Agricultural Waste-Derived Wound Patch for Enhanced Healing of Cutaneous Leishmaniasis Wounds

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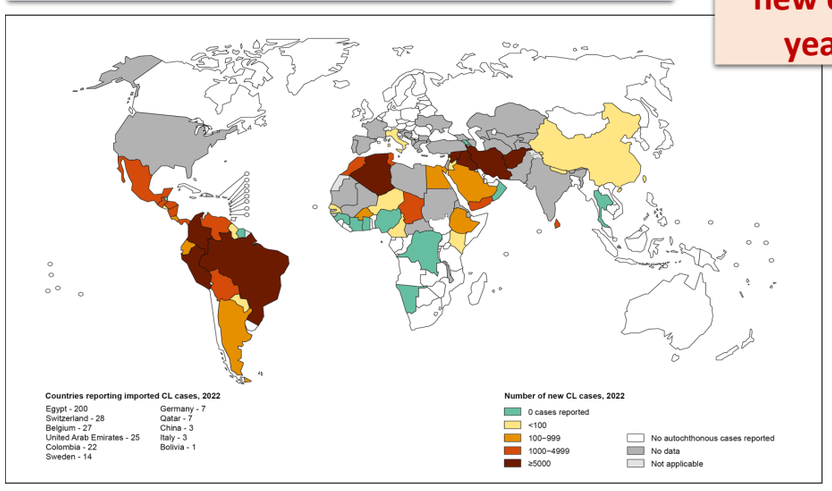
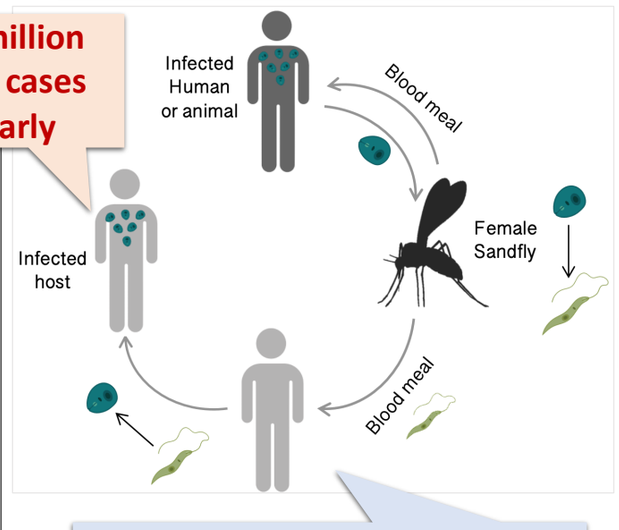
Cutaneous Leishmaniasis (CL)

Status of Endemicity of CL in 2022 (WHO)



Neglected Tropical Disease

~1 million new cases yearly



Vector-borne neglected parasitic disease

Wound characteristics

- Non-healing wounds
- Leaves life-long scars and physical disabilities
- Immunocompromisation

CL Wound

Causes of healing impairment

- Excessive/chronic inflammation
- Secondary bacterial infections !
- Secondary diseases/ Comorbidities

NEED FOR → Ideal treatment: anti-leishmanial, antibacterial, and anti-inflammatory properties to kill the parasites and to accelerate wound closure.

Statement of Problem

CL current curative therapies:

- Mainly rely on **chemotherapy.**
- **Reduced efficiency** to eradicate all parasites.
- **High toxicity** in particular cases with **unwanted side effects**.

Current treatments focus mainly on the eradication of the *Leishmania* parasites without taking into consideration the wound healing aspect of the disease. !

Aim of Study

- Develop an **alternative** treatment for CL wounds, through the design of **dressings** that could **accelerate** lesion healing and **prevent** or **treat** secondary microbial infections.
- At the same time: Conversion of agricultural waste into **value-added product** for biomedical applications.

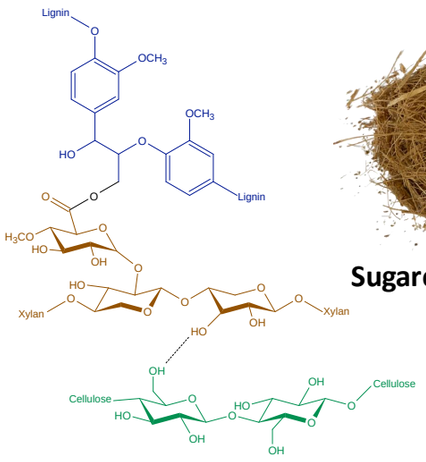
SUSTAINABLE DEVELOPMENT GOALS

3 GOOD HEALTH AND WELL-BEING

13 CLIMATE ACTION

Methodology

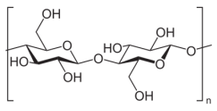
Insoluble Lignocellulosic Biomass



Sugarcane Bagasse (SCB)

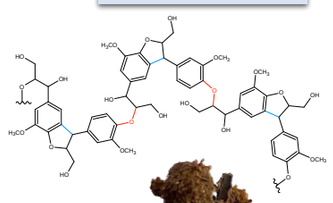
Removal of Hemicellulose

Cellulose



Biocompatibility with human tissue

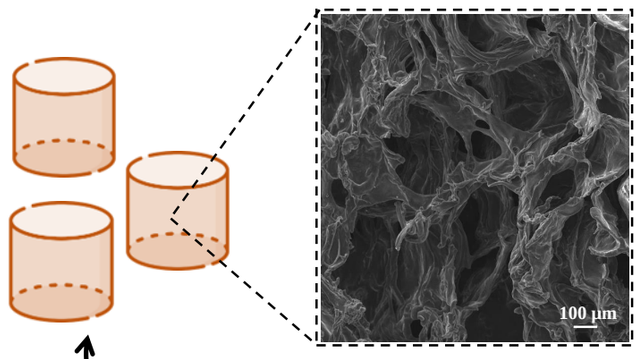
Lignin



Intrinsic Antibacterial properties

Chemical bonding

Cellulose-Lignin Hydrogels



Loading of small natural bioactive molecules

Main Findings

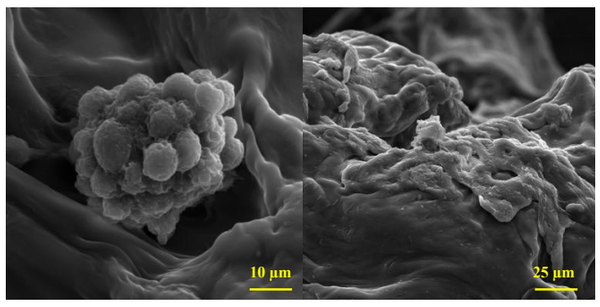
1. SCB Lignin

- IC_{50} of 532.7 µg/ml against mouse fibroblasts (L929).
- repeat units of G-type β-5 dimers, linked by β-O-4', with a molecular weight of 1374 Da.

2. Cellulose-lignin (Cel-lig) Hydrogels

As lignin content increases in the hydrogel:

- **Decrease** in porosity, density, swelling ability
- **Increase** in compressive modulus
- **Increase** *in vitro* antibacterial activity (37 to 57% after 24 hours)
- **Decrease** in bacterial adhesion and coverage on hydrogel
- **Better** mouse fibroblasts (L929) focal adhesion and migration.
- **Slower** *in vitro* degradation.

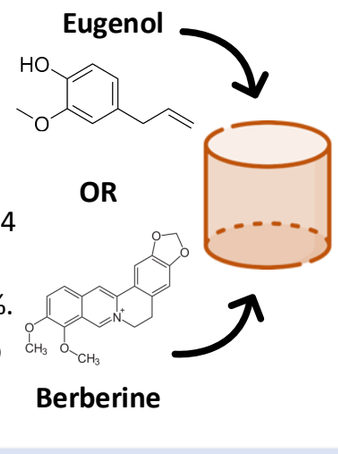


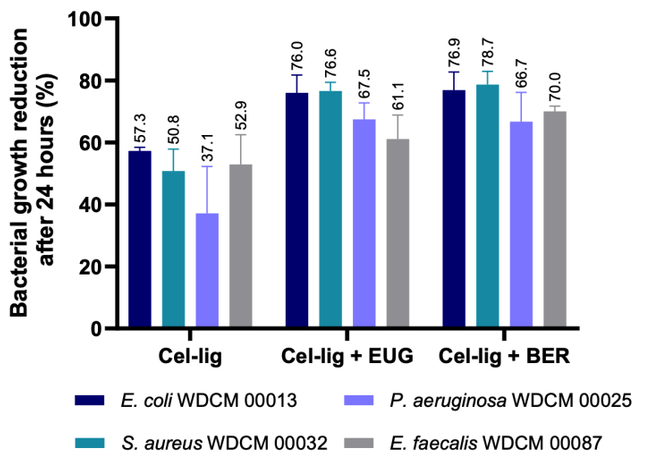
Cluster of L929 cells on cellulose hydrogel | **Elongated L929 cells on Cellulose-lignin hydrogel**

3. Loaded Cel-lig Hydrogels

Cel-lig hydrogels loaded with Eugenol and Berberine:

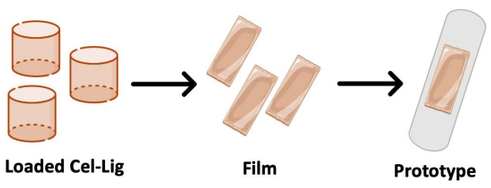
- Ability to swell in different pH and adequate mechanical strength for fibroblast attachment and proliferation.
- Release of eugenol and berberine after 24 hours: > 20%.
- Release of SCB lignin after 24 hours: < 3%.
- Higher antibacterial activity compared to unloaded one.



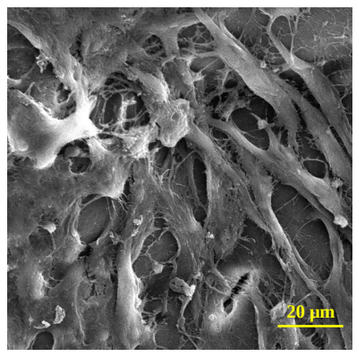


4. Wound patch prototype

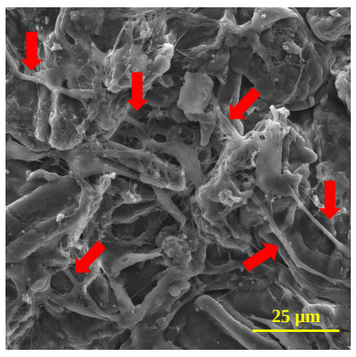
- The loaded BER hydrogel converted into film
  - Further enhanced with specific extracts



- Antibacterial activity against hospital isolates:
  - Mean bacterial growth reduction of 25.4 to 73.9 % after 24 hours.
- Biofilm eradication properties: Eradicated ≥ 50% of *in vitro* mono- and co- cultured biofilms after 24 hours.



Proliferation of Human dermal fibroblasts (HDF) cells onto the film surface



Tubules from human endothelial cells (HUVEC) on the surface of the film

Huët *et al.* (2024), *J. Mater. Chem. B*, 2024,12, 5496-5512
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Acknowledgment