



Karunya INSTITUTE OF TECHNOLOGY AND SCIENCES

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Technical Evaluation of Fiber-Based Packaging and Bio-Polymer Barriers for Liquid Food Applications

TEAM MEMBERS:

Pratheeksha Shalbin - URK25FP2003

Deekshanya Shri L - URK25FP2010

Shanney Maria Simon - URK25FP2006

Problem Statement

Current liquid food packaging (like aseptic cartons) relies on multi-layer laminates of polyethylene (plastic) and aluminum. While these provide an excellent barrier against moisture and oxygen, they are extremely difficult to recycle and are derived from non-renewable resources.

The technical challenge is that fiber-based materials (paper) are inherently porous and hydrophilic (water-attracting), making them unsuitable for liquids unless paired with a barrier that matches the performance of plastic but maintains the recyclability of paper.



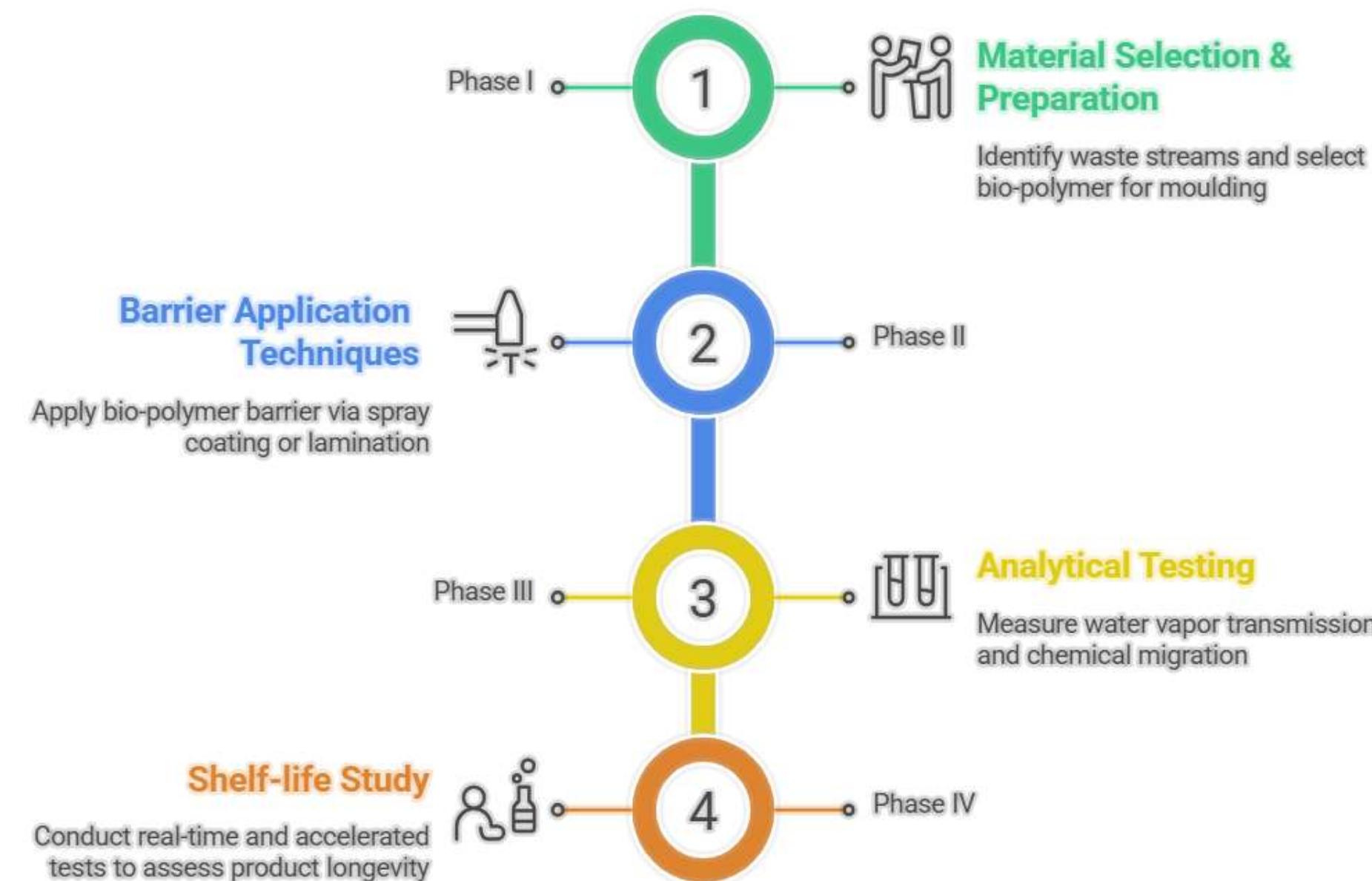
INTRODUCTION



- The global food industry is under increasing pressure to transition from traditional PET and glass packaging to sustainable alternatives like "**Paper Bottles**". Developed through molded fiber technology, these designs aim to establish a circular packaging model.
- For professionals, the primary technical challenge lies in maintaining necessary **Water Vapor (WVTR)** and **Oxygen Transmission Rates (OTR)** to preserve beverage shelf-life and organoleptic properties. Research highlights plant-based liners, such as **Polyethylene Furanoate (PEF)**, as ultra-thin internal coatings that prevent moisture absorption and structural degradation of the wood-pulp shell.
- While difficulties persist in carbonated pressure management and high-speed aseptic filling, these fiber-based systems can reduce plastic use by 60–80%. Ultimately, integrating bio-barrier engineering provides a viable, recyclable pathway for sustainable liquid food distribution.

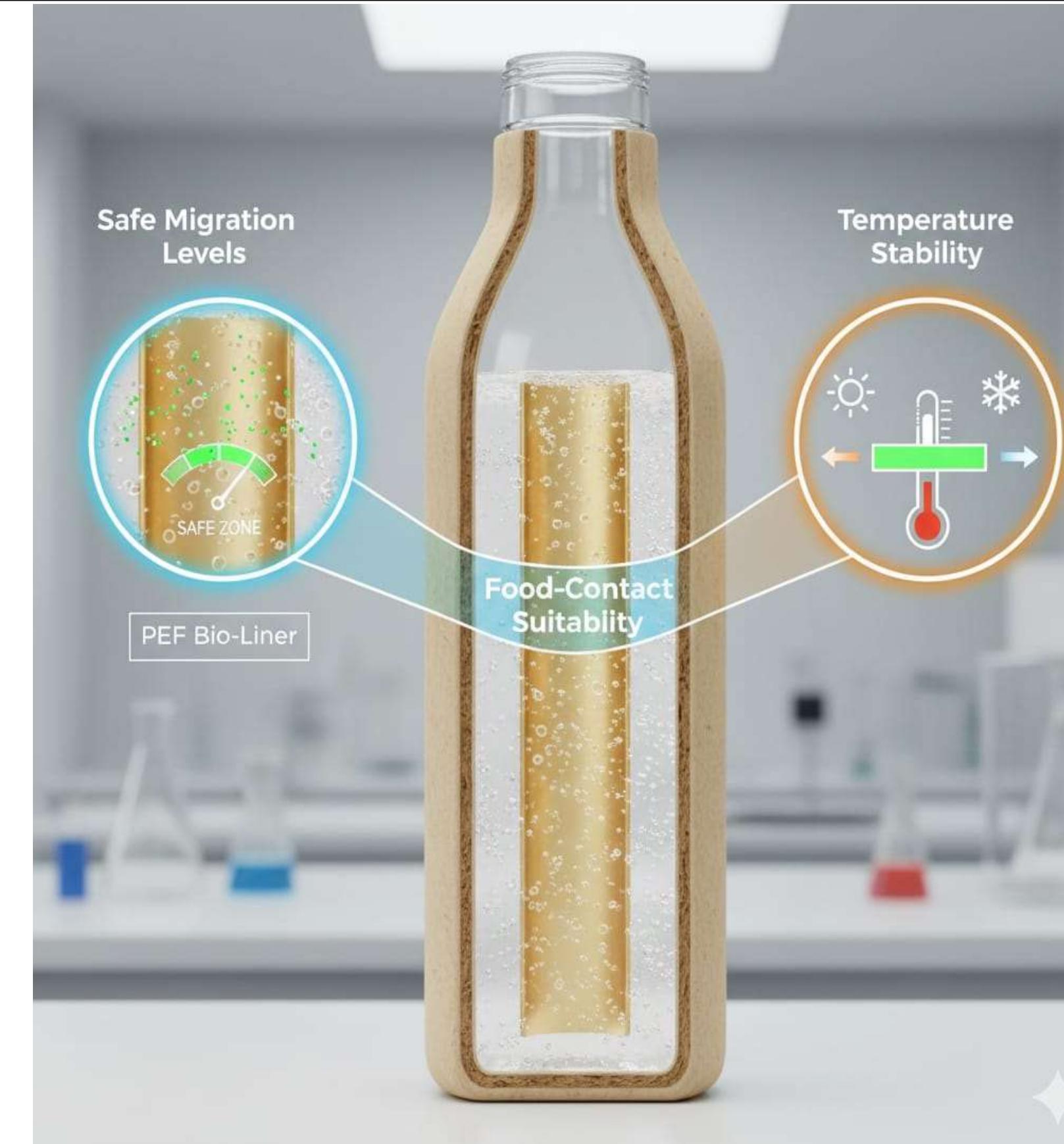
METHODOLOGY

Methodology: From Idea to Prototype



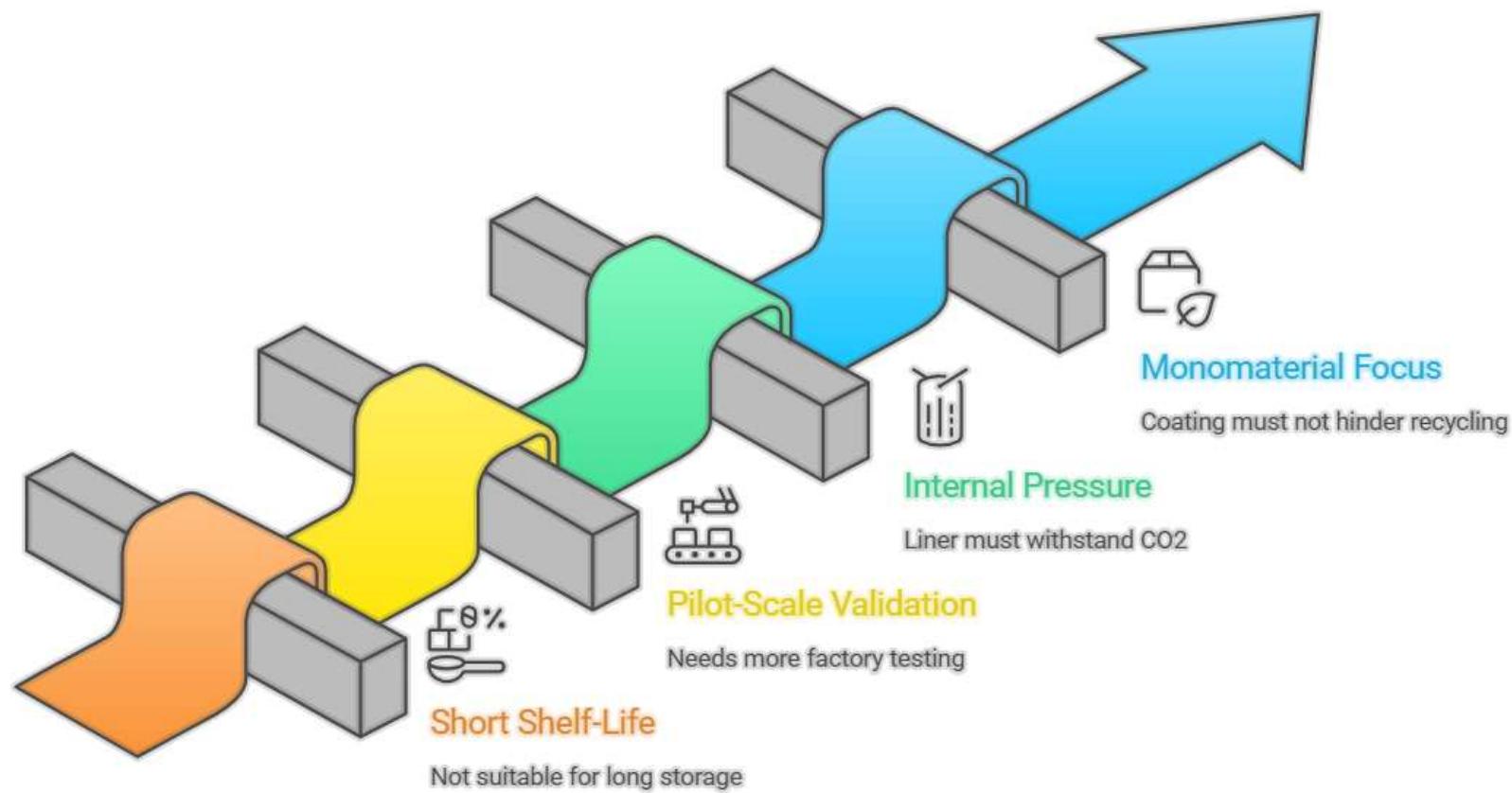
FOOD SAFETY EVALUATION

- Food safety evaluation addresses the critical health and safety concerns related to switching from traditional plastics to plant-based materials.
- Safe Migration Levels: The research confirms that the amount of bio-polymer material transferring into the food or drink stays within safe, acceptable limits.
- Food-Contact Suitability: The bio-polymers used (like PEF) are technically approved for direct contact with liquids, acting as a safe interface between the wood-pulp and the beverage.
- Temperature Stability: The packaging maintains its structural integrity and safety even when stored at various temperatures, ensuring the bottle doesn't degrade on the shelf.



OUTCOMES

Sustainable Packaging: Challenges and Opportunities



This technology can be used in the real world and what the current limitations are.

- **Short-Shelf-Life Applications:** Currently, this packaging is most suitable for liquid foods that don't need to sit on a shelf for years.
- **Massive Plastic Reduction:** Implementing this technology can reduce the industry's plastic use by 60–80%.
- **Pilot-Scale Validation:** While the theory works, the slide notes that more testing is needed to see how these bottles perform in high-speed factory filling lines.
- **Experimental Validation:** We need more real-world tests on how these bottles hold up in fast-moving factory environments.
- **Internal Pressure Management:** For carbonated drinks, the liner must be strong enough to handle the internal pressure of CO₂ without the fiber shell losing its shape.
- **Monomaterial Focus:** The ultimate goal is a "monomaterial fiber system" where the coating is so thin it doesn't interfere with standard paper recycling.

CONCLUSION

- Eco-Friendly Packaging:** The industry is replacing PET and glass with "Paper Bottles" made via Moulded Fiber Technology.
- Bio-Barriers:** Plant-based liners like PEF prevent liquid absorption and maintain the bottle's structure.
- Protection:** These coatings manage WVTR and OTR to preserve drink taste and shelf-life.
- Verified Safety:** Testing confirms safe migration levels and stability across various temperatures.
- Impact:** This design reduces plastic usage by 60–80% while staying recyclable.
- Next Steps:** Challenges remain in high-speed aseptic filling, requiring more industrial-scale testing.

Paper Bottle PESTEL Analysis



KEY REFERENCES

- Avantium. (2024).
PEF and FDCA: Pioneering sustainable chemistry solutions.
- Paboco. (2022).
Paboco reveals a prototype of the next generation paper bottle.
- Burgess, S. K., et al. (2014).
"Oxygen sorption and transport in amorphous poly(ethylene furanoate)."*Macromolecules*, 47(4).





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