A continuous bioreactor system that enhance non-contact co-culture of organisms

Background

Microorganisms naturally exist in complex multi-species ecosystems which have many functionalities, are resilient and can efficiently produce diverse outputs to address health and environmental challenges. However, single-species systems are favoured in research and industry due mainly to a lack of research tools for the control and monitoring of complex microbial ecosystems. Biotechnological production processes can benefit from these co-culture/consortia-based systems, used either as natural or synthetic consortia as they provide certain advantages including broader metabolic capabilities, robustness to environmental perturbations and resistance to invasive species.

Compartmentalised bioreactor systems can be valuable tools for the control of multi-species ecosystems. By physically separating microorganisms such as yeast, microalgae or bacteria these systems can be used as production platforms for the production of valuable products for food (pigments, nutraceuticals), medicine (opiates, alkaloids) and energy (bioethanol, biobutanol, biodiesel) sectors. Such systems combine the control and predictability of single species processes with each reactor compartment individually controlled with respect to variables such as light intensity, temperature, and degree of agitation, combined with the versatility and combinatorial power of microbial ecosystems.

Technology overview

A novel bioreactor system that uses membranes to create a compartmentalized system where two or more species can be co-cultured without mixing of species, while ensuring rapid exchange of metabolites and proteins between compartments and shared medium composition. The system operates continuously, thereby avoiding the discontinuities that characterize other systems, which either use hourly backwashes to clean the membranes or require a change in the direction of the flow between compartments. The compartmentalized system design also allows for individualized control of co-cultured microorganisms with different physiologies, resulting in co processes with improved productivity.

A key feature of the system is the ability to study microbial interactions in real-time, while monitoring the exchange of metabolites, other biochemical products or signaling molecules between microorganisms without cells being in direct physical contact. These contactless co-culturing processes help to alleviate some of the antagonistic interactions that are observed when cells are in physical contact, leading to more productive, more efficient processes with more diverse outputs.

Membrane Based Bioreactor for Non-Contact Co-Culture

Benefits

- Allows for continuous flow
- Rapid media exchange between reactors so that concentration gradients do not build up
- Facilitates equal sharing of media (metabolites, proteins)
- Prevents mixing of species
- Allows for the co-culturing of microorganisms with different physiologies such as yeast and microalgae
- At a large scale, it can allow for the implementation of co-culture bioproducts which haven't been commercialized due to the lack of an appropriate bioreactor configuration
- Allows easy harvesting of the biomass from a single reactor, while still running the linked reactors
- A valuable tool for researchers to study microbial interactions

Applications

- **Research facilities** - The reactor allows for the study of fundamental physiological and molecular interactions between species, which is not currently possible with other commercial systems.
- Suitable for use in the fields of microbial ecology, biotechnology and medical microbiology.
- **Biotechnology** – Development of multi-species co-processes with improved productivity using an ecosystem-driven approach.
- **Bioreactors -** Development of new research tools.
- **Nutraceuticals** – Production of prebiotics, probiotics, and food additives.
- **Food Manufacturing** – Production of alternative food products using yeast, microalgae and /or bacteria.
- **Bioreactor Manufacturing**

Opportunity

Proof of concept has been established. A laboratory scale system has been built and validated. The system can be scaled and can be extended to include more than two species.

Companies of interest

We want to partner with manufacturing companies with capability to develop and distribute this technology. Partners who have markets and experience in the membrane bioreactor sector would be well suited to commercialise this technology.

We want to partner with companies who would like to implement this system in their environment.

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Seeking

Commercial partners, philanthropic funders and investors

IP Status

South African complete application, application number 2022/09280

PCT application was filed, application number. PCT/IB2022/057753 *Membrane Based Bioreactor for Non-Contact Co-Culture*

National phase applications via PCT filed in:

Europe, application number 22765217.9

India, application number 202437021489

USA application number 18/686,122

Figures

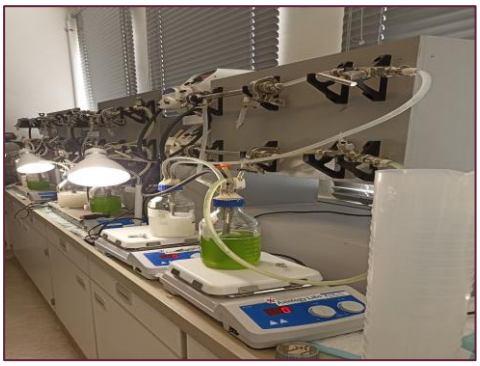

FIGURE 1:

Yeast and Microalgae cultured in separate compartments for pigment production.

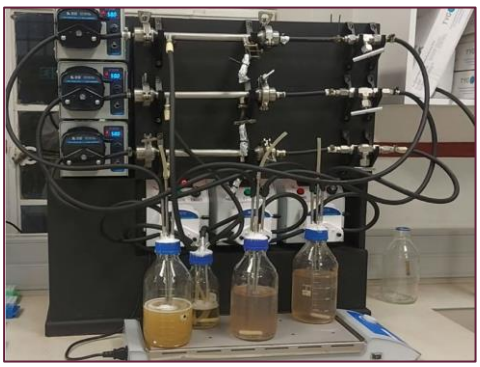

FIGURE 2:

Three species yeast-yeast system.