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INTELLIGENT APPROACHES TO HYBRID COMPOSITE MATERIALS IN FOOD PACKAGING

LABORATORY OF INORGANIC CHEMISTRY AND ADVANCED MATERIALS

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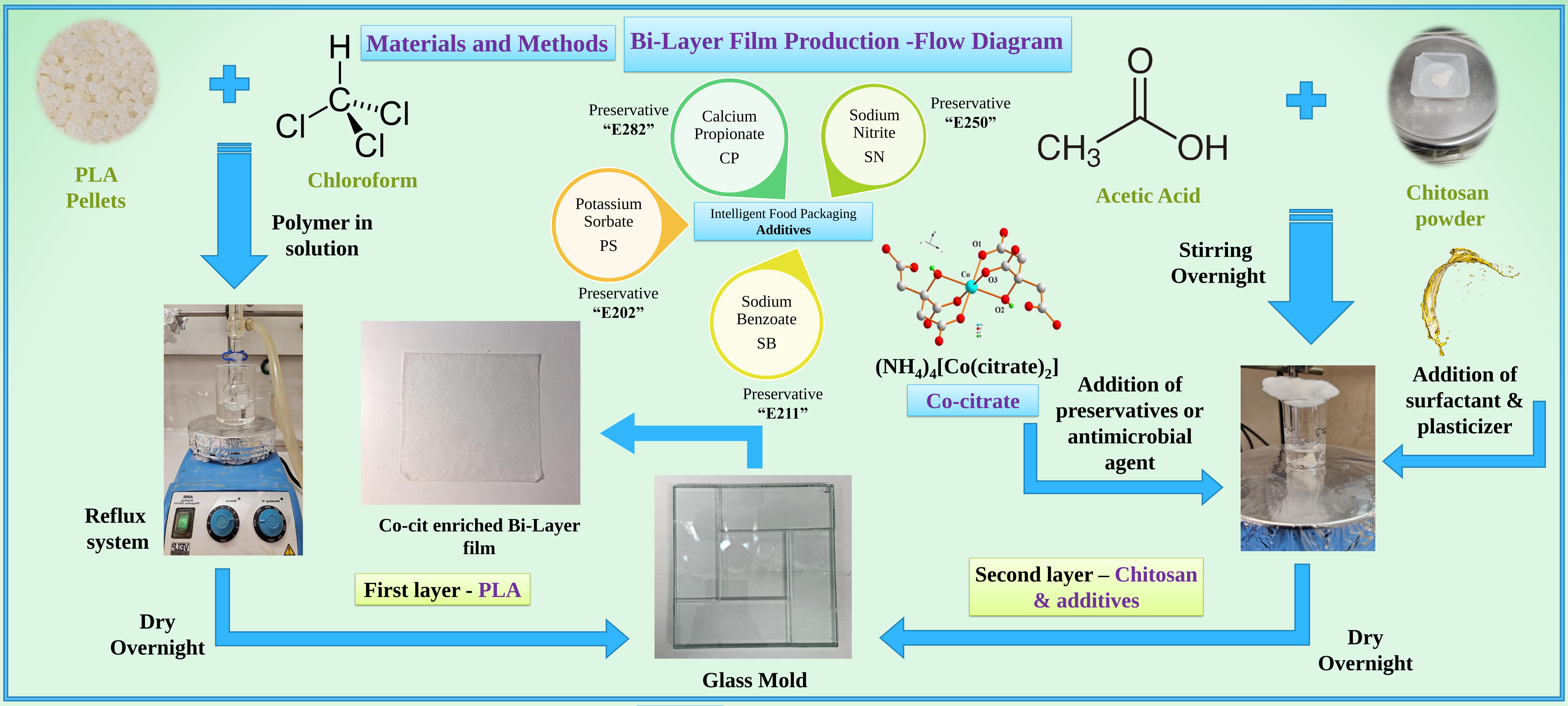
Introduction

Due to the abundant recourses and ease of use, the influence of single-use plastics has spread like wildfire within the modern, consumerist society.[1,2] Plastics made from oil distillation are harmful to the planet and the people alike, from the moment production begins to the moment they decompose, hundreds and thousands of years later. As such, new technologies are beginning to emerge, with eco-friendly alternatives. **PLA** or poly-lactic acid is a biopolymer that can be produced from starchy materials, such as potato, tapioca or sugarcane.[3] **Chitosan** is also a biopolymer, made from the deacetylation of chitin, which can primarily be found in the exoskeleton of crustaceans, such as shrimp, crab and lobster.[4] Both of those materials have good film making qualities and when combined they produce a bi-layer film with good mechanical, physical and barrier properties.[5] The same film can be enriched with different materials,[3] such as preservatives or other antibacterial substances[6] that actively protect food and prolong its life span.

Field of Interest

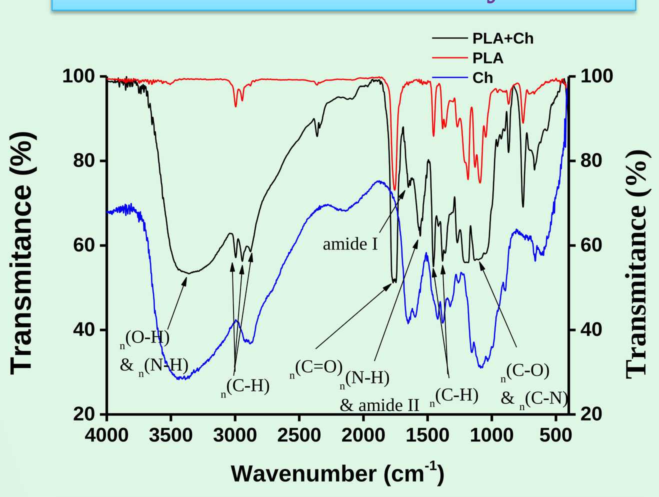
L. monocytogenes & E. coli

Materials and Methods

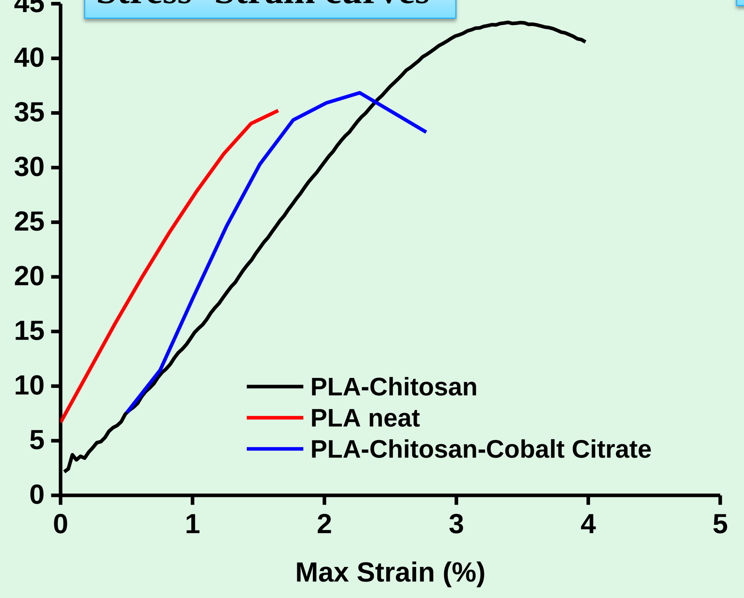


Results

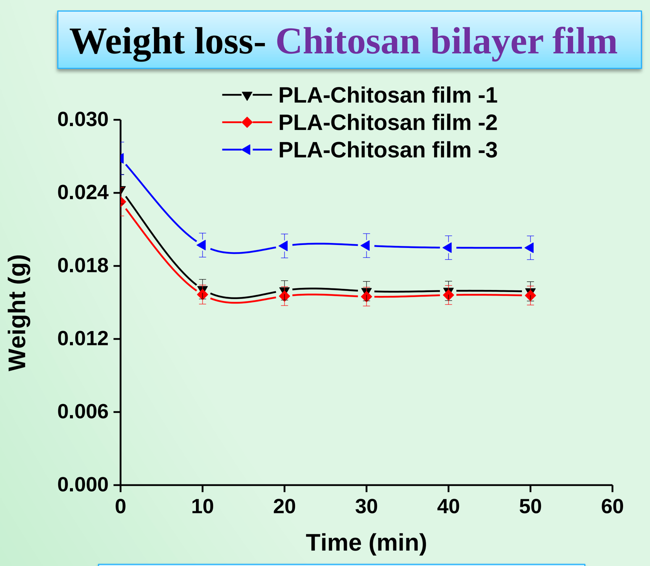
FT-IR PLA- Chitosan bilayer film

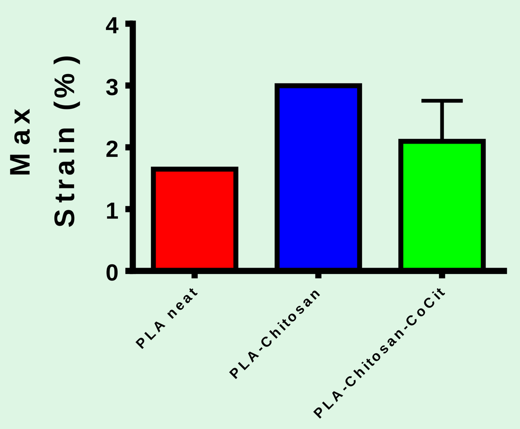


Stress- Strain curves

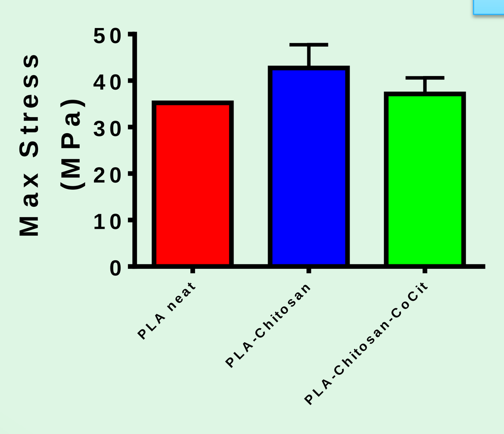


Weight loss- Chitosan bilayer film

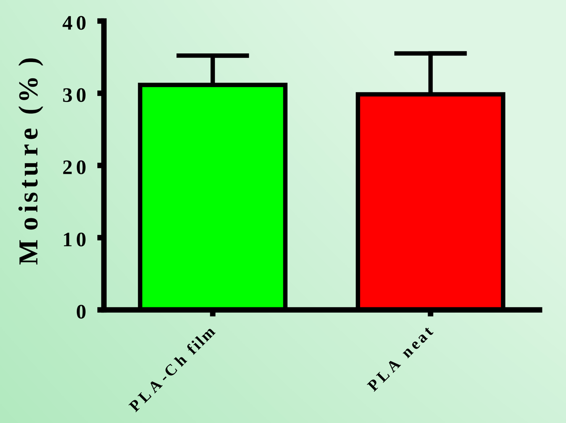


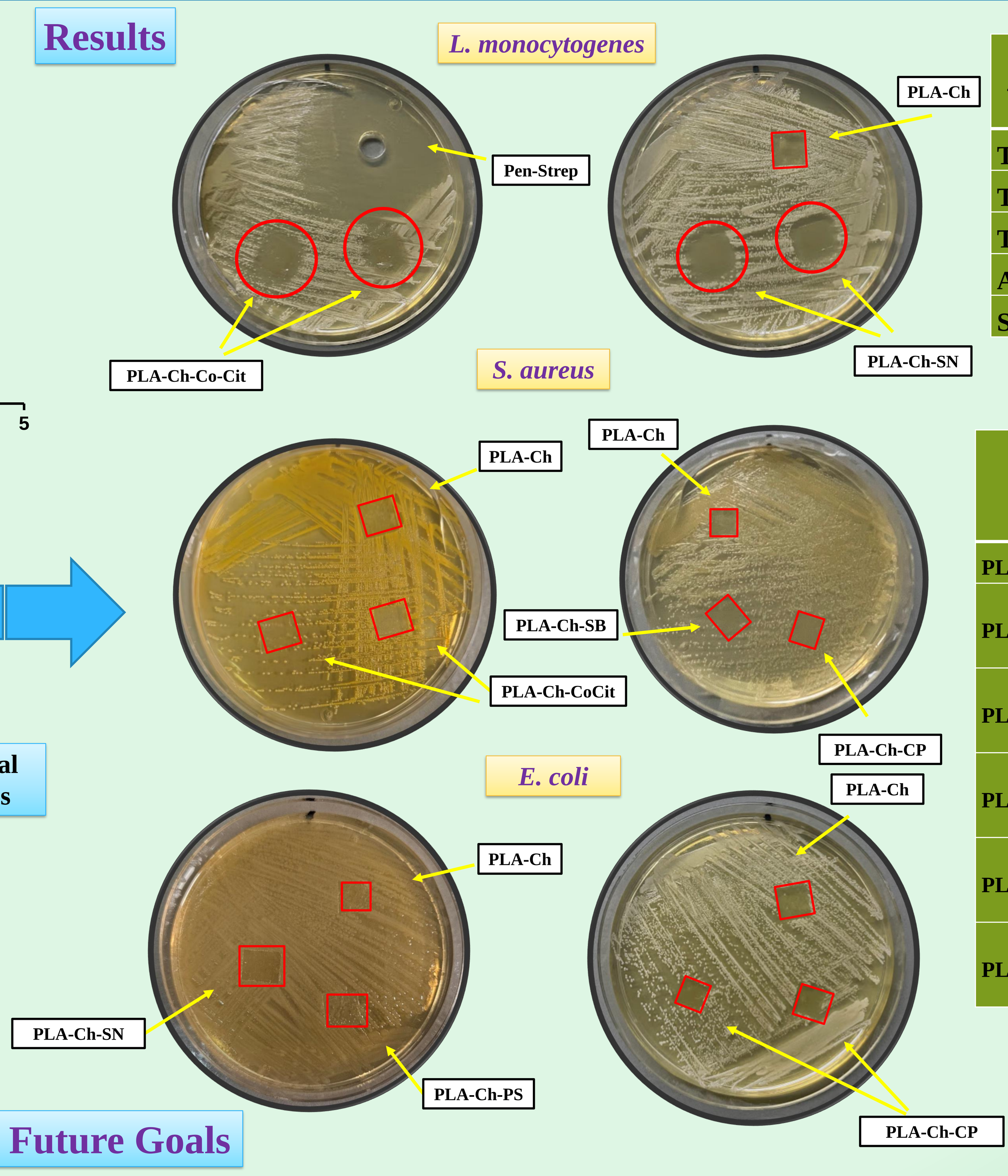


Mechanical properties



Moisture loss comparison





Z.O.I. (mm)	Co-cit	Sodium Nitrite
Test 1	19.2	15.6
Test 2	21.6	14.3
Test 3	12.2	16.1
Average	17.6	15.3
Std Dev.	4.8	0.9

Inhibition	E. coli	S. aureus	L. Monocytogenes
PLA-Ch	+	+	+
PLA-Ch-Co-Cit	+	+	+ +
PLA-Ch-SN	+	+	+ +
PLA-Ch-CP	+	+	+
PLA-Ch-SB	+	+	+
PLA-Ch-PS	+	+	+

(++ Total Inhibition, + Partial Inhibition, - No inhibition)

Discussion - Future Goals

- The emerging PLA-Chitosan films are transparent and exhibit better mechanical properties when compared to simple PLA films. From the stress–strain curve in relation to the Young's modulus, max strain and max stress, it can be surmised that while the PLA film is more rigid, the PLA-Chitosan film is **much more durable and elastic**, properties that are required for food packaging. The films containing Co-cit have a higher Young's modulus, thus being **stiffer** than the other two. The latter have a **smaller tolerance** toward tearing and stretching.
- Both PLA and PLA-Chitosan films are completely transparent, with the latter having an almost imperceptible **yellow tint** due to chitosan. When infused with Co-cit, the films get a slight **pink tint** and when infused with preservatives they get a **white tint**. Both infused films turn **opaque** due to the additives.
- The PLA-Chitosan films have an average thickness of **23 μm**, lower than the theoretical value of **60 μm**, possibly due to pores in the PLA layer. There is no interaction between PLA and Chitosan (FT-IR).
- The films containing Co-cit and the four preservatives were tested for antimicrobial effects against ***E. coli, S. aureus*** and ***L. monocytogenes*** grown in LB agar. A Zone Of Inhibition (ZOI) was seen only against ***L. monocytogenes*** with **PLA-Chitosan-(Co-cit)** and **PLA-Chitosan-Sodium Nitrite** films, with an average diameter of **17.6 mm** and **15.3 mm**, respectively. Penicillin/Streptomycin was used as a negative control.

❖ While this work delves into chemical and biological properties of bilayer films, improvements can be made. The antimicrobial effect of the films must be studied further, with different concentrations and different bacteria and preservatives. Finally, new methods of producing the bilayer membranes must also be investigated, with the possibility of upscaling the production in the future.

Literature

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