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UNIVERSITY OF GEORGIA
College of Engineering
Manufacturing Living Labs

PECAN WORKSHOP | AUGUST 19-20, 2026

Moisture

USDA
FORT VALLEY STATE UNIVERSITY
I LOVE pecans
NPSA NATIONAL PECAN SHELLERS ASSOCIATION

Agenda

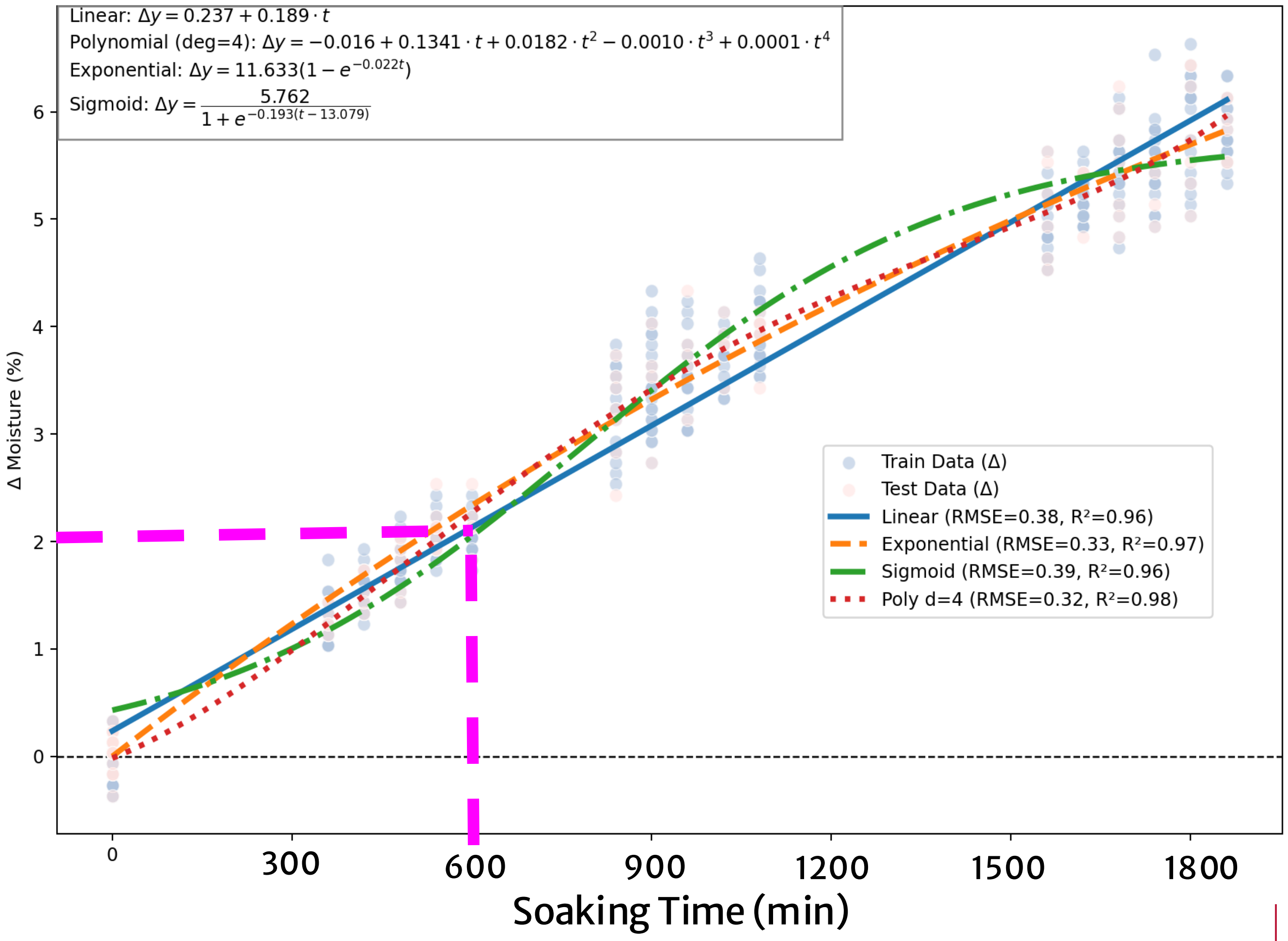
1. 2025 Workshop Recap
2. Negative Pressure Study
3. Equipment Study
4. Publication Status
5. Summary and Recommendation

2025 Workshop Recap

Cold Bath Conditioning

Goal: Characterizing Cold bath behavior of inshell pecans

Variables	Levels	Unit
Initial Moisture	TBD	%
Water Temperature	70	°F
Soaking Time	300-1800	min
Air Dry	10	min



Soaking Time (min) → **Moisture Content (%)**

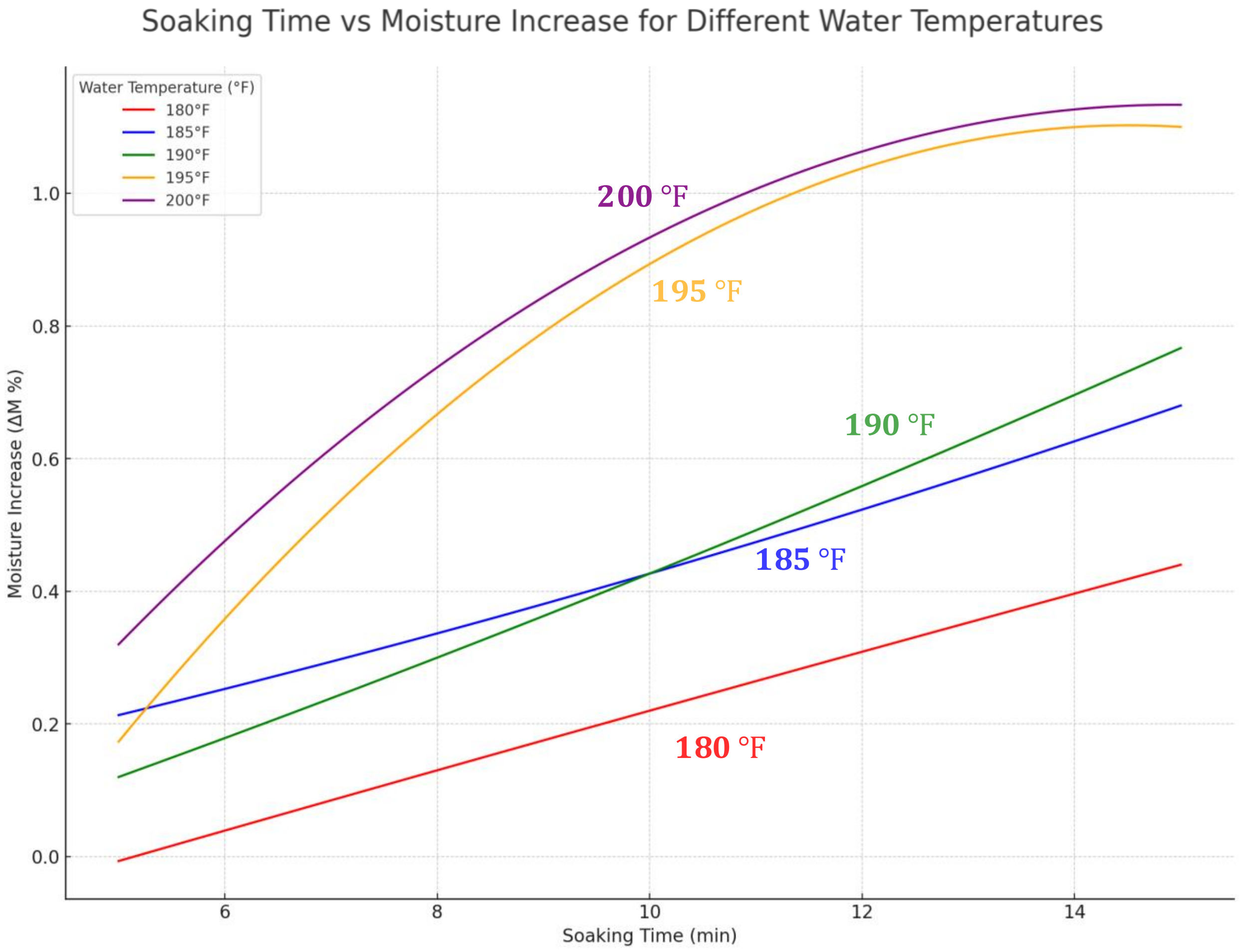
Disclaimer: These Experiments were performed in standard testing conditions (25 C and 1 atm), in our laboratory environments, your results may vary.

2025 Workshop Recap

Hot Bath Conditioning

Goal: Characterizing hot bath behavior of inshell pecans

Variables	Levels	Unit
Initial Moisture	TBD	%
Water Temperature	180-200	°F
Soaking Time	5-20	min
Air Dry	10	min



Soaking Time (min) ↑ → **Moisture Content (%)** ↑

Water Temperature (F) ↑ → **Moisture Content (%)** ↑

2025 Publications

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

Published in Volume 154 (2025) of the Food and Bioproducts Processing Journal.

Negative Pressure Conditioning

2025-2026

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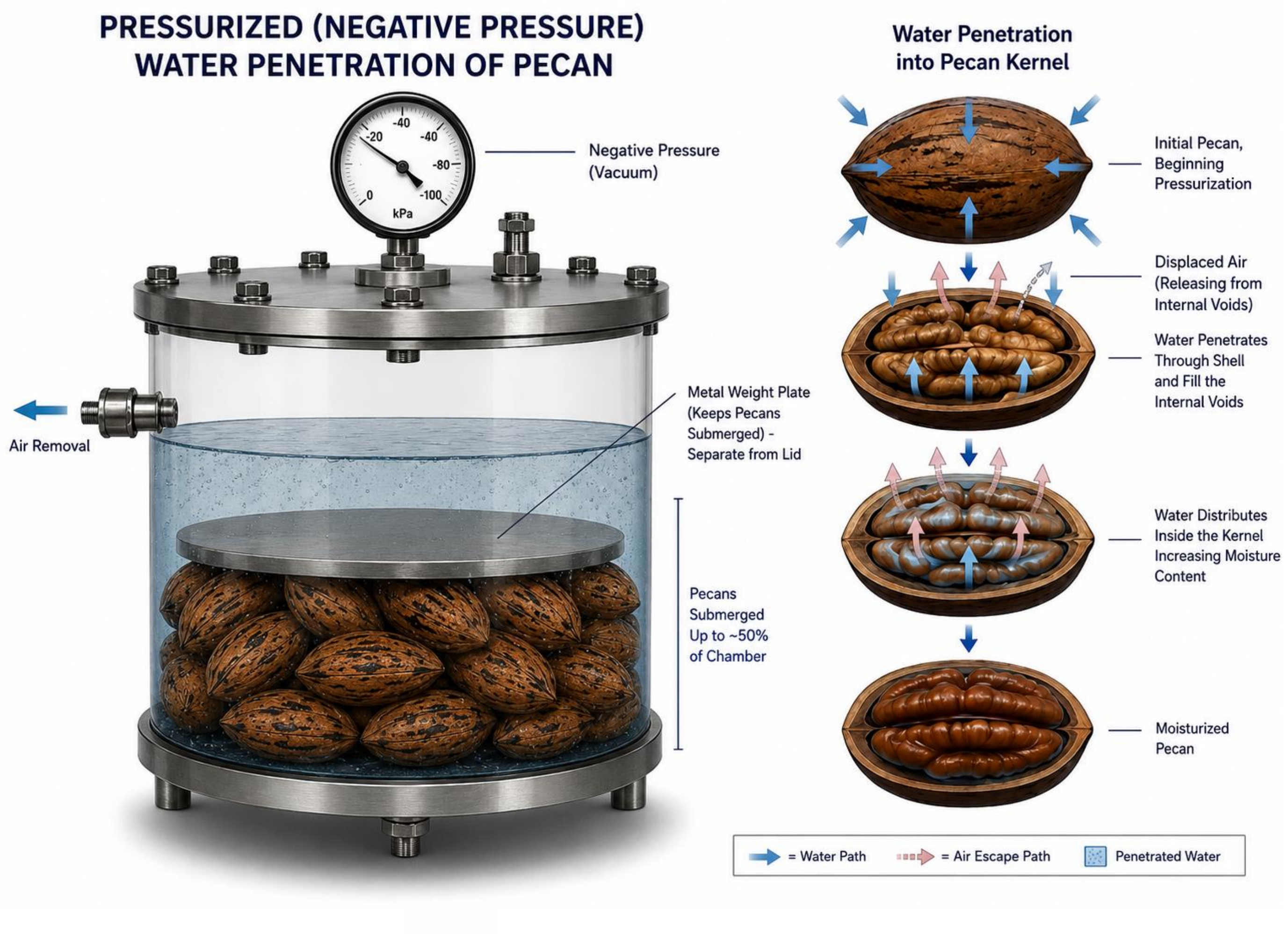
How Negative Pressure Works?

Goal: Find a faster alternative to cold bath that doesn't risk kernel quality like hot bath conditioning does.

Fully Fill up the Chamber → Submerging Kernel in water (using weights) → Reducing Pressure (Vacuum) → Pressurized Penetration

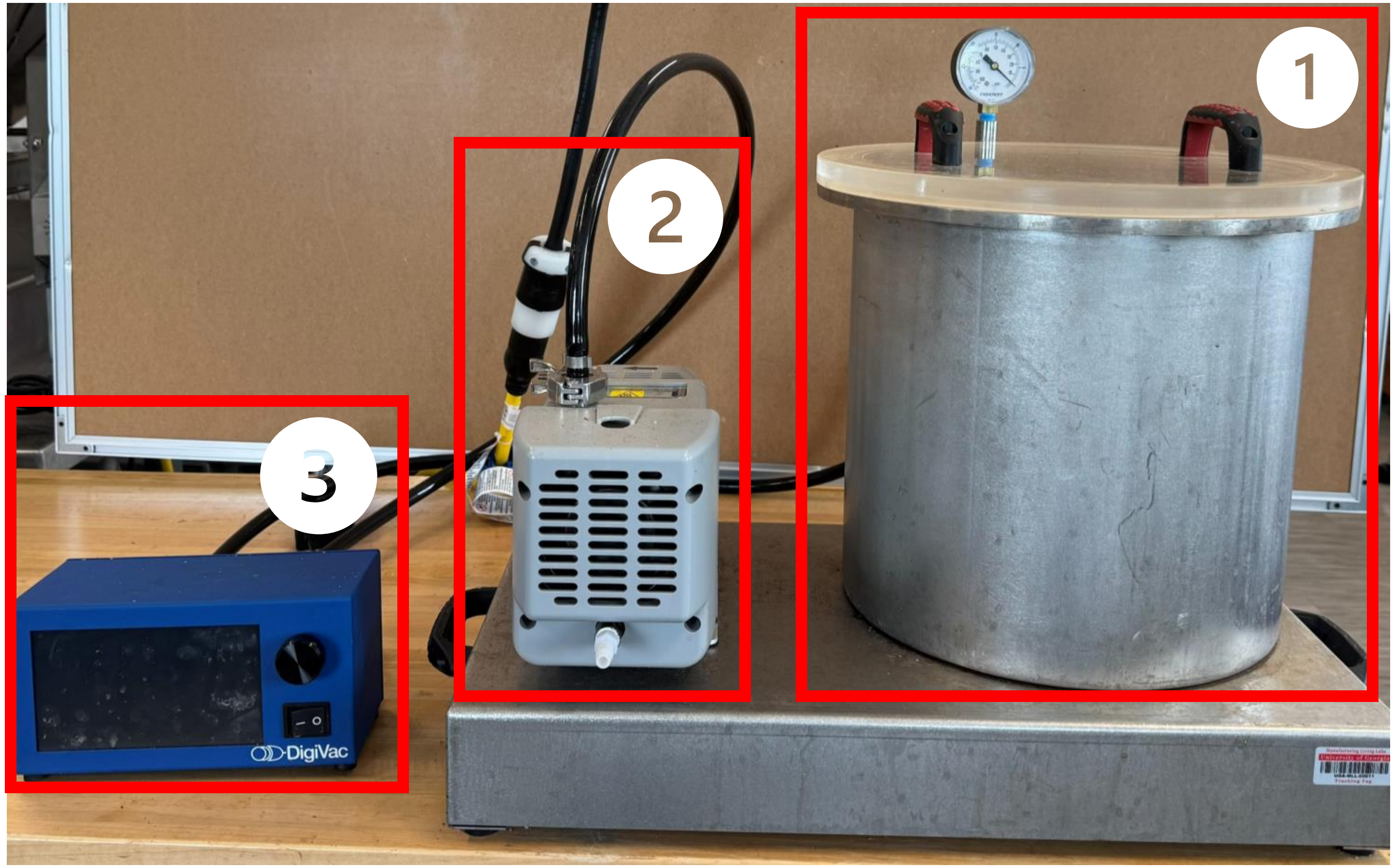


Experimental Configuration

1) Vacuum Chamber

2) Compressor

3) Digital Controller



Study Objectives

- Evaluate the effectiveness of negative pressure treatment for moisturizing in-shell pecans.
- Evaluate negative pressure as faster conditioning method and potential faster alternative than cold bath conditioning.
- Determine the optimal pressure and treatment duration that achieve the target moisture content while preserving kernel quality.

Disclaimer: These Experiments were performed in standard testing conditions (25 C and 1 atm), in our laboratory environments, your results may vary.

Data Collection (Phase 1)

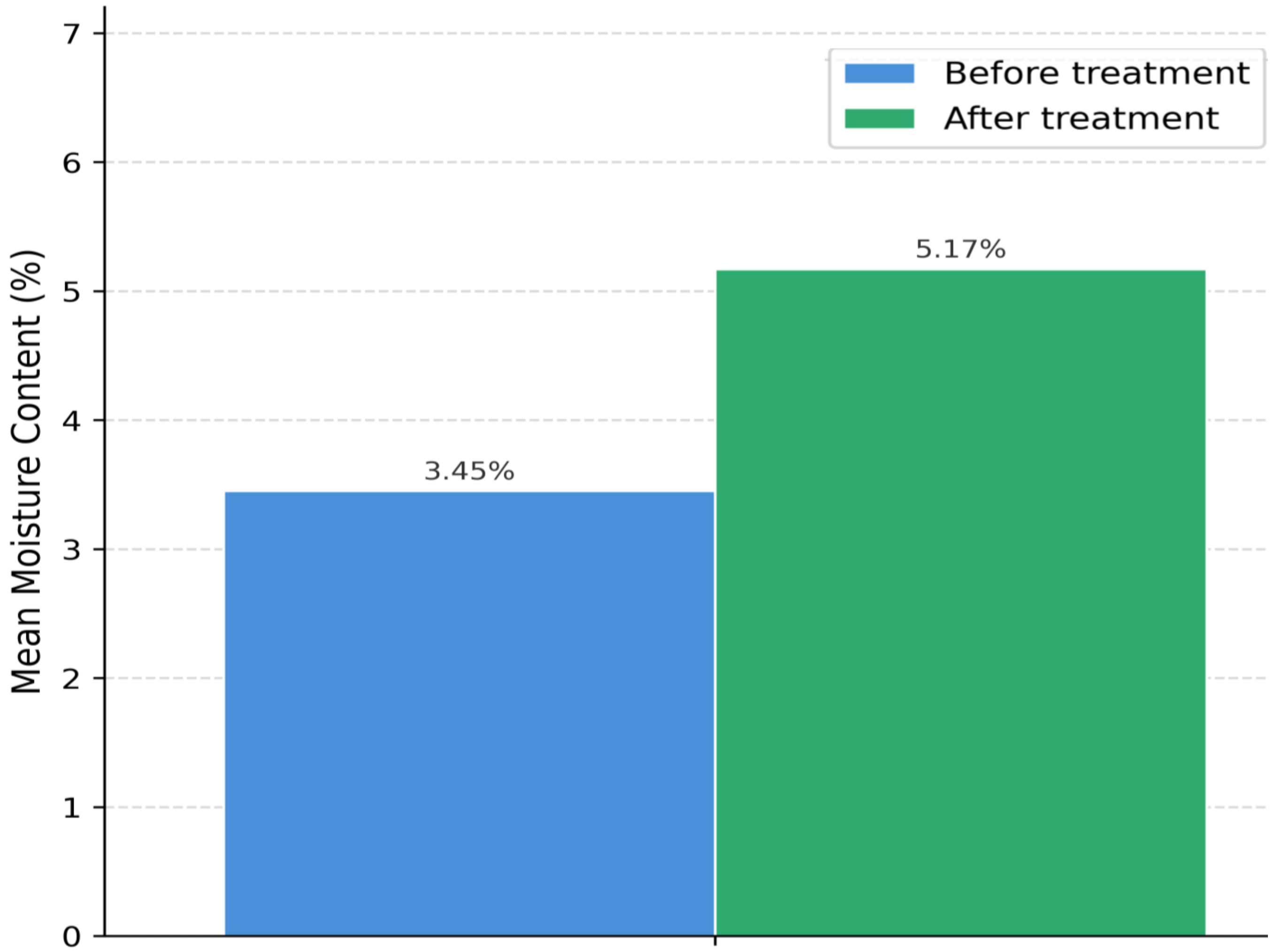
	Independent Variables	Phase 1	Phase 2	Unit
	Initial Moisture	TBD	TBD	%
	Water Temperature	**70**	**70**	°F
	Pressure	**11**	**2.5-33**	kPa
	Soaking Time	**10**	**10-30**	Min.
	Air Dry	**10**	**10**	Min.
Hot Bath Treatment	**Temperature**	190	190	°F
	Time	2	2	Min.

Dependent Variables	Unit
Final Kernel Moisture	%

Results (Phase 1)

n=30

- The negative pressure significantly and consistently increased moisture content in pecan kernels.
- Soaking pecans for **10 minutes at 11 kPa in 70** °F water results in **1.72%** mean kernel moisture gain.



Data Collection (Phase 2)

n=30

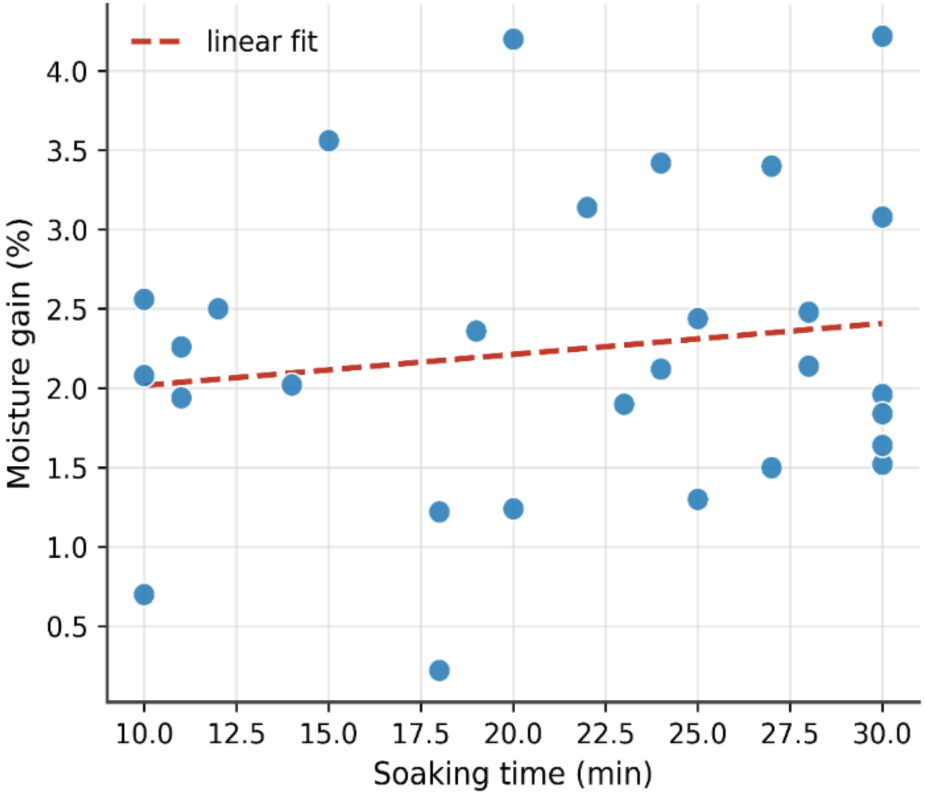
	Independent Variables	Phase 1	Phase 2	Unit
	Initial Moisture	TBD	TBD	%
	Water Temperature	**70**	**70**	°F
	Pressure	**11**	**2.5-33**	kPa
	Soaking Time	**10**	**10-30**	Min.
	Air Dry	**10**	**10**	Min.
Hot Bath Treatment	**Temperature**	190	190	°F
	Time	2	2	Min.

Dependent Variables	Unit
Final Kernel Moisture	%

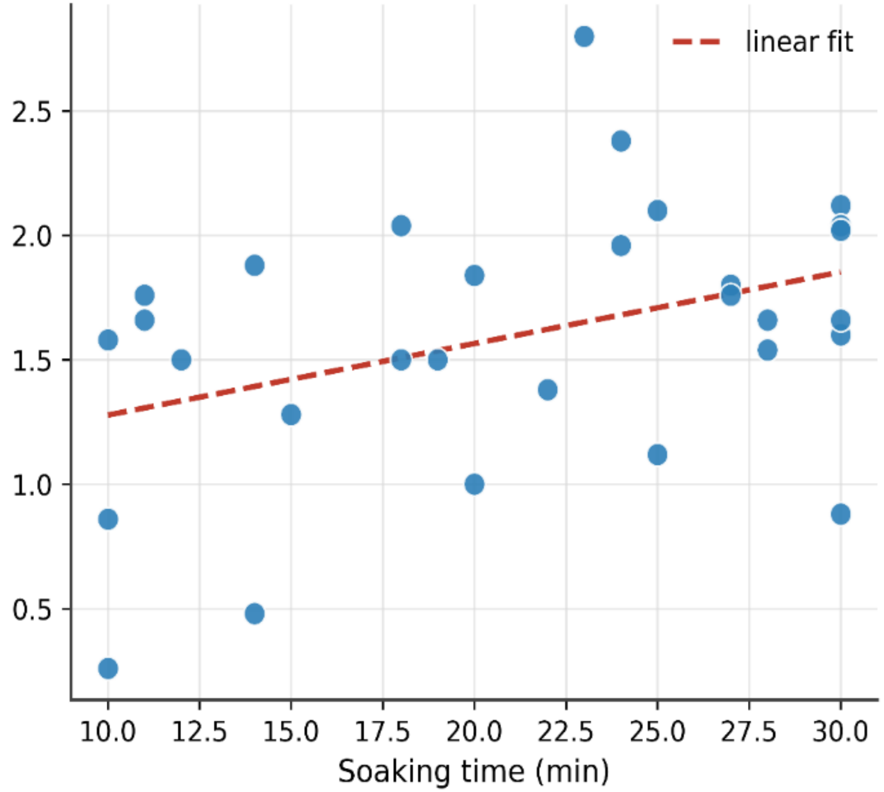
Results (Phase 2)

Gain vs. Soaking time

- Moisture gain follows the expected trends of increasing with the time.



1st Replication

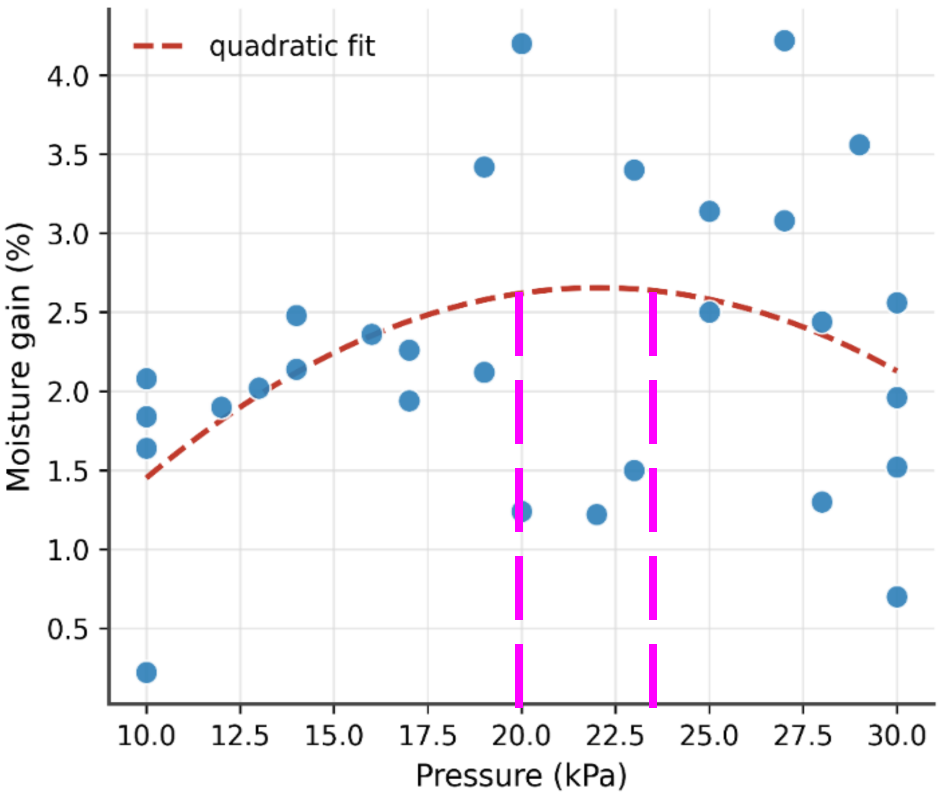


2nd Replication

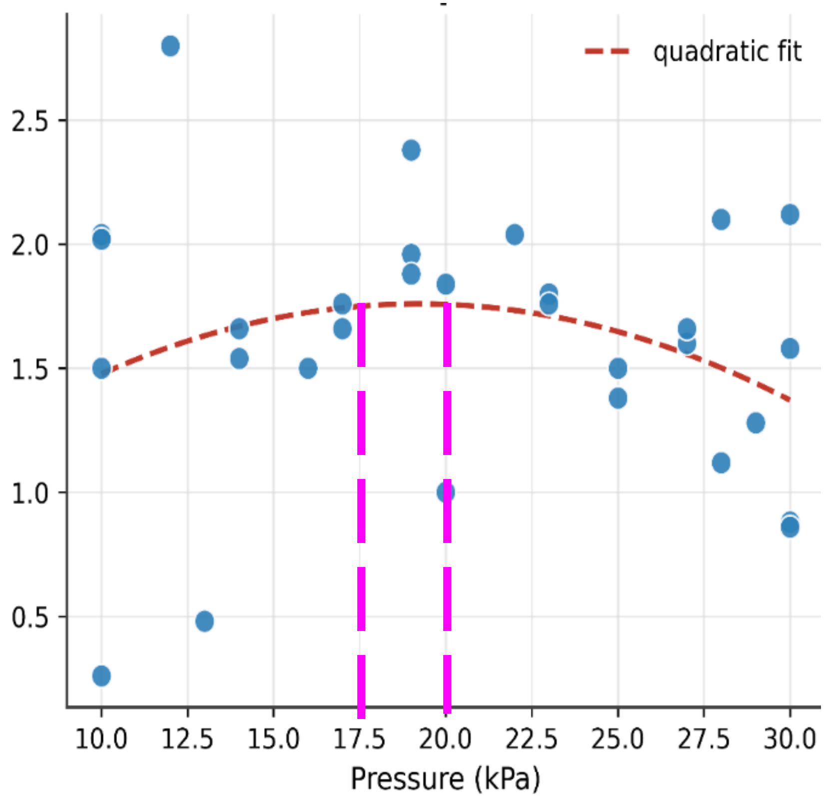
Results (Phase 2)

Gain vs. Pressure

- There's a pressure envelope that gives the best results between **17.5-22.5 kPa.**



1st Replication



2nd Replication

Takeaway

- Negative pressure has a reproducible kernel moisture increase of **1.72%** in **10 minutes** at **11 kPa** in water at **70** °F.

- Moisture gain **increases** with soaking time and pressure with an optimal range between **17.5 – 22.5 kPa**. (Phase 1: 2.02% (4.5% initial moisture) , Phase 2: 1.60% (3.4% initial moisture))
    - Observation: higher initial moisture influences the rate of moisture absorption.

- Negative pressure increases moisture **~4× faster** than hot conditioning (~1.7% in 10 minutes compared to ~0.4%), while cold conditioning shows negligible moisture gain over similar soaking times (<0.1% in 10 minutes)

Disclaimer: These Experiments were performed in standard testing conditions in our laboratory environments; your results may vary.

Next Steps

- Expand and optimize negative-pressure conditioning experiments.
- Investigate and evaluate alternative conditioning methods.
- Establish a pre-processing data pipeline to quantify factors affecting initial moisture content, including harvesting-to-storage and storage-to-delivery times.
- Disseminate and publish research findings.

Measurement Equipment

2026

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Motivation and Objective

Motivation

Different moisture measurement technologies are commonly used in research and industry. Understanding their measurement characteristics can support more informed use of moisture data across different industry applications.

Objective

Evaluate moisture content measurements obtained using multiple measurement technologies under consistent testing conditions and characterize their measurement behavior.

Findings

Moisture Meter	SD	Mean Delta Moisture %
Oven	0.837%	+1.786%
SB900	0.697%	+1.720%
Handheld Moisture Meter – Kernel	1.469%	+4.920%
Handheld Moisture Meter – Chopped	1.024%	+2.389%
Moisture Balance – Crushed	1.546%	+1.212%
Moisture Balance – Chopped	1.359%	+0.850%

Findings

Moisture Meter	SD	Mean Delta Moisture %
Oven	0.837%	+1.786%
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Moisture Balance – Chopped	1.359%	+0.850%

Next Steps

- Develop and integrate an in-situ moisture measurement system within the processing line in collaboration with USDA.
- Assess and validate new moisture measurement technologies.
- Developing a more reliable procedure for Moisture Balance.
- Disseminate and publish research findings.

2026 Publication

Paper 2: Toward Efficient Moisturization of Pecans: Investigating Vacuum Conditioning Methods

(In Progress – Fall 2026)

Authors : Fatemeh Mozaffar , Mozhdeh Rahmanpour, William McConnell, Ayoub Heydarzade, Beshoy Morkos

Planning to submit to Food and Bioproducts Processing Journal.

Summary and Recommendation

Aspect	Cold soaking (water tank)	Negative Pressure (Vacuum Chamber)	Comparison
Time	15 hrs. (900 min) to target moisture content	30 min to target moisture content	Negative pressure is **20-25x** faster
Energy	0 kWh Passive soaking, no power drawn	~0.06 kWh/batch 120 W motor. Run ~ 30 min =0.017 1kWh/kg	**~0.0171 kWh per kg** (less than 1/100 of a cent in energy cost per batch)
Space	~150 L for a 50 kg batch (0.33 kg/L)	~25 L for a 3.5 kg batch (0.14 kg/L)	2.36x more volume per batch, but **~12x-13x** more throughput per unit floor space

Target moisture content: go 2.5% above the initial moisture content
Throughput-normalized metric: Density = batch mass÷Volume; Energy=kWh÷batch mass.

Disclaimer: These Experiments were performed in standard testing conditions (25 C and 1 atm), in our laboratory environments, your results may vary.

All slides available:
https://pecanresearch.uga.edu/

Thank you!

Questions & Comments

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