EXIT- posters

Graduates 2025

Master's programme
in Resource Recovery

SUSTAINABLE COMPOSITES FOR THE FUTURE OFFROADCONSTRUCTION MACHINES

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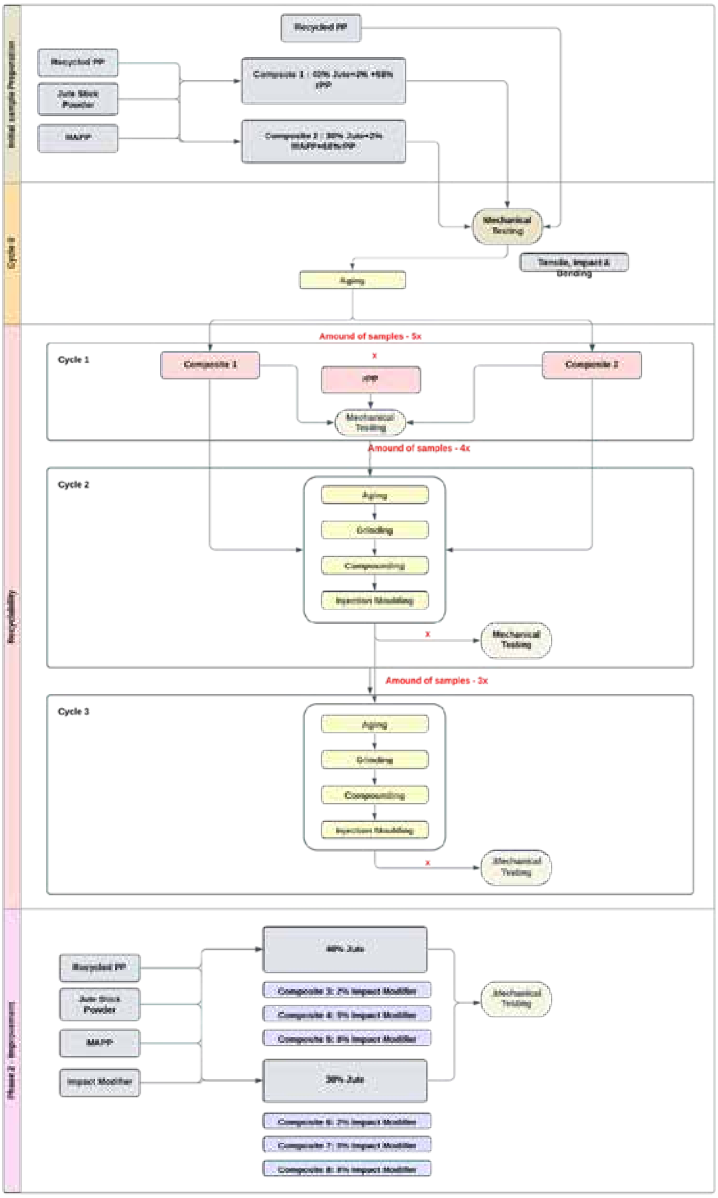
Introduction

The construction equipment industry faces growing pressure to reduce its environmental impact. Interior components in construction machinery, such as dashboards, are typically made from talc-filled polypropylene (PP), offering good performance but raising sustainability concerns due to talc's non-renewable nature. This project explores recycled PP reinforced with biobased fillers like jute and hemp as eco-friendly alternatives. To ensure recyclability and reprocessability, the composites are assessed through thermal ageing, addressing key challenges in maintaining performance over time within existing manufacturing systems like injection and compression molding.



Methodology

Experimental Process

Recyclability & Reprocessability

Influence of Impact Stabilizer

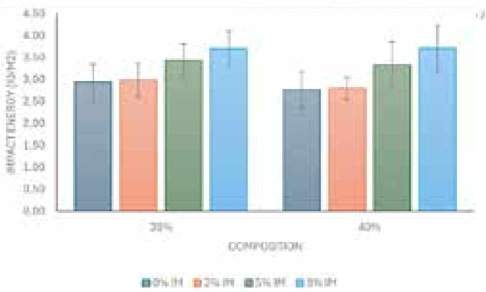
Life Cycle Assessment

Cradle - Cradle

FU - 1 Dashboard

Results

Performance Stability over two ageing and reprocessing cycles



Influence of TPS type Impact Modifier

5% provides the optimum mechanical Properties

Conclusion

- 30% jute + 5% impact modifier gave the best combination of impact strength, stiffness, and thermal durability.
- DMA and thermal ageing tests confirmed stable performance and good recyclability over time.
- 40% jute composite had higher stiffness but suffered from poor uniformity and reduced reprocessability.
- LCA results emphasized the importance of improving energy sources and end-of-life waste management to enhance sustainability.
- Overall, the optimized composite is a promising bio-based, recyclable alternative to talc-filled rPP for dashboard applications.

PYROLYSIS OF ORGANOSOLV PRETREATED OAT HUSKS

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UNIVERSITY OF BORÅS

Introduction

Biomass presents a promising alternative to constantly depletig and environemnt polluting fossil fuels for growing energy demand. Pyrolysis, one of used thermal technologies, converts the biomass into high-energy gases, bio-fuels and solid residue biochar. Utilization of these pyrolysis products at thermal and power plants can produce heat and electricity. Besides that, high-energy gases and bio-fuels can be upgraded to value-added chemicals. However, composition and distribution/yields of these pyrolysis products are influenced by several factors such as pyrolysis conditions, biomass type and its inherited alkali and alkaline earth metals (AAEMs) which catalyse the pyrolysis reactions. Therefore, this study investigates the influences of biomass type, its AAEMs and pyrolysis heating rate on composition and yield of pyrolysis products.

Objectives

Objectives of this study comprise of following investigations

- Influence of a particular acid used to extract the oat husks lignin being used as a biomass feedstock on thermal degradation of extracted lignin and distribution of resultant pyolysis products
- Influence of pyrolysis heating rate on thermal degradation of extracted oat husks lignin as well as distribution of resultant pyrolysis products
- Influence of oat husks lignin contained AAEMs on its thermal degradation as well as distribution of resultant pyrolysis products

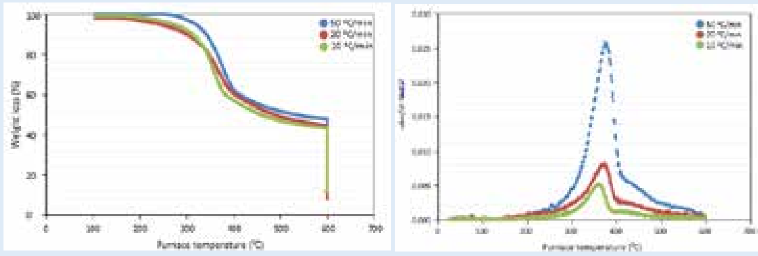
Materials and Methodology

Objectives of this study comprise of following investigations

- Oat husks Lignin samples extracted using oxalic acid and sulphuric acid in an organosolv process
- Conduct demineralization of lignin samples to have lignin samples with reduced AAEMs for comparison study
- Perform thermogravimetric analysis (TGA) of pure and demineralized lignin samples at different heating rates to analyse their thermal degradation
- Perform Pyro-GC/MS analysis of both pure and demineralized lignin samples to investigate the distribution of pyrolysis products

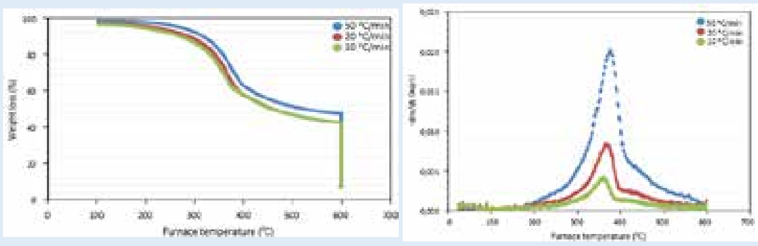
Results

- Shifting of TG curves towards high temperatures at increasing heating rates during pyrolysis of pure & leached lignin
- Relative quick and high weight loss of leacjed lignin than of pure lignin during pyrolysis



(a) (b)

Fig. Curves of TG (a) and DTG (b) for organosolv lignin from oxalic acid treated oat husks



(a) (b)

Fig. Curves of TG (a) and DTG (b) for leached organosolv lignin from oxalic acid treated oat husks

- Relative high volatiles and low char for pyrolysis of pure lignin from oxalic acid treated oat husks than of sulphuric acid treated oat husks
- Relative low volatiles and high char for pyrolysis of leach lignin than of pure lignin

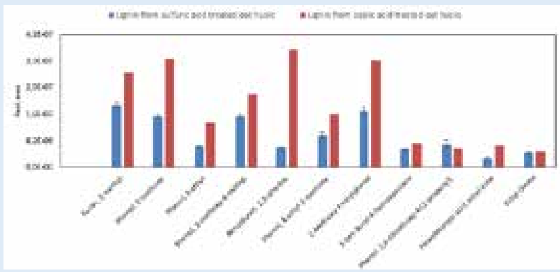


Fig. Peaks areas of GC-MS identified compounds from pyrolysis of sulfuric acid and oxalic acid extracted pure organosolv lignin

Conclusion

- Type/nature of feedstock and pyrolysis heating rate influence the lignin degradation and product distribution
- Lignin contained AAEMs influence its thermal degradtion as well as the product distribution

Development Of Antibacterial Hydrogel From Fungal Cell Wall For Wound Healing

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Introduction

Chronic wounds (e.g., diabetic ulcers, pressure sores), fail to heal within 4 weeks, leading to serious complications and healthcare costs.

Traditional dressings (gauze, antibiotics):
- Painful removal
- Risk of bacterial resistance
- Lack of bioactivity

Hydrogels as an alternative, 3D polymer networks that:
Retain moisture, biocompatible & flexible.
Often incorporate chitosan for antibacterial effects.

Conventional chitosan: derived from crustacean shells, & chemical-intensive.
Fungal chitosan from *Rhizopus delemar* :
- Eco-friendly and biocompatible
- Grown on food waste (e.g., apple pomace, bread waste)

Purpose

This project was aimed to develop antibacterial hydrogels from the fungal cell wall of *Rhizopus delemar*, crosslinked with genipin, for potential use in wound healing.

Methodology


Food waste


Rhyzopus delemar


Bioreactor


Fungal biomass


Pretreated biomass

Alkali pre-treatment of fungal biomass


Alkaline Insoluble Material (AIM)


Hydrogel preparation

AIM mixed with lactic acid to make the hydrogel


Hydrogel

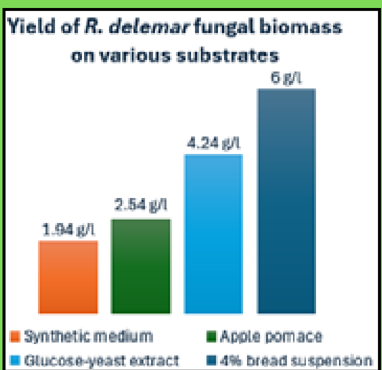

Non-crosslinked hydrogel vs Crosslinked hydrogel

Hydrogel crosslinked with Genipin to enhance stability and mechanical properties


Crosslinked hydrogel as a gel sheet

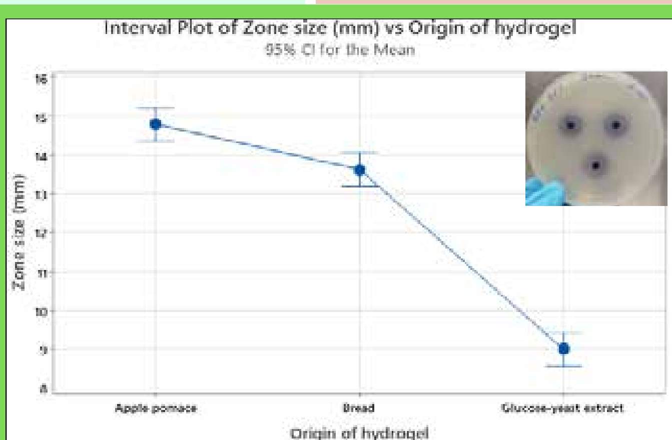
Results

- Waste bread & apple pomace demonstrated their potential as a **sustainable, low-cost** substrates.




Adhesiveness


Swelling property



- Fungal hydrogel derived from apple pomace substrate showed the **highest antibacterial activity** against both *Escherichia coli* & *Staphylococcus aureus*.
- **Genipin enhanced the mechanical properties** of the fungal hydrogel such as swelling, adhesiveness & rheology.

Conclusion

Fungal chitosan-based hydrogels, derived from waste bread & apple pomace, crosslinked with genipin, showed strong antibacterial activity, structural stability, and biodegradability. These results highlight their potential in sustainable biomedical applications like wound healing.

External references
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2. Kanishka B Wijayarathna, E. R., Mohammadkhani, G., Moghadam, F. H., Berglund, L., Ferreira, J. A., Adolfsson, K. H., Hakkarainen, M. & Zamani, A. 2024. Tunable Fungal Monofilaments From Food Waste For Textile Applications. Global Challenges, 8.

Prospective Life Cycle Assessment as a Bioprocess Design Support Tool – A case study of fungal biomass production using thin stillage for fish feed application

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Introduction

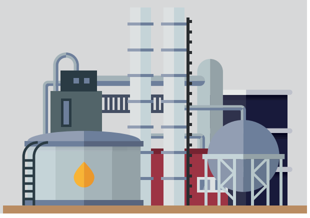
- Global population growth to 9.7 billion by 2050 has created unprecedented protein demand, with marine fisheries reaching sustainable limits while aquaculture becomes the fastest-growing food sector, producing 122.6 million tonnes valued at USD 281.5 billion in 2020.
- Current aquaculture creates resource inefficiency by using fishmeal and plant proteins that could feed humans directly, while alternative proteins fail to meet fish's complex nutritional requirements for amino acids, vitamins, minerals, and oils.

Figure 1: Submerged Fungal Biomass Cultivation in Bubble Column Reactors

- Filamentous fungi species (Neurospora intermedia, Rhizopus delemar, Aspergillus oryzae) efficiently convert agricultural and industrial waste into high-protein biomass meeting aquaculture specifications without competing for agricultural land.
- Fungal protein production enables circular economy principles by utilizing waste substrates like brewers' spent grain, wheat bran, molasses, and apple pomace, with thin stillage from bioethanol production showing particular promise.
- Thin stillage transforms from waste to valuable protein resource through its rich organic matter, solid substrates for fungal attachment, accessible carbon sources like glycerol, and organic acids supporting efficient fungal metabolism.

Objective

This study aims to demonstrate how prospective Life Cycle Assessment (pLCA) can be effectively integrated into the design phase of sustainable bioprocesses, thereby enabling informed decision-making for environmentally optimized biotechnological systems.



Methodology

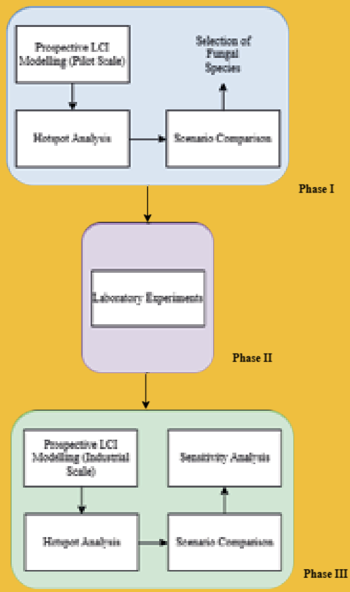


Figure 2: Three Phase Prospective LCA Methodology

Goal & Scope

- Assess environmental impacts of fungal biomass production from thin stillage
- Compare different fungal species for aquaculture feed applications
- System boundary: thin stillage to dried fungal biomass (cradle-to-gate)

Phase 1: Pilot-Scale pLCA

- Applied Piccinno et al. (2016) framework at 10,000 L scale using Karimi et al. (2023) data
- Conducted hotspot analysis across fungal species scenarios
- Identified *Rhizopus oligosporus* as most environmentally favorable option

Phase 2: Laboratory Validation

- Validated assumptions through shake flask experiments
- Scaled up to 3.5 L bubble column bioreactors
- Determined optimal dilution ratios and actual biomass yields

Phase 3: Industrial-Scale pLCA

- Used SuperPro for industrial-scale LCI modeling
- Incorporated experimental data (yields, dilution ratios, energy/material balances)
- Built refined pLCA and identified hotspots for future development

Results & Discussion

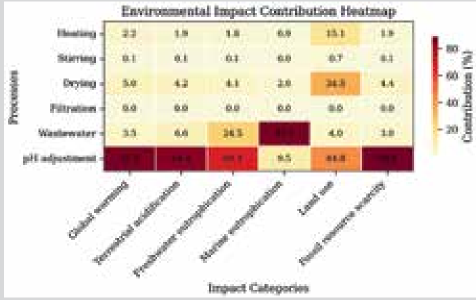


Figure 3: Environmental Hotspots in Pilot Scale Fungal Biomass Production

- Hotspot analysis of base case scenarios identified pH adjustment as the major environmental impact contributor (Figure 3).
- *R. oligosporus* was selected as alternative scenario based on literature evidence of its ability to grow in acidic pH conditions of thin stillage, eliminating pH adjustment requirements.
- Scenario comparison validated R. oligosporus as the optimal choice, demonstrating superior environmental performance compared to other fungal species for thin stillage biomass production.

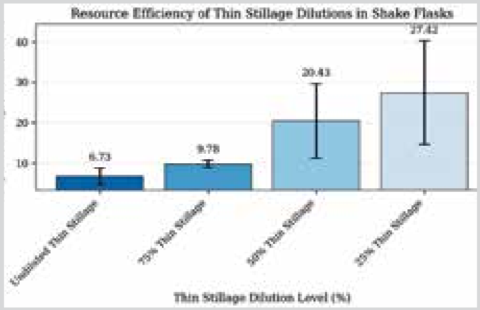


Figure 4: Resource Efficiency of Thin Stillage Dilutions in Shake flasks for *R. oligosporus*

- Optimal thin stillage dilutions of 50% and 25% maximized dry fungal biomass production efficiency. Dilution reduces solids content, enhancing nutrient/oxygen transport and heat transfer.

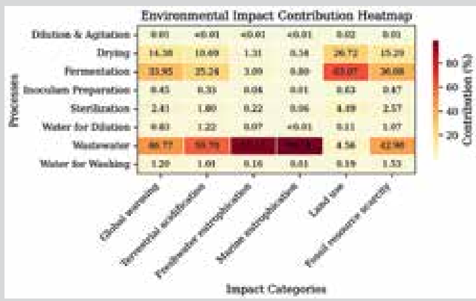


Figure 5: Environmental Hotspots in Industrial Scale Fungal Biomass Production

- Waste treatment emerged as the primary environmental hotspot in industrial-scale *R. oligosporus* production (Figure 5).

Conclusion

- Prospective LCI modeling coupled with pLCA effectively optimizes submerged fungal biomass fermentation processes at early technology development stages, proving crucial for identifying environmentally intensive process steps before implementation and providing a robust framework for developing sustainable biotechnology processes that valorize waste streams like thin stillage into valuable biomass.

Future Research Recommendations

- Investigate fermentation time vs. organic matter reduction relationships in spent medium.
- Assess feasibility of reducing/eliminating biomass washing and impacts on crude protein content.
- Develop customized wastewater treatment process modelling in SimaPro for spent fermentation medium (25% thin stillage).
- Design integrated bioprocess simulation with water recycling and recovery systems using SuperPro Designer.
- Integrate techno-economic optimization with environmental considerations for early-stage technology development.

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Life Cycle Assessment (LCA) Of Glass Waste as Alternative Cement

MSc in Resource Recovery

Nema Jafari

Introduction

Cement production is a major contributor to carbon emissions and resource consumption, driving the need of sustainable alternatives in the construction industry. Glass waste, particularly float glass, has emerged as a promising partial replacement for cement. This study conducts a Life Cycle Assessment (LCA) to evaluate environmental performance or using recycled glass waste as an alternative cementitious.

Methodology

This study is based on a Life Cycle Assessment (LCA) using the ISO 14044 frameworks. Data was sourced from Environmental Product Declarations (EPDs), GaBi, and Ecoinvent databases. Three concrete production scenarios were analyzed: conventional concrete (Base Case), concrete with recycled float glass (Case 1), and concrete with recycled float glass and recycled concrete aggregates (Case 2).

Discussion

Case 2 consistently showed the best environmental performance. Although higher recycled content slightly increased water consumption, the overall environmental benefits far outweighed this trade-off. Mechanical performance also improved up to 20% glass replacement.

Contribution to Circular Economy

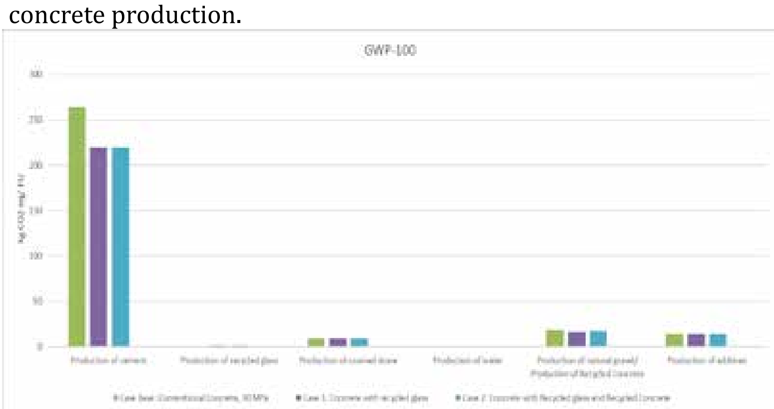
Using recycled float glass in concrete helps close material loops in construction. It reduces the demand for virgin materials and diverts glass waste from landfills, aligning with circular economy principles.

Key Result

The production of raw materials is the main contributor to the Global Warming Potential (GWP) throughout the concrete life cycle, with cement manufacturing being the most significant factor. This is primarily due to the calcination process, which releases large amounts of carbon dioxide. In the base case scenario, representing conventional concrete with a compressive strength of 30 MPa, the GWP reaches approximately 263.43 kg CO_2-equivalents, with cement production accounting for the largest share.

In Case 1, where recycled float glass is used as a partial cement replacement, the GWP from cement production is reduced to around 219.53 kg CO_2-equivalents—an approximate 17% reduction. The environmental impact of the recycled glass itself is minimal, contributing only about 1.38 kg CO_2-equivalents.

Further improvements are observed in Case 2, which incorporates both recycled float glass and recycled concrete aggregates. This scenario significantly reduces the environmental impact associated with natural gravel, even achieving negative emissions of approximately −17.13 kg CO_2-equivalents. These results clearly highlight the environmental benefits of using recycled aggregates in concrete production.



Conclusion

Recycled float glass is a promising cement substitute. It improves environmental and mechanical performance, making it a viable option for sustainable and circular concrete production.