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Hydrogel-Like Biofilms of *Candida tropicalis*: Biofouling of Polymeric Prosthetic Materials and Emerging Antifungal Strategies

Bindu Sadanandan and Kavyasree Marabanahalli Yogendraiah

Department of Biotechnology, M S Ramaiah Institute of Technology, Bengaluru 560054, Karnataka, India

Introduction

- *Candida tropicalis* is an emerging non-*albicans Candida* species causing biofilm-associated infections on polymeric prosthetic and indwelling devices.
- These biofilms exhibit hydrogel-like architecture, composed of viscoelastic extracellular polymeric substances (EPS) that enhance adhesion, resistance, and persistence.
- Such biofouling on polymeric materials (polypropylene, silicone, polyurethane) poses a major challenge in biomedical applications.

Hydrogel-Like Biofilm Architecture

- The ECM acts as a hydrogel network, rich in β-glucans, proteins, lipids, and extracellular DNA.
- It provides mechanical stability, moisture retention, and drug diffusion resistance.
- The gel-like matrix mimics natural hydrogels, enabling cells to survive environmental stress and antifungal exposure.

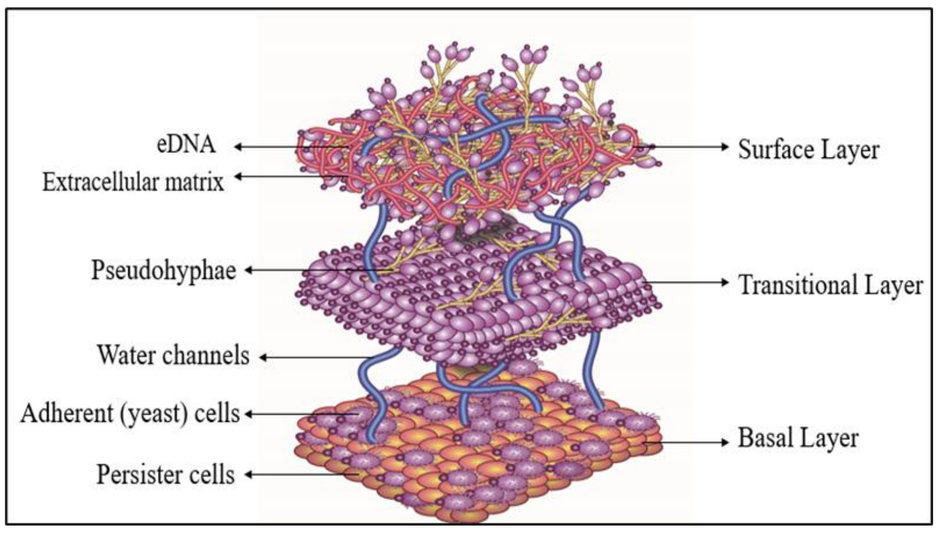

Fig 1. 3D stacks of *C. tropicalis* biofilm

Stages of Biofilm formation

Step 1: Cell adhesion on hydrophobic polymer surface

Step 2: EPS accumulation → hydrogel layer formation

Step 3: Mature, resistant biofilm → persistent colonization

Step 4: Dispersion → Release of planktonic cells

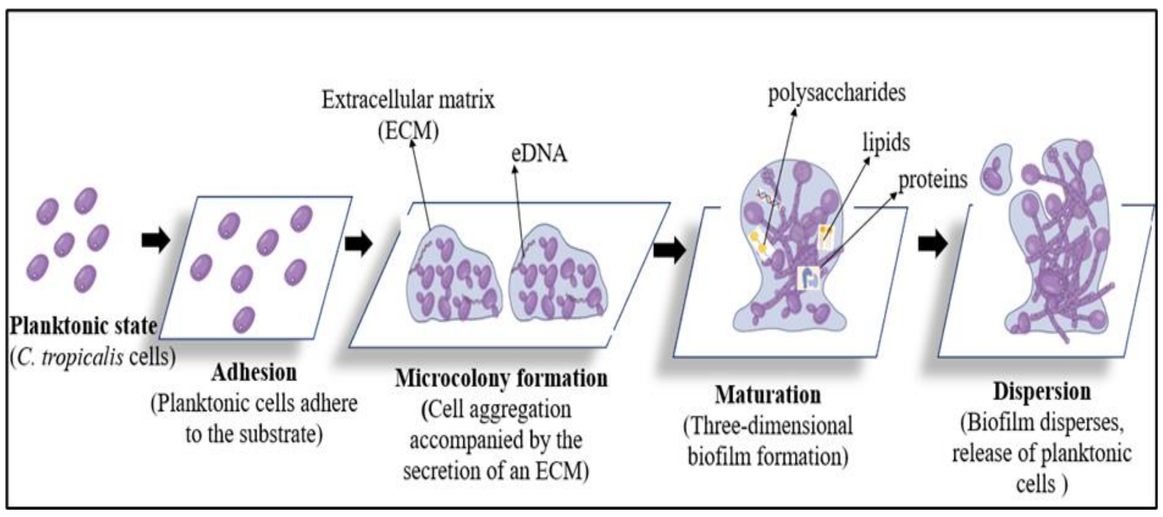

Fig 2. Biofilm Formation Stages of *C. tropicalis*

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Emerging Antifungal and Antifouling Strategies

Natural Compounds

- Palmitic acid – disrupts mature biofilms by reducing ergosterol and inducing oxidative stress.
- C-10 massoia lactone – damages the extracellular matrix and suppresses hyphal growth.

Drug Repurposing

- Minocycline + Fluconazole combination shows synergistic antibiofilm activity, restoring susceptibility in resistant *C. tropicalis* isolates.

Biomaterial Engineering

- Chitosan-coated silicone surfaces reduce fungal adhesion and biofilm formation.
- Such functionalized biomaterials represent a promising strategy to prevent prosthetic biofouling.

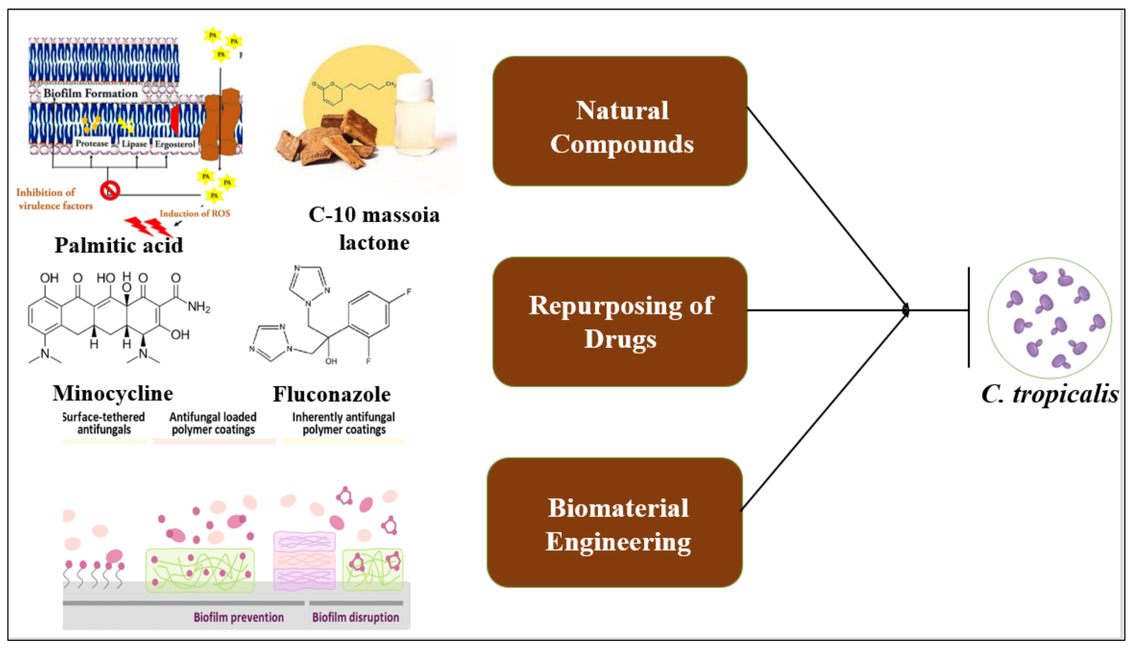

Fig 3. Emerging antifungal strategies against *C. tropicalis*

Translational Insights

- Integration of natural molecules, repurposed drugs, and biofunctional materials signals a paradigm shift in antifungal research.
- Emphasis is moving from pure pharmacological inhibition toward biofilm–surface interaction control.
- These interdisciplinary approaches can lead to infection-resistant prosthetic designs and improved patient outcomes.

Conclusion

- The hydrogel-like biofilm architecture of *C. tropicalis* underlies its persistence, antifungal resistance, and biofouling potential.
- Targeting both biofilm structure and surface adhesion mechanisms is vital for effective infection control.
- Combining chemical, biological, and materials-based interventions can pave the way for next-generation antifouling strategies.

References

- Amann, V., Kissmann, A. K., Firacative, C., & Rosenau, F. (2025). Biofilm-Associated Candidiasis: Pathogenesis, Prevalence, Challenges and Therapeutic Options. *Pharmaceuticals*, *18*(4), 460.
- Dasilva, M. A., Andrada, K. F. C., Torales, M. M., Hughes, I. M., Pez, P., García-Martínez, J. C., & Paraje, M. G. (2024). Synergistic activity of gold nanoparticles with amphotericin B on persister cells of Candida tropicalis biofilms. *Journal of nanobiotechnology*, *22*(1), 254.