National Science Fair
Research Paper

Project ID	**NSF-SCH2025-229**
Project Title	**Probiotics vs. Spoilage: Can Fermented Food Extracts Slow Fruit Rot?**
Level	**Primary level**
Category	**Life Science**
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Contents

ABSTRACT:

Food spoilage caused by molds and bacteria leads to large amounts of fruit waste every year. In my research I have investigated whether natural probiotics from fermented foods can slow fruit spoilage and extend shelf life. Probiotic extracts from rice water fermentation and yogurt whey were tested on fruit samples (grapes and strawberries) and compared to untreated controls. Each fruit was dipped in the probiotic solution and observed daily for visible mold growth. The day to first mold was recorded for 2-4 replicates of each treatment. Results showed that fruits treated with probiotic extracts spoiled significantly later than the untreated samples. On average, control fruits developed mold in about 2–3 days, while those treated with rice water and yogurt extracts lasted 4–6 days before visible spoilage. The acidic environment and beneficial bacteria in the probiotics likely inhibited spoilage microbes. This suggests that simple, natural probiotic coatings could be an effective and eco-friendly method to reduce food waste and preserve fresh fruits without artificial chemicals.

INTRODUCTION:

Fruits spoil quickly because of microbes (mainly molds and some bacteria). Chemical preservatives can delay spoilage but raise health and environmental concerns.
Fermented foods (yogurt, fermented rice water) contain probiotics that produce acids and other antimicrobial compounds. This project tests whether simple, food-safe extracts from everyday ferments can slow visible spoilage when applied to fruit offering a low-cost, eco-friendly approach to reduce food waste.

PROBLEM SELECTION & STATEMENT:

Household food waste is a global problem. Fruit spoilage normally occurs within
days at room temperature, causing food loss. Food scientists study bio-preservation (using beneficial microbes or their products to protect food), but most commercial methods require lab equipment or special products. For homes and schools, a low-tech, safe method that uses everyday fermented foods would be valuable.

The problem this research addresses is: Can safe, cell-free extracts from fermented foods (yogurt and fermented rice water) be used to slow fungal spoilage of fresh fruit at room temperature?
Why this is novel:
* Tests metabolites from ferments (not just live bacteria).
* Compares a dairy source (yogurt) with a low-cost regional source (fermented rice water).
* Focuses on visible mold spoilage (fungal) of fruit — practical and under-explored level.

HYPOTHESIS:

Primary hypothesis: Grapes & Strawberries coated with a starch film containing fermented-rice extract will show a longer time to first visible mold and lower percentage spoilage after 7 days than uncoated strawberries.

Secondary hypothesis: Yogurt extract will also reduce spoilage but may differ in effectiveness from rice extract.

DESIGN OF STUDY:

Variables

* **Independent variable**: Treatment applied to fruit (type of extract/coating).

* **Dependent variables**:
* Day to first visible mold on each fruit (days).
* Percentage of fruits spoiled at Days 3, 5, 7.
* Mold severity score (based on number of fruits) at Days 3, 5, 7.

* **Controlled variables:** Fruit type and source, ripeness stage, washing procedure, coating method and drying time, storage temperature and location, handling procedures, number of fruits per treatment.

Materials required

- Fresh strawberries (uniform, same supermarket batch) — 10 fruits (2 per treatment minimum).
- Fresh grapes- 20 fruits (4 per treatment)
- Plain unsweetened yogurt (store bought).
- Rice and clean water to make fermented rice water (about 100 g rice + 300 ml water).
- Corn-starch (or potato starch).
- Measuring spoons/cups, small saucepan, mixing bowls, stirring spoon.
- Cheesecloth or coffee filter and small funnels / clean jars.
- Clean trays or shallow boxes, paper towels.
- Gloves, disposable aprons, safety glasses.
- Marker and labels.
- Ruler or transparent grid to estimate mold area.
- Camera or phone for daily photos.
- Notebook or spread sheet for data recording.

PROCEDURE

To Make fermented rice water

1. I have rinsed 100 g rice quickly, placed in clean jar with 300 mL boiled-and-cooled sterile water. Covered with clean cloth and left at room temperature 12–24 hours to ferment (do not exceed ~30°C).

2. After fermentation, strained through cheesecloth or coffee filter into a clean jar to remove solids. The liquid was collected — (this is fermented rice water) Refrigerated and used in very same day.

Prepare yogurt extract and starch gel

3. Yogurt extract: Mix 50 g plain yogurt + 150 ml sterile water, stir, and then filter through cheesecloth or coffee filter. The liquid was collected (this reduces solids and many cells). Kept chilled.

4. **Starch gel:** To Make a small batch: mixed with 1 tablespoon corn-starch with 3 tablespoons of cold water to form slurry. Heat ~150 ml water to near-boil, added slurry and stirred until thick and clear. It was removed from heat and cooled to warm.

5. For each coating, mix 10 ml of cooled starch gel with 10 ml of the appropriate extract (rice extract for A & yogurt extract for B) Stirred and kept covered.

Prepare fruit and coat

6.To water and pat dry on paper towels: Purchase uniform strawberries and grapes. Rinse gently under clean

7. Label trays for each group (A–D). Place 4 grapes on each tray.

8. **Coating:** Dip each grapes in its group's coating solution for ~5s or brush on evenly using a clean brush. For group D (untreated), do not coat. Allow coated fruits to dry on paper towels ~30–60 minutes.

9. Record this as Day 0. Place all trays in the same storage area (room temperature, away from direct sunlight)

(The same procedure follows for grapes)

Day 1–Day 7: Daily observations

10. Each day at the same time, inspect every fruit and record:
* Whether any visible mold is present in the number of fruits (Yes/No); if yes, record the day to first mold.
* Mold severity score (based on molds appeared on number of fruits, total for each treatment=4): 0 = no mold, 1 = <5% surface area, 2 = 5–25%, 3 = 26–50%, 4 = >50% or heavily rotten.

* Take a photo of representative fruits for visible observation.

11. Continue daily for 7 days (7 days is minimum recommended).

Experimental groups for each fruit

* A — Starch + Fermented Rice Extract (coating)

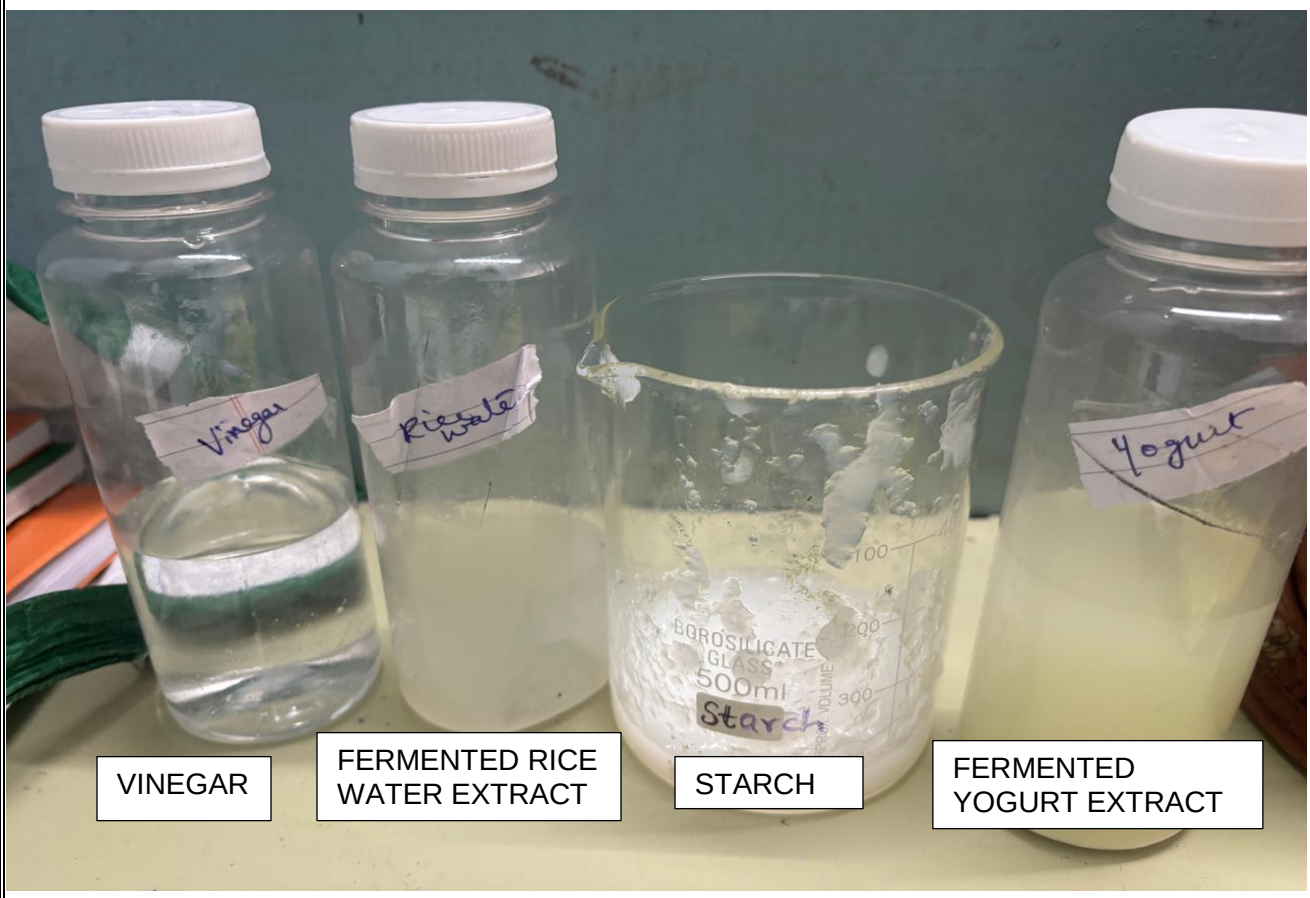
* B — Starch + Yogurt Extract (coating)

* C — vinegar or commercial preservative coating

* D — No coating (untreated negative control)

COLLECTION OF DATA:

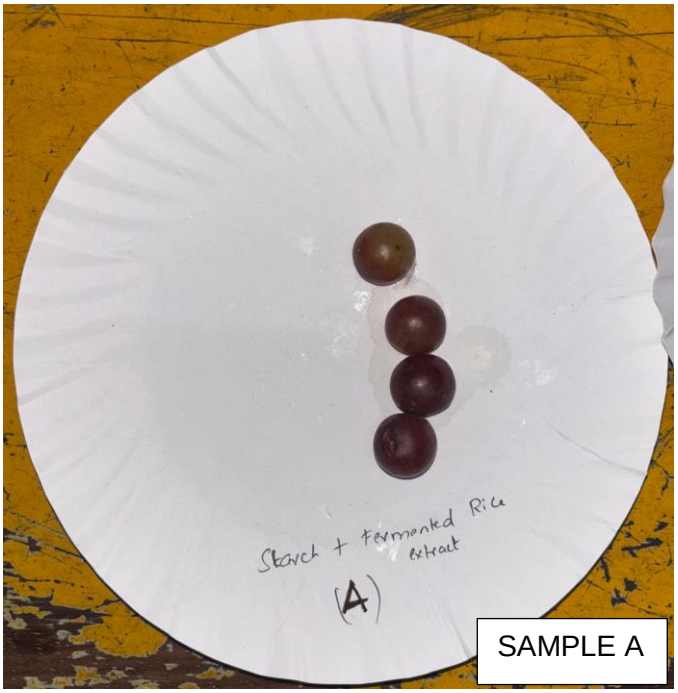
Different Treatment



Grapes day 1 coating

Sample A Starch+ fermented rice extract & SAMPLE B (starch+ yogurt extract)

Day 3 Grapes coating



SAMPLE A

SAMPLE B

SAMPLE A (starch+ fermented rice extract) & SAMPLE B (starch+ yogurt extract)

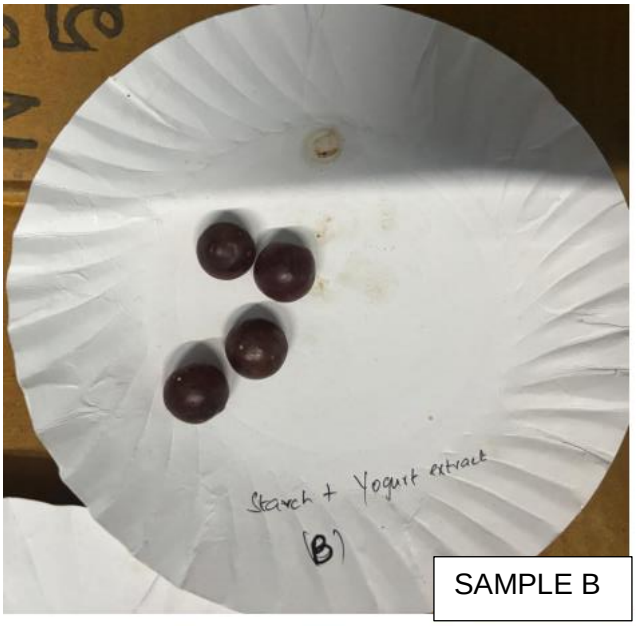
SAMPLE C
VINEGAR

SAMPLE D
NO COATING

SAMPLE C (only Vinegar) & SAMPLE D (no coating)

Grapes day 5 coating

SAMPLE A



SAMPLE B

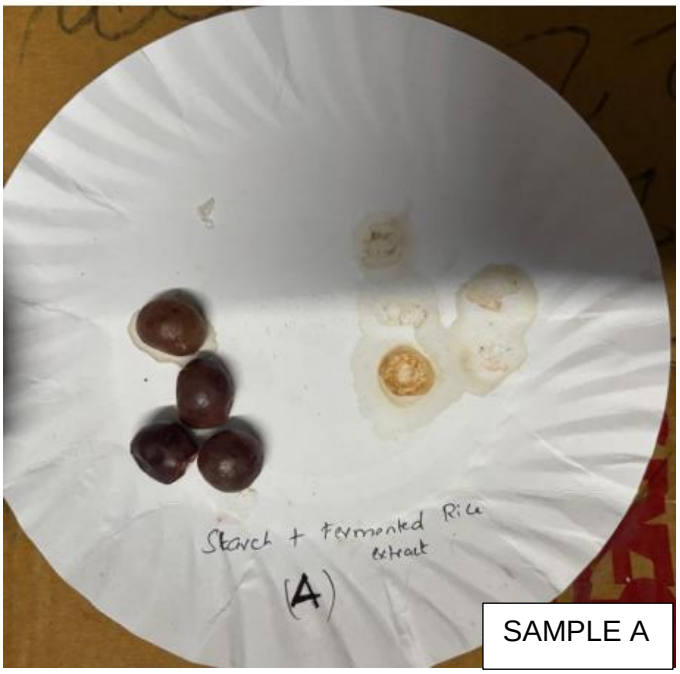
SAMPLE A (starch+fermented rice extract) & SAMPLE B (starch+ yogurt extract)

SAMPLE C
VINEGAR

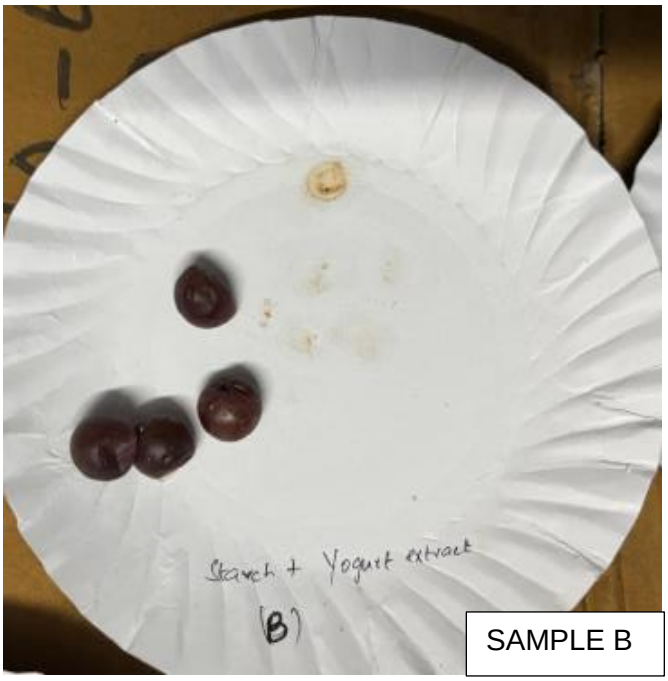
SAMPLE D
NO COATING

SAMPLE C (only Vinegar) & SAMPLE D (no coating)

Grapes day 7 coating

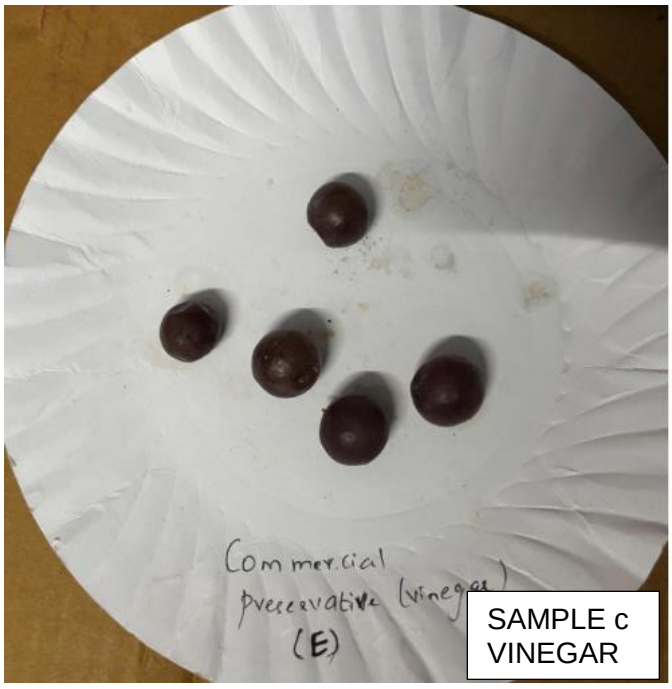


SAMPLE A



SAMPLE B

SAMPLE A (starch+fermented rice extract) & SAMPLE B (starch+ yogurt extract)



SAMPLE c
VINEGAR

SAMPLE D
NO COATING

SAMPLE C (only Vinegar) & SAMPLE D (no coating)

Strawberry day 1 coating

SAMPLE A

SAMPLE B

SAMPLE A (starch+fermented rice extract) & SAMPLE B (starch+ yogurt extract)

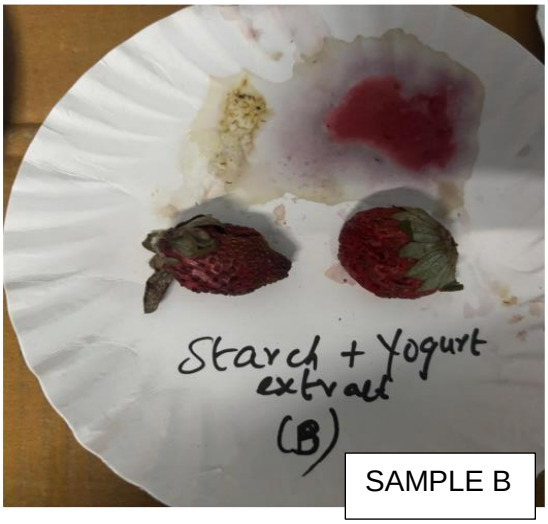
SAMPLE C

SAMPLE D
NO COATING

SAMPLE C (only Vinegar) & SAMPLE D (no coating)

Strawberry day 5 coating

SAMPLE A



SAMPLE B

SAMPLE A (starch+fermented rice extract) & SAMPLE B (starch+ yogurt extract)

SAMPLE C

SAMPLE D
NO COATING

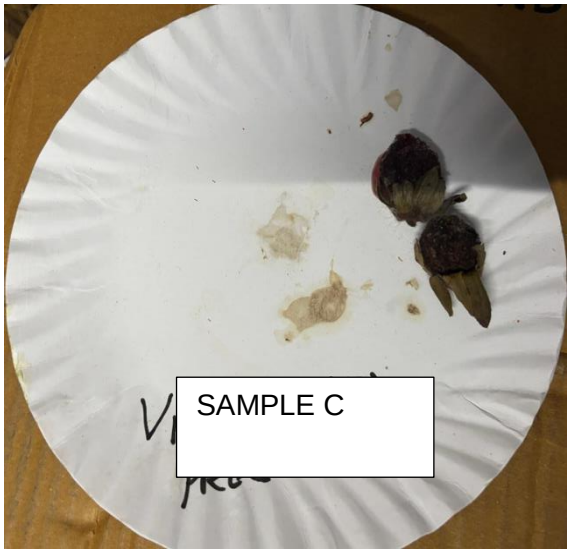
SAMPLE C (only Vinegar) & SAMPLE D (no coating)

Strawberry day 7 coating

SAMPLE A

SAMPLE B

SAMPLE A (starch+fermented rice extract) & SAMPLE B (starch+ yogurt extract)



SAMPLE C

SAMPLE D
NO COATING

SAMPLE C (only Vinegar) & SAMPLE D (no coating)

DATA ANALYSIS TABLE

Grapes (vs) different coatings: formation of mold observation on number of fruits.

S. No	Treatment	No. of fruits (n)	Day coated	Mold score day 3	Mold score day 5	Mold score day 7	Mean Mold score	% fruits with mold day 7
1	A — Starch + Fermented Rice Extract	**4**	**23/10/2025**	**0**	**2**	**3**	**1.7**	**75%**
2	B — Starch + Yogurt Extract	**4**	**23/10/2025**	**0**	**3**	**4**	**2.3**	**100%**
3	C— vinegar	**4**	**23/10/2025**	**0**	**1**	**2**	**1**	**50%**
4	D — No Coating	**4**	**23/10/2025**	**2**	**3**	**4**	**3**	**100%**

Mean calculated based on mold scores recorded on Day3, Day5, Day 7.

Mean= Mold score day 3+Mold score score day 5+Mold score day 7

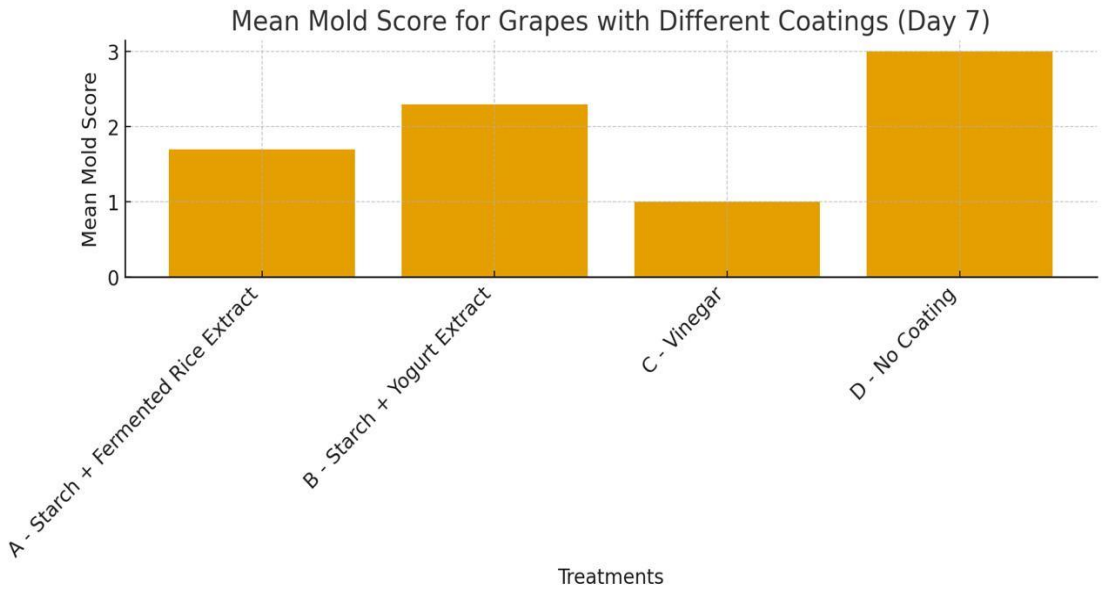
3

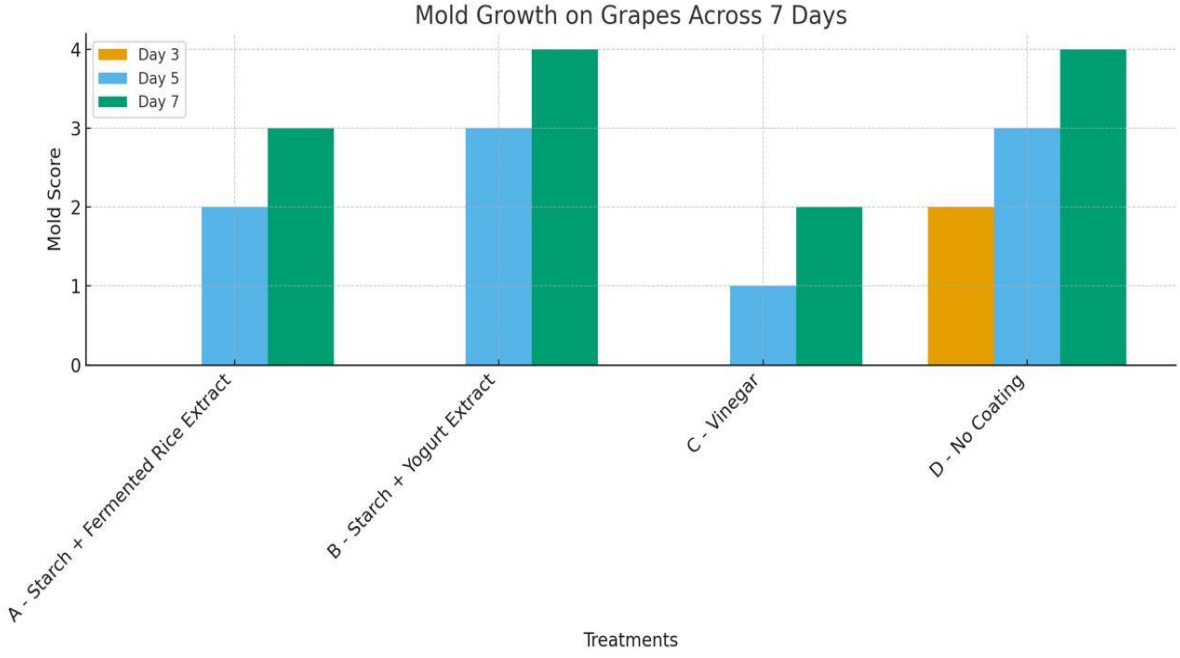
Strawberry vs different coatings: formation of mold observation

S. No	Treatment	No. of fruits (n)	Day coated	Mold score day 3	Mold score day 5	Mold score day 7	Mean	% fruits with mold day 7
1	A — Starch + Fermented Rice Extract	**2**	**23/10/2025**	**0**	**0**	**2**	**0.7**	**100%**
2	B — Starch + Yogurt Extract	**2**	**23/10/2025**	**0**	**1**	**2**	**1**	**100%**
3	C — vinegar	**2**	**23/10/2025**	**0**	**0**	**1**	**0.3**	**50%**
4	D — No coating	**2**	**23/10/2025**	**2**	**2**	**2**	**2**	**100%**

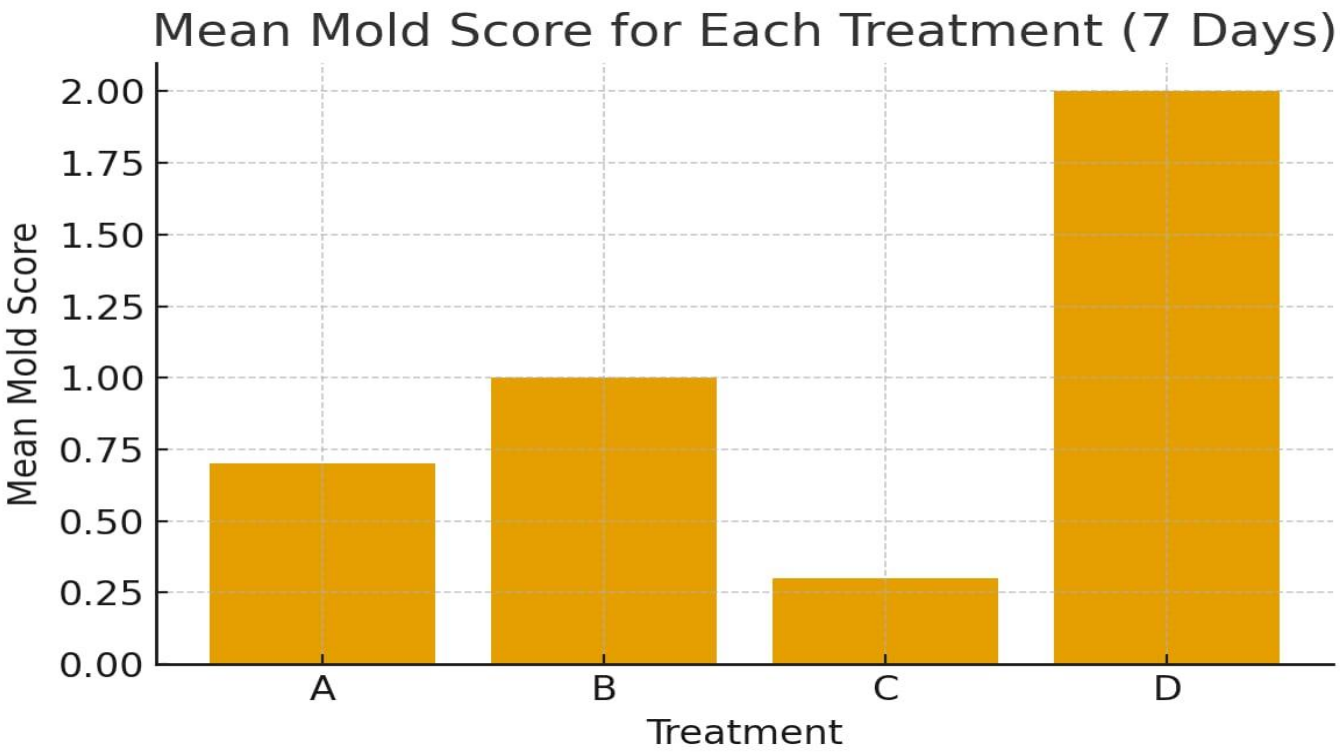
GRAPHICAL REPRESENTATION

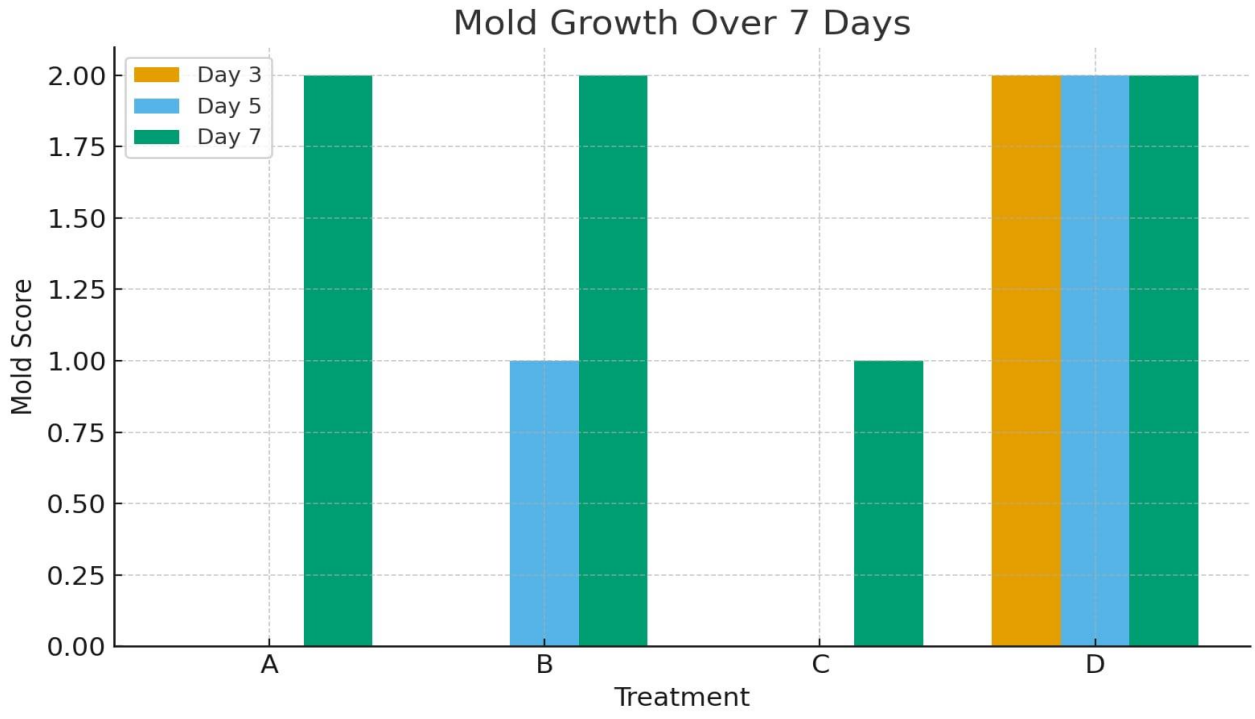
GRAPES





STRAWBERRY


Mean Mold Score for Each Treatment (7 Days)
Mean Mold Score
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
A
B
C
D
Treatment


Mold Growth Over 7 Days
Day 3
Day 5
Day 7
Mold Score
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
A
B
C
D
Treatment

RESULTS:

The results show that different coatings had a significant effect on mold growth in strawberries and grapes stored over 7 days.

Across both fruits, mold growth patterns showed clear differences among the coatings:

1. Vinegar (Treatment C)
   - Most effective coating for both grapes and strawberries.
   - Showed the lowest mold scores and the lowest % mold incidence (50%) on Day 7.
   - Mold onset was delayed, and severity stayed minimal.

2. Starch + Fermented Rice Extract (Treatment A)
   - Provided moderate protection.
   - Delayed mold growth until later days (Day 5 or 7), but did not prevent mold completely providing enhancement is needed for future to use this as an alternative for chemical preservatives.
   - Mold incidence reached 75–100% by Day 7.

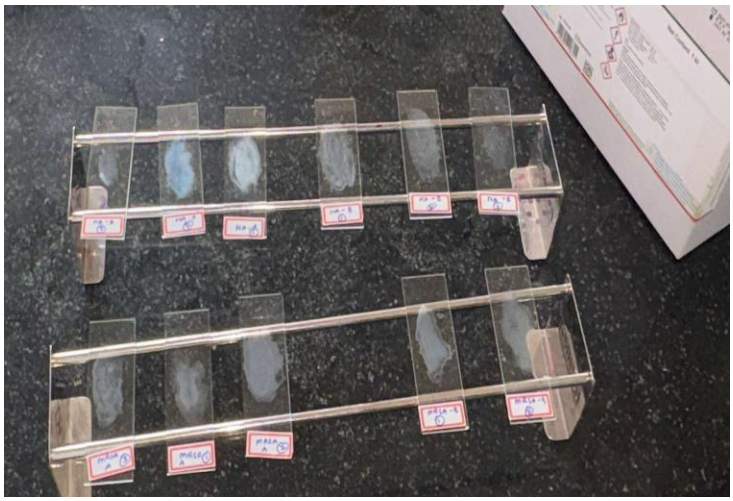
3. Starch + Yogurt Extract (Treatment B)
   - Showed limited effectiveness.
   - Mold appeared earlier than Treatment A and increased significantly by Day 7.
   - 100% mold incidence for both fruits.

4. No Coating (Treatment D – Control)
   - Least effective for both fruits.
   - Showed the highest mold scores and 100% mold incidence.
   - Mold appeared earliest and remained consistently high.

Overall, vinegar coating was most effective in reducing mold growth in both fruits, followed by starch + fermented rice extract for moderate control.

The fermented rice water extract and yogurt extract were tested for microbial observation and by doing microbial culture and gram staining the results observed showed the presence of gram +ve and gram –ve bacterias that acted as a barrier for delaying mold formation in both fruits.

Samples & Isolates on Nutrient Agar and MRS Agar (selective medium for lactic acid bacilli)



Gram Staining of total 11 isolates

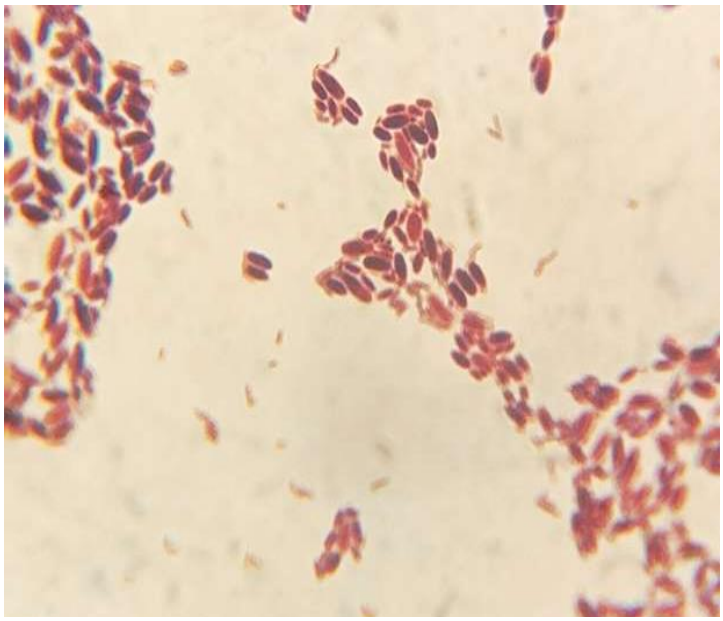


Figure 1 Sample B -NA- Isolate 2 Gram positive bacilli

Figure 2 Sample B -NA- Isolate 1 Gram negative bacilli

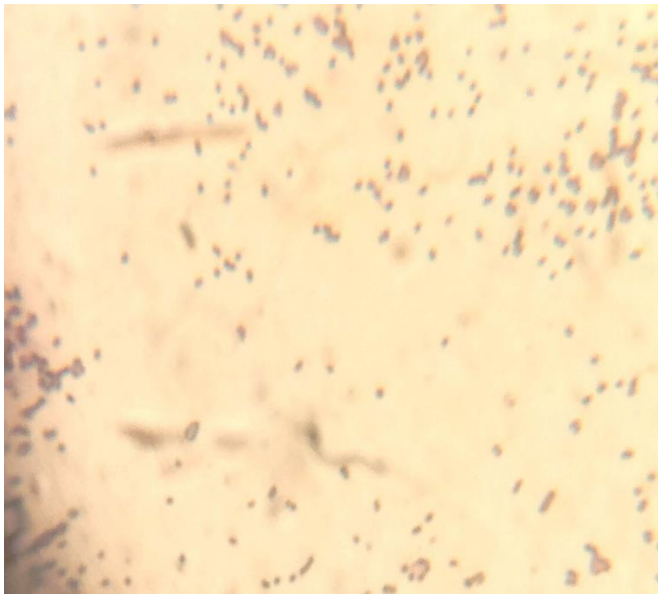


Figure 3: Sample A -NA- Isolate 1 Gram +ve Bacilli

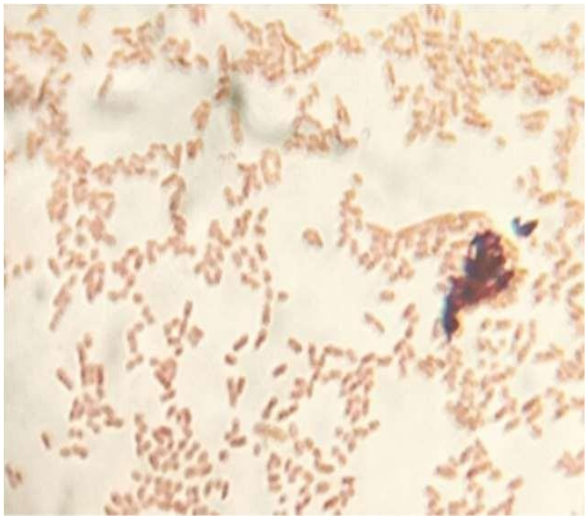


Figure 4 Sample A-NA-Isolate 3 Gram – ve Bacilli

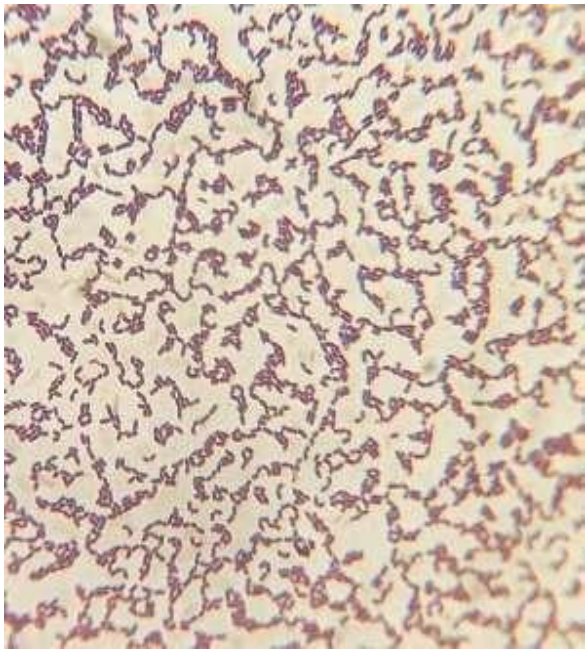


Figure 5 MRSA-Sample-B-Isolate-1 gram +ve Bacilli

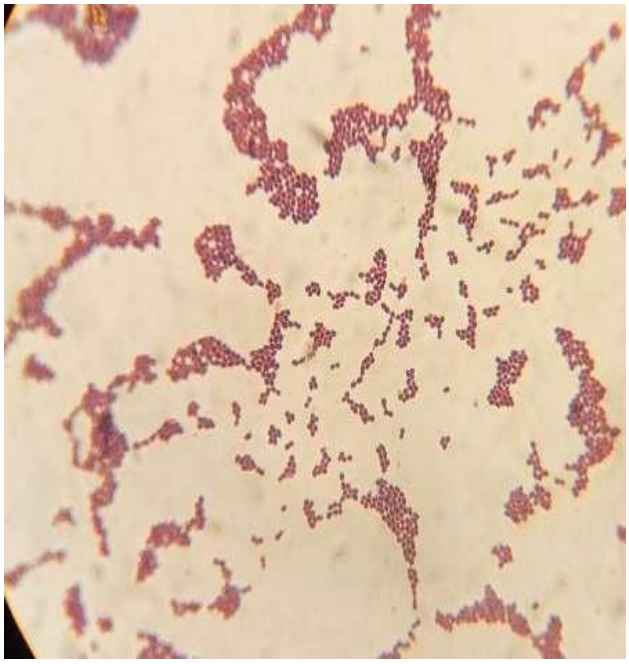


Figure 6 MRSA-Sample-A-Isolate-3 Gram +ve Cocci

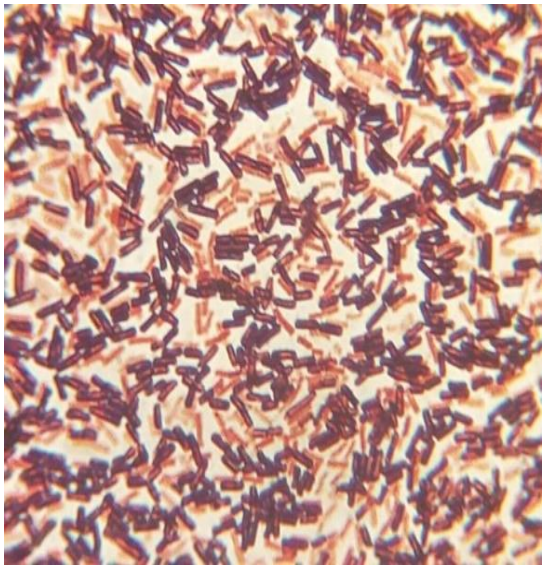


Figure 7 MRSA-Sample-A-Isolate-2 gram +ve Bacilli

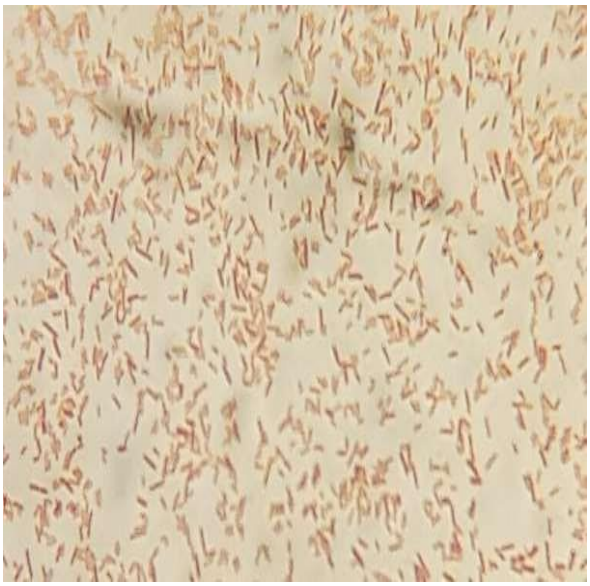


Figure 8 Sample A-NA-Isolate 2 Gram –ve Bacilli

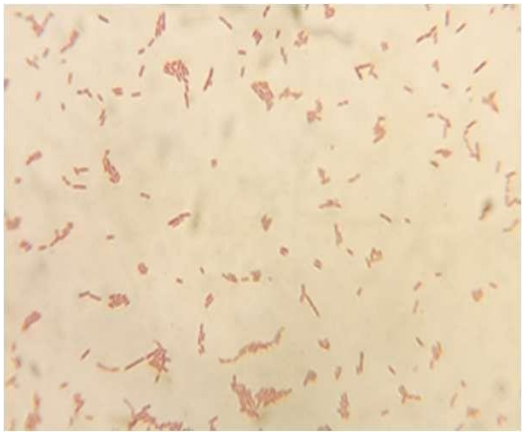


Figure 9 Sample B -NA- Isolate 3Gram -Ve Bacilli

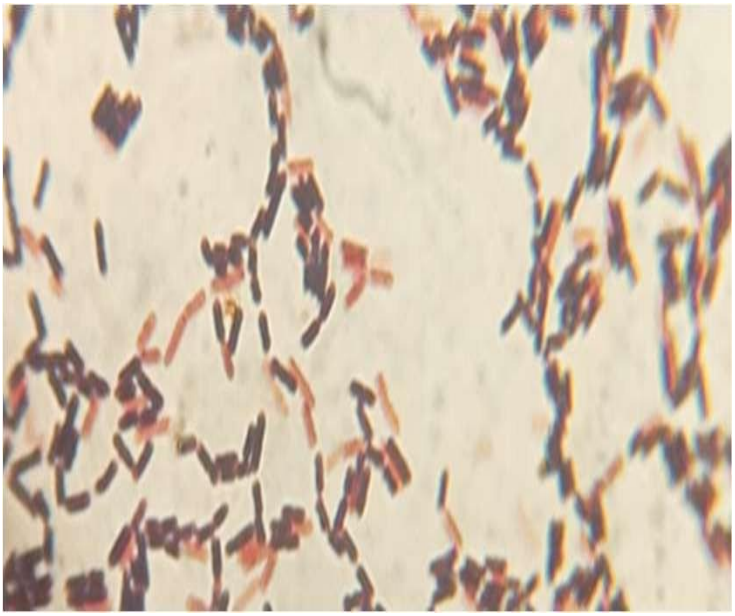


Figure 10MRSA-Sample-A-Isolate-1

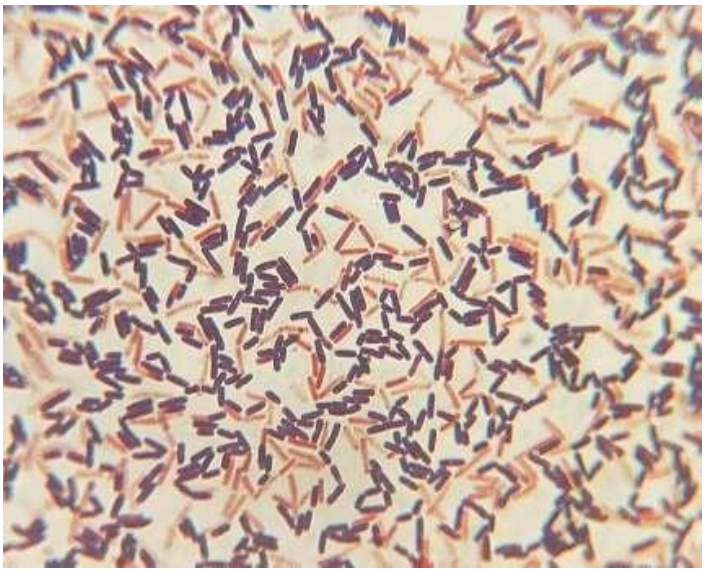


Figure 11MRSA-Sample-B-Isolate-2 Gram +ve Bacilli

DISCUSSION

The application of natural coatings significantly delayed mold growth on both strawberries and grapes. Coatings acted as physical barriers that reduced respiration rate and moisture loss, delaying microbial spoilage.

- Vinegar coating (C) demonstrated antifungal properties due to its acetic acid content, which inhibits fungal spore germination and growth.

- Fermented rice extract (A) and yogurt extract (B) provided some protection likely because of the presence of organic acids, probiotics, and antimicrobial metabolites, but were less effective than vinegar needed some advancement in development.

- No coating (D) showed rapid spoilage, confirming that starch alone lacks strong antifungal activity.

- Grapes, with higher surface sugar and moisture, exhibited more mold growth overall compared to strawberries, emphasizing the need for stronger antimicrobial coatings for such fruits.

The results align with previous findings that acidic natural coatings (like vinegar or citric-based) extend fruit shelf life by suppressing mold development whereas **fermented rice extract water** extract could provide moderate protection delaying mold which supports the hypothesis can be true.

CONCLUSION

- Vinegar coating and fermented rice extract proved to be the most effective natural preservative for both strawberries and grapes, while vinegar reducing mold development by 50% compared to uncoated fruits then comes fermented rice extract which proved to delay spoilage which indicates the action of microorganisms present in it.

- Fermented rice extract and yogurt extract offered moderate protection and could be potential eco-friendly alternatives to synthetic preservatives.

- Starch alone or no coating treatments were ineffective, resulting in complete mold growth by day 7.

- The use of simple, edible, and natural substances like vinegar and fermented rice extract provides a sustainable and affordable method to extend the shelf life of perishable fruits.

FUTURE ADVANCEMENTS

1. Combination Coatings: Future studies can combine vinegar and fermented rice water extracts with biopolymers like starch or chitosan for longer preservation.

2. Shelf-Life Testing: Extended trials beyond 7 days and under different storage temperatures (refrigerated vs room temperature) can provide more realistic insights.

3. Sensory Analysis: Future work can include taste, color, and texture evaluation to ensure coatings do not alter fruit quality.

4. Microbial Studies: Identification of specific fungi or bacteria inhibited by each coating using microbiological tests can help optimize formulations.

5. Eco-Packaging Integration: Combining fermented rice extract-coated fruits with biodegradable packaging could offer a complete eco-friendly preservation system.

REFERENCES:

Edible Coatings and Future Trends in Active Food Packaging for Fruits and Vegetables

This article discusses the use of plant extracts, natural volatile compounds, and essential oils in food coatings to reduce spoilage and enhance the shelf life of fruits and vegetables.

Probiotic-Loaded Seed Mucilage-Based Edible Coatings for Fresh Fruit Preservation

This research explores the use of probiotic-loaded seed mucilage-based edible coatings to control spoilage-causing microorganisms in fresh fruit, thereby delaying deterioration.

Starch-Based Coatings for Food Preservation: A Review

This review focuses on starch-based coatings as materials used to extend the shelf life and preserve the quality of foods during storage.

Effect of Antimicrobial Starch Edible Coating on Shelf-Life of Fresh Strawberries

This study evaluates the effect of antimicrobial starch edible coatings on the shelf life of fresh strawberries, finding that the coatings reduce postharvest spoilage.

ACKNOWLEDGEMENT

- Praising the Almighty, for giving me good strength throughout my research work and enabling me to complete the fair project successfully.

- I have taken efforts in this project .However, it would not have been possible without the kind support and help of many individuals and organizations.

- I would like to extend my sincere thanks to all of them. I would like to express my deep thanks to my Correspondent Mr. Sadique Batcha.

- I express my deep sense of gratitude to my Principal Mrs. Sogra Jabeen, Vice Principal Mrs. Rabia Basri and Guide teacher Mrs. Farhana Nasuha for their guidance and valuable suggestions & developing my interest in the investigation and in the presentation of this report.

- I would like to thank my parents who helped and motivated me a lot for doing a science fair project