Integrated biorefinery of *Jatropha curcas* L. seed:

Integrated biorefinery of Jatropha curcas L. seed: Valorization of Kernel into Biofuels and Molasses, and Seed Coat into Biopolymers and Cellulose Nanofibrils.

Jorge Hurtado[1,2], Raúl Hernández-Altamirano[2], Rosana Moriana*[1]

[1] Department of Chemical Engineering, MATS research group, UV-University of Valencia, Valencia, Spain

[2] Mexican Center for Cleaner Production of the National Polytechnic Institute, CMP+L-IPN, Mexico

INTRODUCTION

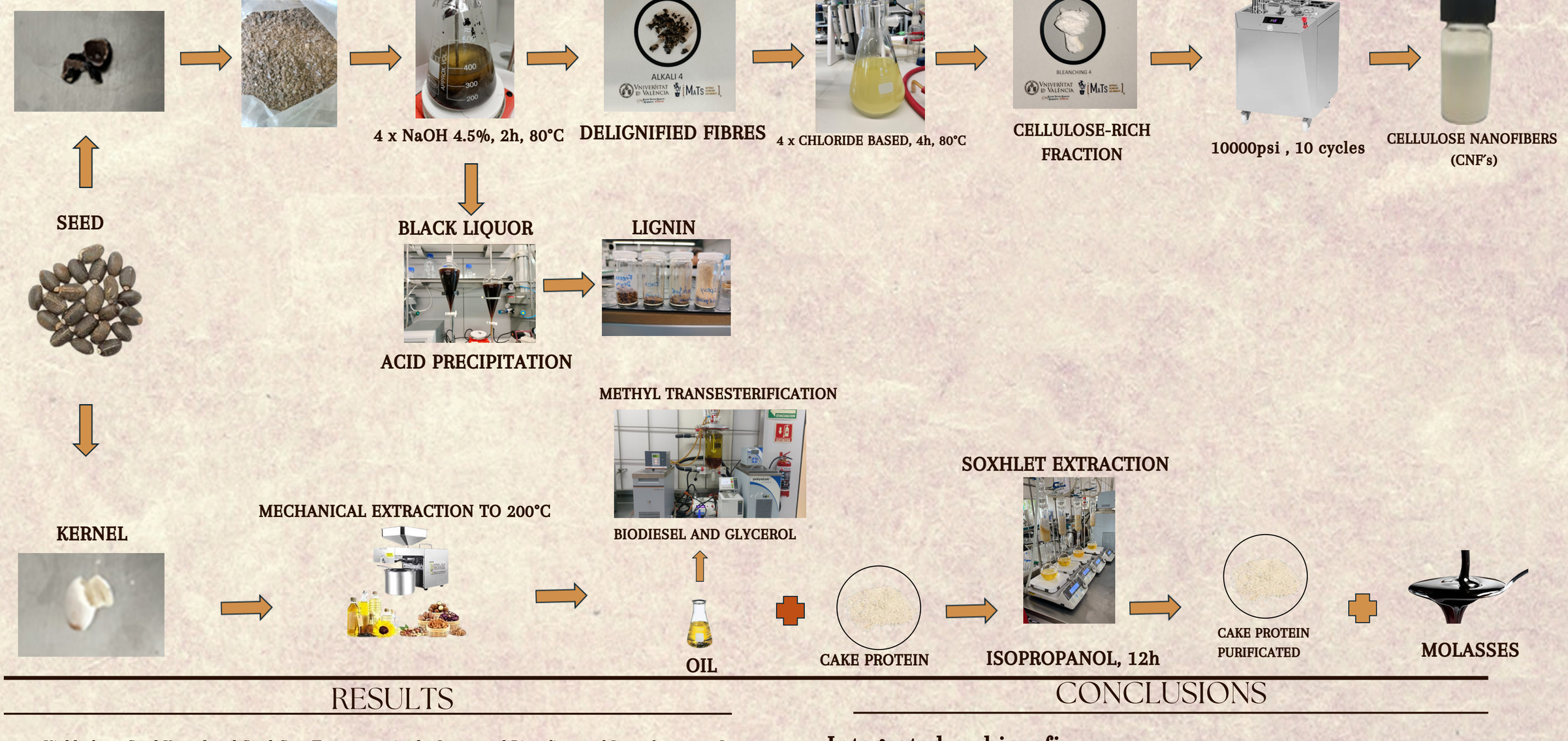
- The rising global demand for **sustainable alternatives** to fossil-based products is driving innovation in **biomass valorization pathways** and the development of **renewable packaging materials.**
- **Biorefineries** enable full biomass utilization, combining both **fuel production** with **biopolymer** generation for **bio-based** packaging solutions, supporting **circular bioeconomy**.
- ***Jatropha curcas* L.** is drought-tolerant, oil-rich, and native to Mexico/Central America, produces seeds with high potential for complete fractionization and **integrated valorization.**
- Although the Kernel is well-studied for biofuel production, the seed coat remains underutilized despite its high lignocellulosic content.

OBJECTIVES

Develop the first **integrated biorefinery** for full valorization of ***Jatropha curcas*** L. seed.

Transform both kernel and seed coat into **high-value products** through sequential fractionation and conversion.

METHODOLOGY



RESULTS

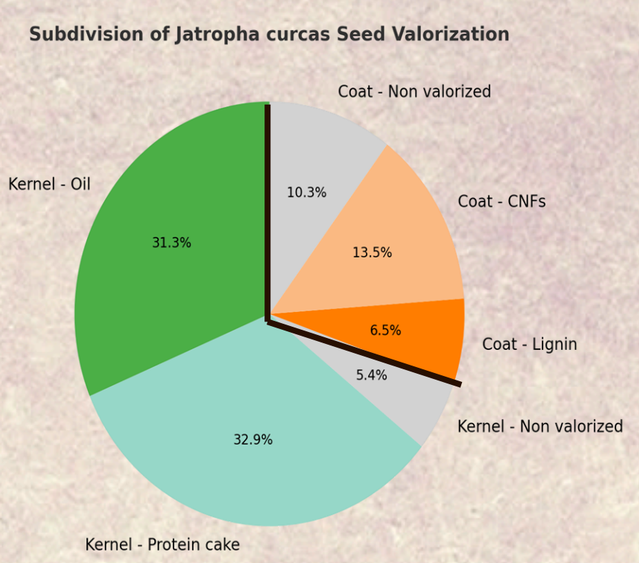
Yields from Seed Kernel and Seed Coat Treatments in the Integrated Biorefinery of *Jatropha curcas* L.

Seed Fraction	Product	Yield (% dry mass)	Notes
Kernel (69.0 ± 2.8%)	Oil	45.0 ± 2.5	Extracted at 200 °C
	Biodiesel	90.3 ± 3.4 *(of oil)*	ASTM-D6751 compliant
	Glycerol	9.4 ± 2.8 *(of oil)*	Coproduct transesterification
	Protein cake	47.3 ± 1.0	Coproduct after oil extraction
	Protein purificated	45.0 ± 1.9*(of protein cake)*	Coproduct after molasses extraction
	Molasses	~10 *(of protein cake)*	Obtained by Soxhlet.
Coat (30.1 ± 3.1%)	Lignin-rich fraction	21.5 ± 3.4	From alkaline treatment
	Cellulose-rich fraction	44.6 ± 2.4	Bleached from bleaching treatment
	Cellulose nanofibrils (CNF´s)	44.6 ± 3.0	From homogenized cellulose

Proof of concept: films of PVA aditivated with lignin and nanofibrils cellulose reinforcements.

CONCLUSIONS

- **Integrated biorefinery processes enable almost full vallorization of *Jatropha curcas* L seeds.**
- Multiple high-value outputs: **biodiesel for energy** application; lignin and **cellulose nanofibrils as bio-based additives for packaging films**; and proteins and molasses as nutritional coproducts
- **Supports sustainable bio-based industries & circular economy.**



Acknowledgments: RM is grateful for Grant RYC2021-034380-I funded by MCIN/AEI/10.13039/501100011033 and the European Union "NextGenerationEU"/PRTR. RHA is grateful the financial support from SECIHTI-Project Apoyo LN-2025-I-4, SIP-IPN multidisciplinary Project 2377, (modules SIP-20251243 and SIP-20251331). We are grateful to the Laboratorio Nacional de Desarrollo y Aseguramiento de la Calidad de Biocombustibles (LaNDACBio) for allowing access to the laboratory facilities and for technical assistance.