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PRESSEMITTEILUNG

Microalgae:
Possible prospects for agriculture

New sources of income with high-quality fatty acids and dyes from microalgae / Project with the participation of the University of Hohenheim sees potential

Will German agriculture rely on microalgae in the future? In any case, numerous valuable recyclables can be produced with the single-cell aquatic plants. Consequently, they possess great potential as a renewable raw material and biomass source for the bioeconomy. In the collaborative project "FuTuReS", researchers from the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB, the University of Hohenheim in Stuttgart and the Karlsruhe Institute of Technology (KIT) investigated under what conditions and for what purposes algae cultivation is worthwhile. After two years' work on the project, the research team has arrived at positive conclusions: The key lies in the selection of the right recyclables and the use of artificial light.

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Microalgae are frugal and productive at the same time: All they need is light, carbon dioxide (CO2), and a few nutrients – and they already start producing recyclables. Depending on the specific type of algae, the single-cell organisms can produce dyes, omega-3 fatty acids or proteins that are suitable, for example, for use in the food or cosmetics industry. In addition, they are also an ideal source of biomass that can be used as high-quality animal feed. Algae cultivation could thus potentially open up promising business areas for farmers.

Transdisciplinary approach: piloting, balancing, stakeholder participation

In order to tap into this potential for agriculture, the FuTuReS collaborative project, funded by the German Federal Ministry of Food and Agriculture (BMEL), addressed the question of how algae cultivation must be designed in concrete terms to ensure that it is both economically viable and ecologically sound.

In parallel, the project investigated the interests and expectations of practitioners and technology developers in the agriculture and food sectors. As a result of this participatory process, FuTuReS came up with concrete scenarios and recommendations for action on how microalgae can be integrated into agricultural production cycles in the future.

Process data from microalgae production and recyclables extraction

For the project, the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB played out various cultivation scenarios on a pilot scale for the first time. Algae cultivation in photobioreactors on the one hand in sunlight in outdoor facilities or greenhouses and on the other hand with artificial lighting in closed indoor facilities.

The researchers used the unicellular diatom Phaeodactylum tricornutum, which can also be readily cultivated under the conditions of the central European climate. The focus of the studies was on the production of the dye fucoxanthin, eicosapentaenoic acid (an omega-3 fatty acid, EPA for short) and proteins, as well as the value added generated in the process.

"In order to increase the economic profitability of algae cultivation, in FuTuReS we also extracted the various recyclables from the same biomass one after the other according to the principle of a biorefinery," explained Dr. Ulrike Schmid-Staiger, project coordinator at Fraunhofer IGB and head of the Institute's algae biotechnology research group. In this way, dyestuffs, fatty acids, proteins, and carbohydrates could be obtained as individual fractions.

Higher biomass yield thanks to continuous artificial lighting

The next step involved the evaluation of the generated process data by the University of Hohenheim. The balances revealed that continuous lighting with artificial light from energy-saving LED lamps had advantages over the (naturally non-continuous) use of sunlight or daylight in open-air operation. The uninterrupted light supply during the day and night increased the microalgae biomass produced from 14 to 123 tons per hectare, while significantly reducing the cost of producing one kilogram of biomass - by as much as 70 percent.

Although the electricity needed was slightly more than 50 percent higher (54 percent), significantly less water and land were needed (80 and 86 percent, respectively). "The increased biomass yield offset the higher costs of artificial lighting," was the positive conclusion of Sebastian Weickert, a research associate in the Department of Biobased Products in the Bioeconomy at the University of Hohenheim.

In contrast, the yield of the recyclables produced in the process presented a differentiated picture: "Our investigations were successful for fucoxanthin and EPA – for these high-priced products, we see that the production effort pays off economically," said Dr. Schmid-Staiger. However, the extraction of proteins beyond this no longer increased profitability, as proteins were currently available globally at relatively favorable prices.

"For biomass production with artificial light, you do not need agricultural land or you can use disused agricultural infrastructure, such as empty barns. This and the high yields form recyclables makes algae cultivation a potentially lucrative business – it all depends on which products you want to manufacture and for which industry they are intended," Weickert summed up.

Agricultural enterprises open to algae cultivation

Beyond the results for the natural sciences, the project delivered another important result: Agricultural enterprises are generally open to algae cultivation, but they do stress the need for further research and funding.

"Under favorable conditions, microalgae cultivation could become a new business segment for some stakeholders in agriculture for the production of regional high-quality products – the potential is definitely there. This has been clearly shown by our research work," summed up Dr. Christine Rösch, head of the research group "Sustainable Bioeconomy" of the Institute of Technology Assessment and Systems Analysis (ITAS) at the Karlsruhe Institute of Technology (KIT).

She recommended the consistent further development of microalgae technology, especially with regard to control and automation, and the promotion of investment and cooperative partnerships. "In the FuTuReS project, we placed great emphasis on engaging with stakeholders from the outset and involving them in the research," explained the scientist.

In this way, their experience, knowledge, expectations, and fears could be directly taken into account. As a result, the project team was able to develop criteria and scenarios that were not based solely on the knowledge and visions of the researchers involved, but were closer to the ideas of the potential users of algae technology.

FuTuReS: Funding

The partners of the collaborative project "FuTuReS – Economic and ecological evaluation of a biorefinery approach to the production of fucoxanthin and EPA on a pilot scale and transdisciplinary scenarios on an industrial scale in Germany" (FKZ: 22017218, 2219NR180 and 2219NR178) would like to thank the Federal Ministry of Food and Agriculture (BMEL) and the Agency for Renewable Resources (Fachagentur für Nachwachsende Rohstoffe e. V.) for their funding.

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