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UNIVERSITY OF GEORGIA
College of Engineering
Manufacturing Living Labs

Moisture

Results of Cold Bath and Hot Bath Moisturization

USDA

FORT VALLEY STATE UNIVERSITY

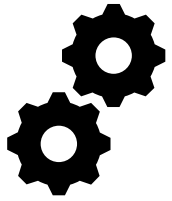
I LOVE pecans

NPSA NATIONAL PECAN SHELLERS ASSOCIATION

Objectives

How can cracking and shelling processes be optimized to maximize half yields, improve efficiency, and reduce waste in pecan processing?

Moisture content



Mechanical Properties
such as firmness and flexibility

Research Objectives

How can cracking and shelling processes be optimized to maximize half yields, improve efficiency, and reduce waste in pecan processing?

Research Objective 1	Identify effective moisture conditioning methods
Research Objective 2	Measure and compare their effects
Research Objective 3	Develop predictive models for industry use

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Research Objective 1	Identify effective moisture conditioning methods
Research Objective 2	Measure and compare their effects
Research Objective 3	Develop predictive models for industry use

Equipment and Modification

SB900

IR3000

Aqualab 3

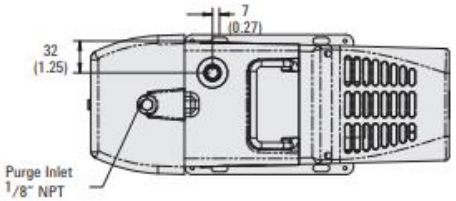
Equipment and Modification

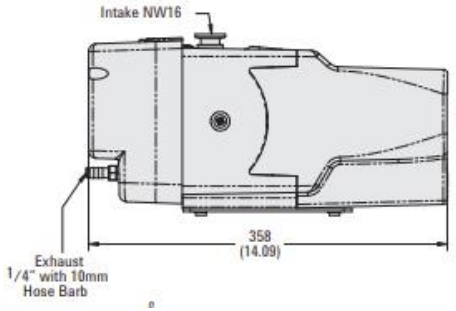
Forced Air Convection Oven

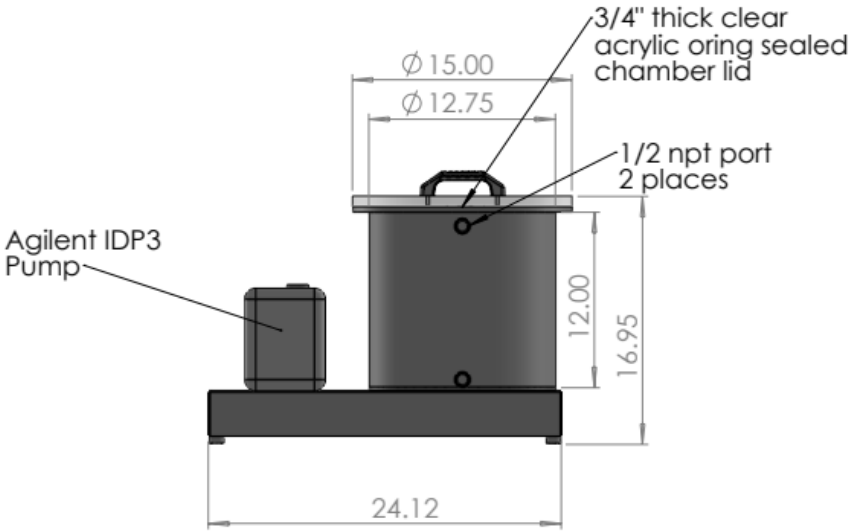
Sous-Vide Precision Cooker

Equipment and Modification

Vacuum Chamber







Experiments and Results

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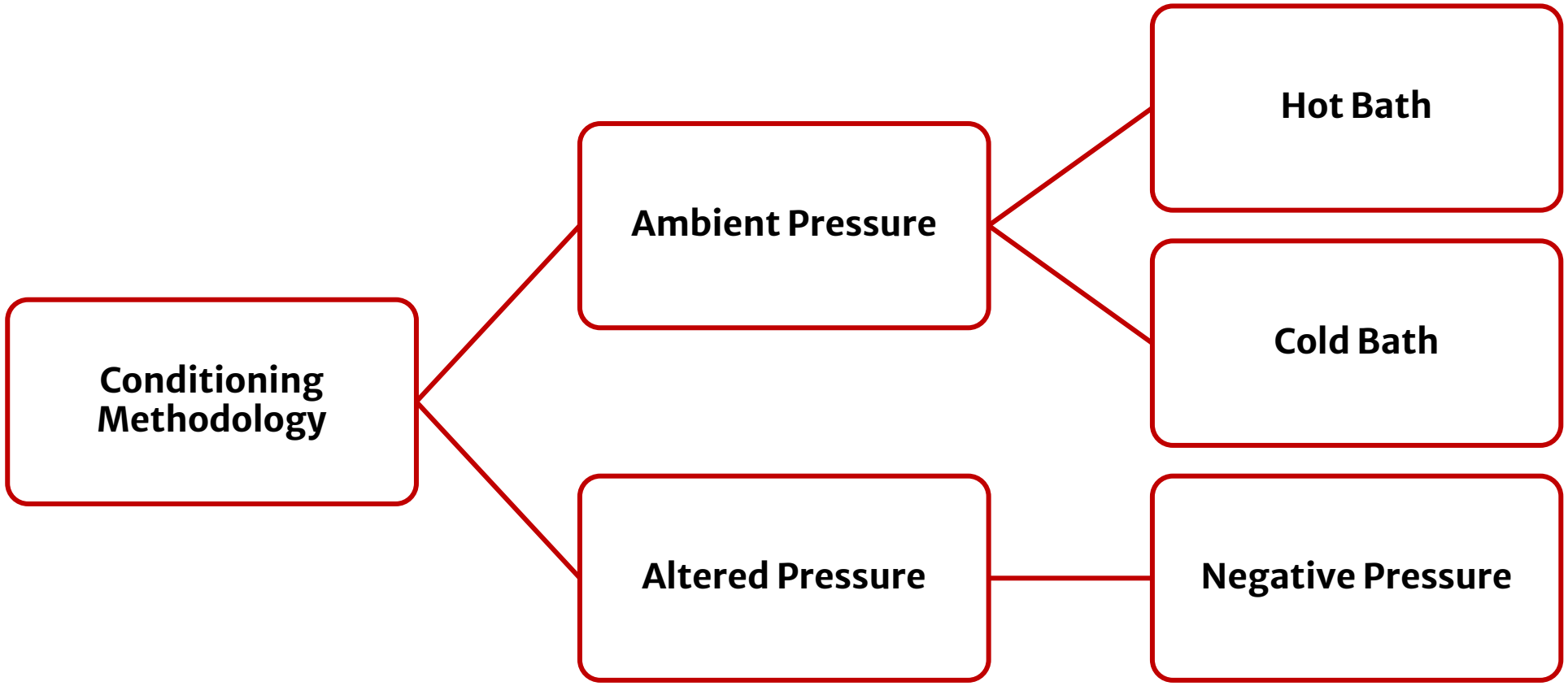
Methodology Overview



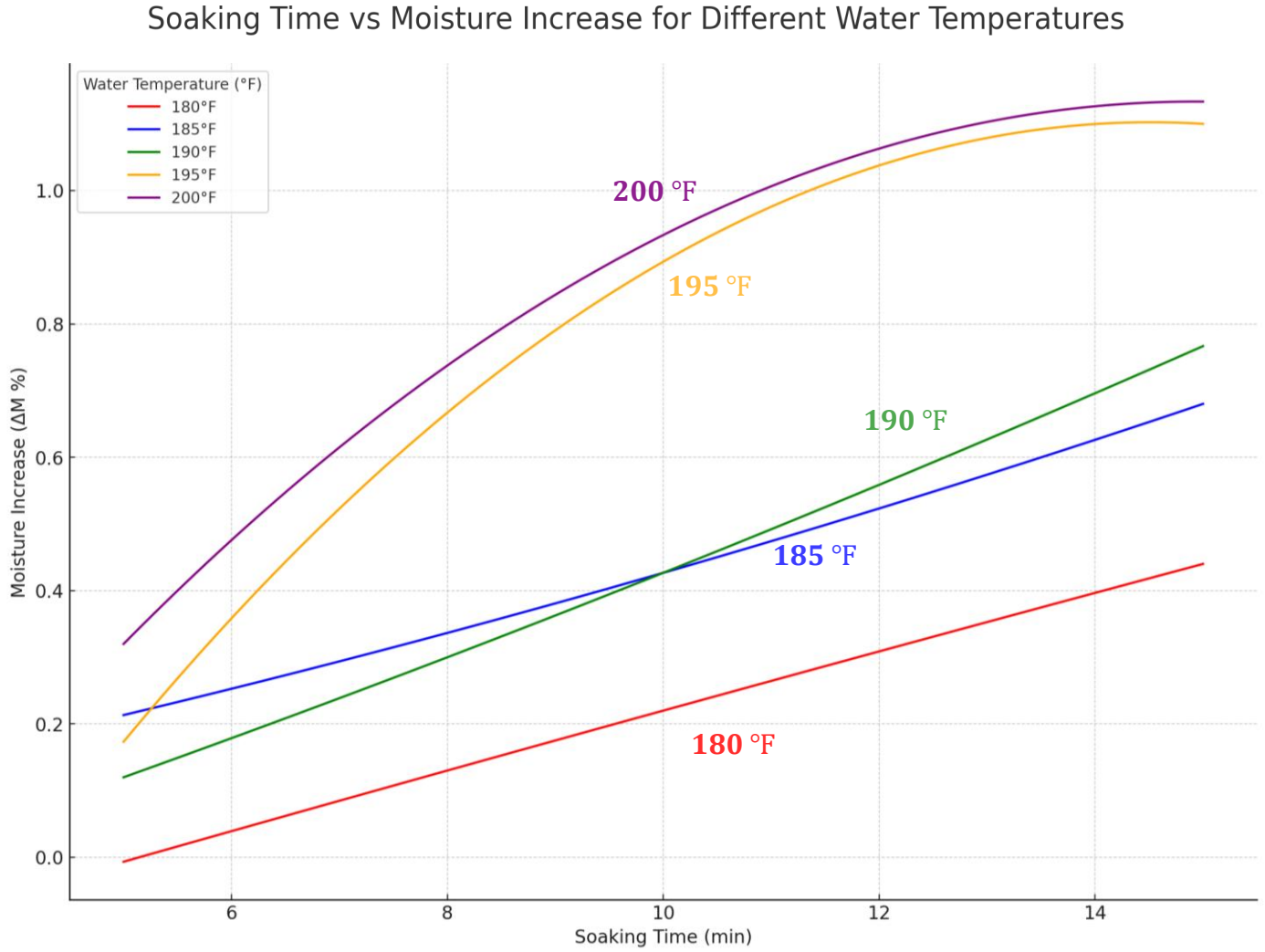
Experiments Outline

- Hot Bath Study (Small Batch) – 2023-2024
- Cold Bath Study (Small Batch) – 2023-2024
- Cold Bath Study (Large Batch) – 2024-2025
- Air Dry Study (Large Batch) – 2025
- Negative Pressure – 2025-2026

Hot Bath Study – Small Batch

small-batch (3.5 lbs.)

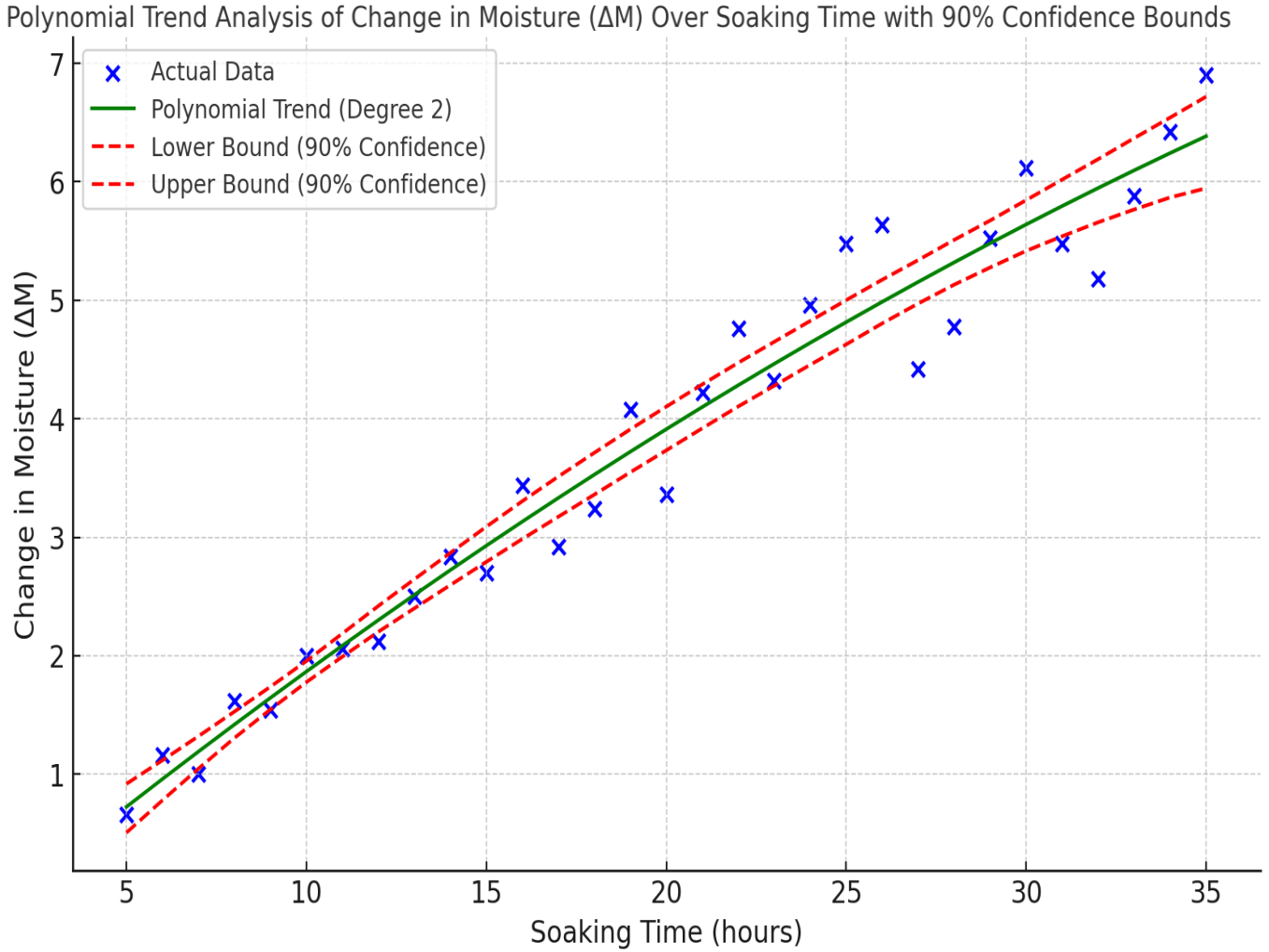
- As soaking time increases, Moisture content generally increases.
- As Water Temperature increases, Moisture content generally increases.



Cold Bath Study – Small Batch

small-batch (3.5 lbs.)

- As soaking time increases, Moisture content generally increases.
- The area between the red dashed lines shows the range within which the true trend is likely to fall with 90% confidence.



Cold Bath Study – Large Batch

2024-2025

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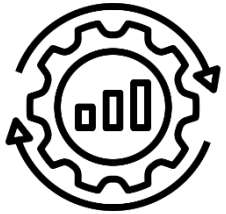
Objective

Goal: *Test if small-batch (3.5 lbs.) results scale to* $\geq 33\ lbs$.

Validate Scalability



Optimize Conditioning Parameters

Adjust "recipe" if scaling changes results

Design of Experiment

Independent Variables	Levels	Unit
Initial Moisture	TBD	%
Water Temperature	**70**	°F
Amount	**33**	lbs.
Soaking Time	**6–31**	Hrs.
Air Dry	**10**	min
Pecan Variety	Desirables	—

Dependent Variables	Unit
Final Kernel Moisture	%

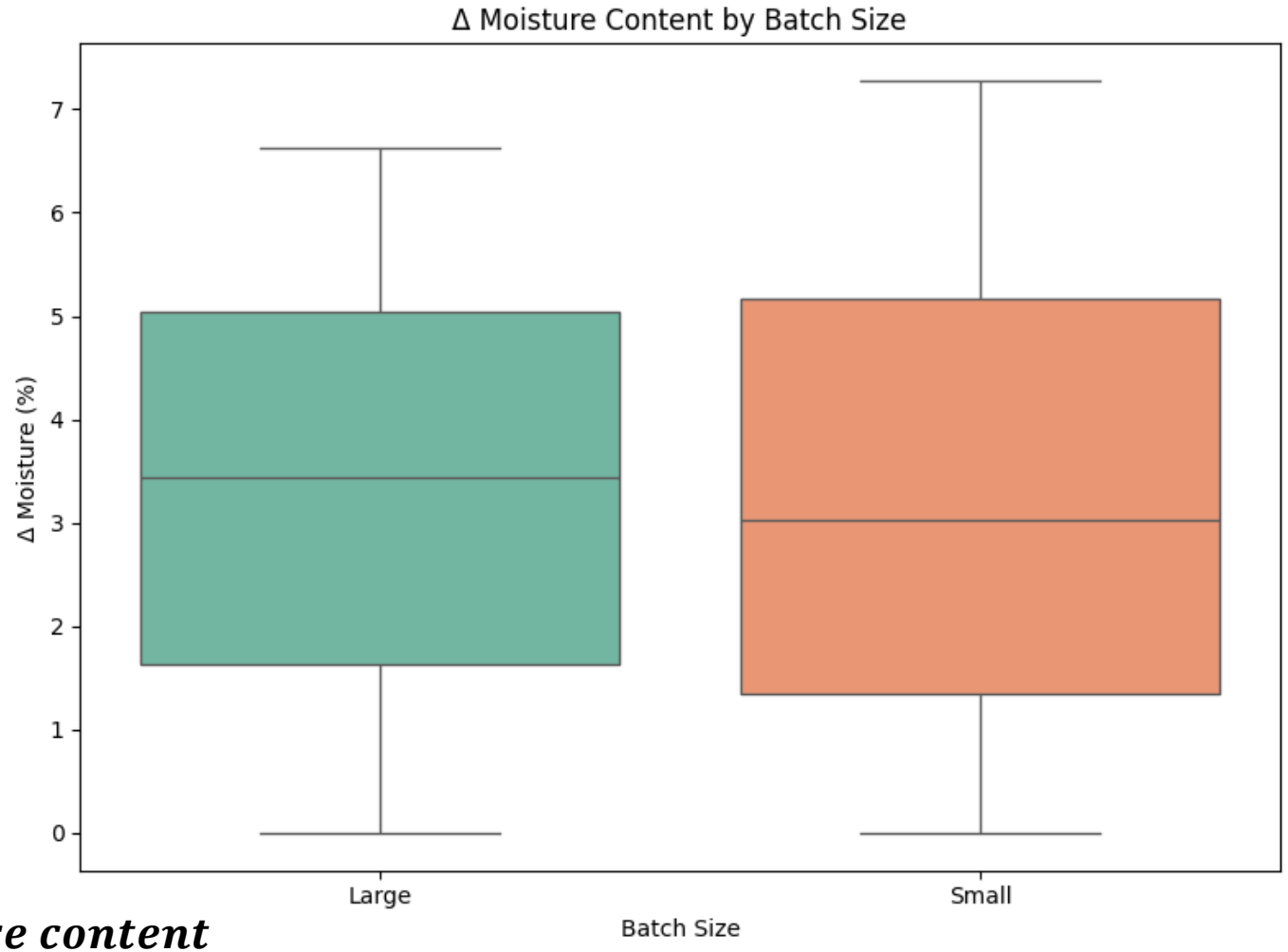
Procedure

1. Fill the Bags → 2. Soak in cold Water (70F) → 3. Use Weights per Bag for Submerging → 4. Remove After Soaking → 5. Air Dry (10 min., no fan) → 6. Crack using Meyer → 7. Shell manually → 8. Measure Moisture

Result and Discussion

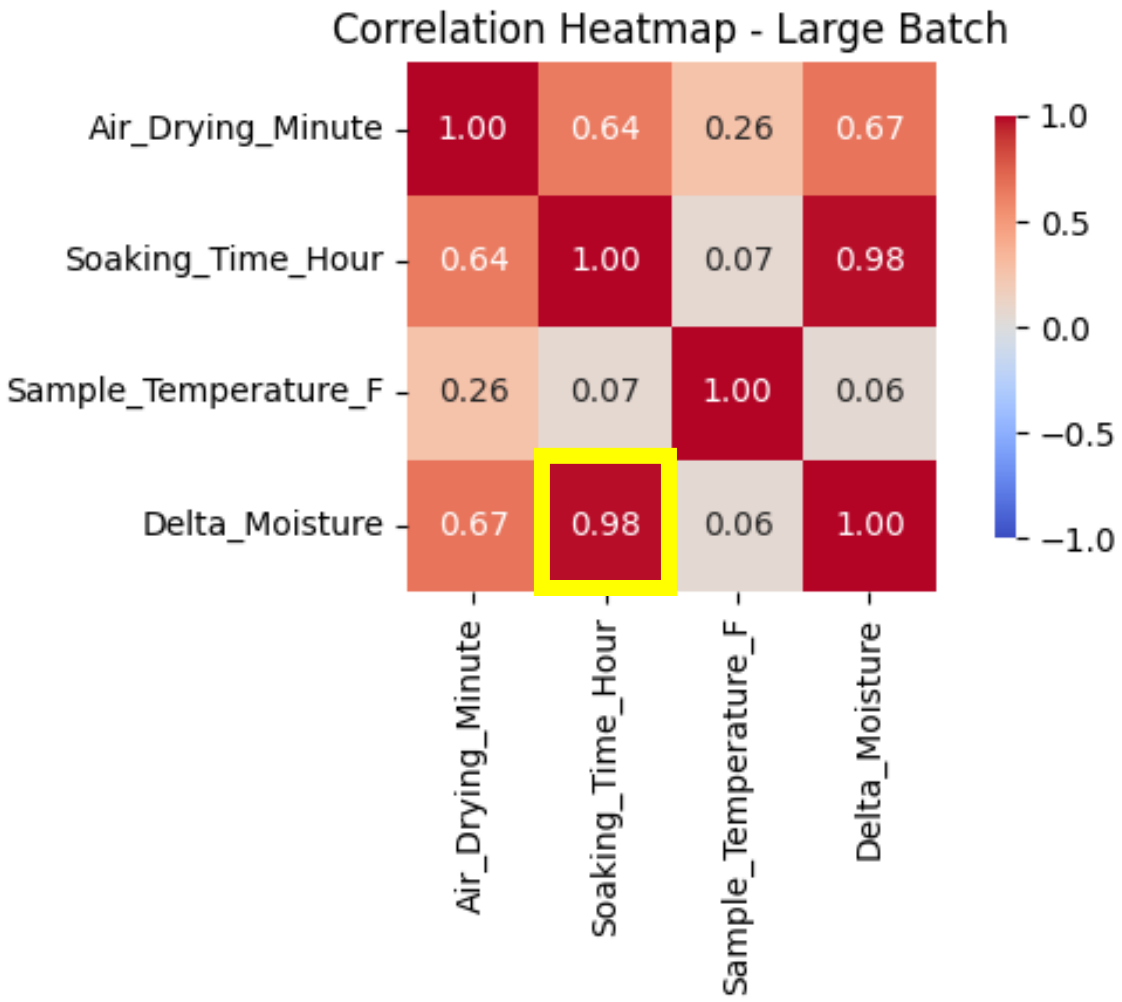
Both batches:

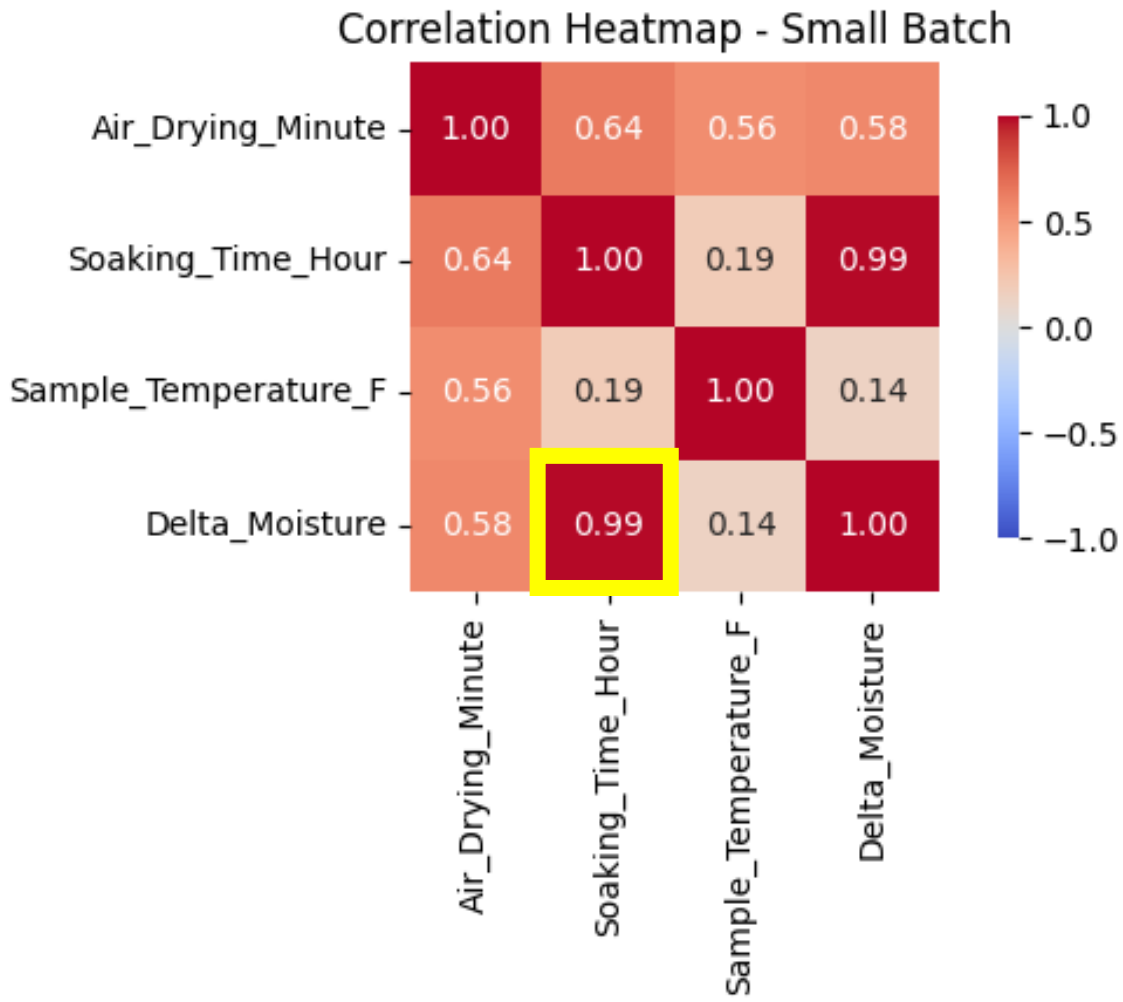
- Similar lower bound (~3%) → consistent initial dry state
- Similar distribution in absorbing the moisture.



$* \boldsymbol{Note}: \Delta \boldsymbol{Moisture\ content}\% = \boldsymbol{Final\ Moisture\ content} - \boldsymbol{Initial\ Moisture\ content}$

Result and Discussion



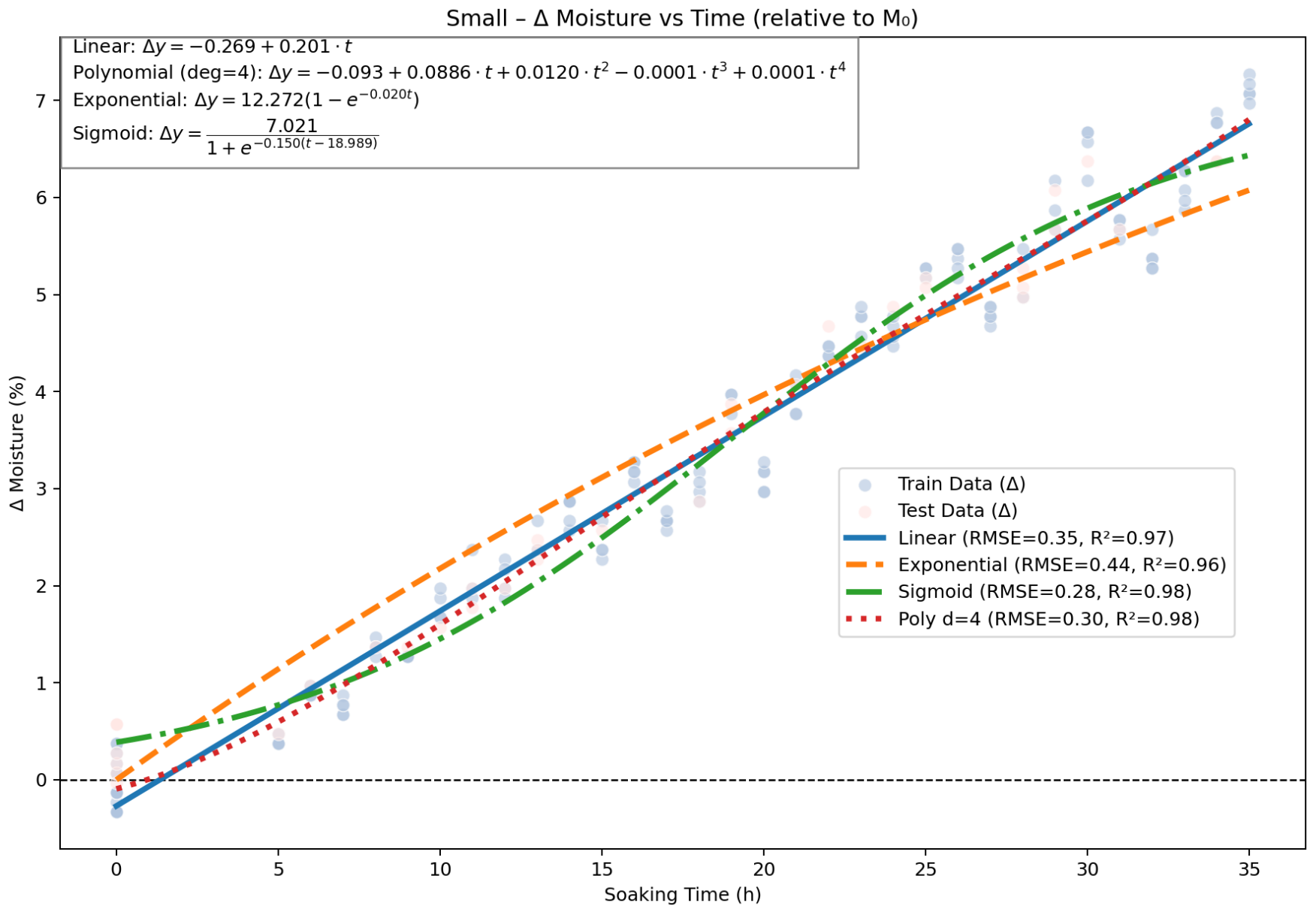


Result

Small Batch

- Soaking time ↑,

  Moisture content ↑

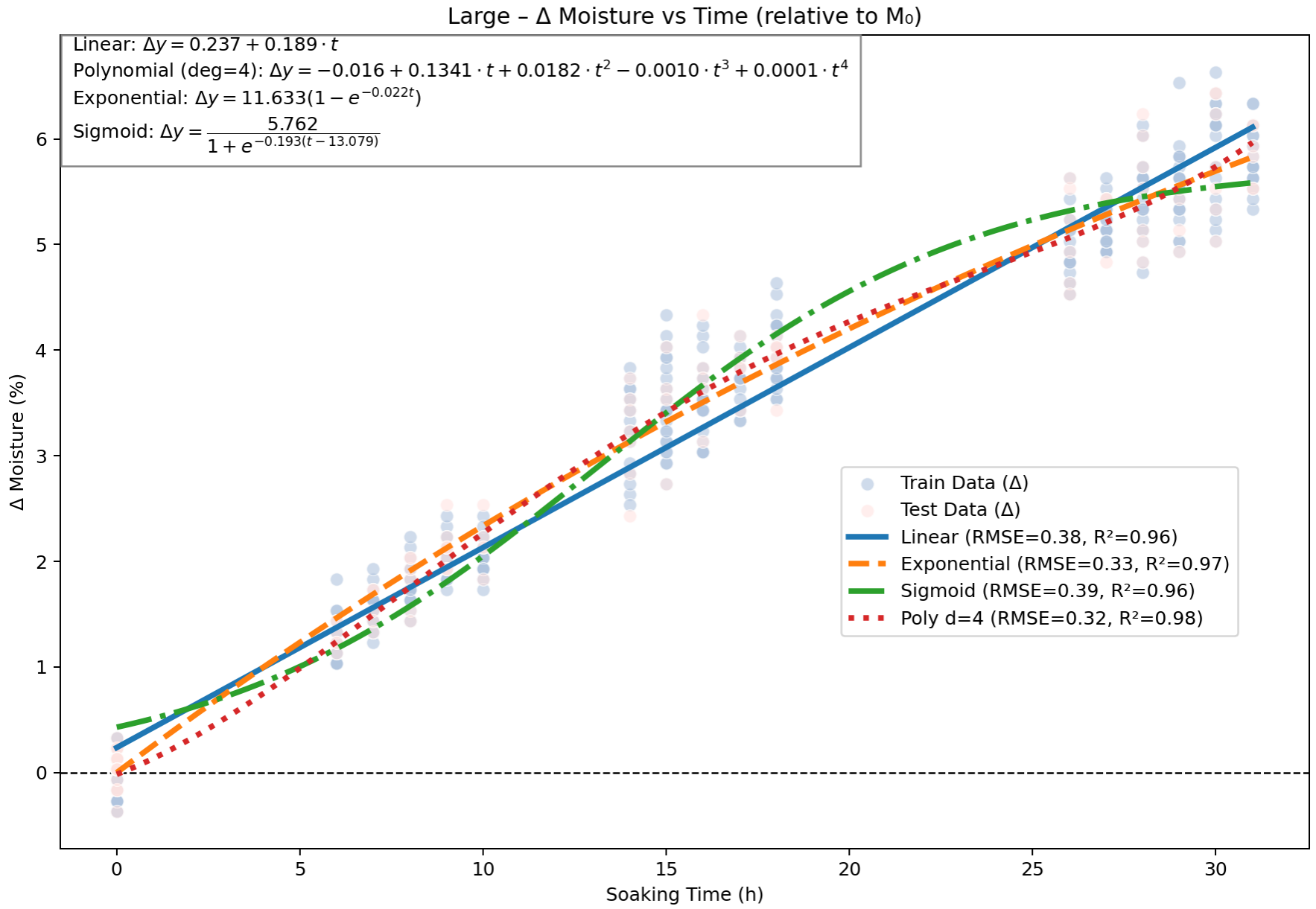


Result

Large Batch

- Soaking time ↑,

  Moisture content ↑



Recommendation

1. Use small batches when precise moisture control is needed (e.g., reaching 8.5% moisture). Predictive models show they consistently hit target levels 1–2 hours faster than large batches.

2. Use large batches when throughput is prioritized over speed. Though they take longer to reach target moisture, they may improve processing efficiency at scale.

Air Drying Study
2024-2025

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Objective

To evaluate the effect of air drying on pecan processing throughput by determining the optimal drying time for in-shell pecans that prevents shell stickiness during cracking while maintaining kernel moisture within acceptable thresholds.

Design of Experiment

Independent Variables	Levels	Unit
Initial Moisture	TBD	%
Water Temperature	**70**	°F
Soaking Time	**5-50**	Hrs.
Air Dry	**0-60**	min
Pecan Variety	Desirables	—

Dependent Variables	Unit
Final Kernel Moisture	%
Final Shell Moisture	%

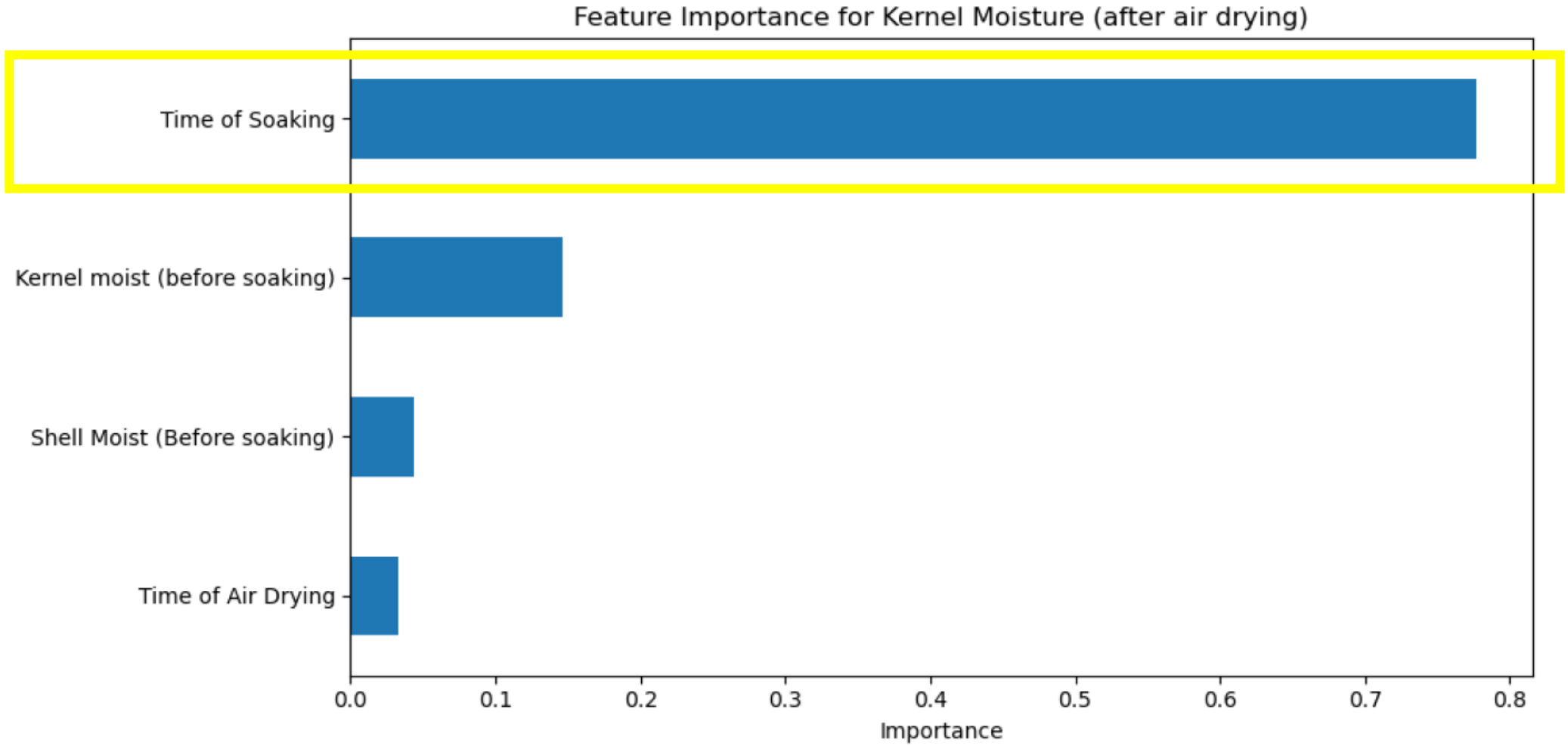
Procedure

1. Fill the Bags → 2. Soak in cold Water (70F) → 3. Use Weights per Bag for Submerging → 4. Remove After Soaking

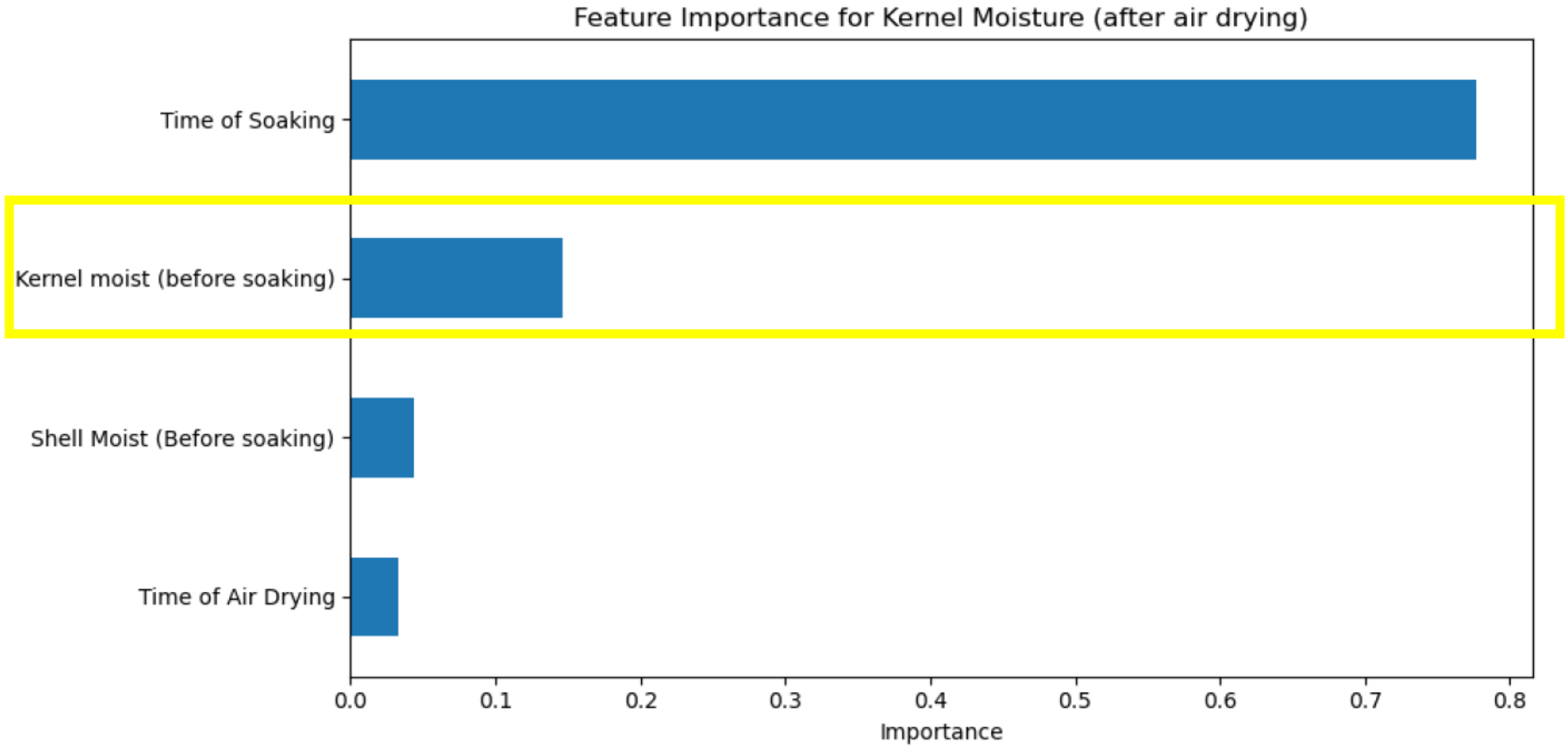
4. Remove After Soaking → 5. Air Dry → 6. Crack using Meyer → 7. Shell manually → 8. Measure Kernel Moisture

8. Measure Kernel Moisture → 9. Measure 1 gr of Grinded Shell → 10. Place Crucible in Oven with 105℃ (3 hrs.) → 11. Weigh the Sample → 12. Calculate Shell Moisture

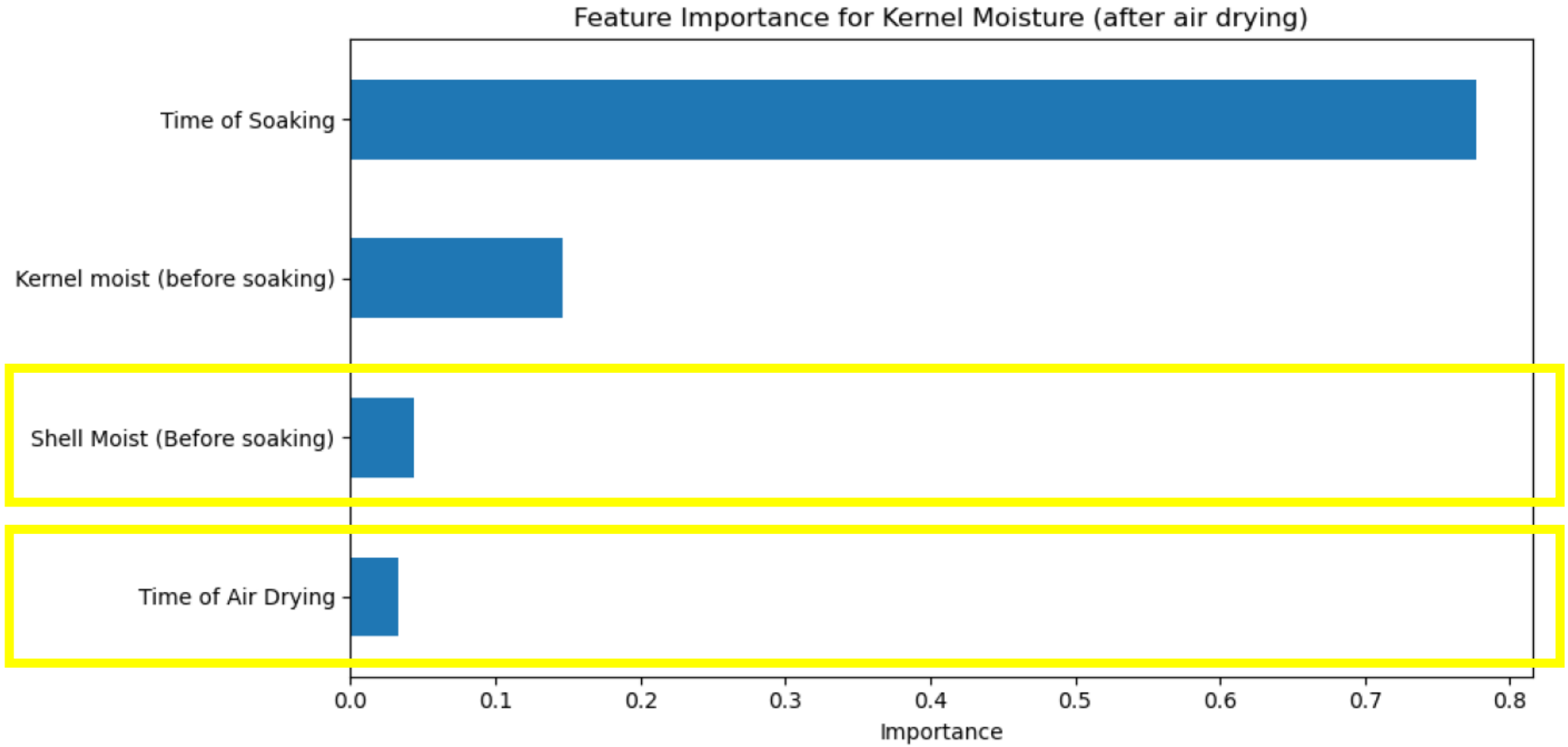
Result and Discussion - Kernel



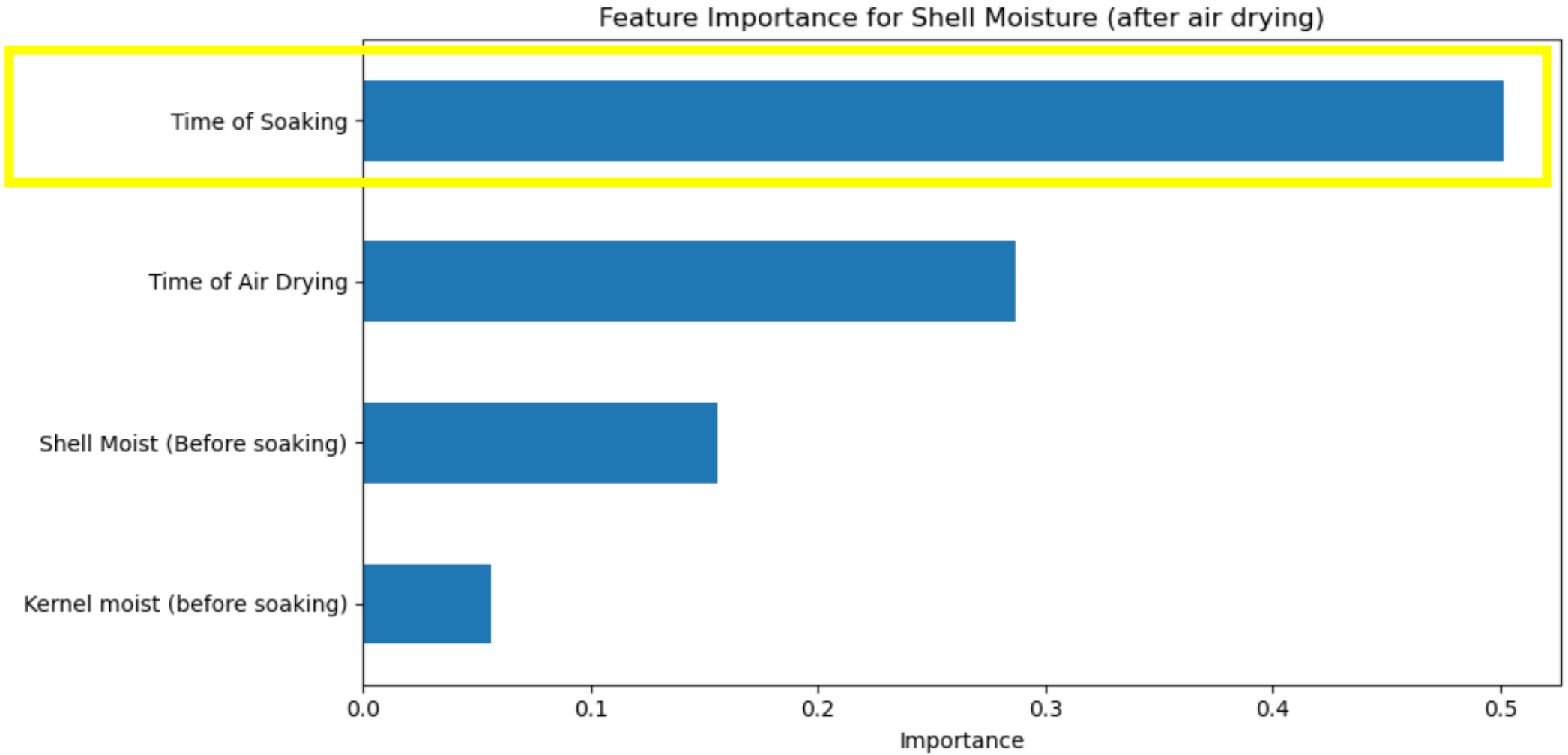
Result and Discussion - Kernel



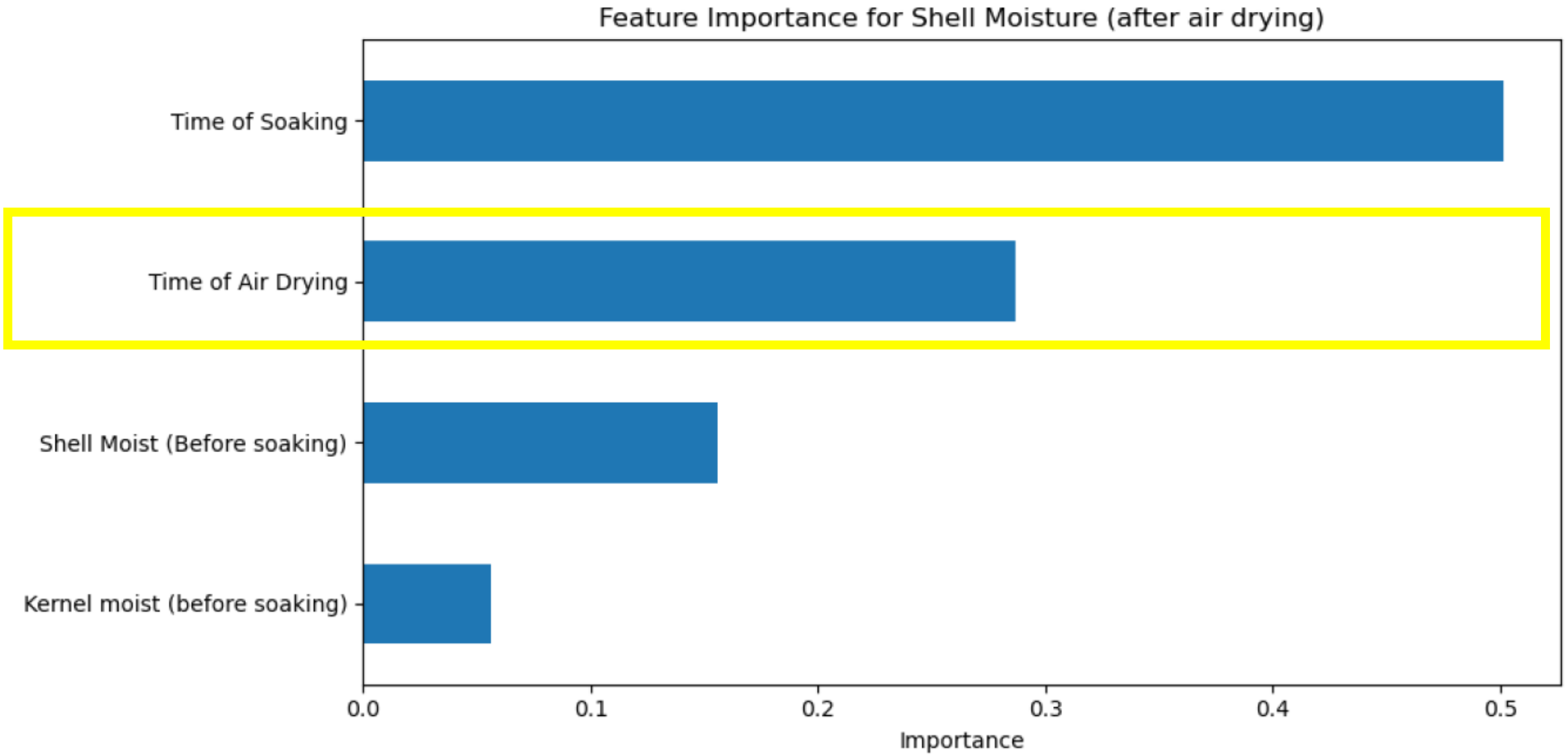
Result and Discussion - Kernel



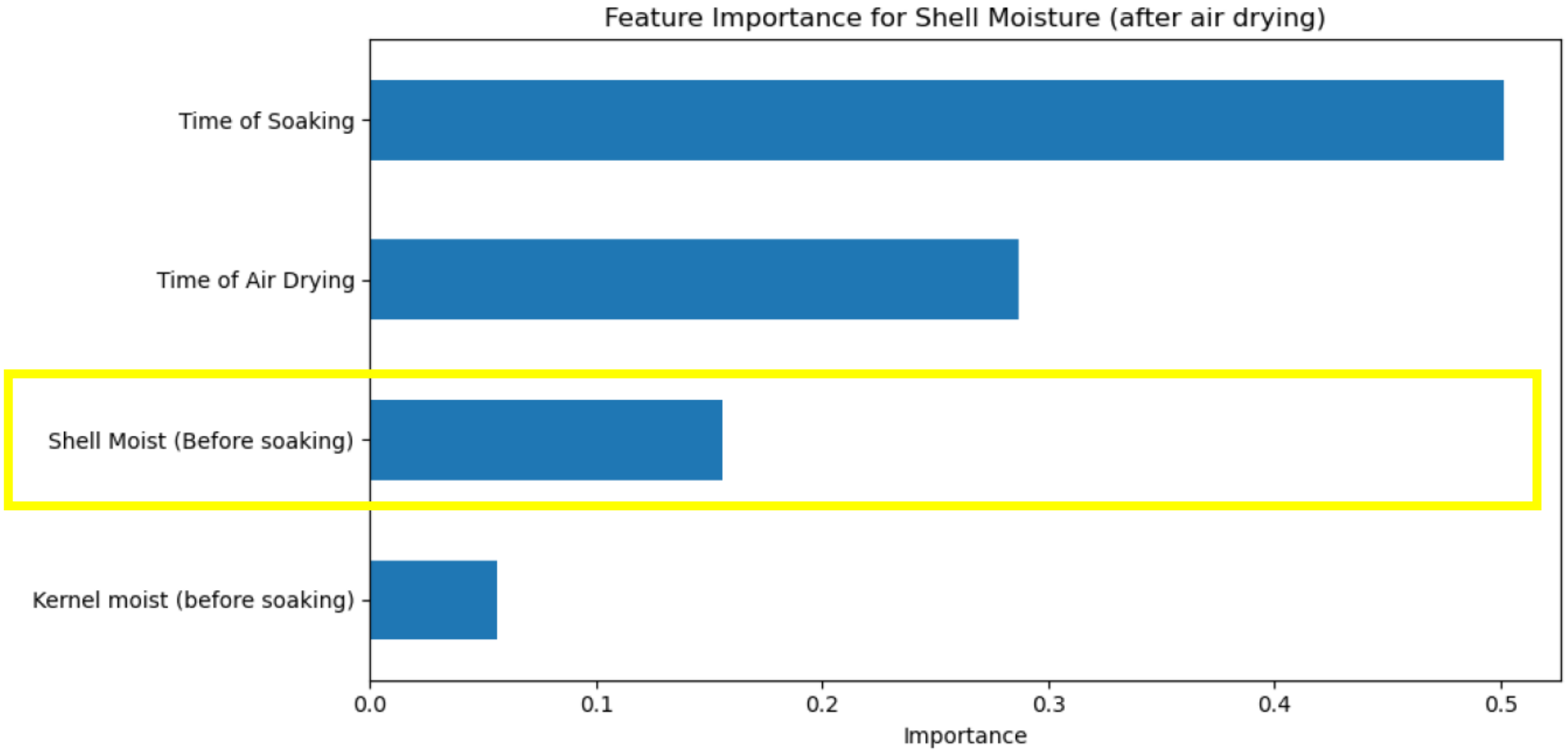
Result and Discussion - Shell



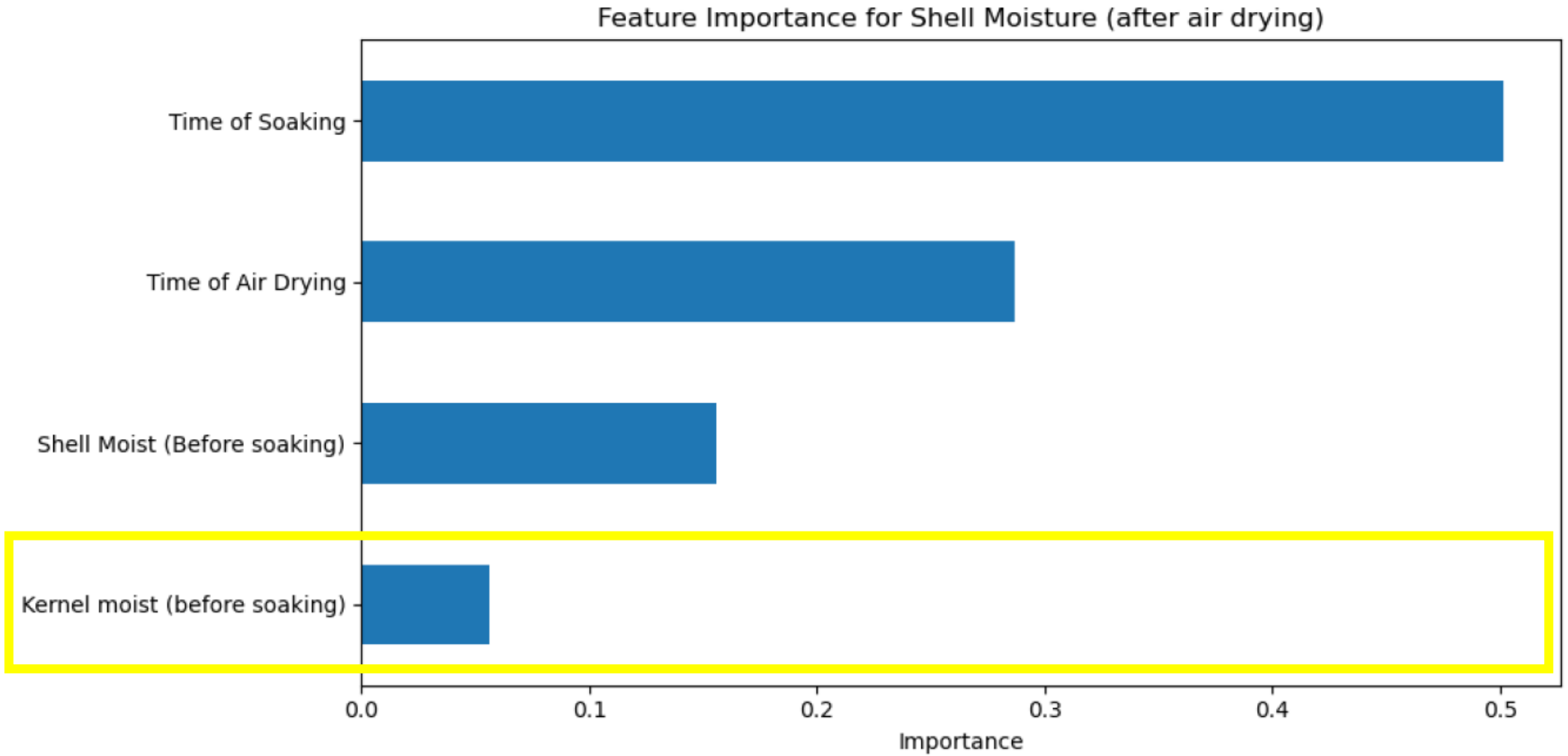
Result and Discussion - Shell



Result and Discussion - Shell



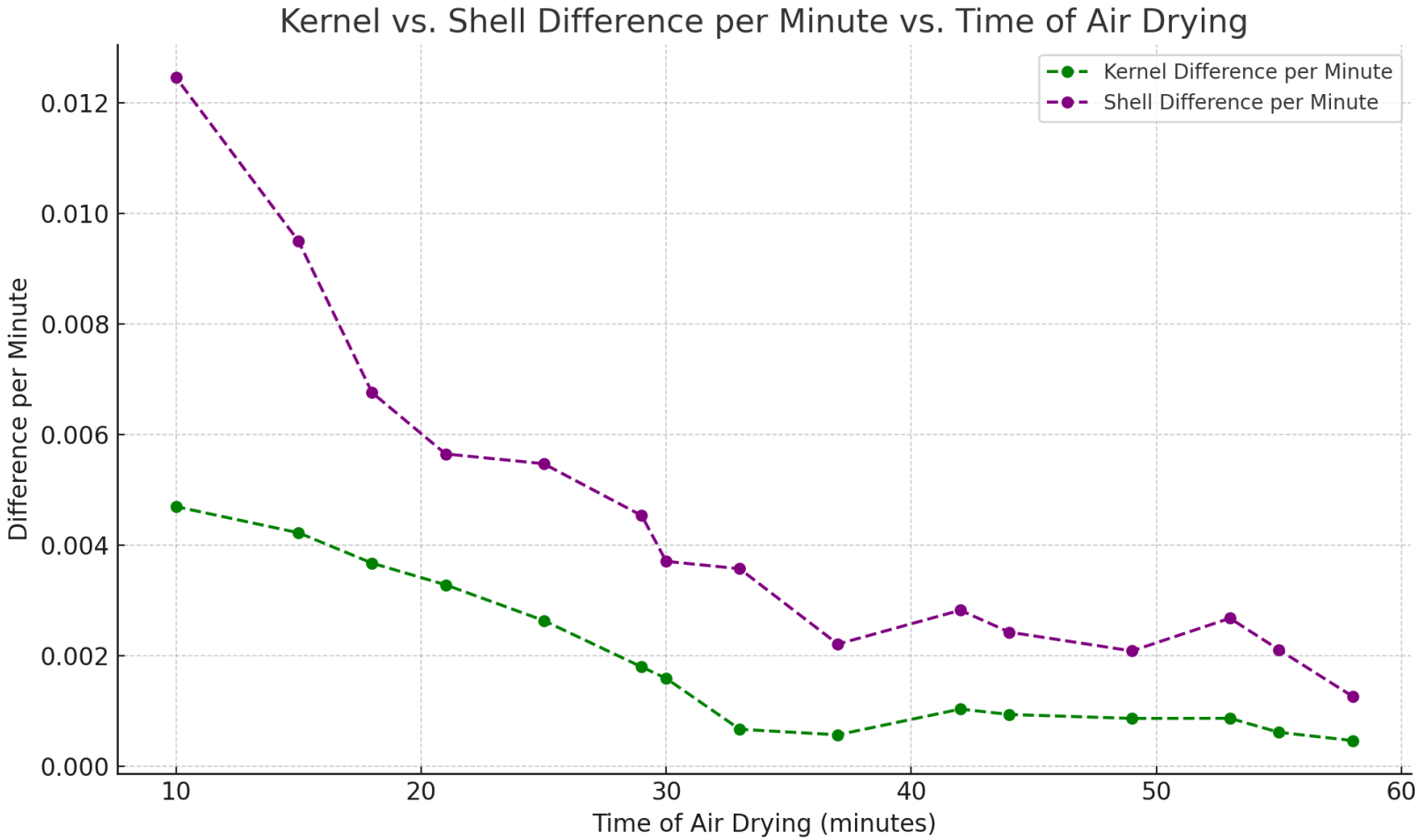
Result and Discussion - Shell



Recommendation

1. **Minimal kernel impact** after 30 minutes

2. **Shell moisture stabilizes** beyond 30 minutes



Negative Pressure Study

2025-2026

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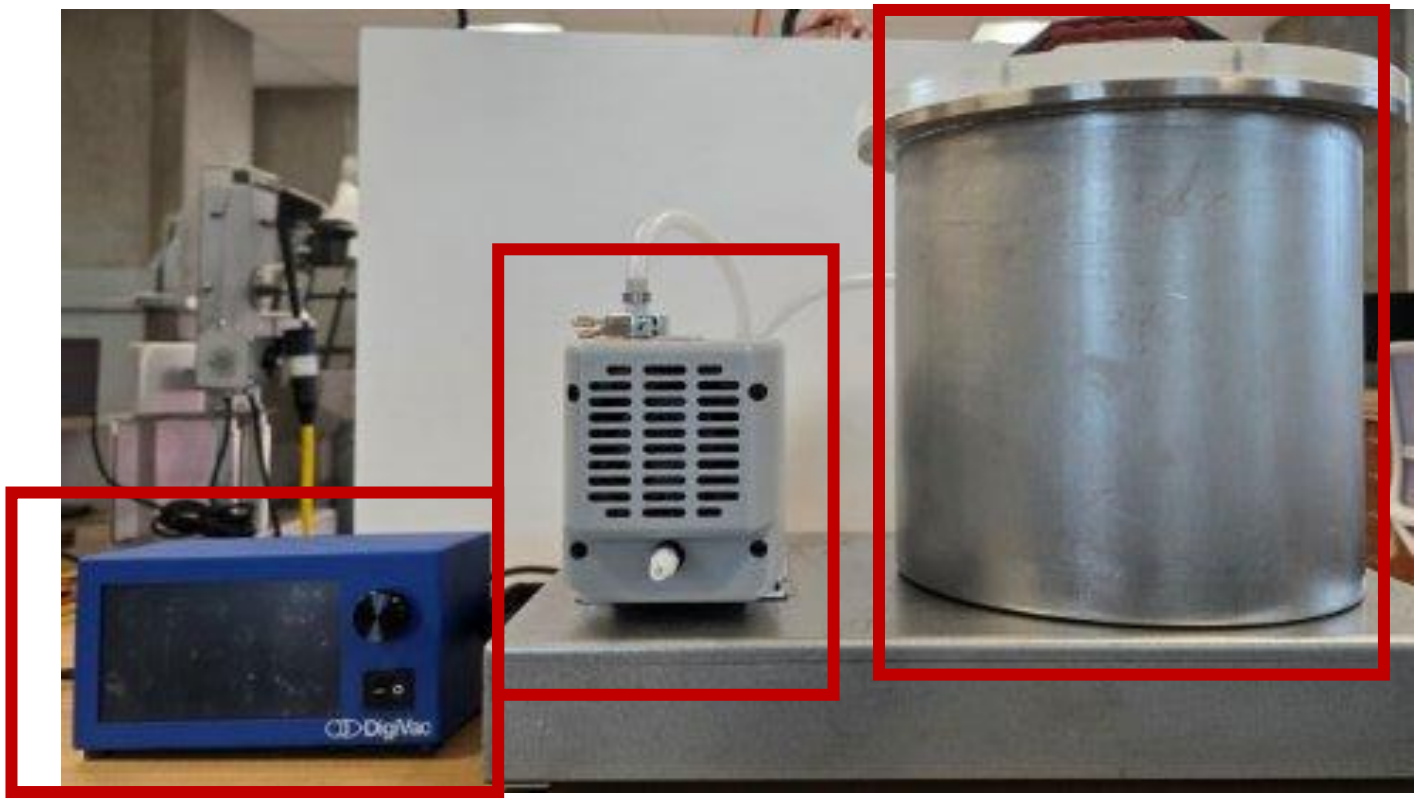
Negative Pressure

- Adding Moisture without overheating the kernels.
- Faster Moisture Uptake



Mechanism

1. Air Trapped in Pores and Shell Microcracks
2. Application of Negative Pressure (Vacuum)
3. Pressure Release (Return to Atmospheric)
4. Repeated Cycles (Optional)

Summary & Recommendation

Cold Bath Study

- **Small batches**

When precise moisture control is needed and hit target levels 1–2 hours faster than large batches.

- **Large batches**

when throughput is prioritized over speed.

Air Drying Study

- **Minimal kernel impact** after 30 minutes → safe to air-dry longer without quality loss.
- **Shell moisture stabilizes** beyond 30 minutes → extended drying offers little added benefit.
- Supports **longer air-drying when needed**, especially for kernel stability.

Publication

Paper 1: Characterizing Moisture Content variation in Pecan Kernels under Cold and Hot Water Soaking Treatments

Authors : Mozhdeh Rahmanpour, Fatemeh Mozaffar, Micheal Pegan, Beshoy Morkos

Submitted to Food and Bioproducts Processing Journal.

Food and Bioproducts Processing

Supports open access

Future Work 2026

Experiment:

- **Negative Pressure**

  Collecting data and compare the results to other approaches

Future Publications:

Paper 2: Air-Drying impact on shell and kernel moisture content

Paper 3: Negative Pressure

Thank you

Questions & Comments

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