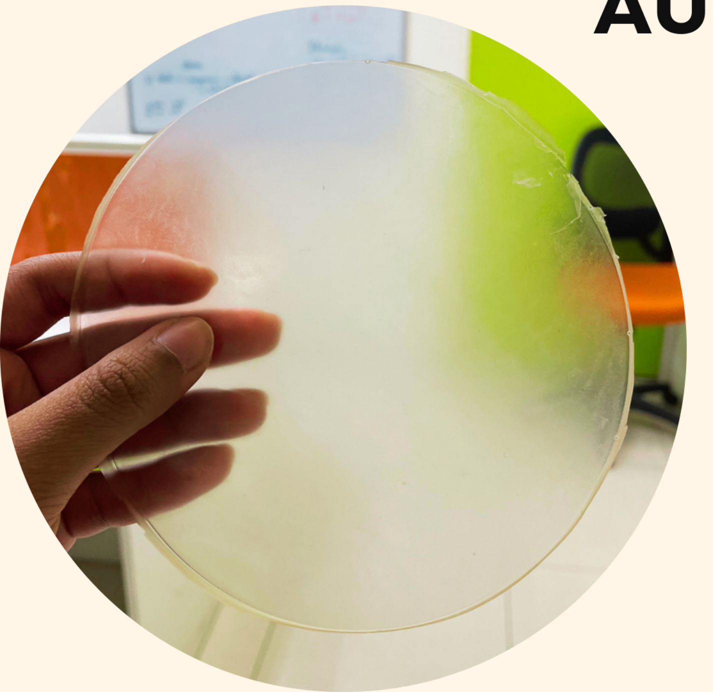
DEVELOPMENT OF PECTIN AND SODIUM ALGINATE COMPOSITE FILMS WITH IMPROVED BARRIER AND MECHANICAL PROPERTIES FOR FOOD PACKAGING APPLICATIONS

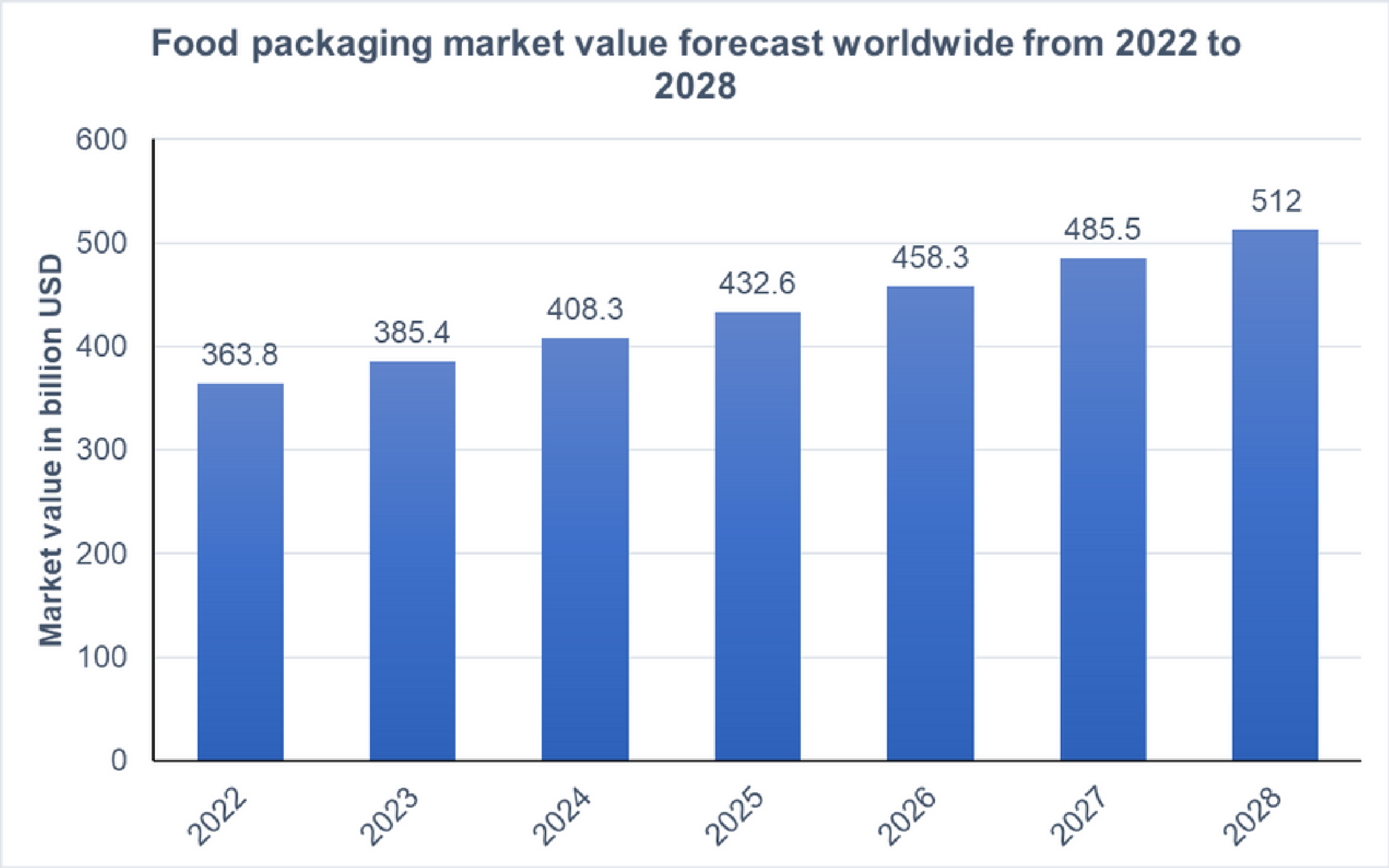
AUTHORS: ABHAY KANNAN, M DHEEPTHA, YAMINI SUDHA SISTLA



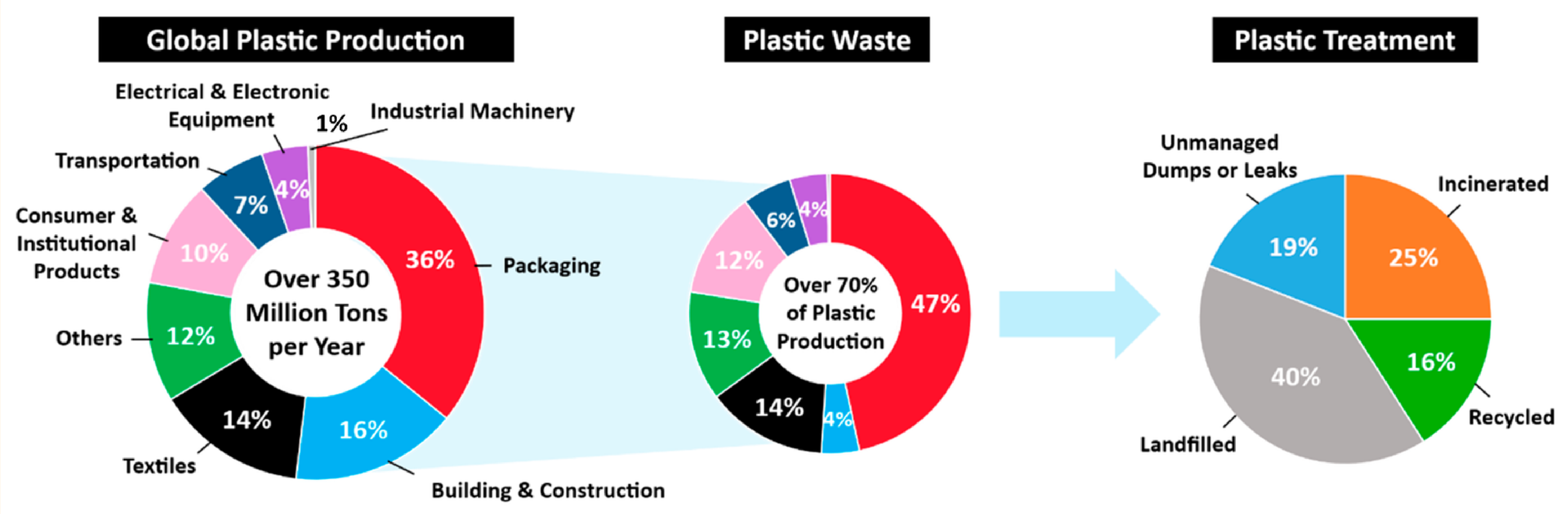
CHEMICAL ENGINEERING DEPARATMENT,
SHIV NADAR INSTITUTION OF EMINENCE, INDIA

INTRODUCTION

- Food packaging was predicted to have a global market value of around 363 billion dollars in 2022.
- Global food packaging market it is expected to reach USD 512 Billion by 2028.
- Synthetic Polymers used in packaging currently take years to degrade and digest for human body.
- Various key parameters for the study, such as concentration of plasticizer and stabilizer, pH, stirring time, sonication, temperature and humidity for drying, had an effect on the final output.



Source: https://www.statista.com/statistics/876489/food-packaging-market-value-forecast-worldwide/



Source: https://www.mdpi.com/bioengineering/bioengineering-09-00098/article_deploy/html/images/bioengineering-09-00098-g001-550.jpg

METHOD & DESIGN OF EXPERIMENT

- Components were weighed and dissolved in hot distilled water.
- The solution was stirred, using a magnetic stirrer, at a constant temperature of and speed.
- Remaining larger particles were homogenized using a Homogenizer at constant speed.
- The film forming solution was filtered out and homogenized using an Ultra-Sonicator.
- During the process a constant pH of 3-4 was maintained.
- The solution was equally poured into petri dishes and placed in Humidity chamber at a constant temperature of 40˚C and 60% relative humidity.
- The films were peeled and placed in pouches in a vacuum desiccator.
- A two-level three-factor (2^3) design of experiments was implemented for this research.
- The three factors considered were:
  (1) Concentration of Sodium Alginate
  (2) Concentration of Castor Oil
  (3) Concentration of D-Sorbitol
- High, Medium and Low values were considered for each component.
- The amount of pectin was kept constant (15 gm in 600 mL distilled water).

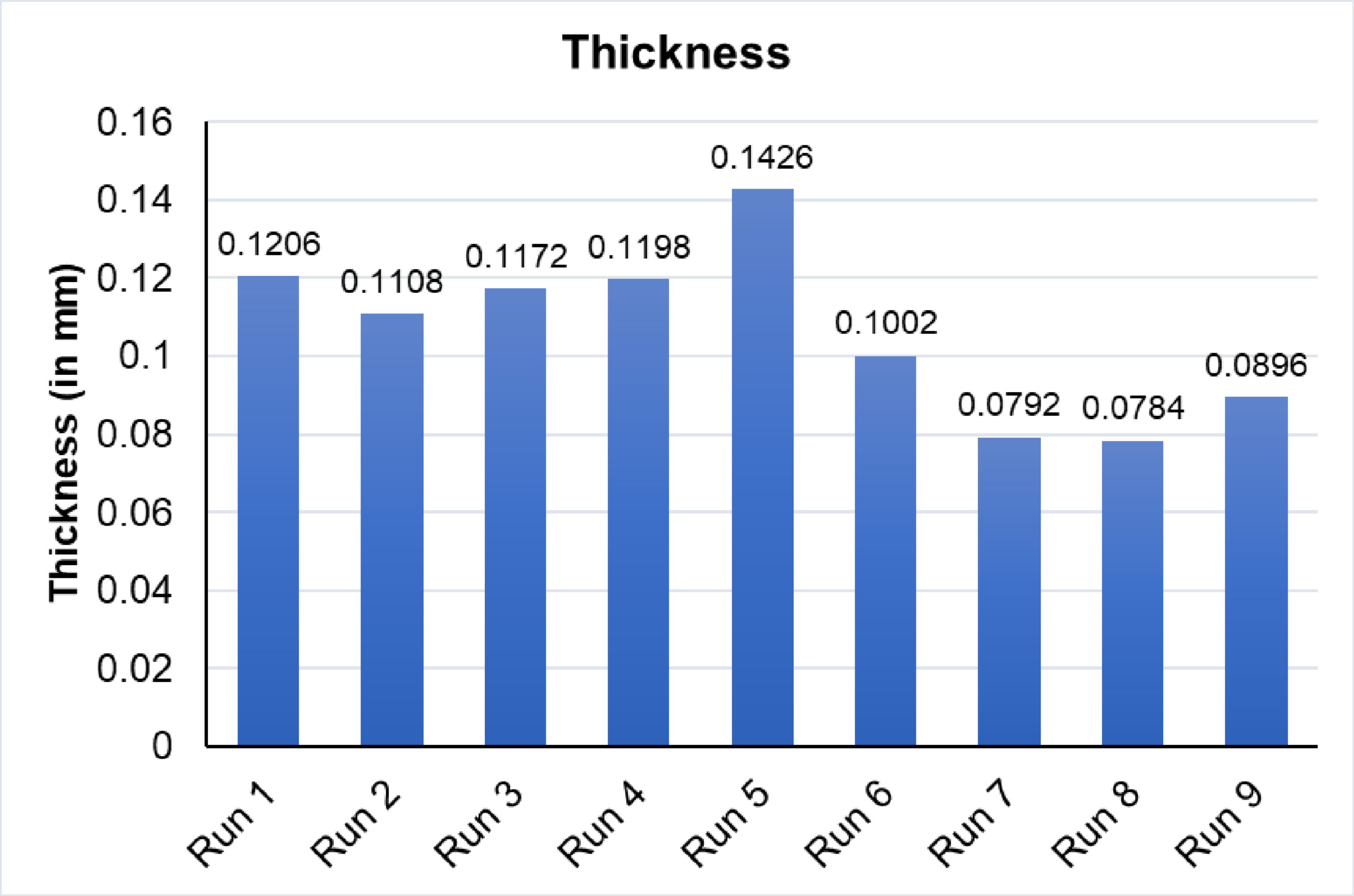
DESIGN OF EXPERIMENT

Run No.	Sodium Alginate (gm)	Castor Oil (gm)	D-Sorbitol (gm)
1	7.5 (High)	2.25 (High)	4.5 (High)
2	3.75 (Low)	2.25	4.5
3	7.5	1.5 (Low)	4.5
4	3.75	1.5	4.5
5	7.5	2.25	2.25 (Low)
6	3.75	2.25	2.25
7	7.5	1.5	2.25
8	3.75	1.5	2.25
9	5.625 (Medium)	1.875 (Medium)	3.375 (Medium)

RESULTS & DISCUSSION

Thickness

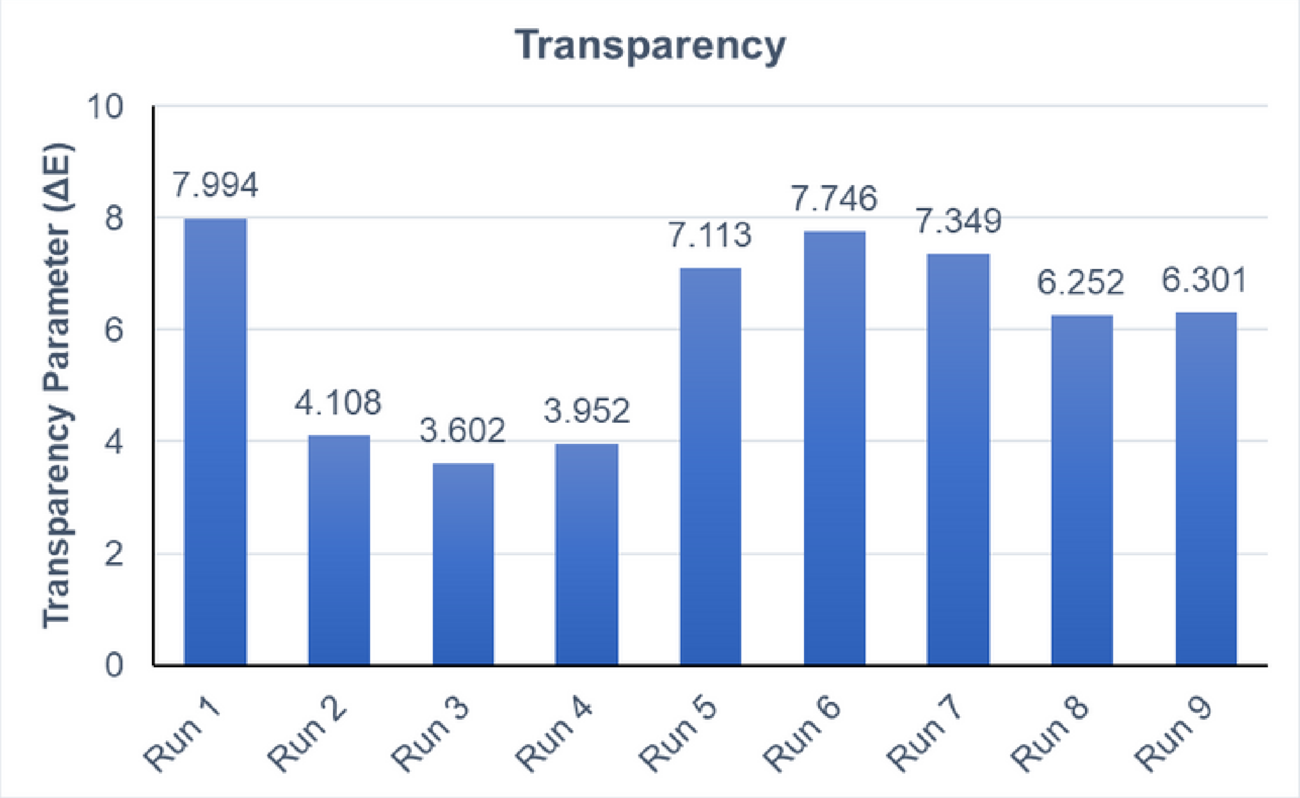
All films were thin, with an average thickness of 0.11 ± 0.004 mm. These were measured using a micrometer.



Transparency

All films prepared were transparent with the total colour difference or transparency parameter (ΔE) in the range of 3 to 11.
ΔE was calculated using the given formula:

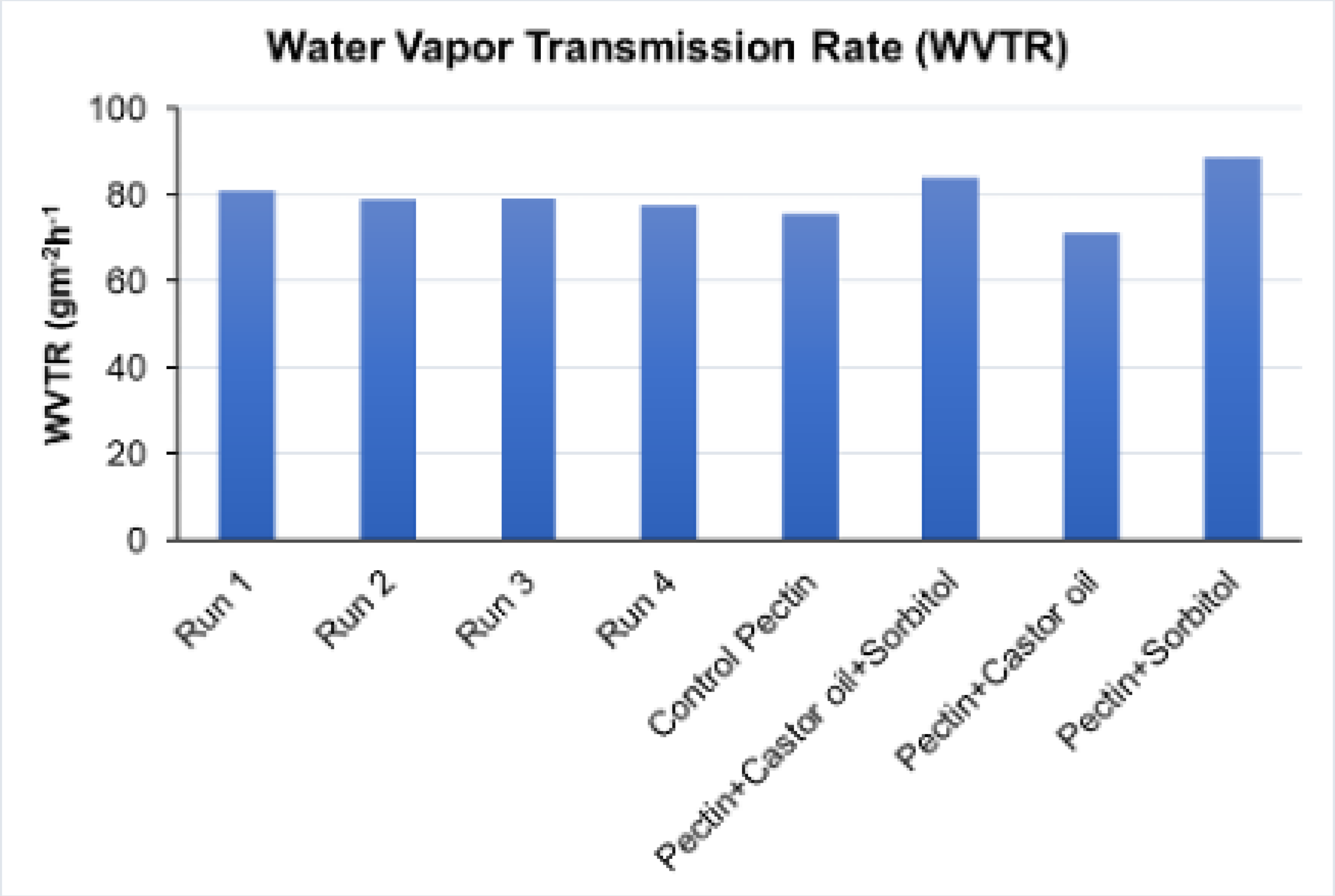
$$\Delta E = \sqrt{(L^* - L)^2 + (a^* - a)^2 + (b^* - b)^2}$$



RESULTS & DISCUSSION

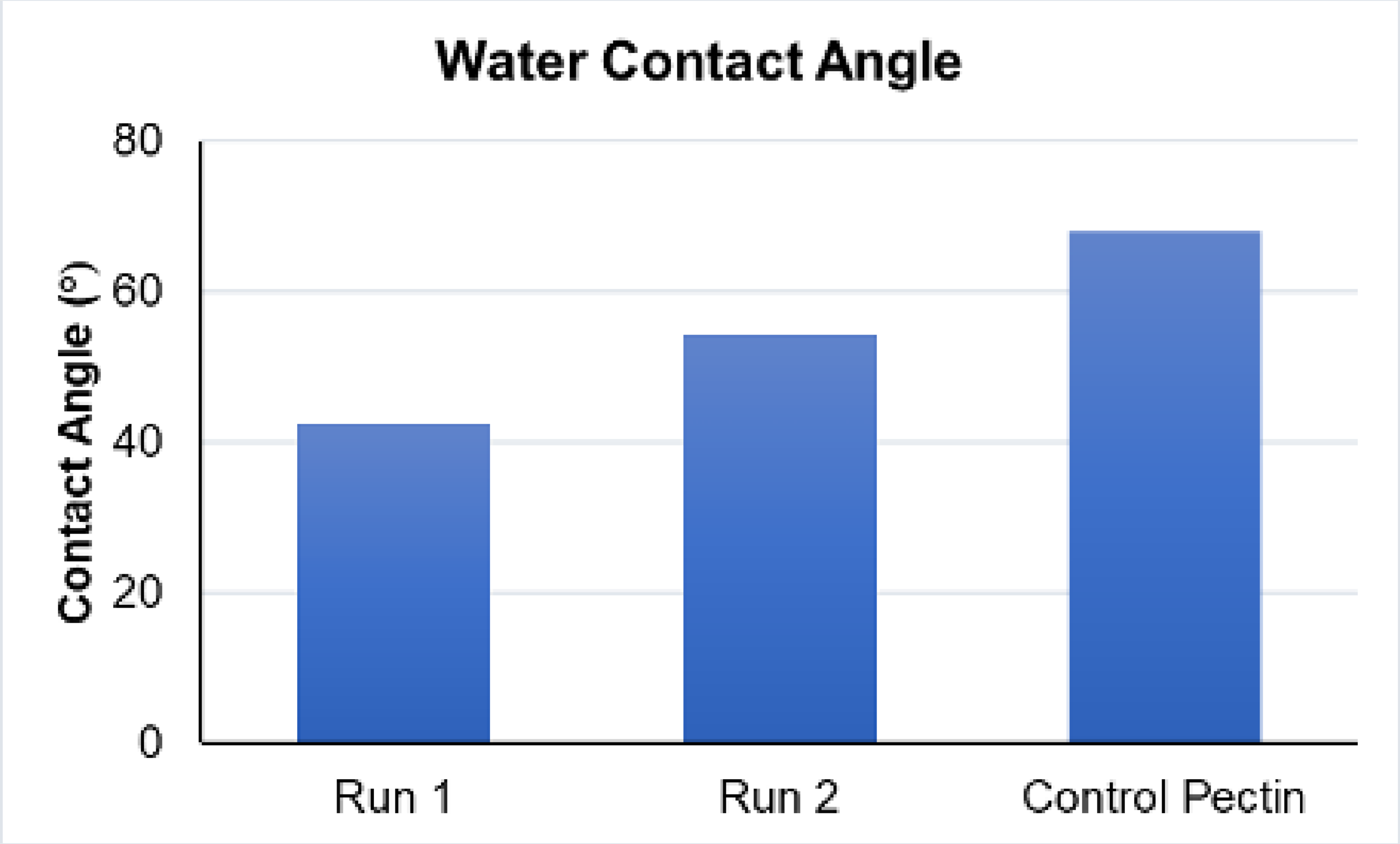
WVTR

Compared to control pectin films the WVTR has slightly increased at a range of 80 g/m²/h.This could be attributed to the presence of hydrophilic sodium aliginate and sorbitol plasticizer.



Water Contact Angle

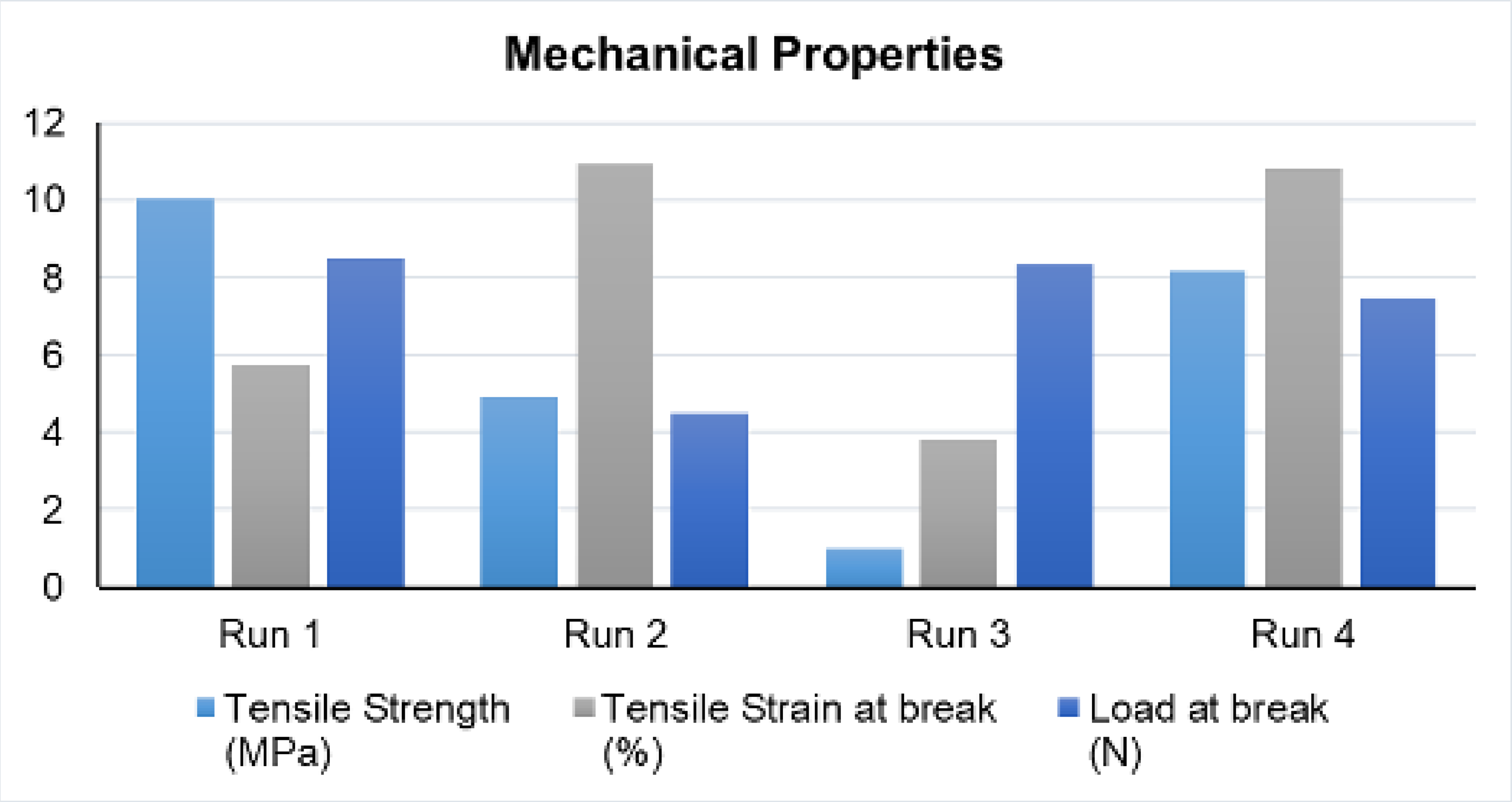
The Water Contact Angle of Run 1 and Run 2 are 42.45˚ and 54.18˚, shown below, which is less than that of control pectin (67.92˚). Therefore, it is evident that the hydrophilic plasticizer sorbitol has in a way reduced the surface hydrophobicity of pectin films.



RESULTS & DISCUSSION

Mechanical Properties

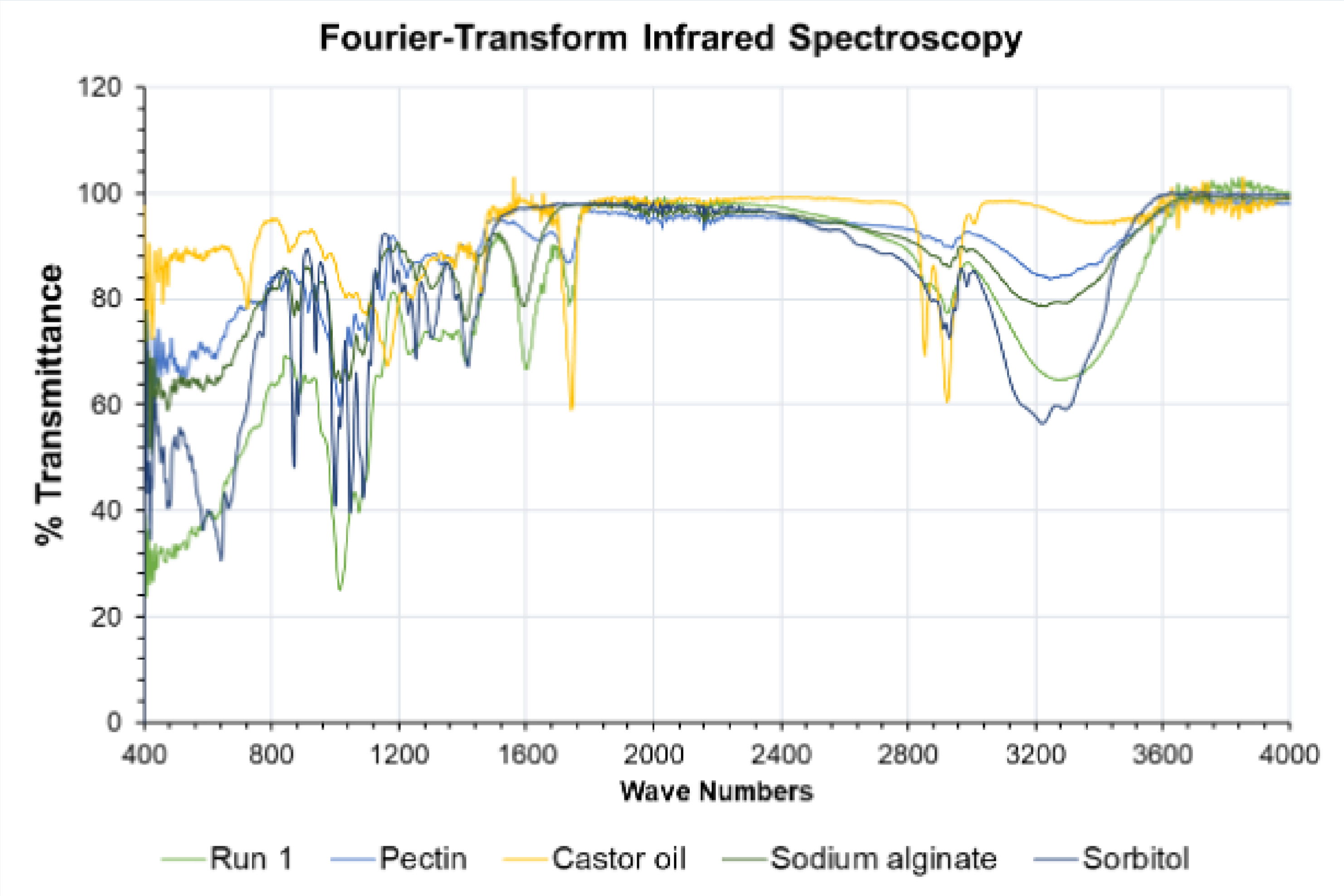
- Tensile strength, load at break, and percent strain at break are compared.
- The mechanical properties suggest that the low concentration of sodium alginate and castor oil and a high concentration of sorbitol has improved the flexibility and strength of the films.
- This is apparent from the improved elongation at break for Run 2 and Run 3 than Run 1.
- As per the figure shown below, Run 4 is the optimum concentration in terms of acceptable mechanical properties.



RESULTS & DISCUSSION

Fourier Transform Infrared Spectroscopy (FTIR)

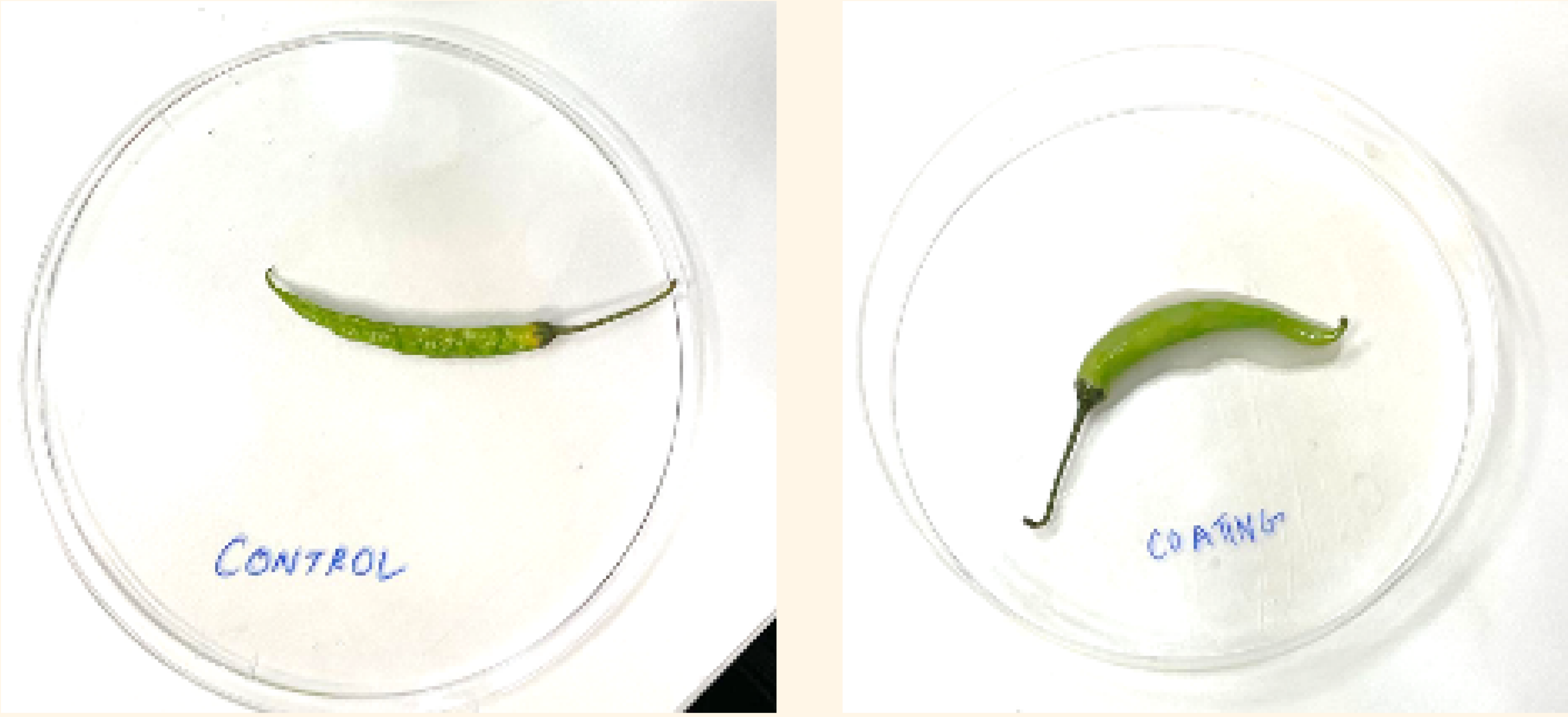
- There are no new chemical bonds formed in the film preparation process and the film is an outcome of a pure physical process.
- Peaks at 3300 cm^{-1} are linked to the O–H stretching vibrations of the hydroxyl groups in pectin.
- Peaks at 1650 cm^{-1} are related to the C=O stretching vibration of the carbonyl group in pectin.
- Peaks at 2920 cm^{-1} and 2850 cm^{-1} were caused by the castor oil's aliphatic chains' C–H stretching vibrations.



RESULTS & DISCUSSION

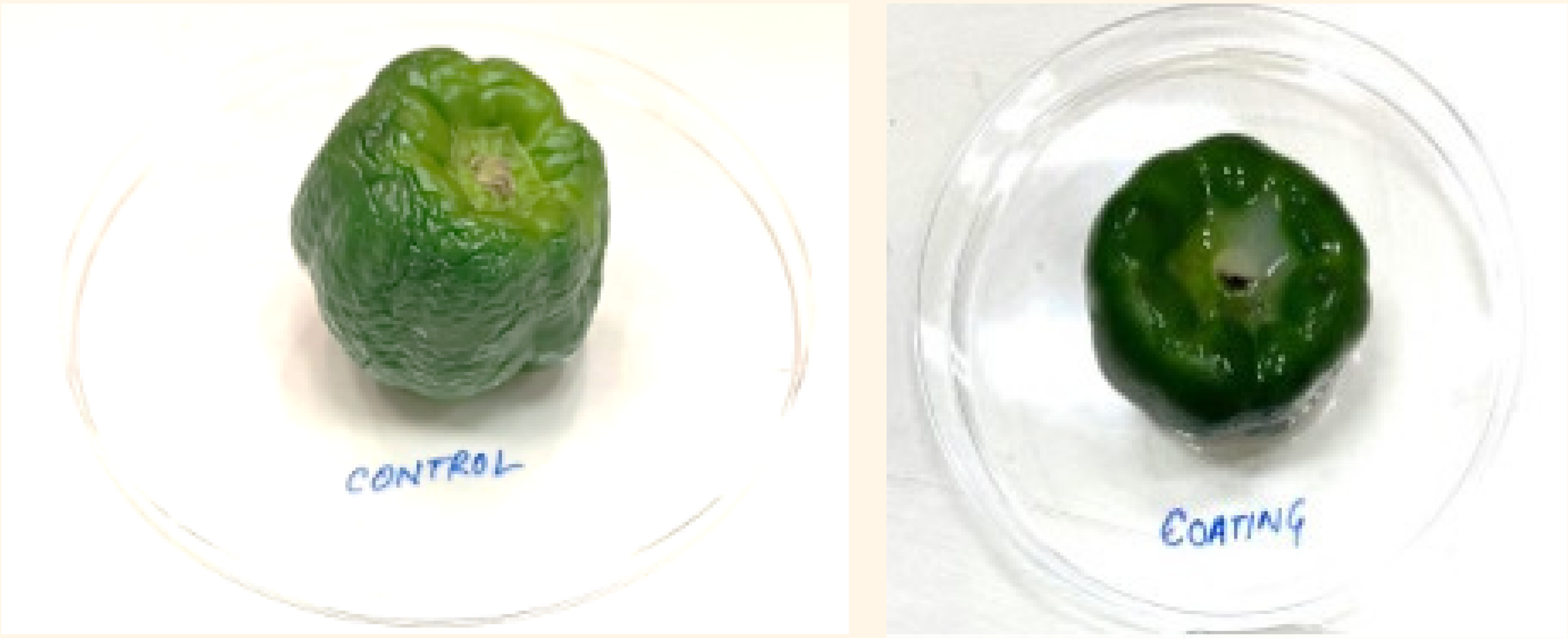
Shelf Life Test

Food products coated with the film forming solution proved to have lasted longer than the ones left undisturbed. Thus, proving that the films extend the shelf life of food products



(a) (b)

(a) Control Chili kept to compare with the coated one wrinkled; (b) Chili coated with film forming solution stayed fresh

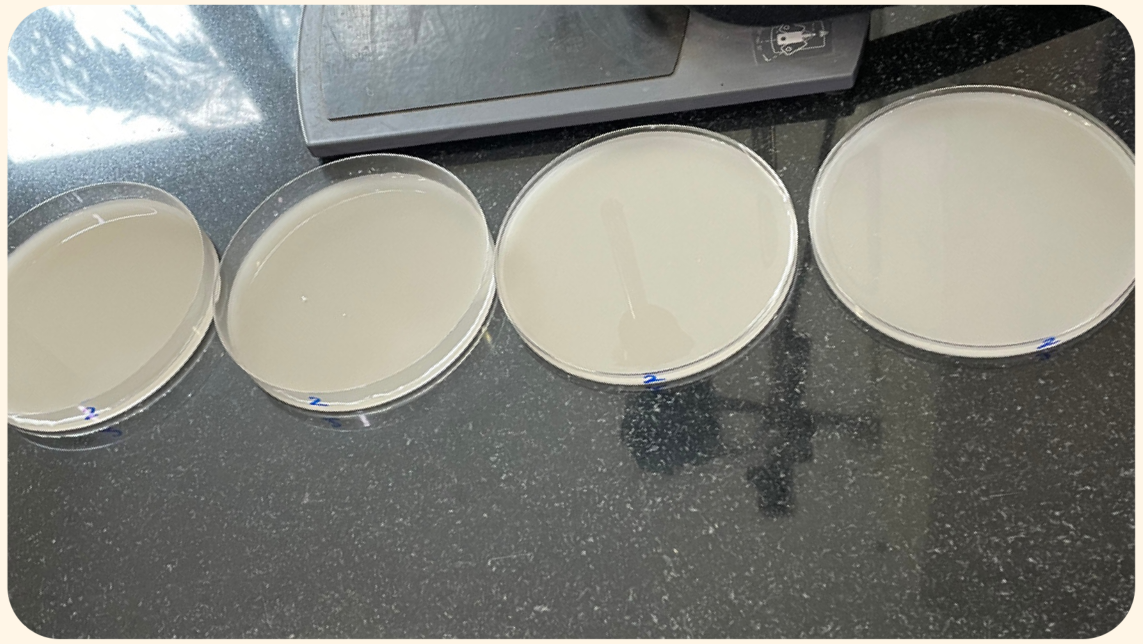


(a) (b)

(a) Control Capsicum kept to compare with the coated one wrinkled; (b) Capsicum coated with film forming solution stayed fresh.

CONCLUSIONS

- The polysaccharide-polymer films were successfully developed with sodium alginate range between 25%-50% w/w, Castor oil 10%-15% w/w and D-Sorbitol 15%-30% w/w.
- All films and control films were thin, flexible and transparent.
- Films based on design of experiments compared to the control films showed:
  (1) Improved barrier properties
  (2) Improved mechanical properties - tensile strength and load at break
  (3) Improved hydrophobic properties
  (4) Improved shelf life on food products



- FTIR Analysis provides information that no new chemical interactions were formed as compared to the pure components. This shows a purely physical process.
- These biodegradable composite films proved to be environment friendly as compared to synthetic polymer based films.

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THANK YOU

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