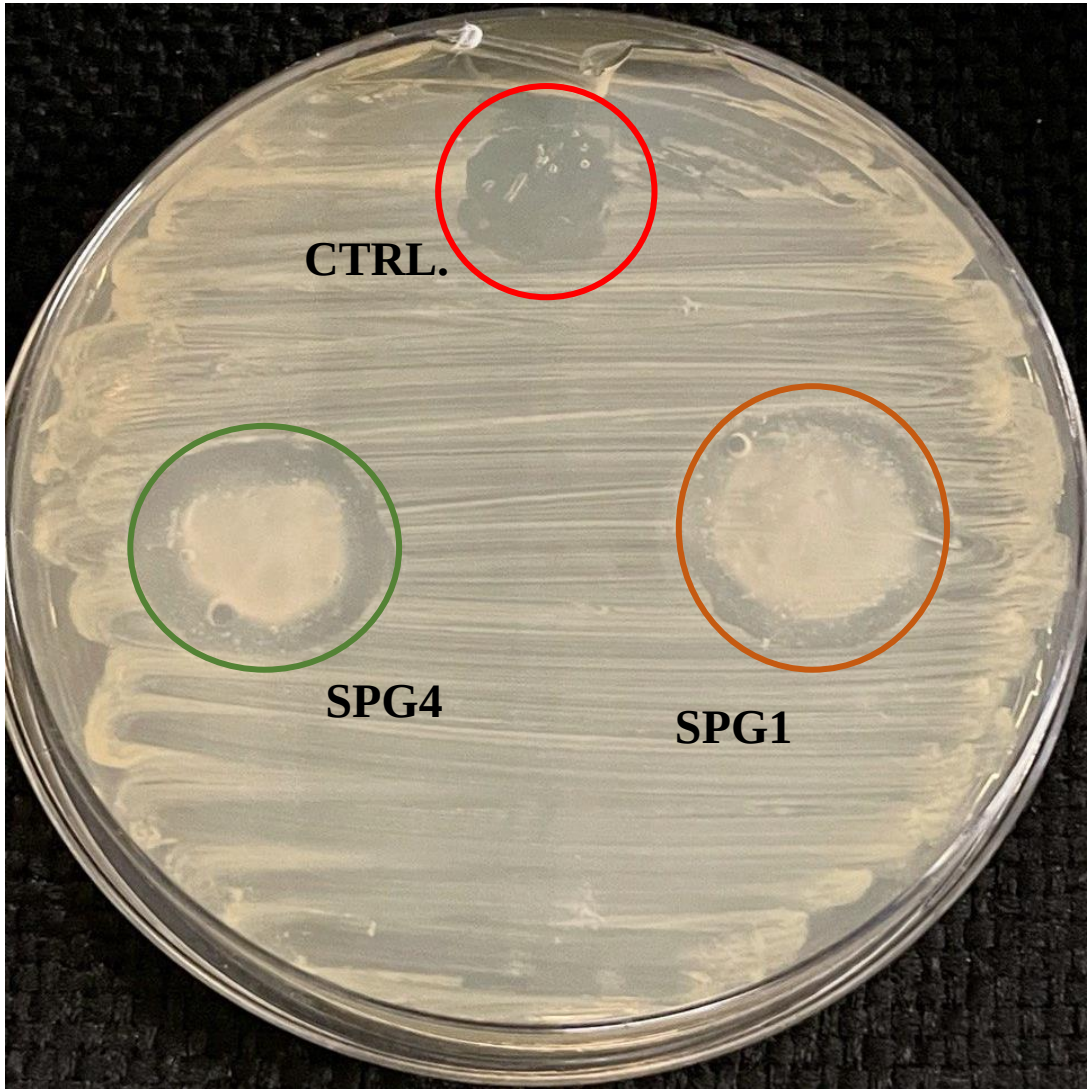
Results and Discussion

Antibacterial Efficiency



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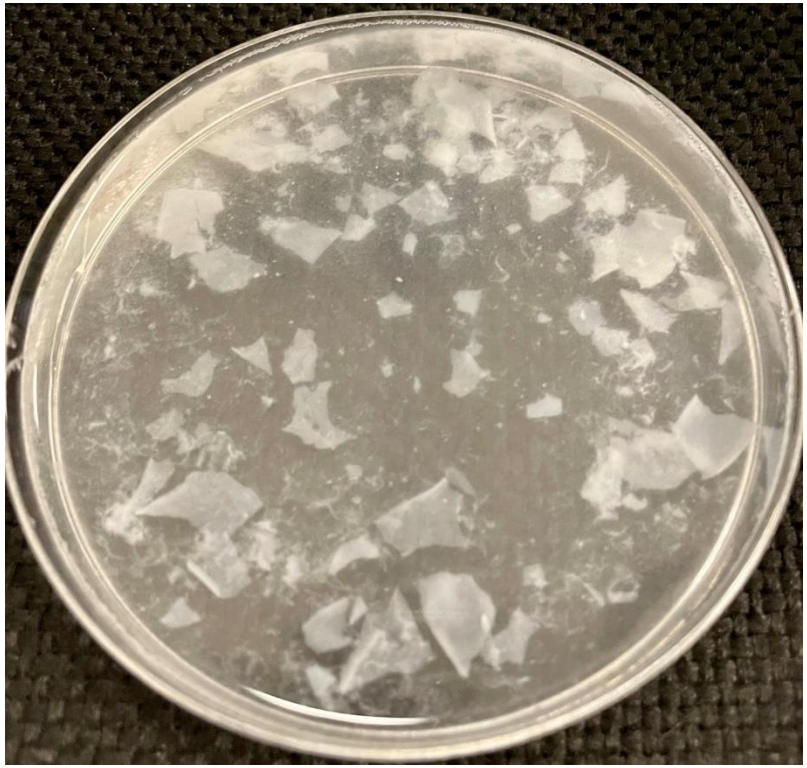
Results and Discussion

Solubility

- Solubility will increase regarding the increase of Citric Acid Concentration
- Due to the associated crosslinking and plasticizing effects
- The residual CA in the films facilitates the plasticizing effect that could improve the solubility
- However, crosslinking effect reduces the films solubility as crosslinking minimizes transport between PVA chains and solvent molecules into the polymer matrix
- Thus, the net effect of these tradeoffs is an increase in solubility trends



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Conclusions

- According to the **U.S. CDC**:
  I. 6 in 10 adults are suffering from a **chronic disease**
  II. 4 in 10 adults are suffering from two or more chronic diseases
  III. Such chronic diseases are the leading cause of disability and death
  IV. Also, they are a key contributor to the country's **3.5 trillion** USD annual healthcare costs
- The global medical gauze and tapes market size was valued at **6.3 billion** USD in **2019** (expected growth rate of **4.2%** from **2020 to 2027**)
- A worldwide increase in the incidence of chronic diseases such as cancer, diabetes, etc. is driving the market for medical **gauze and tapes**
- Novel Fabrication process for starch-based materials (dressings)
- Precise mechanical characterization of the material (**4 MPa** Tensile strength, with **180%** elongation-at-break)
- Higher Swelling Index (**407%**) comparing to the literature
- Significantly higher **WVTR** (**4000** g/m^2/day)
- Very good flexibility, in-vitro degradation, and good antibacterial activity
- Excellent materials to be utilized in **wound dressing applications** (a substitute to the conventional materials)

Thank YOU!

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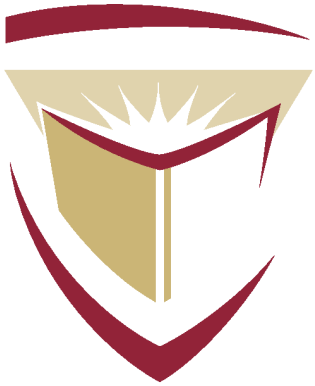

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