Microbe potential

Connectomix Bio is helping to unleash the potential of microorganisms to deliver sustainable innovation in the F&B industry. In its latest endeavour, the company is modelling a process to produce microbial lipids that could bring new flavours and functional properties to plant-based products. We caught up with chief science officer Milena Ivanisevic and managing director Dorian Leger to find out more.

To begin, could you tell us a bit about Connectomix Bio and your aims in the alt-protein space?

Connectomix Bio is harnessing the bioeconomy to design a more sustainable future. We're a biotech consulting company that provides techno-economic models for universities, start-ups and larger businesses. With these models, we help organisations predict how their biomanufacturing technology will perform in economic and environmental terms when scaled up. With our recent grant award from the Good Food Institute, we are complementing our computational work with some preliminary lab tests to explore high-value lipid production that can support the alt-protein industry.

Can you take us through the process by which a team led by Connectomix is aiming to turn agricultural byproducts into lipids?

Microorganisms are capable factories that can perform very specialised functions. In this process, we use two main categories of microbes. In the first stage, we use microbes that break down low-value complex organic byproducts and waste into a simple gas, and in a second stage, we use microbes that take the simple molecules from the first to build up new high-value molecules.

First, organic matter is fed into an anaerobic digester and broken down by microbes called archaea, resulting in the production of biogas. This is roughly 50/50 methane and carbon dioxide, and includes water and traces of hydrogen sulphide.

This biogas is cleaned up and transferred directly or first transformed into alternative intermediates, such as biomethane, methanol or H_2+CO_2. Then, in the second process, the cleaned-up biogas or the alternative intermediates are fed to a second reactor to cultivate specialised microbes. These microbes accumulate biomass rich in protein and lipids. The biomass is harvested and processed into food-grade lipids and co-products. The lipids can then be incorporated into a wide range of alternative proteins and conventional foods.

How can these fats be used to enhance plant-based products like meat alternatives?

Multiple products are possible from the system we are investigating, such as phospholipids, glycolipids and triacylglycerols, as well as co-products like xanthan gum and proteins. These ingredients can be added to plant-based products to give them various functional properties as well as tastes. For example, phospholipids are known to impart a meat-like flavour in imitation chicken.

If you talk to people in the alt-protein industry, whether they are consumers, cooks or producers, you will notice that fats are the first thing they mention when you ask what can further improve alt-protein products. Currently, this industry uses coconut oil, which doesn't have all the properties to provide a satisfying sensory experience.

Microorganisms are hidden gems, and with modifications we can imitate fats that come from pork, beef or plants. There is a long road ahead, but it is certain that there is more to microbial fats than we currently think.

What kinds of byproducts can be used?

The microbes doing the work in the anaerobic digester can break down a wide range of organic carbon materials into biogas. So really, a wide

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array of byproducts can be used, and that's the beauty of the process. Waste from restaurants and landfills, wastewater, industrial organic waste like potato starch and agricultural byproducts can all be considered.

Society needs to find ways to close resource loops wherever we can. Based on FAO data, some 1.3 billion tons of food get wasted yearly, or approximately 30% of total production. If this waste isn't utilised in a controlled manner, it can contaminate aquatic and land ecosystems, and contribute to greenhouse gas emissions. There are several ways to valorise this waste. Upcycling it with the use of microbes is not a novel idea; there is an extensive body of research and many publications investigating different options. What we are doing is comprehensively calculating the economic potential of facilities converting byproducts to lipids, and hopefully this builds momentum to bring technology from lab- to industrial-scale applications.

What are some of the different areas the project will be exploring?

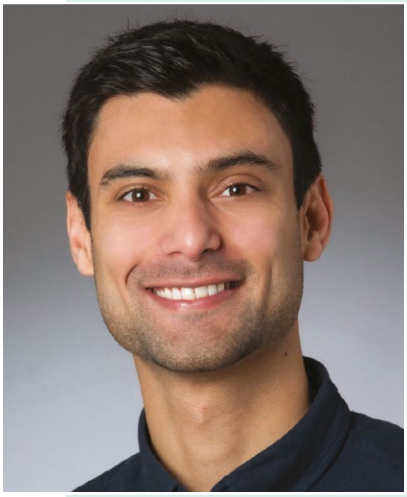
This byproducts-to-lipids project is really focused on calculating the profitability of various bioeconomic routes for upcycling side streams into high-value molecules. The analysis will shed light on the most promising combinations of feedstocks, microbes and downstream processes, and how these lead to different products. While we will utilise literature and industry information, part of our team will also work in the lab to gain new insights by growing the microbes in various conditions. The research will culminate in an open-access publication which will give entrepreneurs and investors a tool to evaluate the opportunity.

How scalable is the process the team is developing?

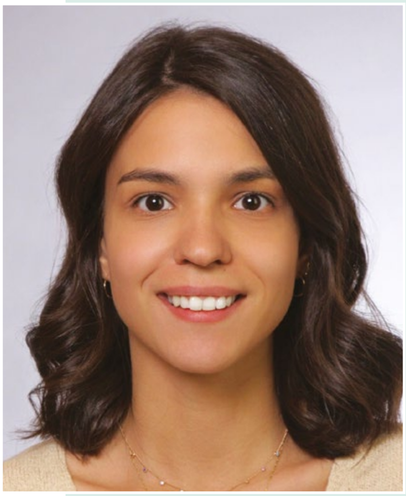
We believe that the most disruptive technologies are non-disruptive in their implementation because they leverage existing technology and infrastructure and thus scale rapidly. In this case, the process we are modelling will extend outwards from existing value chains. Organic byproducts are ubiquitous across multiple industrial sectors and biogas production has been growing substantially in the last decade. What will take more time to scale up is the type of fermentation capacity needed in the second step of the process. If our model finds that these byproducts-to-lipids routes are economically viable, then our research could serve as a catalyst to further scale up fermentation capacity.
It's worth noting that some types of fermentation, like for beer and wine, are already massively scaled up, so there's potential for tech transfers and maybe even repurposing assets.

How important do you think open-access research will be in driving the development of the plant-based food industry?

For the type of research we are doing we find it particularly important. Techno-economic analyses (TEAs) are a first step in assessing a bioproduction business plan. However, these labour-intensive studies are typically conducted by the R&D departments of individual companies, which leads to siloed information and repetitive work across the industry. Furthermore, the narrow scope of solitary TEAs does not lead to generalised findings. This is a major obstacle impeding a rapid evolution of the economy towards sustainable business models. Open-access research can open up the conversation.



Dorian Leger



Milena Ivanisevic