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Promoting the Future of Innovative Sustainability in Composite Materials for Environmental Impact Reduction

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16/11/23

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Promoting the Future of Innovative Sustainability in Composite Materials for Environmental Impact Reduction

- *The environmental challenges posed by traditional building materials.*
- *Impact of non-degradable materials on the ecosystems.*
- *The importance of preserving the beauty of the environment for future generations.*

Plastics found in the Ocean

Images showing environmental degradation and deforestation

Images showing pristine and untouched environment

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About Iheoma

- Dr. Iheoma Chigoziri Nwuzor is a Polymer Chemist/Scientist
- My previous research theme was: Developing Sustainable Alternative Material Sources to Conventional Polymer Raw Materials.

Previous Research Background/Vision

- My previous research was focused on the synthesis, functionalization, characterization, and applications of sustainable polymer raw materials.
- Develop a novel solution to the pressing issues of composite material waste.
- Develop innovative sustainable manufacturing techniques

- I am currently working with NextCOMP as a Research Associate at the University of Bristol.
  - NextCOMP: Enhancing the compressive performance of conventional fibre-reinforced polymer composites through a hierarchical approach.

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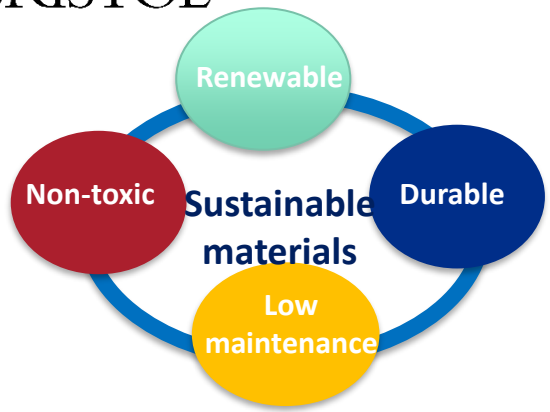
- **Sustainable Materials**
  - **What makes these materials sustainable?**



World's Composite Manufacturing Challenges

- Sustainability and environmental regulations
- Innovation and Research
- Energy efficiency
- Waste management

- **Sustainability in Composite Materials**

❖ **Accelerating the development of composites, processes, and technologies to reach NetZero**

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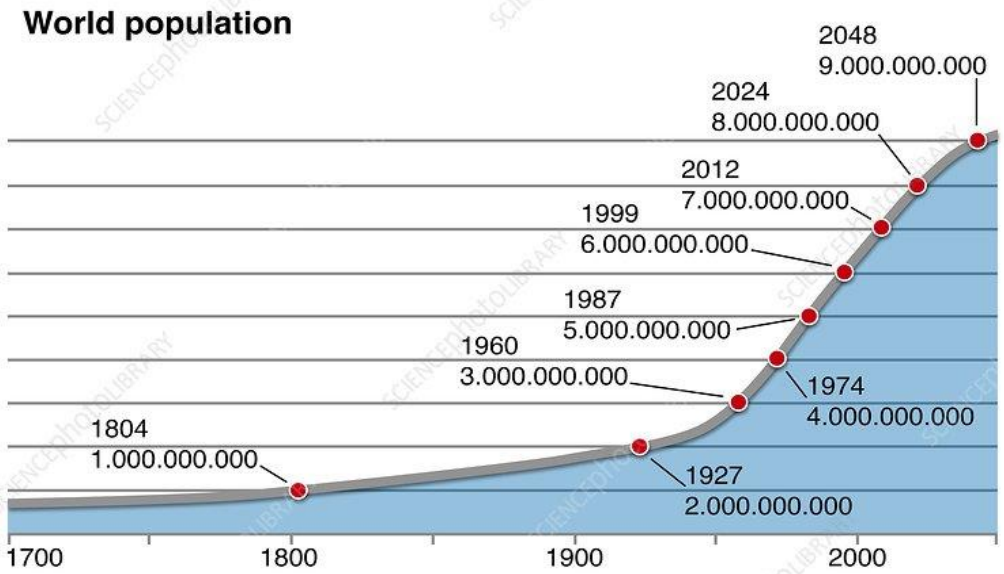

There has always been a constant demand for sustainable food production due to the ever-growing population.

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This process needs to Stop

More food on the table, more agricultural waste generated

Burning leads to environmental pollution, and the government setting new stringent laws

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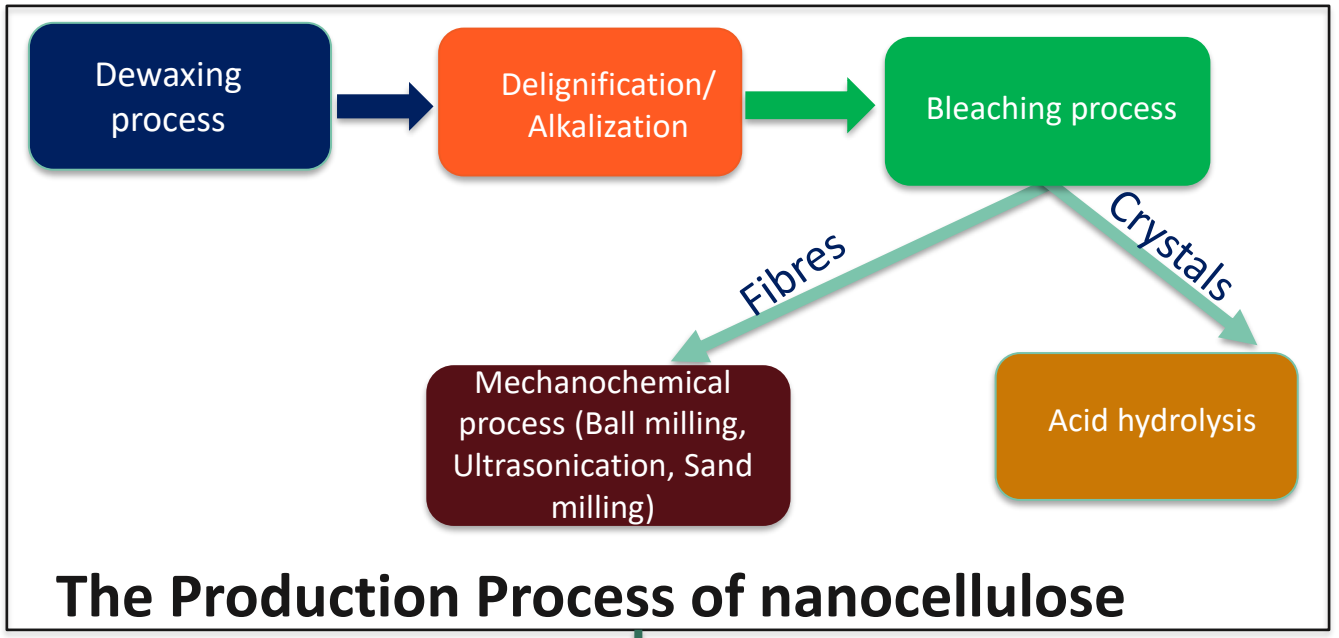

Agricultural waste needs to be increasingly used in the production of cellulose nanomaterials to aid in the removal of environmental pollutants

Agricultural waste reinforcing fibres offer a sustainable engineering solution.

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Aim: To synthesize bio-resin from agricultural waste

Cashew Nut Shell preparation

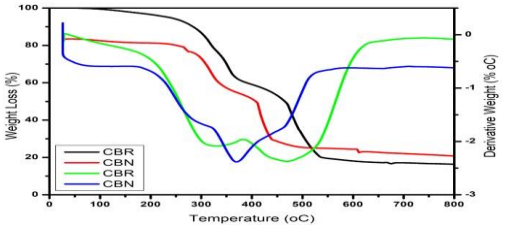
Crushed CNS

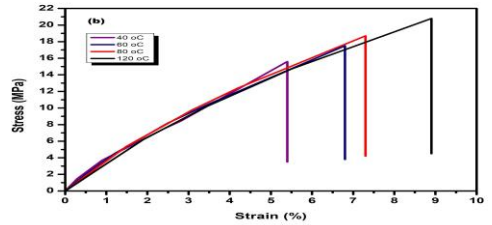
Extraction

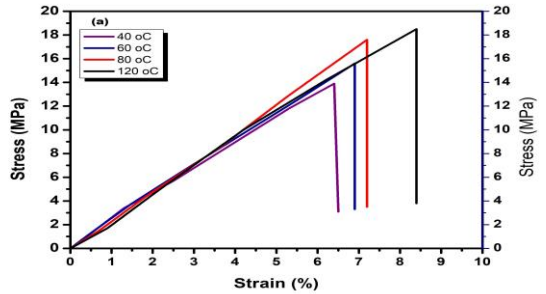
Decarboxylation

Cardanol

Bio-based resin







Research Outcome: 1. This project was successful because we achieved a bio-based resin from agricultural waste that is as good as a synthetic system. This has helped in the development of a green resin product for sustainable engineering.

2. Published in Journal

Nwuzor, I. C., Okolie, P. C., Ezeani, O. E and Nwanonenyi, S. C. (2022). Production of epoxidized cardanol-based vinyl ester resins with cinnamic acid for eco-friendly coating materials. Emergent Materials, 1–14, https://doi.org/10.1007/s42247-22-00396-6.

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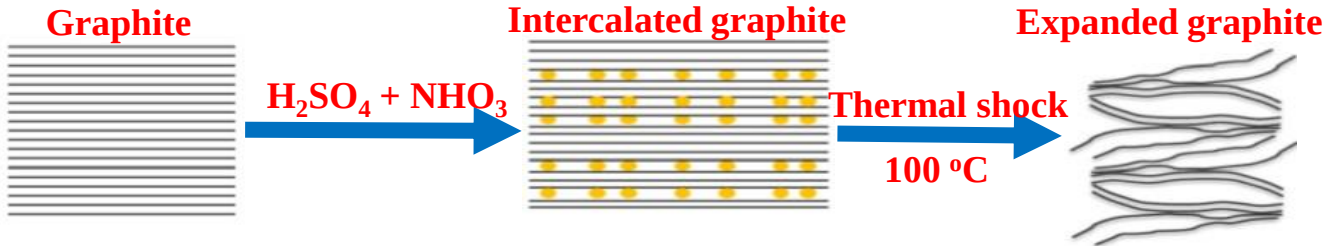
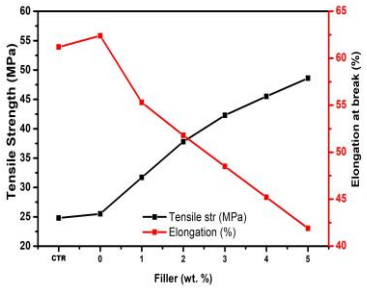
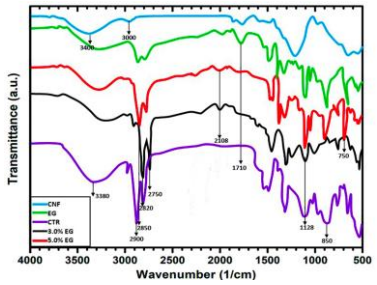
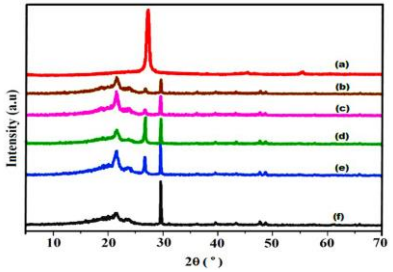
Aim: To fabricate nano-biocomposite with bio-based resin from agricultural waste and reinforcing nanofibrils from agricultural waste









Nano-biocomposite

Research Outcome: 1. This project successfully fabricated nano-biocomposite from agricultural waste for sustainable engineering application.

2. This has shown one of the potentials of the bio-based resin synthesized from agricultural waste. It also helped to overcome the challenges of burning agricultural waste and created a sustainable engineering product from natural reinforcing nanofibres.

3. Published in Journal

Nwuzor, I. C., Chukwuneke, J. L., Ewulonu, C. M. and Okolie, P. C. (2022). Fabrication of cardanol thermosetting resin reinforced with cellulose nanofibril/expanded graphite nano-biocomposites. *Industrial Crops and Products*, 187, 115392. https://doi.org/10.1016/j.indcrop.2022.115392.

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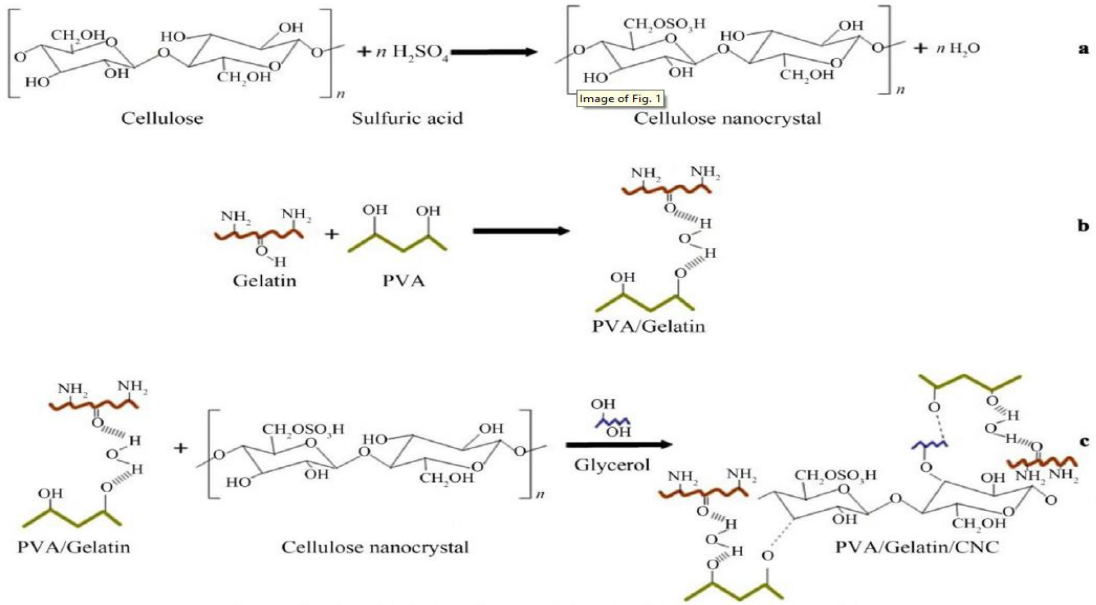
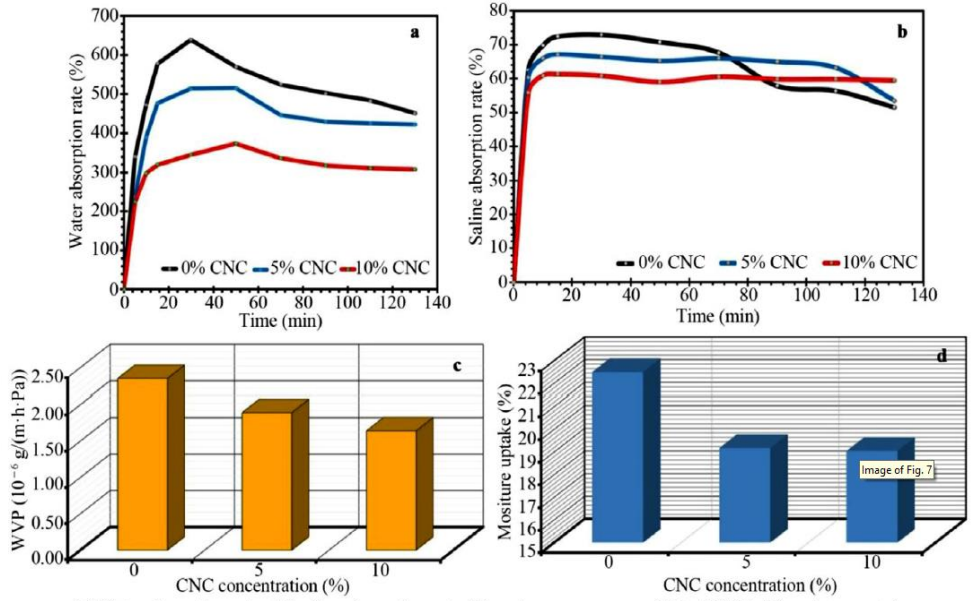
Aim: Fabrication of nanocomposite film with agricultural weed (water hyacinth) for food packaging applications



(a) Synthesis of CNC; (b) blending of PVA and gelatin; (c) fabrication of the films

H.C. Oyeoka, C.M. Ewulonu, I.C. Nwuzor et al. Journal of Bioresources and Bioproducts 6 (2021) 168–185



(a) Water absorption rate; (b) saline absorption rate; (c) water vapour permeability (WVP); (d) moisture uptake

Research Outcome:

1. This project was successful because we achieved a sustainable food packaging product from agricultural weed (transforming weed into a sustainable product). This helped to overcome the environmental nuisance caused by water hyacinth.

2. Published in Journal

Oyeoka, H. C., Ewulonu, C. M., Nwuzor, I. C., Obele, C. M. and Nwabanne, J. T. (2021). Packaging and Degradability Properties of Polyvinyl Alcohol/Gelatin Nanocomposite Films Filled Water Hyacinth Cellulose Nanocrystals. Journal of Bioresources and Bioproducts, Elsevier, 6(2), 168-185 DOI: https: //doi.org/10.1016/j.jobab.2021.02.009

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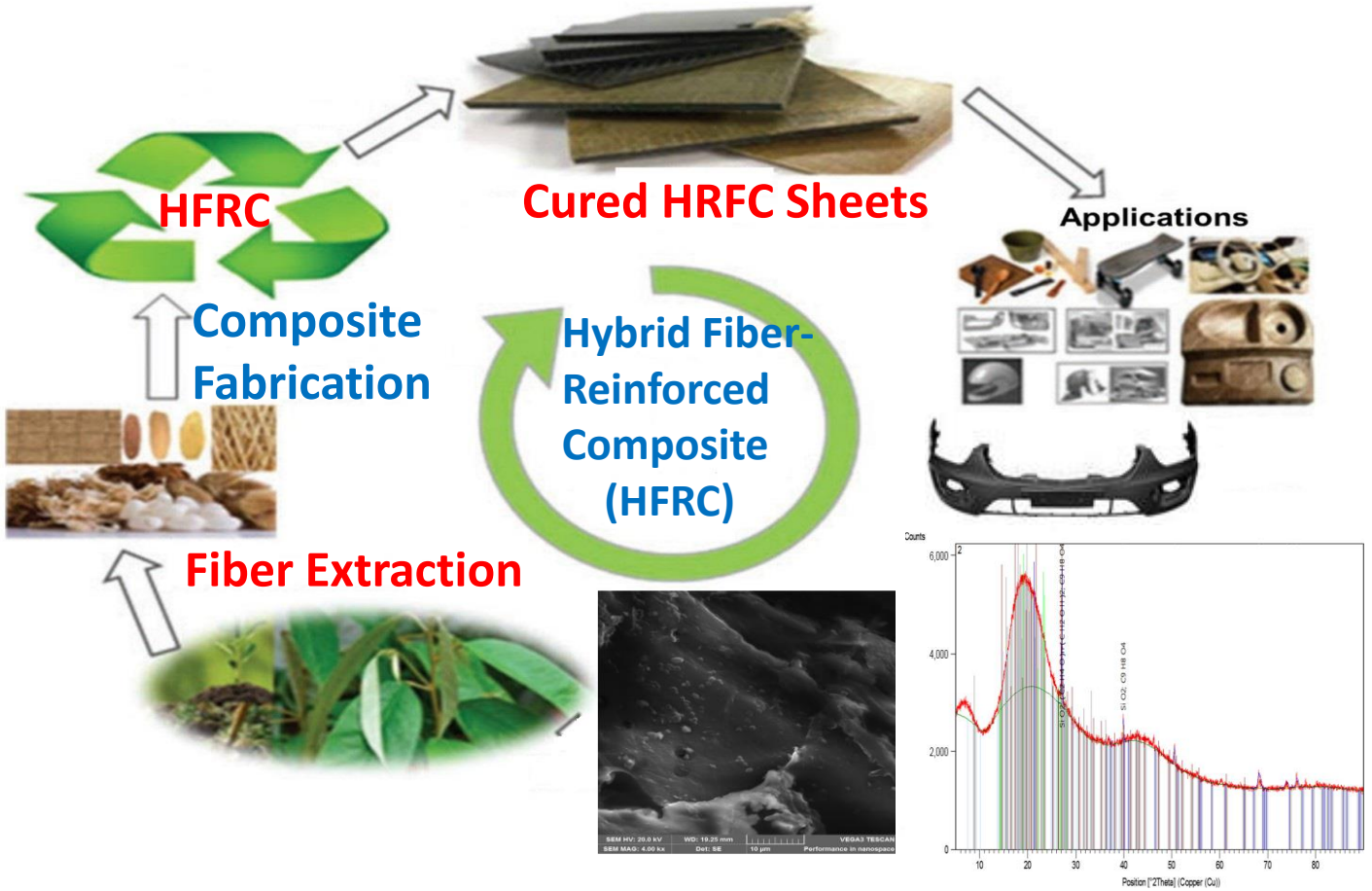
Aim: To fabricate composite from natural fibre for car bumper application



Research outcome:

1. Successful fabrication of composite from natural reinforcing fibres for automobile (car bumper) application.

2. This assisted in overcoming the challenges of burning agricultural waste and created a sustainable engineering product from natural reinforcing fibres.

3. Published in Journal

Nwuzor, I. C., Atuanya C. U. and Olisa O. (2021). Momordica angustisepala fibres and ant hill particles/polyester value-added hybrid composites for bumper application. World Journal of Engineering. 18(1), 136-145. DOI 10.1108/WJE-03-2020-0096

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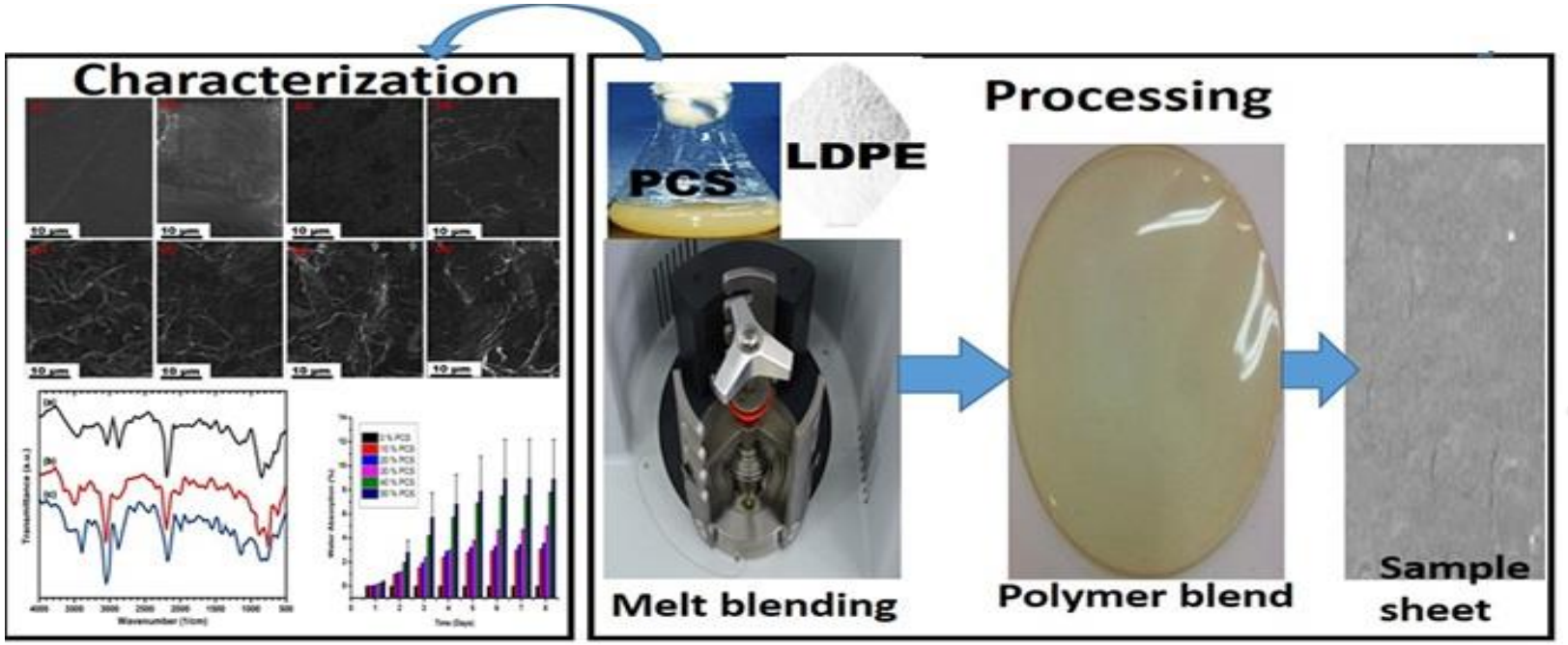
Aim: To induce biodegradation to polyethylene films/bags



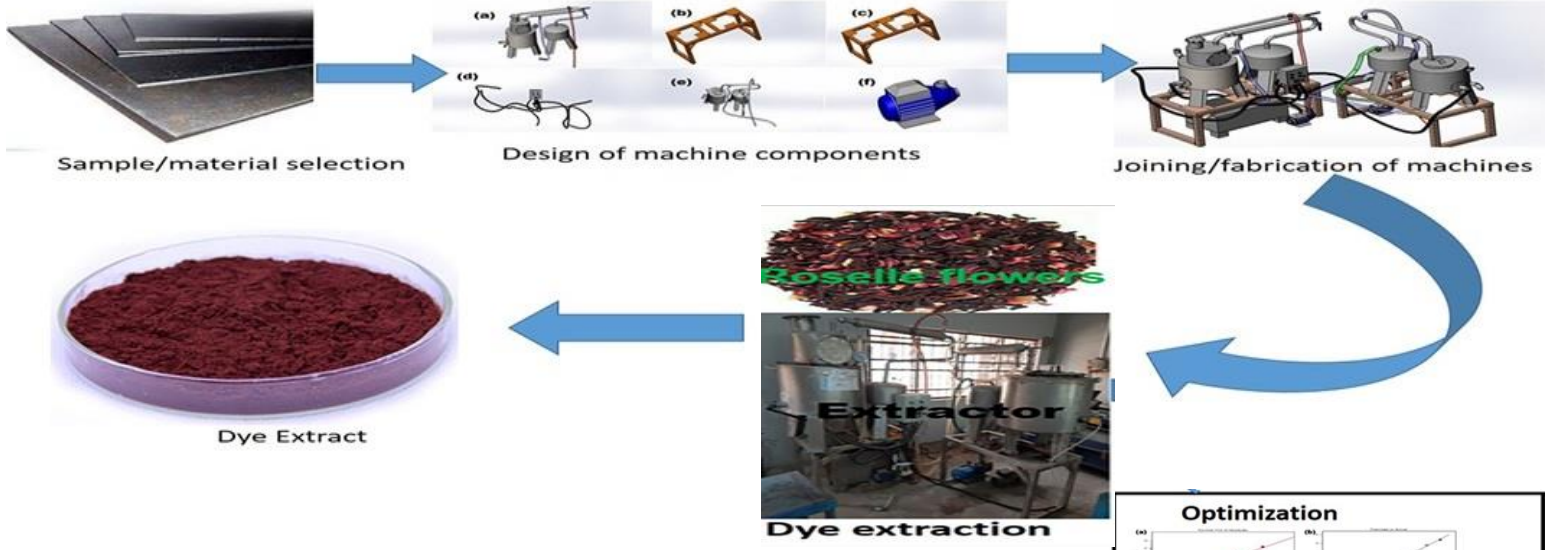
Research Outcome:

1. **This project was successful because we achieved biodegradation in LDPE films which aided in finding alternative plastic bag systems to minimize the problems in the ocean.**

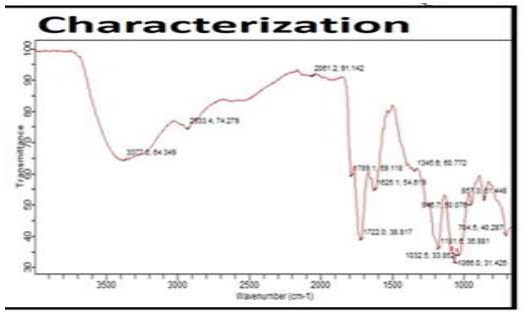
2. **Published in Journal**

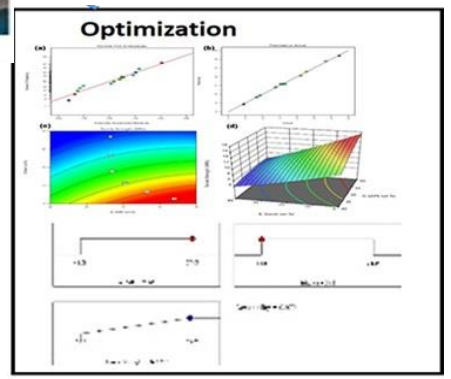
Nwuzor, I. C., H. C. Oyeoka, S. C. Nwanonenyi and G. O. Ihekweme (2023). "Biodegradation of low-density polyethylene film/plasticized cassava starch blends with central composite design for optimal environmental pollution control." Journal of Hazardous Materials Advances 9: 100251.

Aim: To fabricate a dye extractor for natural dye extraction



Dyed fabrics with good fabric and dye interaction





Research Outcome:

1. Achieved a sustainable dye material that is comparable to conventional dyes.
2. Overcame the environmental challenges posed by the release of hazardous industrial effluents from conventional dyes.
3. Achieved eco-friendly dye material systems.
4. Published in two journals

Nwuzor, I. C., Adinoyi, B. J., Ewulonu, C. M., Chukwuneke, J. L., & Obika, E. N. (2022). Combined Natural Dye Extractor and Dryer Fabrication Process. *Journal of Materials Science Research and Reviews*, *10*(2), 33-43.

Nwuzor, I. C., B. J. Adinoyi, C. F. Okey-Onyesolu and H. C. Oyeoka (2023). "Hibiscus Sabdariffa Natural Dye Extraction Process with Central Composite Design for Optimal Extract Yield." Sustainable Chemistry for the Environment: 100008.

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Key Challenges to the use of natural materials in composite manufacture

- Moisture Absorption
- Variability in fibre quality, length, and diameter
- Durability and Aging
- Compatibility with Matrix Materials
- Lower Strength and Stiffness
- Processing Challenges
- Biodegradability
- Regulatory Compliance
- Limited High-Temperature Performance
- Long-Term Performance Data

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Concluding Remarks

- Sustainable composite materials are vital in addressing environmental challenges.
- Synthesized bio-based resin from agricultural waste.
- Fabricated a nano-biocomposite for sustainable engr. application; Produced food packaging films from agric. weeds.
- Fabricated composites for automobiles; Successfully created a system that induced biodegradation in PE films.
- Designed and produced dye extraction and dryer machines.
- With ongoing advancements, natural fibre composites have the potential to offer sustainable solutions in various industries while mitigating some of these challenges.
- As sustainable invention continues, the environmental performance of composites will continue to improve to more sustainable choices.

Thank you for your attention

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