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Uncovering the biotechnological potential of microalgae

Dr Daniel Kurpan

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Uncovering the biotechnological potential of microalgae

Microalgae are tiny organisms with huge potential. As well as being found in food supplements and skincare products, they could provide us with new drugs and be a source of sustainable fuel. However, most commercially cultured microalgae species are not adapted to grow in the regions where biotechnology companies want to use them. Which is why, at **Agroscope** in Switzerland, **Dr Daniel Kurpan** is collecting native microalgae species and analysing them to determine how they could be used for biotechnological applications.

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Fields of research
Biotechnology; microbiology; phycology

Research paper
Isolation, characterization, and maintenance of native Swiss microalgae for biotechnological prospection. Kurpan et al. (2025) doi: 10.1038/s41598-025-10989-w

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Talk like a ...
biotechnology researcher

Biofilm – a layer of microorganisms (e.g., slime that accumulates on a damp surface)

Biotechnology – the use of biological organisms to create products that benefit humans

Colorimetric method – a laboratory technique to measure the concentration of a compound based on its colour intensity

Culture – (noun) cells that have been grown in a laboratory; (verb) to grow cells in a laboratory

Lipid – an organic water-insoluble molecule (e.g., fats and oils)

Microalgae – a very diverse group of microscopic photosynthetic organisms (technically, they are not classified as plants)

Productivity – a measure of how much biomass can be produced per unit of volume per unit of time

Spectrophotometer – a device that measures how much light a sample absorbs and refracts

After a rainy day in the Swiss mountains, you might find Dr Daniel Kurpan poking around in puddles. He is on a mission to collect microalgae: microscopic photosynthetic organisms that are found in lakes, ponds, rivers, biofilms, oceans and – you guessed it – puddles!

"Microalgae are a group of very diverse organisms which can be used in various industrial sectors," says Daniel, a biologist at Agroscope. "However, the incredible diversity of microalgae remains largely unexplored in today's biotechnology sector." Around the world, only a few species are currently grown and used for commercial applications, meaning we are missing out on the huge potential benefits that microalgae could bring to society.

Why are microalgae useful?

Have you ever had a drink or smoothie containing spirulina? If so, you have consumed microalgae! Spirulina is commonly used as a dietary supplement due to its many health benefits, and scientists are looking to microalgae as a sustainable, plant-based way to feed the world's growing population. Many microalgae species are high in protein and vitamins, making them an ideal food source for humans and animals. Microalgae with a high lipid content can be used to produce biodiesel, providing a sustainable source of energy. And microalgae containing anti-inflammatory compounds and antioxidants are used in the pharmaceutical industry to develop new drugs and cosmetic products.

Why is Daniel collecting Swiss microalgae?

Most of the microalgae species that are currently used for biotechnological applications come from tropical regions. However, biotechnology companies in non-tropical parts of the world can benefit in two ways from using local microalgae instead. "First, native species are already adapted to local conditions," explains Daniel. "Second, they do not pose environmental risks associated with the introduction of exotic species."

Daniel is part of the team that has been creating AlgoScope, the first public Swiss microalgae culture collection. "We conduct sampling campaigns throughout Switzerland to collect samples of native microalgae species," he explains. "Back in the laboratory, we isolate each species, characterise them to determine their properties, then maintain them as cultures so they will survive in the collection for extended periods." So far, AlgoScope contains over 120 Swiss microalgae species. "This culture collection provides new biological and genetic resources for study and exploitation," Daniel continues. Scientists can examine the collection to find microalgae species that could be used to improve the national biotechnology sector.

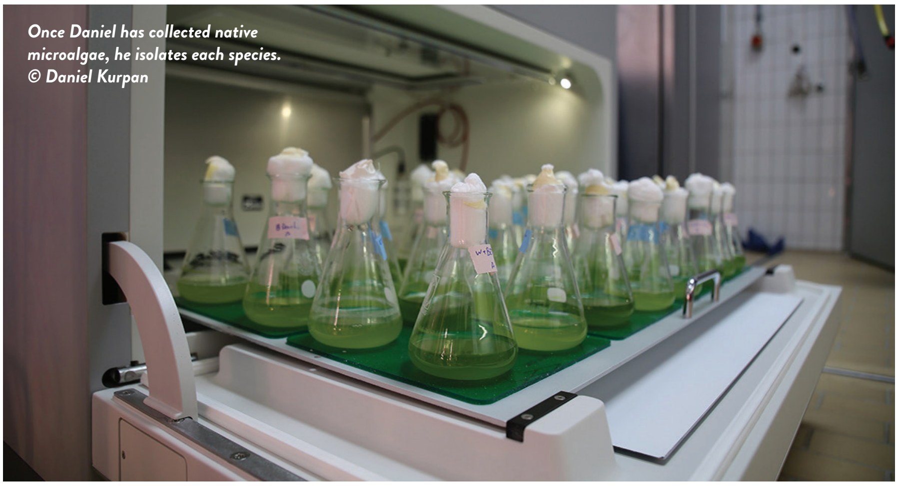
The AlgoScope team is collecting microalgae from biofilms and puddles around Switzerland. © Daniel Kurpan

How is Daniel analysing native microalgae species?

Having built up the microalgae culture collection, Daniel is now analysing some of the species it contains to explore their biotechnological potential. Characteristics such as productivity and biochemical composition impact whether a microalgae species will be useful for commercial applications, so these are key properties that Daniel is investigating. "Market demand must be met in terms of both quantity and quality," he explains. "For example, if the goal is to create a protein source for food, the microalgae biomass must contain an adequate amount of high-quality proteins."

To be commercially useful, a species must have a high enough productivity that growing it is economically viable. To test the productivity of different species, Daniel measures the growth rate of samples that he cultures, using three different techniques to monitor cell growth. At regular intervals, he uses a microscope to count the number of microalgae cells in a sample, he dries and weighs a known volume of culture, and he uses a spectrophotometer to track changes in the colour of the culture as the cells grow.

The biochemical composition of a microalgae species will determine what applications it can be used for, with protein-rich species being useful for food supplements and lipid-rich species being useful for energy production. To analyse the composition of different species, Daniel uses colorimetric methods and physical separation methods. "Colorimetric methods involve a molecule that binds to the specific compound of interest, resulting in a colourful complex," he explains. "The intensity of the resulting colour is proportional to the concentration of the compound of interest and can be measured using a spectrophotometer." Physical separation methods, such as filtration, evaporation and distillation, physically separate the compound of interest out from the sample, where it can then be measured (e.g., by weighing or comparing with known standards).



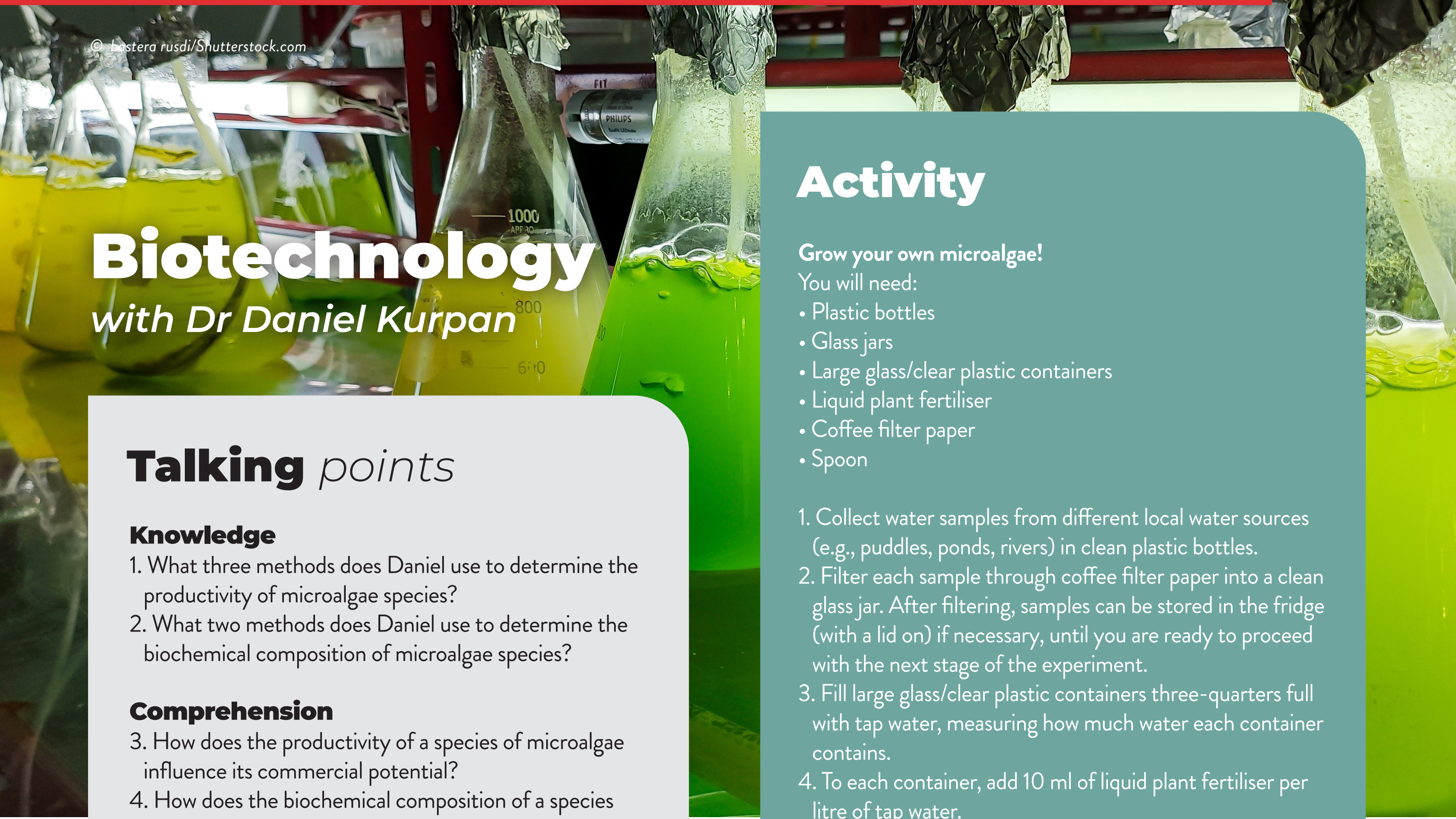
Once Daniel has collected native microalgae, he isolates each species. © Daniel Kurpan

What has Daniel discovered?

"We have discovered that microalgae growth characteristics are extremely diverse and species-specific, which aligns with the huge physiological diversity of microalgae," Daniel says. "We have also discovered that, despite the great diversity among microalgae, the amino acid profiles of most species are very similar."

In a recent study, Daniel characterised the productivity and biochemical composition of seven native Swiss microalgae species from AlgoScope. He identified two species (*C. saccharophilum* and *T. brasiliensis*) that have great potential for being used as animal feed, as both have high productivity, protein levels and fatty acid content. "Based on our results, these species are good candidates for feed material," he says. "However, scale-up feasibility analysis and animal acceptance tests need to be conducted before actual implementation."

Through his research, Daniel is exposing the incredible potential of microalgae for solving some of the world's most pressing problems, such as how to sustainably feed and power an ever-growing population. These amazing organisms will have an exciting role in the biotechnology of the future!



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Biotechnology

with Dr Daniel Kurpan

Talking *points*

Knowledge

1. What three methods does Daniel use to determine the productivity of microalgae species?
2. What two methods does Daniel use to determine the biochemical composition of microalgae species?

Comprehension

3. How does the productivity of a species of microalgae influence its commercial potential?
4. How does the biochemical composition of a species of microalgae influence its potential biotechnology applications?

Application

5. What scale-up feasibility analysis and animal acceptance tests do you think scientists need to perform before *C. saccharophilum* and *T. brasiliensis* can be used as animal feed?
6. In addition to those mentioned in the article, what other biotechnological applications do you think microalgae could be used for?

Analysis

7. Why do you think it is a problem if biotechnology companies use microalgae species that are not adapted to grow in local conditions?

Creativity

8. Macroalgae – or seaweed – is commonly eaten in many places around the world, but currently microalgae is still considered an unusual food by most people. After all, the scum growing on the surface of a pond doesn't look very appetising! How would you design a campaign to encourage people to adopt microalgae in their diets?

Activity

Grow your own microalgae!

You will need:

- Plastic bottles
- Glass jars
- Large glass/clear plastic containers
- Liquid plant fertiliser
- Coffee filter paper
- Spoon

1. Collect water samples from different local water sources (e.g., puddles, ponds, rivers) in clean plastic bottles.
2. Filter each sample through coffee filter paper into a clean glass jar. After filtering, samples can be stored in the fridge (with a lid on) if necessary, until you are ready to proceed with the next stage of the experiment.
3. Fill large glass/clear plastic containers three-quarters full with tap water, measuring how much water each container contains.
4. To each container, add 10 ml of liquid plant fertiliser per litre of tap water.
5. To each container, add 20 ml of one of your water samples per litre of tap water, making a note of which container contains which water sample.
6. Use a spoon to mix the contents of each container.
7. Place the containers in a well-lit place (e.g., on a windowsill or near artificial lights).
8. Observe the changes in each container over a few weeks as your microalgae grow. For example, note how the colour in the container changes with time and, if possible, record the appearance of the microalgae under a microscope at regular intervals.
9. Why does the water in the container turn green? After a few weeks, why does the green colour disappear? Do you observe any differences between the containers containing different water samples? If so, what do you think is causing those differences?
10. Once the colour of a container turns anything other than green, empty it down a drain or onto grass. If the initial growth in a container is anything other than green, do not continue with that experiment as non-algal microorganisms may have colonised the tank.

More *resources*

- Visit Daniel's Futurum page to read his article in Portuguese: **futurumcareers.com/uncovering-the-biotechnological-potential-of-microalgae**
- Agroscope explains why microalgae are a good alternative source of protein: **agroscope.admin.ch/en/microalgae-a-sustainable-protein-alternative**

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