New biofuel production system powered by a community of algae and fungi

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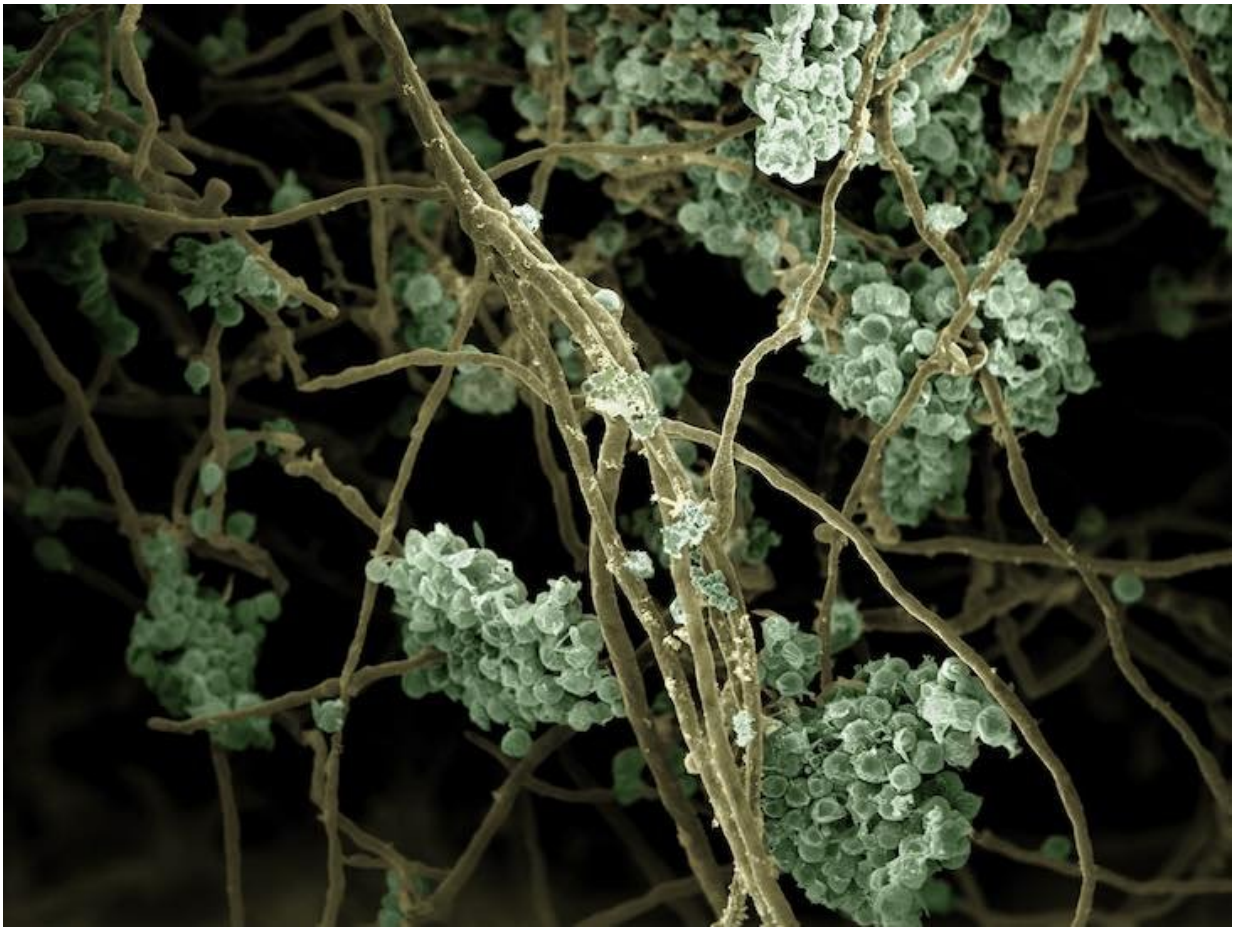

When scientists place the organisms in the same environment, the algae (green) attach to the fungi (brown). Credit: Zhi-Yan Du and Igor Houwat; MSU-DOE Plant Research Laboratory, 2018

MSU scientists have a new proof of concept for a biofuel production platform that uses two species of marine algae and soil fungi. It lowers cultivation and harvesting costs and increases productivity, factors that currently hold back biofuels from being widely adopted.

The species of alga, Nannochloropsis oceanica, and fungus, Mortierella elongata, both produce oils that we can harvest for human use. With these oils, we could make products like biofuels to power our cars or omega-3 fatty acids that are good for heart health.

When scientists place the two organisms in the same environment, the tiny algae attach to the fungi to form big masses that are visible to the naked eye. This aggregation method is called bio-flocculation.

When harvested together, the organisms yield more oil than if they were cultivated and harvested each on their own.

"We used natural organisms with high affinity for each other," says Zhi-Yan (Rock) Du, the study's first author. "The algae are very productive, and the fungus we use is neither toxic to us nor edible. It's a very common soil fungus that can be found in your back yard."

Other advantages reported by the researchers:

- The system is sustainable, since it doesn't rely on fossil fuels. The fungi grow on sewage or food waste, while the algae grow in sea water.
- It is cheaper to harvest, as the big masses of algae and fungi are easily captured with simple tools, like a piece of mesh.
- The method is potentially easier to scale, as the organisms are wild strains that have not been genetically modified. They pose no risks of infecting any environment they come in contact with.

Solving problems that hamper biofuel production

Bio-flocculation is a relatively new approach. Biofuels systems tend to rely on one species, such as algae, but they are held back by productivity and cost problems.

First, systems that only rely on algae suffer from low oil productivity.

"Algae can produce high amounts of oil when their growth is hindered by environmental stresses, such as nitrogen starvation. The popular method in the lab for algae oil is to grow the cells to high density levels and then starve them by separating them from the nutrients with centrifugation and several washing methods," Du says. "This approach involves a lot of steps, time, and labor, and is not practical for industrial scale production."

The new approach feeds the algae with ammonium, one source of nitrogen that algae can quickly use for growth. However, the ammonium supply is controlled so the algae produce the maximum cell density and automatically enter nitrogen starvation. The closely monitored nitrogen diet can increase oil production and lower costs.

The second problem is the high cost of harvesting oil, because algae are tiny and hard to collect. Harvesting can take up to 50% of oil production costs.

"With bio-flocculation, the aggregates of fungi and algae are easy to harvest with simple and cheap tools," Du says.

Looking forward, the scientists want to mass produce biofuels with this system. They also know the entire genomes of both organisms and could use genetic engineering tools to further improve the method.

The study was conducted in the labs of Christoph Benning and Gregory Bonito. It is published in the journal *Biotechnology for Biofuels*.

More information: Zhi-Yan Du et al. Enhancing oil production and harvest by combining the marine alga Nannochloropsis oceanica and the oleaginous fungus Mortierella elongata, *Biotechnology for Biofuels* (2018). DOI: 10.1186/s13068-018-1172-2