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Bioprocesses for a Sustainable World

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Sustainability and Sustainable Development

- Sustainable development: Meet the needs of the present without compromising the ability of future generations to meet their own needs.
- Global agreement that this concept rests on the interdependent and mutually reinforcing pillars of economic development, social development, and environmental protection
- Economies of the world have to date, overexploited natural resources and severely undervalued the ecological goods and services that form the basis of all economic activity



Equitable Resource Consumption



Changes in Global Investments and Trade





South Africa must prioritise decarbonisation, as \$1.5bn of exports to EU are at risk

2ND MARCH 2023

ARTICLE ENQUIRY

SAVE THIS ARTICLE

BY: SCHALK BURGER

Changes in Global Investments and Trade



The Department's approaches to these issues:

Sustainable feedstocks

Lignocellulosic biomass





Local biomass

Agri-products/waste







The Department's approaches to these issues:



The Department's approaches to these issues:

Sustainable feedstocks



Advanced materials



Novel Bioprocesses

Replace traditional C-intense products

Quantification of sustainability



Quantification of sustainability



Assessment LCA

Need technologies that rise to the challenge:



Some examples from our researchers





Prof Annie Chimphango



Advanced materials (Cellulose/Hemicellulose-based) for Biomedical applications





Physical properties:

- Degree of polymerization and substitution
- Molecular weight
- Surface charge- Zeta potential
- Particle size, shape





Functional properties:

- biosensors
- Implantation matrix
- Encapsulation matrix
- Coatings
- Sorbents
- Emulsifiers
- Reinforcements
- Additives
- Fillers
- Film forming
- Barrier properties
- Tissue growth matrix
 - 3-D printing

Mango waste (peels and seeds) biorefinery scenarios

I. Combined heat and power production only

2. Co-production of pectin and combined heat and power 3. Sequential recovery of pectin and polyphenols coupled with combined heat and power production





4. Co-production of pectin, ethanol and combined heat and power 5. Sequential recovery of pectin and polyphenols coupled with ethanol + combined heat and power production

6. Co-production of bioethanol and combined heat and power

Techno-economic and sustainability Studies





Steam Explosion Preparation of Lignocelluloses for Bioconversions and Biomaterial



Pilot-scale Bioprocess Development





TECHNO-ECONOMICS AND SUSTAINABILITY Benchmarking of alternative products



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Preliminary market research

Products with the highest level of market attractiveness, or lowest market risk profiles scored highest points



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6. Substitution Threats

3. Market Growth Rate

Industrial Demonstration of Novel Bioprocessing Technologies



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Sustainable Health Product Manufacturing for South Africa



Sustainable Health Product Manufacturing at Chem Eng, Stellenbosch University

Vaccine and Drug manufacturing

- mRNA synthesis enzyme bio-foundry and process development (SAMVAC, SAMRC, SU Microbiology)
- Advance separation techniques in mRNA vaccine novel aqueous two-phase separations (SAMRC)
- Oral tablet manufacturing improving robustness and affordability in drug formulation (TAGENDI)
- Bioprocess and Biopharmaceutical studentship training programme (CFFSS-SAMRC)

Indigenous knowledge, medicinal plants and endophytes

- Endophyte bioactives from South African medicinal plants for human healthcare (SA-NRF)
- In vitro endophytic growth in bioreactors for a sustainable, environmental, and economical industry (SA-NRF)
- Traditional Afrikan beer brewing safety and social responsibility (Kwela Brewery)

Cosmeceuticals and Nutraceuticals

- Naturally derived waxes from organic fatty acids for the cosmetics industry (Cerax Pty Ltd)
- Cultivated meat production towards sustainable meat technology (Mzansi Meat Co.)
- Probiotic chocolates natural stability and flavour profiles



Improvements to Anaerobic Digestion of Organic and Biowastes

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Bioaugmentation treatment using specific microbes

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Biogas-fuelled absorption refrigeration to curb post-harvest losses

Completed Objectives

- Modified refrigerator running on biogas
- BMP selected feedstocks
- Fridge performance
- Thermodynamic modelling



Fresh shredded substrates for BMP analysis before ensilage and anaerobic digestion. A: Fish effluent; B: Water hyacinth; C: Common reed; D: Cow manure and E: Maize stover



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For applications in wax production

(Low value) sugars — Oils (unsat.) — (High value) waxes







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Microscope imaging of intracellular oils

• Oil quantification using Nile Red fluorescent staining (x100/1.46 magnification)



R. toruloides DSM 4444



R. toruloides NCYC 1576



Y. lipolytica DSM 8218



Utilising kelp resources - Some processing options

- Mechanical rupture
- Solvent extraction
- Chemical breakdown
- Enzymatic hydrolysis
- Fermentation
- Other...?

(And once you've solubilised, you may need to separate, purify, recover)



Research pathway to commercialisation



Cannabinoid recovery and purification



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Integrating with growing industries – winterisation was separation

- Wax components quantified:
 - Alkanes
 - Fatty acids
 - Fatty alcohols
 - Sterols
 - Terpenoids
 - cannabinoids



CBD







a-linoleic acid







nonacosane







Speciality bioproducts - getting the organisms to make value

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Biosurfactants Antifungal



Metal recovery



Skin care

MEL-B CREAM MFDS approved for whitening, anti-wrinkle functions

Biohydrogen via photofermentation



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Bioprocessing at Stellenbosch University



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Contributions to sustainability up and down the chain



Bioprocess Engineering



Bioproducts & Bioenergy



Bioresources & Circularity



Environment & Sustainability



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Thank you Enkosi Dankie

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TITUES VIEWS

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