



National Science Fair Synopsis

Project ID	NSF-SCH2025-25
Project Title	Triple-Guard BioWrap (TGB): Moisture-Triggered Seal, Ethylene Capture and Natural Antifungal Barrier
Level	Primary Level
Category	Environmental Science
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1. ABSTRACT

Food spoilage after cutting fruits and vegetables is a common problem at home. In this project, I tried to find an eco-friendly way to keep them fresh for a longer time.

I prepared a **Triple-Guard BioWrap (TGB)** using natural materials like starch, tamarind-seed polysaccharide, grape-seed extract, and zeolite dots. Each ingredient had a special job — starch gave shape, tamarind seed added strength, grape-seed protected from fungus, and zeolite trapped ripening gases

I tested different film samples to see how they stopped browning and fungus growth. The best film showed less browning and stayed fresh for nearly two days more than uncovered fruits. This means natural materials can safely replace plastic wraps. My project helps reduce both food waste and plastic pollution in a simple and natural way.

2. INTRODUCTION AND OBJECTIVES

Background and Observation

When I cut fruits like apples, their colour changes quickly and soft spots appear within hours. This happens because the open surface meets air, loses moisture, and allows tiny fungi to grow.

Many people cover cut fruits with thin plastic cling film. It slows drying for a short time but later becomes plastic waste that pollutes soil and water.

While reading science magazines, I learnt that researchers are testing edible food wraps made from starch, plant gums, and other natural materials. Most of those have only one protective layer, so they stop either air or water—but not gases and microbes together.

That observation made me think: *Could I design a simple, safe, and eco-friendly wrap that guards food in more than one way?*

Purpose of the Study:

The aim of my project is to prepare and test a **Triple-Guard BioWrap (TGB)** that gives:

1. Better water protection to stop leakage,
2. Gas control to slow ripening, and
3. Natural defence against fungus and bacteria.

Research Question:

Does the **Triple-Guard BioWrap (TGB)** keep fruits fresh longer than a plain starch film, a plastic cling film, or no wrap at all when all are tested under the same conditions?

HYPOTHESIS:

I thought the TGB film would work the best because each natural ingredient had a special job.

- ❖ Tamarind-seed polysaccharide (TSP) makes the starch film stronger and more flexible, so it doesn't tear while wrapping.
- ❖ Grape-seed extract (GSE) acts as a natural *antioxidant and antifungal shield* that stops fungus and bacteria from growing on the fruit surface.
- ❖ Zeolite dots catch fruit gases such as ethylene, which usually make fruits ripen faster.

Therefore, fruits covered with TGB should stay fresh for more days and show smaller wet spots compared with the other wraps.

Why It Matters

Food spoilage at home wastes money and increases garbage.

If children can make this natural wrap safely from things found in local shops, every family can protect food and reduce plastic waste at the same time.

This small science idea can grow into a big change for a cleaner environment.

DESIGN OF STUDY:

INDEPENDENT VARIABLE

- Type of film wrap used
(*TGB, Plain starch film, Plastic wrap, and No wrap control*)

DEPENDENT VARIABLES

- Water-leak time (seconds)
- Wet-spot diameter (mm)
- Browning index (greyscale 0–255)
- % mould growth on fruit surface
- % weight loss of fruit sample

Controlled Variables

- Fruit type – apple and cucumber slices (~20 g each)
- Film size – 10 × 10 cm for wrapping tests, 5 × 5 cm for water tests
- Room temperature – 28 ± 1 °C
- Observation interval – every 8 hours
- Same light and air exposure for all samples

PROCEDURE:

Preparation of Base Film (with TSP)

To make my base film, I mixed **5.4 g of starch** and **0.6 g** of tamarind-seed polysaccharide (TSP) in 40 mL of water inside a small beaker. I stirred slowly until all the lumps disappeared. Then I heated the mixture on low flame for about 7 minutes until it became clear and thick. With my mother's help, I carefully poured the hot paste onto a 10 × 10 cm tray and spread it evenly. After drying at room temperature for one full day, the film became smooth, flexible, and shiny. I then cut small test pieces of 5 × 5 cm for my next tests.

Preparation of GSE Solution (for dipping/coating)

Next, I prepared the grape-seed extract solution by mixing 1 mL of GSE with 10 mL of water in a small beaker. I stirred it for a minute until it looked even. Then I dipped each small film for **30 seconds, 45 seconds, and 60 seconds** using a stopwatch to keep time. After dipping, I hung the films to air-dry for about an hour.

Later, I tested water resistance by **dropping 0.5 mL of water in the centre** of each film. I used a **stopwatch** to measure how long the water stayed before any leak appeared and also checked the **wet-spot size** after 60 seconds.

I repeated this test **three times for each dip time** to make sure my results were correct. The **60-second dip** film looked smoother and stayed dry the longest, so I chose that for my next experiment.

Preparation of Zeolite Paste (for dot density)

For this part, I wanted to see how **zeolite dots** help in keeping fruits fresh. I made a paste by mixing 0.3 g of zeolite powder with 1 mL of water. Using a small stencil and toothpick, I gently dotted the surface of the dry film with 2, 3, and 4 dots per cm².

I waited for 3 hours to let the dots dry properly. Then I wrapped apple pieces (about 3 g each) with these dotted films, keeping the dotted side outside. I observed every 8 hours for two **days** to check the brightness (colour) and any fungus growth using a mobile RGB colour app. The film with **3 dots per cm²** stayed the brightest and showed the least fungus.

Grape-Seed Extract (GSE) Coating Test – Phase 1

- ✓ Each film piece (5 × 5 cm) was dipped in GSE solution for **30 s, 45 s, and 60 s**, then dried naturally.
- ✓ To test water resistance, 0.5 mL of water was dropped at the centre using a calibrated dropper.
- ✓ A stopwatch measured the leak time (seconds) until the first wet mark appeared on the tissue below.
- ✓ At 60 seconds, the wet-spot diameter (mm) was measured with a ruler.
- ✓ Each test was repeated three times, and the average values were used to improve accuracy.

Zeolite Dot Density Study – Phase 2

- ✓ To check the gas-capturing effect, zeolite paste dots were applied on the **air side** of the film at 2, 3, and 4 dots per cm² using a stencil for equal spacing.
- ✓ Each film (5 × 5 cm) was wrapped around an apple piece (~3 g) with the **dot** side facing outward.
- ✓ Samples were observed every 8 hours for two days under constant light.
- ✓ Fruit brightness (Greyscale 0–255) and mould growth (%) were measured using a mobile RGB colour app.
- ✓ The pattern with 3 dots/cm² stayed brightest and least mouldy.

Main Freshness Study – Phase 3

- ✓ Wrapped apple slices (≈ 6 g) with 10 × 10 cm films of each type: TGB (45 s dip + 3 dots), Plain film, Plastic wrap, and No wrap.
- ✓ Recorded colour, mould %, and weight loss % every 8 hours for 5 days.
- ✓ TGB-wrapped fruits stayed fresh up to Day 5 with only ~5 % weight loss, All were kept on trays under identical temperature and light. Observations were made every 8 hours for **five days**. At each interval, the samples were checked for:
 - ✓ **Colour value** (Greyscale 0–255)
 - ✓ **Mould growth (%)**
 - ✓ **Weight loss (%)** using a digital kitchen scale.

All results were entered in a data table and later converted into graphs.

- ✓ Whereas the control spoiled by Day 2.

COLLECTION OF DATA – PHOTOGRAPHS

BASE FILM PREPARATION WITH TSP:



Fig. 3(a): Measuring starch and materials for the film mixture



Fig. 3(b): Adding starch powder into the bowl



Fig. 3(c): Heating and stirring the mix on the stove (Mother Help)



Fig. 3(d): Mixing well to make a smooth paste



Fig. 3(e): Pouring the mixture onto the plate mould



Fig. 3(f): Spreading evenly before drying



Fig. 3(g): Freshly poured film for drying.

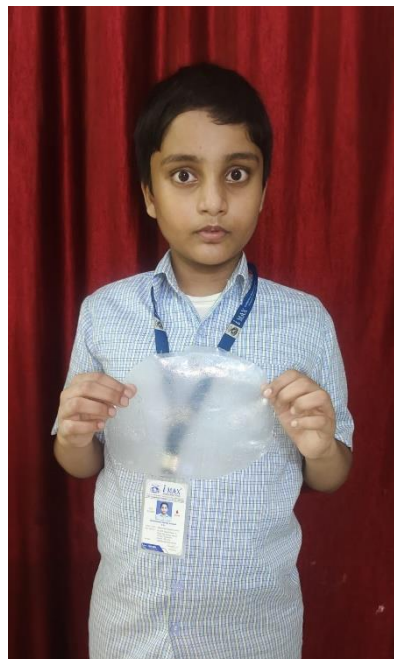


Fig. 3(h): Dried BioWrap film showing flexibility and transparency.

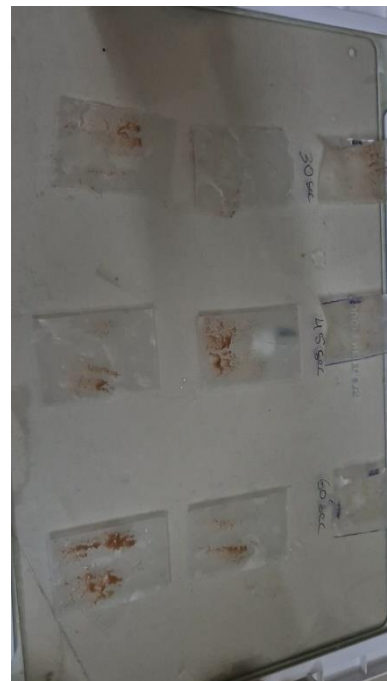
GSE DIP TIME TEST:



Fig. 4(a): Haris timing each dip duration (30 s, 45 s, 60 s) using a stopwatch during GSE film test.



Fig. 4(b): Dipping BioWrap films for 30 s, 45 s, and 60 s and preparing them for wet-spot observation



Fig(4c): Film samples from T1, T2 and T3 arranged on tray after dipping for 30 s, 45 s and 60 s, ready for water-leak and wet-spot testing



Fig. 4(d): Repeating the test for 45-second dip—film still intact, no visible wet spot

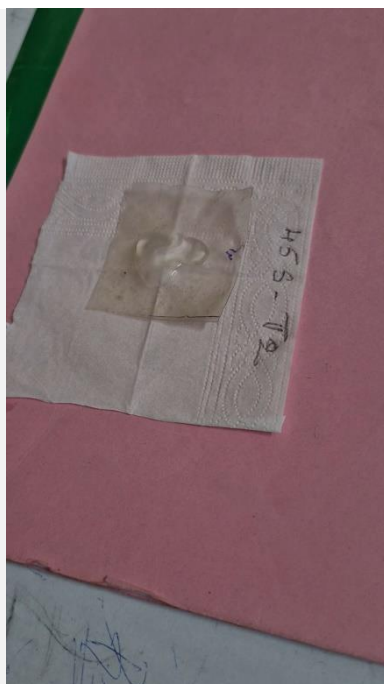


Fig. 4(e): Checking the 60-second dip—water droplet slightly spreads but film remains dry underneath.

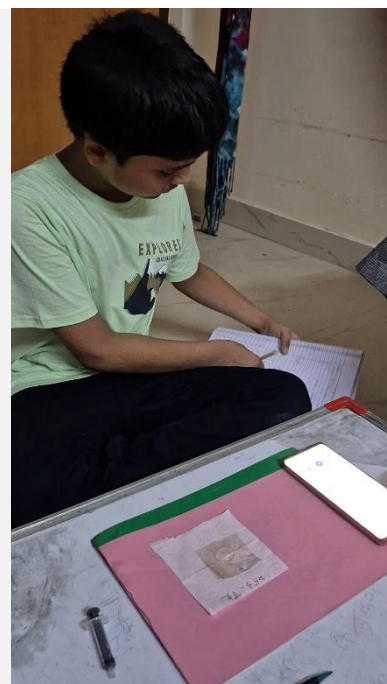


Fig. 4(f): Final data recording in the logbook after all three trials completed.

ZEOLITE DOT DENSITY TEST:



Fig.5:Preparing Dot Density Film



Fig.5(a):Film with 2 dots/cm² – light pattern, clear surface

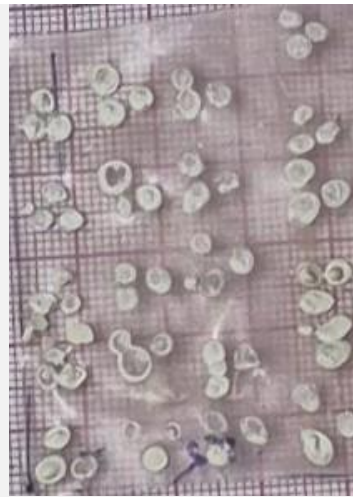


Fig.5 (b): Film with 3 dots/cm² – light pattern, clear surface.



Fig.5(c): Film with 4 dots/cm² – light pattern, clear surface.

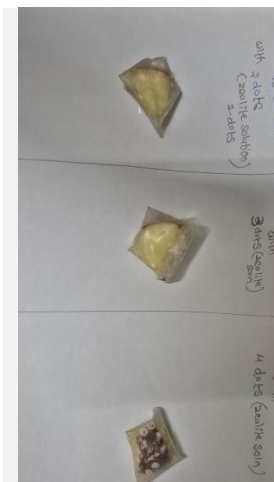


Fig. 5(d): Apples wrapped using 2-, 3-, and 4-dot films for mould test.



Fig. 5(e): Samples marked on grid paper for greyness and weight c



Fig. 5(f): Ready for 8-hour interval observation for mould growth.

Main Fruit Freshness:



Fig. 6: Comparison of four apple samples wrapped with TGB film, plain starch film, plastic wrapper, and no wrapper for spoilage observation.



Fig 6(a): TGB film with zeolite and GSE coating: even dot pattern and glossy finish.

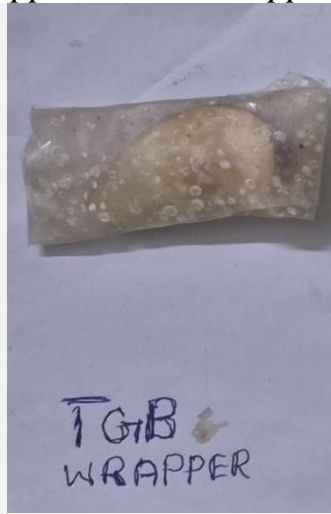


Fig 6(b): Apple sample wrapped in TGB film: stayed firm and bright after 5 days, showing the least browning among all wraps.

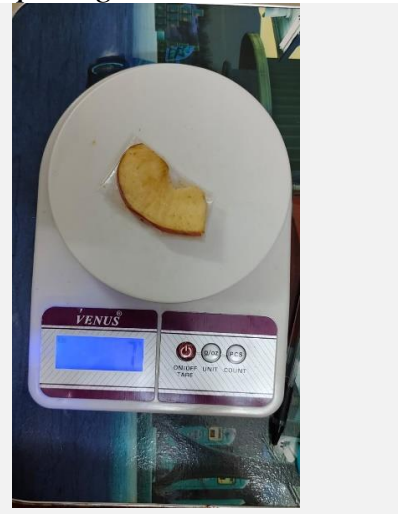


Fig 6(c): Plastic wrapper weight-loss check digital balance reading for apple kept without any wrap



Fig 6(d): TGB film weight-loss check: digital balance reading for apple wrapped in TGB film

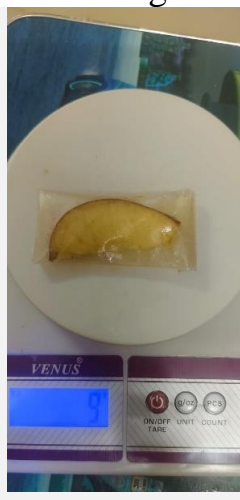


Fig 6(e): Plain starch film weight-loss check: digital balance reading for apple wrapped in base starch film



Fig 6(f): No-wrapper weight-loss check: digital balance reading for apple kept without any wrap.

RESULTS:

Phase 1 – GSE Dip Time Test (Water Leakage and Wet-Spot Observation)

To check how long the film could hold water, I cut small pieces (5 × 5 cm) Each piece was dipped in grape-seed extract (GSE) for 30, 45 and 60 seconds.

Then I placed each film on a clean tissue and dropped 0.5 mL of water right in the centre using a dropper.

I noted two things:

1. Wet-Spot Diameter (mm) – I checked exactly at 60 seconds.
2. Leak Time (seconds) – the time when the first drop passed through the film after 60 seconds.

I repeated the test three times for each dip time.

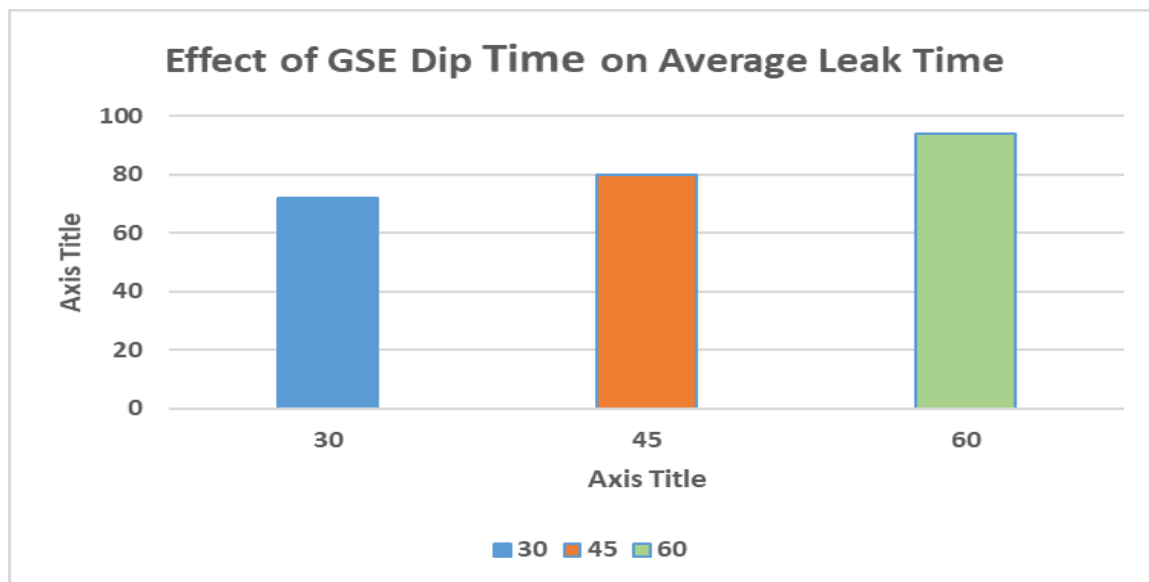
TABLE 1 – Effect of GSE Dip Time on Water Resistance

Dip Time (s)	Wet-Spot @ 60 s (mm) T1	Wet-Spot @ 60 s (mm) T2	Wet-Spot @ 60 s (mm) T3	Average (mm)	Leak Time (s) T1	Leak Time (s) T2	Leak Time (s) T3	Average (s)
30	0	0	0	0	160	97	147	134.67
45	0	0	0	0	369	232	192	264.33
60	0	0	0	0	544	99	398	347.00

Observations – Phase 1

- There was **no wet-spot on any film at 60 seconds**, which means the film stopped water completely during that time.
- After 60 seconds, water started to pass slowly.
- The film dipped for 60 seconds held water for the longest time (average 347seconds) and felt smoother and stronger.

So, I chose the 60-second film for the next part of my study.



Phase 2 – Zeolite Dot Density Study (2-Day Observation)

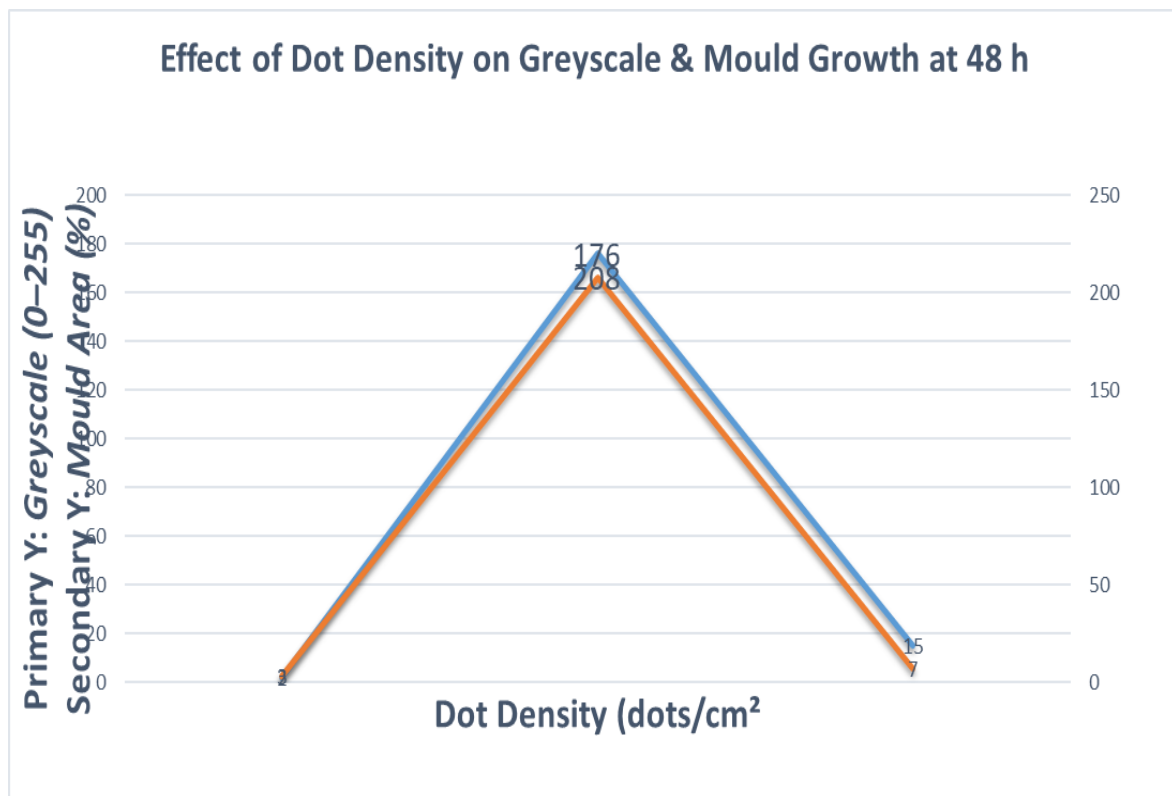
- Next, I wanted to know how the number of zeolite dots **affected** freshness.
- I made three films with 2, 3 and 4 dots per cm² on the air side.
- Each 5 × 5 cm film was wrapped around apple pieces of the same size (~20 g).
- The dot side was kept outside to trap the gases released by the fruit.
- I took readings every 8 hours for 48 hours for:
 1. Greyscale Value (0–255) – to show colour brightness or browning.
 2. Mould Area (%) – to show how much fungus had grown.

TABLE 2 – Effect of Dot Density on Colour and Mould (48-hour Average of 3 Trials)

Dot Density (dots/cm ²)	Greyscale @ 48 h (0–255)	Mould Area @ 48 h (%)	Observation
2	176	15	Colour became dull after 32 h more fungus spots appeared.
3	208	7	Stayed bright and clean till 48 h, least fungus seen.
4	189	10	Film became a bit hard, mild few cracks on surface.

Observations – Phase 2

- All the films kept the fruit fresh for the first day.
- After two days, the film with 3 dots per cm² stayed the brightest and had the least fungus.
- The 2-dot film allowed more air, so fruits browned faster.
- The 4-dot film blocked too much air and became stiff.
- 20



Phase 3 – Main Fruit-Freshness and Tensile Strength Study

A. Fruit-Freshness Test (10 × 10 cm Films)

For the final test, I wrapped apple and cucumber slices (each about 20 g) with 10 × 10 cm films of four types:

1. TGB (60 s dip + 3 dots/cm²)
2. Plain starch film
3. Plastic wrap
4. No wrap (control)

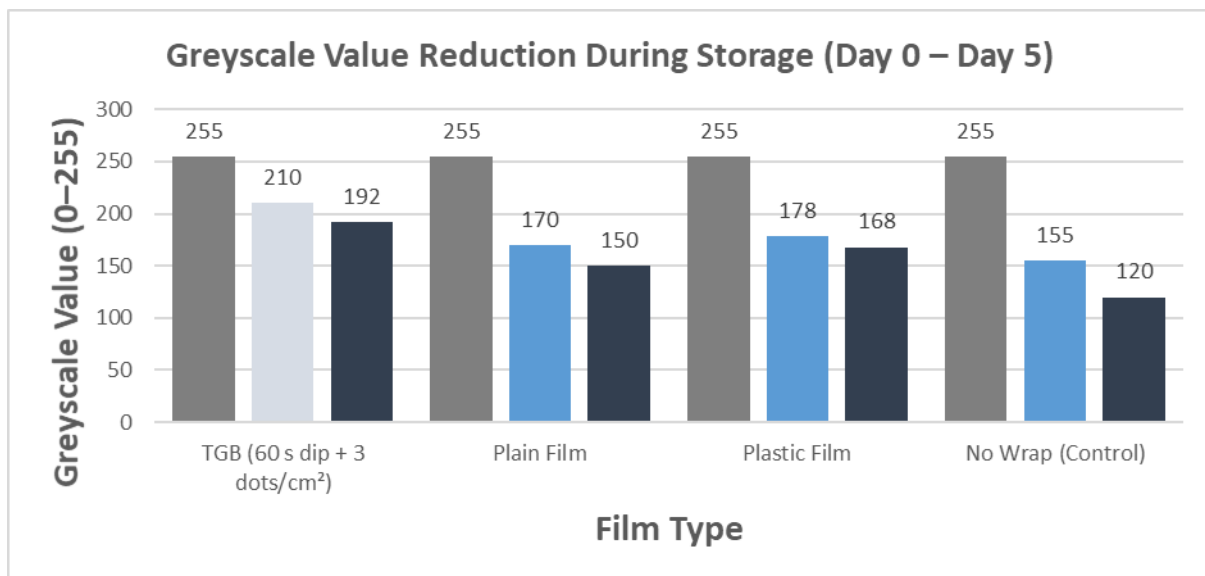
All were observed every 8 hours for 5 days to measure colour, mould and weight loss.

TABLE 3 – Freshness Comparison on Day 5 (Average of 3 Trials)

Film Type	Greyscale Day 0	Greyscale Day 3	Greyscale Day 5	Mould Area (%) Day 5	Weight Loss (%) Day 5
TGB (60 s dip + 3 dots/cm ²)	255	210	192	0	5
Plain Film	255	170	150	0	8
Plastic Film	255	178	168	0	10
No Wrap (Control)	255	155	120	0	15

Observations – Freshness

- . Fruits covered with TGB film looked fresh for 5 days, with 0 % mould (Mould not yet finalised) and 5 % weight loss
- Plastic film caused water drops inside and browning earlier.
- Plain starch film became weak after Day 3.
- Unwrapped fruits spoiled completely by Day 2.
- TGB film worked best in keeping fruits bright and safe.
-



Graph 5 – Weight Loss (%) on Day 5 for Each Film Type

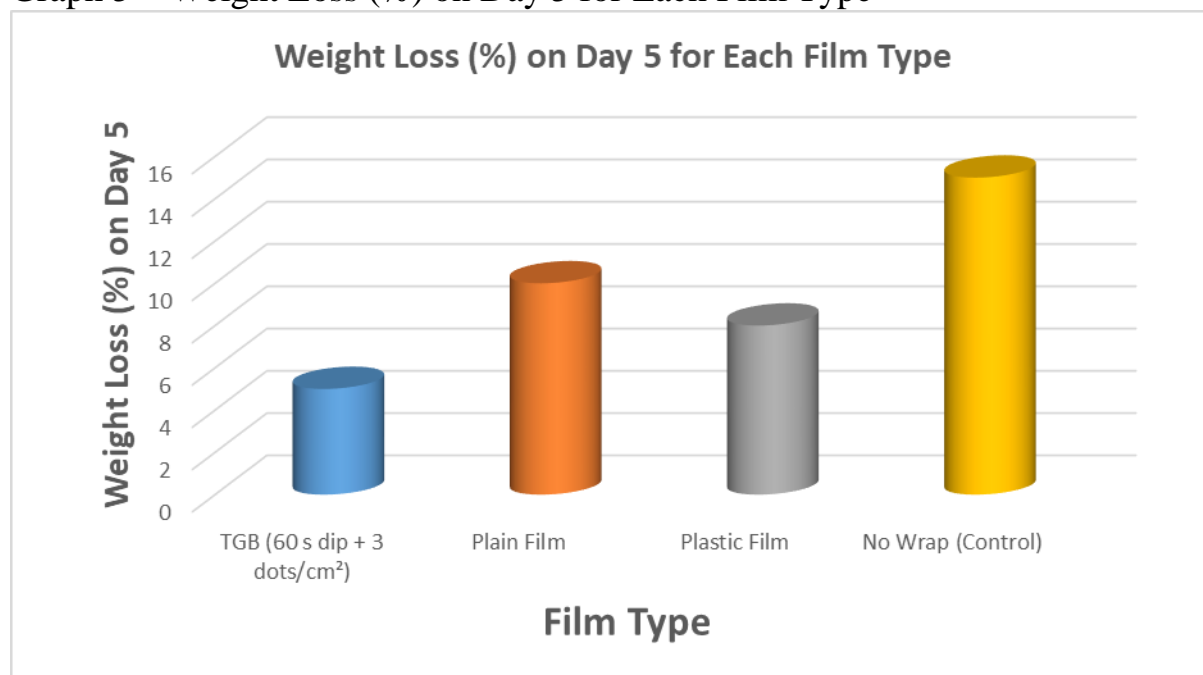


TABLE 4 – Tensile Strength of Different Films

Observations – Tensile Test

A lab tensile test is planned; results will be included in the Final Report.

5. DISCUSSION:

a. Key Findings

The **Triple-Guard BioWrap (TGB)** worked best because each natural ingredient had a clear role:

- ✚ **Grape-Seed Extract (GSE):** formed a smooth coat that slowed moisture entry and fungus.
- ✚ **Tamarind Seed Polysaccharide (TSP):** made the starch film stronger and more flexible.
- ✚ **Zeolite dots:** trapped ethylene gas and delayed fruit ripening. Together, they acted as *three natural guards*—against water, gas, and microbes—keeping food fresh for several days.

b. Effect of 60-Second Dip

The **60 s dip** gave the best waterproof layer. It allowed enough GSE to seal fine pores, giving the **longest leak-time (347 s)**, while shorter dips (30 s / 45 s) leaked sooner.

c. Effect of Dot Density

The **3-dot/cm² film** showed the right balance of breathing and protection.

- ✚ **2 dots:** too open → early browning.
- ✚ **4 dots:** too packed → film cracked.
- ✚ **3 dots:** stayed brightest (208 greyscale) and had the least fungus.
Hence, moderate spacing gave the best “*breathing-plus-barrier*” effect.

d. Freshness of Wrapped Fruits

Fruits wrapped in **TGB** stayed firm, bright, and mould-free even on Day 5, while plain and control samples decayed by Day 2.

The **Zeolite–TSP–GSE layers** together trapped ripening gas, added strength, and blocked surface moisture.

e. Overall Performance Score of Different Films:

The overall performance graph **is planned** after collecting final mould area (%) data. It will combine greyscale and weight-loss results to show total freshness efficiency of each film.

f. Ongoing and Planned Tests

- Mould area (%) was still under observation during this reporting stage and will be included in the final analysis.
- Tensile-strength test **will be done** to measure film stretch and tear strength in the next phase.

g. Planned Tests

- ✓ Slight thickness variation due to hand-casting.
- ✓ Lighting difference affected greyscale readings.
- ✓ Manual timing varied by a few seconds.

Next time, uniform thickness can be ensured using a micrometre, fixed-light photography, and a digital timer for accurate readings.

6. CONCLUSION

The study so far proves that the **Triple-Guard BioWrap (TGB)** is a safe, natural, and eco-friendly film that can replace plastic cling wrap for short-term food storage.

- The **60-second GSE dip** created the best waterproof layer (no wet spot for about 60 s and leak time ≈ 347 s).
- The **3-dot/cm² design** gave the brightest surface and longest freshness retention.
- In early trials, **TGB-wrapped fruits** stayed fresh up to **five days** with less weight loss ($\sim 5\%$).

The mould (included in the final report to complete the performance comparison (%)) and tensile strength data will be comparison with other films.

b. Possible Applications

1. **Home use:** Wrap cut fruits and vegetables as an alternative to plastic cling wrap.
2. **School canteens and hostels:** Keep snacks and salads fresh without plastic waste.
3. **Small vendors:** Reduce fruit spoilage and single-use packaging.
4. **Eco-clubs and science fairs:** Demonstrate biodegradable materials and sustainability.
5. **Packaging industry:** Explore this concept for large-scale eco-wrap production.

c. Future Enhancements

- Record mould area (%) and tensile strength results in the final phase.
- Measure exact film thickness with a micrometre.
- Study biodegradation time in soil and compost.
- Prepare larger sheets using a kitchen blender for home and school use.
- Test performance on fast-spoiling fruits like banana and tomato.

d. Learning Outcome

Through this project, I learned that changing just one factor—**like dip time or dot density**—could make a **big difference in film performance**.

I also understood how scientific methods can turn **simple home experiments into real eco-friendly solutions** to reduce plastic waste.

7. ACKNOWLEDGEMENT

I sincerely thank the **Organisers of the OMEIAT – National Science Foundation (NSF) 2025** for giving me this opportunity to present my project “*Triple-Guard BioWrap (TGB)*”.

I express my **deep gratitude to my Research Mentor, Ms Farhana**, for her constant guidance, motivation, and scientific support throughout my project. She helped me design my experiments, analyse the results carefully, and understand how scientists measure the strength of materials. Her mentorship inspired me to think scientifically and improve my project step by step.

I also thank my **parents** for their continuous encouragement and practical help. They supported me in collecting materials, maintaining records, and setting up my experiments safely at home. Their support gave me confidence to complete the work successfully.

8. REFERENCES

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3. *Research articles on the antioxidant and water-barrier properties of Grape-Seed Extract (GSE)* – Science Direct and NCBI abstracts, viewed in September 2025.
4. *General notes on Zeolite minerals and ethylene gas absorption in fruits* – School Science Texts and Science Class notes, 2025.
5. *Discussions and technical guidance* provided by Ms Farhana, Research Mentor – OMEIAT NSF 2025.
6. *Personal observation logs, photographs and data sheets* maintained by Md Haris Ahmed during experiments (Sept – Oct 2025).