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European Commission

CORDIS Results Pack on algae

A thematic collection of innovative EU-funded research results

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Discovering algae's power as a renewable resource

Research and Innovation

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Editorial

Algae provide an effective, sustainable, unlimited and almost entirely untapped resource for bio-based processes and products. Dense with energy and rich in nutrients, this natural product is ripe for exploitation by forward-thinking research organisations and commercial companies.

An almost endless number of products may be produced from algae, thanks to the vast number of species, whose composition can be influenced by changing the cultivation conditions. They range from minute unicellular organisms that may be seen only through a microscope (microalgae) to multicellular forms (macroalgae), more commonly known as seaweed.

The successful exploitation of algae can help solve unsustainable processes, thereby boosting the bioeconomy and aiding the transition to a more sustainable society and a cleaner, healthier environment. Furthermore, their use in a variety of commercial applications helps to reduce pressures on land-based products or non-renewable resources.

The importance of algae

Algal communities are important components of marine ecosystems and several macroalgae species are used as food or as a habitat by organisms such as fish or invertebrates. Algae also provide bioremediation services through the uptake of dissolved nutrients from the water that, if not removed, could cause eutrophication. Because they are photosynthetic organisms, algae can contribute to carbon sequestration, thereby helping to reduce ocean acidification.

The European Union's latest Bioeconomy and Blue Growth strategies show that algal biomass is becoming increasingly significant as a resource for a variety of commercial applications. According to the European Commission's 2018 Annual Economic Report on the EU's Blue Economy, the EU algae biomass sector currently employs 14 000 people and has a value of EUR 1.69 billion, which includes research and development, equipment production and jobs in the larger supply chain that depend on output from the algae sector.

Increased production of macroalgae and microalgae is gaining widespread recognition in Europe as an important resource that can be used as a raw material for a wide range of uses. A growing number of companies are now involved in harvesting, cultivating, or processing algae to create a wide range of high-value products, including food, animal feed, nutraceuticals, fertiliser and bio-based products, thereby contributing to the success of the European Blue Economy.

Spotlight on innovation

This CORDIS Results Pack highlights nine projects funded under the EU's Horizon 2020 Research and Innovation programme, investigating industrial processes and applications involving microalgae and seaweed. These include food, cosmetics, recycling, health and water quality. The pack also raises awareness of the importance of this growing economic sector among consumers.

Microalgae with macro potential

Algae are incredibly diverse with applications in the food, cosmetics and pharmaceuticals industry. To maximise the potential of algae as farmed crops, it is paramount to study and understand their microbiome.

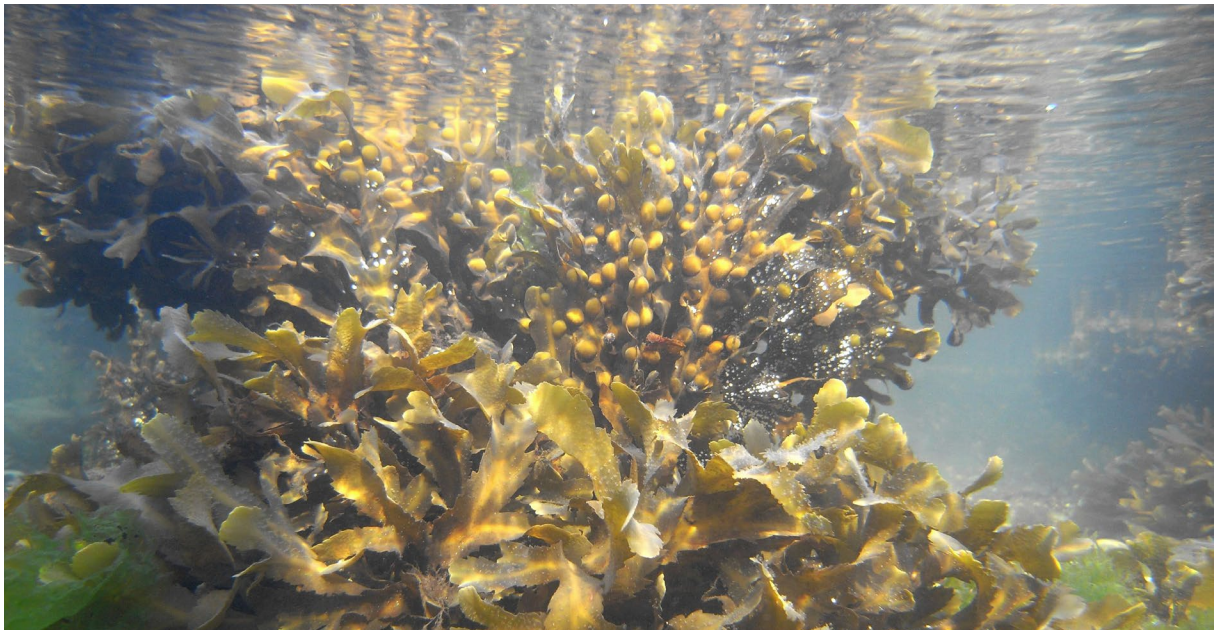
To meet the growing demand for algae but also understand their role in ecosystem functioning, more information on their biology is required. As part of the Marie Skłodowska-Curie Innovative Training Network, the ALFF project set out to study and control both beneficial and harmful microbes, collectively known as the algal microbiome.

On algae-microorganism interactions

ALFF was an international collaboration aiming to train early-stage researchers in the field, advance algal cultivation and devise new biocontrol strategies. Project partners worked to identify naturally occurring algal symbionts and pathogens and characterise their interactions through state-of-the-art genomics, molecular and biochemical techniques. "Our key goal was to identify which microorganisms control algal morphogenesis, are indispensable to algal survival or cause devastating diseases," explains project coordinator Ms Claire Gachon.

ALFF researchers have made significant scientific discoveries including the identification of novel groups of phytoplankton parasites and the presence of bacterial genes in subcellular structures known as plastids of some microalgae. The consortium has also had a key role in the publication of a reference genome for the sea lettuce Ulva, which will set a gold standard for the entire research community for years to come.

Furthermore, scientific data emerging from ALFF can be exploited for developing concrete and environmentally-



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friendly solutions for the reduction of biofilm formation in photobioreactors used for microalgal cultivation. In this context, researchers tested a number of compounds for reducing the impact of diseases in microalgal production facilities.

Supporting innovation capacity

Our key goal was to identify which microorganisms control algae morphogenesis, are indispensable to algal survival or cause devastating diseases.

Project activities have advanced research and innovation-related human resources, with early-stage researchers developing unique, interdisciplinary scientific profiles. In addition, ALFF demonstrated excellent cross-sectoral collaboration with the industry and strengthened the European innovation capacity in the field. "The structure of the project, together with first-rate financial resources, have enabled us to work as a team and to strive for excellence at all times," emphasises Gachon.

Algae have an almost untapped biotechnology potential, but current research focuses on metabolite discovery, aquaculture yield improvement and engineering bottlenecks. As agricultural practices show, controlling the interaction of land crops with mutualistic or pathogenic microbes is critical to successful production.

Maximising microbiome potential

The fundamental knowledge generated during ALFF will help address the challenges associated with the commercial exploitation of algae and enhance the rapidly developing industry of algal aquaculture. The information will also be useful for the energy industry, which is developing biofuels from both microalgae and seaweeds that could serve as crude oil substitutes.

To maximise the diversity of audiences reached by the programme, ALFF partners undertook a broad range of outreach and dissemination activities. First year multimedia technology students at the Karel de Grote Hogeschool produced short animation videos about ALFF explaining the concepts of parasitism, symbiosis, biofilms and endosymbiosis between bacteria and algae. These were showcased in 2016 at UGC cinemas in Antwerp and later refined and featured on the project website. Gachon underlines the importance of "getting the public to understand the opportunities and issues relating to the sustainable use of our aquatic freshwater and marine resources, within and beyond the EU."

PROJECT
ALFF - The Algal Microbiome: Friends and Foes

COORDINATED BY
The Scottish Association for Marine Science LBG, United Kingdom

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/rcn/193927

PROJECT WEBSITE
msc-alff.org/

A novel photobioreactor for low-cost microalgae cultivation

An EU-funded project developed a novel photobioreactor that produces sustainable chemicals from microalgae. The yield of microalgae in this novel reactor is 400 % higher compared to the state of the art.

The world is shifting towards a bio-based economy to meet the growing demand for more sustainable food, materials, chemicals, pharmaceuticals and energy. Microalgae cultivation is an effective, sustainable and unlimited resource for valuable bio-based processes and products. However, the industry has reached a standstill in recent decades, with relatively low yields, recurring contaminations and high costs.

High-capacity, low-cost production

According to the latest estimates, the European algae biomass market is worth around EUR 3 billion and is expected to generate a compound growth rate of 6.7 % (2017 to 2022). However, microalgae cultivation is still expensive and inefficient – the low production rates, which are less than 400 gr/m^3 per day, prohibit wide-scale usage in different industrial sectors.

Partly funded by the EU, the Brevel project developed a photobioreactor that can produce microalgae on an industrial scale at low costs. "Our new system solves the capacity and cost issues associated with microalgae production. The core innovation is the use of optical fibres that distributes sunlight to microalgae cultures effectively and efficiently," notes Yonatan Golan, CEO of Brevel Ltd.

What's more, the photobioreactor is fully automated and relies on advanced image analysis, machine-learning and constant online monitoring and control technologies. With a capacity that is 400 % higher than current microalgae cultivation systems and its affordable cost, it is set to lead the microalgae industry forward and help foster the European bioeconomy.

Recovering natural astaxanthin

Microalgae are photosynthetic microorganisms that can rapidly generate biomass from solar energy, carbon dioxide and nutrients found in water. In particular, they are one of the most promising groups of organisms for the sustainable commercial production of bioproducts such as natural pigments and antioxidants including astaxanthin.



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The global astaxanthin market size was estimated at EUR 600 million in 2016. But although demand for natural astaxanthin

Being the first of its kind, our novel photobioreactor can meet the increased demand for using natural colourants instead of synthetic, promoting consumption of healthier salmon.

has been steadily increasing, over 95 % of the currently available astaxanthin is produced synthetically due to lower production costs.

Humans mainly use astaxanthin as a dietary supplement. This carotenoid pigment can also be used as an animal feed additive providing the orange/red colour in farm-raised salmon. "Being the first of its kind, our novel photobioreactor can meet the increased demand for using natural colourants instead of synthetic, promoting consumption of healthier salmon," concludes Golan.

Microalgae cultivation can make an important contribution towards transitioning to a bio-based economy. Natural astaxanthin will be the first product derived once the Brevel photobioreactor is commercialised and will be sold to salmon feed manufacturers at a comparable price to the synthetic carotenoid".

PROJECT
Brevel - A solar based, internally-illuminated bioreactor for microalgae cultivation

COORDINATED BY
Brevel Ltd, Israel

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/rcn/218508

PROJECT WEBSITE
brevel.co.il/

Taking tomorrow's sustainable super crop from lab to market

Microalgae cultivation can play a vital role in transitioning to a more sustainable society and biobased economy. An EU initiative has helped to commercialise several disruptive products by cultivating this super crop.

Microalgae are Earth's most efficient CO^2 capture system. They are an inexhaustible raw material with the highest protein content on the planet, and a source of sustainable and unlimited biofuels. They boost agricultural productivity and make daily harvesting possible. For these main reasons, microalgae have the potential to address societal challenges like environmental sustainability, energy efficiency and food security.

The EU-funded INTERCOME project was based on the photosynthesis phenomenon, a biological process essential to life on Earth

Basically, we turned an operational demonstration production plant in southern Spain into a fully commercial industrial facility.

that microalgae have been carrying out for billions of years. Fostered by light energy, photosynthesis transforms inorganic compounds into organic matter. "We optimised this process and reproduced it intensively," says Carlos Rodriguez-Villa Förster, Managing Director of AlgaEnergy, a company specialising in microalgae biotechnology. This was done to "obtain very valuable products derived from microalgae biomass in meeting the growing needs of different sectors, particularly agriculture, nutrition, cosmetics and aquaculture."

Upscaling microalgae production capacity

INTERCOME validated the productive process and further developed AlgaEnergy's production facilities. This helped to guarantee a high quality supply of microalgae throughout the year. "Basically, we turned an operational demonstration production plant in southern Spain into a fully commercial industrial facility," he notes.

Project partners designed and implemented a modulated production plant, and elaborated an operation protocol to simultaneously culture various microalgae strains without risking contamination. They modified the operational facilities to ensure the culturing capacity during seasons with suboptimal temperatures.



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The project team stabilised microalgae biomass to be produced in different delivery formats such as fresh paste and freeze-dried. It conditioned the processing facilities by making the necessary production layout adjustments and equipment upgrades.

The researchers scaled up the culture volume of selected strains for four main products: agricultural biostimulants, skincare dermocosmetics, nutrition additives and hatchery feed. They implemented the production and practices protocol to guarantee safety and quality processes. Lastly, they obtained product certifications for biomass and the final products.

The market isn't aware of microalgae as a raw material and the benefits of microalgae-based products. INTERCOME addressed these bottlenecks to commercialisation by extensively disseminating its activities, promoting microalgae-based solutions to targeted sectors and explaining their advantages compared to existing solutions.

Explosive company growth

Thanks to INTERCOME, AlgaEnergy's revenues shot up, and so did its attractiveness to partners and investors. A multinational industrial automation company invested EUR 10 million to buy a minor stake in AlgaEnergy. "This capital injection substantially increased the company's value," says Förster. The strategic business collaboration will help in developing microalgae culturing technologies, accelerating the development of novel products and reducing costs to enter new markets.

According to Förster, AlgaEnergy is the first company focused on applying microalgae to agriculture. Farmers are benefiting from a competitive solution that enables them to greatly increase profitability and competitiveness thanks to higher productivity and quality, and a better response to stress like climate change. The customer repetition rate is over 90 %. In the cosmetics domain, AlgaEnergy has developed 3 lines totalling 18 products that will be launched to the market in 2019.

AlgaEnergy is going global. It's exporting innovative solutions to over 20 countries and opening the first subsidiaries in Japan, India, Italy and the United States. Mexico, Brazil and Australia will soon follow.

PROJECT
INTERCOME – INTERnational COmmercialization of innovative products based on MicroalgaE

COORDINATED BY
AlgaEnergy S.A., Spain

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/rcn/206372

PROJECT WEBSITE
algaenergy.es/intercome/

Symbiotic algae-bacteria treat saline wastewater

An EU-funded project is exploiting the beneficial symbiotic relationship between algae and bacteria for recovering water, energy and nutrients from salty wastewater cost-effectively.

The food and drink industries produce vast amounts of wastewater each year. Although the effluents are controlled by EU Directives, some parts of the sector – notably canned fish, meat processing, pickled vegetables, tanneries, aquaculture and others – produce very salty water with high levels of organic matter. Not only is this effluent harmful to the environment, but it is also difficult and expensive to treat, especially for small businesses.

"The main cost in wastewater treatment is the energy needed to oxygenate the wastewater for the bacteria breaking down organic waste to breathe," notes Dr Jose Ignacio Lozano, who had been leading the EU-funded project SALTGAE. By adding algae into the water treatment equation, the project targets to reduce the total cost of water treatment by 25 %. It gets even better: the process produces energy in the form of biogas (methane) that can be used for power applications and recover nutrients (mainly phosphorous and nitrogen) that in excessive amounts can pollute the water.

A well-orchestrated synergy

SALTGAE's modular water treatment technology purifies saline wastewater containing considerable amounts of organic matter, while also valorising the resulting biomass into different by-products.

In a first stage, wastewater with a high biochemical oxygen demand (DBO) is treated by a two-phase anaerobic digestion



© Sergio Ibáñez Pérez

process. In this stage, organic matter is converted into biomass, thanks to the carefully selected bacteria that can adapt to high saline levels.

Although SMEs make up only 5 % of the EU's food and drink sector, they total 15 000 business with a combined turnover of EUR 64 billion, so the market is substantial.

Another stage involves passing this partially cleaned water to an algal pond, where a consortium of algae and bacteria recover nutrients (phosphorous and nitrogen), valorising algae extracts into chemicals, edible coatings, and new construction materials. Working symbiotically, the bacteria transform the remaining organic matter into CO^2. This is consumed by the algae, which convert it into their own biomass using solar energy. At the same time, the bacteria are fed oxygen by algae.

The third stage of SALTGAE's treatment technology involves use of membrane technology to remove salinity and aid the reuse of high-quality water.

Opportunities for SMEs

Three demonstration sites representing three different scenarios are now running. "Using a combination of bacteria and algae allows us to save 90 % of the energy required for aeration, while also recycling CO^2 that would otherwise be released into the atmosphere. What's more, the produced algal biomass can be further utilised and sold," adds technical manager Mr Robert Reinhard.

The site in Italy is treating effluent from the milk industry, a plant in Slovenia is dealing with tannery waste water, while the site in Israel is processing waste from fish farming. The algal biomass produced in all sites was successfully tested in several products ranging from feed for piglets, protective edible coatings for fruit or bio-composites for 3D printing.

SALTGAE provides significant benefits for SMEs, making it possible for them to treat their effluent more economically and effectively with the sale of biomass as a new source of revenue. "Talking of numbers, a cubic metre of municipal wastewater requires up to 7 kWh for removing dissolved organic pollutants; we typically spend an additional 0.5 kWh for aeration," explains Dr Lozano. "Although SMEs make up only 5 % of the EU's food and drink sector, they total 15 000 business with a combined turnover of EUR 64 billion, so the market is substantial," concludes Mr Reinhard.

PROJECT

SALTGAE – Demonstration project to prove the techno-economic feasibility of using algae to treat saline wastewater from the food industry

COORDINATED BY

FUNDITEC – Foundation for Development and Technological Innovation, Spain

FUNDED UNDER

H2020

CORDIS FACTSHEET

cordis.europa.eu/project/rcn/203268

PROJECT WEBSITE

saltgae.eu/

Seaweed safety put to the test

Growing population demands necessitate alternative sustainable food sources such as seaweed. However, safety of seaweed products must first be addressed before extensive human consumption.

Seaweed contains high amounts of arsenic in different chemical forms, which can be toxic to humans and animals, causing various health problems including cancer. Although arsenic is mainly toxic in its inorganic form, little is known about the safety of arsenic encountered in organic compounds such as arsenosugars, and especially arsenolipids found in seaweed. It is of paramount importance to evaluate the toxicity of seaweed arsenic compounds.

Measuring arsenic in seaweed

To contribute to consumer safety, under the Marie Skłodowska-Curie fellowship, scientists of the EU-funded SilhouetteOfSeaweed initiative had to overcome existing limitations associated with the measurement of arsenic compounds. For this purpose, the non-profit, independent research company Matís collaborated with a European partner organisation with expertise in the measurement of arsenolipids. "Our main goal was to provide key reference data that are essential for risk assessment of algae used for human consumption and identify the best season for harvesting seaweed where the amount of toxic arsenic is at its lowest," explains project coordinator Dr Gunnlaugsdóttir.

Our main goal was to provide key reference data that are essential for risk assessment of algae used for human consumption and identify the best season for harvesting seaweed where the amount of toxic arsenic is at its lowest.

It is unclear where and how arsenosugars and arsenolipids are produced, but most likely this happens within the seaweed. After establishing the necessary facilities at Matís, researchers analysed the arsenolipid, arsenosugar and total arsenic chemical profile of four different species of edible brown algae using arsenic speciation, an analytical technique that can distinguish between the different arsenic species.

In addition, they analysed the arsenic species in different sections of the seaweed for example holdfast, stipe, young frond, old frond and reproduction system. "The idea was to identify potential environmental conditions that affect arsenic content in seaweed and increase understanding on where the different arsenic species are formed in the seaweed," continues Dr Gunnlaugsdóttir.

Results showed that arsenolipids accounted for 2-16 % of the total arsenic in seaweed, while the toxic inorganic form of arsenic accounted for less than 1 % in the seaweed species investigated. This finding suggested that arsenolipids may be a significant contributor to seaweed toxicity. Arsenic and arsenosugar composition were found to be species specific, suggesting that certain seaweed species are more suitable for human consumption.

Interestingly, when scientists associated the seaweed arsenic content with environmental conditions, they discovered that total and inorganic arsenic were the lowest during the summer months. The total content of arsenolipids also indicated it was higher in winter/spring than summer/autumn.

Since the ideal harvest time of these seaweeds is often in spring or early summer, the findings underline the importance of more research on the toxicity and effect arsenolipids may have on human health. Researchers hope that this observation will improve our understanding of how and where arsenolipids are formed.

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Improving food safety and public health

The need for estimating arsenic composition in different foods was underlined by the European Food Safety Authority (EFSA) article 'Scientific Opinion on Arsenic in Food' (2009). The results of the SilhouetteOfSeaweed project provide unprecedented knowledge on the amount and distribution of arsenolipids in seaweed and are central for the risk assessment of algae.

Considering the potential of seaweed as a sustainable source of raw materials in the food industry, it is important to underpin the safety requirements for the marketing of seaweed-based food products in Europe. Dr Gunnlaugsdóttir is confident that SilhouetteOfSeaweed project findings can serve as the foundation for future legislation on toxic arsenic species, ensuring product safety and public health along with food security.

PROJECT
SilhouetteOfSeaweed – Overcoming barriers in estimating toxicity of arsenic species in seaweeds

COORDINATED BY
MATIS OHF, Iceland

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/rcn/195292

PROJECT WEBSITE
english.matis.is/

SMILE for weight loss and memory boost

A new food supplement ingredient for weight management and sustained cognitive function – SMILE – is being extracted and formulated by a unique process from specially selected marine microalgae.

With EU funding for the project SMILE (Slimming and Memory-Booster MIcroaLgae Extract), the French start-up Microphyt has developed and produced a new flagship product, also known as SMILE. "Control of the whole process from A to Z including marketing ensures optimal sustainability and cost-effectiveness," points out Vincent Usache, Microphyt CEO.

Tests for safety and efficacy a priority

Application for the authorisation of SMILE ingredients, screened for nutritional composition and toxins, was submitted to the European Commission at the end of 2018. Overall results demonstrated the robustness of the SMILE process and the safety of its ingredients taking into account compliance with current legislation.

Microphyt has also successfully conducted preclinical studies on mice to confirm the efficacy of the pool of active molecules in SMILE – marine xanthophylls and omega-3 fatty acids – that act in synergy at several levels of brain function.

The power of a SMILE

Production of active ingredients occurs in 5 000-litre–capacity unique tubular photobioreactors. The closed cultivation system ensures total control of inputs and the absence of external contamination. After biomass harvest, freezing and drying, the green extraction process completes valorisation.

SMILE ingredients are a carefully balanced formula of three independent fractions. Active ingredients – xanthophylls and omega-3 fatty acids – are dissolved in the matrix, based on natural coconut oil. A natural antioxidant is added to protect the active molecules from oxidation and extend the shelf life of the product.

Research by Microphyt product manager Dr Antoine Delbrut established cost-effective and eco-friendly parameters for co-extraction of fucoxanthin and the polyunsaturated fatty acids. A paper has been published in the journal ***Molecules***.

Patents filed and marketing in full swing

Control of the whole process from A to Z including marketing ensures optimal sustainability and cost-effectiveness.

Microphyt has already started to prepare for the arrival on the market of the SMILE ingredients by assembling relevant market tools. To date, 20 potential customers have been visited and Microphyt continues to communicate with other possible clients via its website and international exhibitions.

Two ingenious methods relating to the ingredients have been patented during the SMILE project. Management of light availability for each microalga cell during culture increases the accumulation of secondary pigments up to twice the concentration quoted in literature data.

The second patent deals with the use of SMILE ingredients and their specific composition to prevent cognitive disorders in humans and animals. Among these, cognitive decline with age and cognitive alterations induced by prenatal stress can occur over an individual's lifetime. As demonstrated in the preclinical model, SMILE ingredients provide significant improvement in cognitive functions such as short-term memory



© microphyt

SMILE of the future

Researchers are ready to follow up on the European application and answer any questions from the European Food Safety Authority. For the American market, the New Dietary Ingredients file is in progress.

Testing for efficacy continues full steam. This year, several ingredients from the SMILE range will be tested in a series of eight preclinical studies on different applications, including additional studies on cognitive maintenance and weight management.

The most promising extract-application combinations will be selected for a clinical study panel to confirm the beneficial effects on humans.

PROJECT
SMILE - Slimming and Memory-Booster MIcroaLgae Extract

COORDINATED BY
Microphyt, France

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/rcn/205002

PROJECT WEBSITE
microphyt.eu/en/objective-smile/

An edible sunscreen product

Everyday use of beauty and personal care products exposes people to more than 100 chemicals with potential toxic effects. Alternative technologies are required that are more friendly to the skin and the environment.

Many chemicals present in beauty products such as parabens or phthalates cause undesirable toxic effects in humans and the environment. Even UV filter molecules present in sunscreen creams designed to protect against sunlight exposure are absorbed by the body, causing disruptive effects on the endocrine system.

To address this issue, the EU-funded TARASÓL project developed an innovative sunscreen formulation that is purely organic and risk-fee. The filter has been designed, developed and commercialised by the Icelandic company Taramar. As founder and CEO of Taramar, Prof. Gudrun Marteinsdottir explains, "TARASÓL is the result of years of basic research in marine biology and nutritional science leading to novel knowledge on the functional properties of seaweed."

Employing seaweed properties for sunscreen

The Taramar team of scientists generated a method for producing water-based skincare products utilising unique compounds with beneficial properties for skin and body. The science has been conducted in collaboration with European and USA universities and research institutes. Most of the results have been published in scientific journals.

Research results showed that the Icelandic seaweed has antioxidant powers similar to green tea and cranberries. Seaweed extracts have the capacity to stimulate immunomodulating responses and protect skin cells from aging.



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After overcoming a number of research and development challenges, Taramar scientists succeeded at producing a UV filter that avoids the toxic and harmful chemicals currently used in most beauty products in the market. At the same time, they discovered safe and natural methods to preserve the functional properties of the seaweed bioactive molecules while prohibiting microbial growth with the NoTox™ technology. As a result, the TARASÓL UV filter lacks conventional preservatives and is 100 % safe for skin and body. The antioxidant and anti-inflammatory properties of seaweed provide additional and clearly visible benefits to the skin.

TARASOL is the result of years of basic research in marine biology and nutritional science leading to novel knowledge on the functional properties of seaweed.

Furthermore, researchers observed that some organic compounds such as collagen and vitamin C cannot be easily transferred over cell membranes. Therefore, they encapsulated the seaweed components in a liposome-based delivery system that stabilises and releases the bioactive UV filter upon sunlight exposure.

Taking TARASÓL to the market

Like all the other formulas by Taramar, the innovative TARASÓL product is a fully natural formulation that renders it technically edible and remains stable at room temperature for more than a year. "There is nothing similar to TARASÓL on the market today," states Prof. Marteinsdottir.

According to Prof. Marteinsdottir, the next step of Taramar is to "optimise all processes, set up the production and the market and distribution." The organic personal care and cosmetics global market is estimated to grow at approximately 10 % per year, with organic sunscreens calculated to be worth nearly EUR 200 million per year. As a result, TARASÓL is expected to be a commercial success, significantly increasing the company's revenue and doubling the number of jobs by year 2023. Considering the health-related impact of cosmetic chemicals on endocrine function and fertility, TARASÓL provides a safer alternative, giving the opportunity to people to stay in the sun without compromising their health.

PROJECT
TARASÓL – The pioneering bio-marine liposomal Sunscreen released to the skin upon sunlight exposure

COORDINATED BY
TARAMAR EHF, Iceland

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/rcn/213629

PROJECT WEBSITE
taramar.com

Algae-based fertiliser turns vegetable farming green

There is a growing demand for 'green' vegetables but farmers are reluctant to change to these revenue-generating practices. Researchers have made it easier for farmers to get their products labelled as green through sustainable, easy-to-adopt technology..

In the beginning we definitely want to obtain experience from support and maintenance coming from onsite ponds installed in Hungary, Austria and Romania. After that we will expand into other markets as well.

Regulations and consumer needs have expanded the market for food products labelled green. However, affordable technological tools to produce vegetables sustainably are not readily available. To compound the challenge, European vegetable suppliers have neither the knowledge nor the willingness to change their cultivation methods.

The EU-funded VegaAlga (Sustainable agricultural eco-system: business and technological solution for eco-conscious vegetable cultivation using on-site produced algae fertilizer) initiative set out to establish a sustainable agricultural ecosystem using microalgae-based fertiliser. The VegaAlga team worked with the Vegetable Trading Centre – regional market leaders in vegetable production, and Multisense – a technology-intensive start-up, to create the new ecosystem.

Project leader, Mr Zoltán Basa, says the innovation process was divided into two important parts. The first was to improve and finalise an algae production system so that the algae can be cultivated securely. The second part was to successfully show that the algae treatment on the soil works. "In the first part, we selected the open pond production system and it was definitely the most crucial factor," Professor Basa explains.

The team tested two different-sized ponds, 12m^3 and 25m^3, and installed all the ponds in a greenhouse to better control the physical parameters. They developed and used a special paddle wheel for a continuous production cycle and to prevent sedimentation.

The researchers next developed the VegaAlga system in which they grew the algae in raceway ponds with optimal conditions to maximise the growth rate. The team created their own control system that they used to monitor the status of every pond, called "Pond Master". They used the system to monitor parameters such as pH, electrical conductivity, dissolved oxygen, and oxidation reduction potential.

The project was not without its challenges, however, as Professor Basa explains. "The team faced issues with the size and the material of the ponds, which they needed to get correct to avoid infections that would hinder production." They initially found it difficult to find partners to work with; Mr Basa found that SME companies seldom work with innovative partners outside their comfort zone.

VegaAlga developed microalgae-based fertiliser that was positively received by farmers that tested the product. Farmers completed a questionnaire where the majority (15 of 17 farmers) said the algae fertilisers were more effective than inorganic products in the market.

The new product has generated a significant amount of interest: consumers and industry professionals bombarded the commercial partner with questions.

A Customer Development Plan was created to commercialise their technology to produce microalgae sustainably, and in a cost-effective, environmentally friendly manner. The team also developed a smaller microalgae-fertiliser production system to



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allow farmers to produce fertiliser on their own land in a cost-effective and eco-friendly way. This would allow farmers to label their products as "green" and sustainable, which comes with a significant revenue boost.

Looking forward, Mr Basa says the VegaAlga team will look for distributors of the product, as they have already started to build up a sales team. The project already has orders not only in the field of agriculture, and they plan to focus on other potential business opportunities.

The VegaAlga open pond system was selected by the Budapest Savage Works Ltd. for innovation support for the company from 2018. "In the beginning we definitely want to obtain experience from support and maintenance coming from onsite ponds installed in Hungary, Austria and Romania," Mr Basa says. "After that we will expand into other markets as well."

PROJECT
VegaAlga - Sustainable agricultural eco-system: business and technological solution for eco-conscious vegetable cultivation using on-site produced algae fertilizer

COORDINATED BY
Zöldségcentrum Kft, Hungary

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/rcn/213629

PROJECT WEBSITE
vegaalga.eu/en/

Omega-3 from seaweed

The global demand for omega-3 fatty acids is increasing in nutraceutical, cosmetic and pharmaceutical applications. Current extraction methods from fish are not sustainable, requiring alternative and greener solutions.



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Omega-3 fatty acids are known for their capacity to prevent cardiovascular disease. Astaxanthin, a carotenoid pigment with antioxidant capacity has received great interest due to its ability to cross the blood-brain barrier. It is considered a high-value added compound for the protection of the central nervous system and for preventing diseases such as Alzheimer and dementia. The traditional chemical synthesis of astaxanthin and extraction practices of omega-3 suffers from low efficiency and lead to overfishing and high energy consumption.

To meet the growing demand of these compounds, the EU-funded VOPSA2.0 project proposed to obtain omega-3 and astaxanthin from marine microalgae through a sustainable industrial bioprocess. VOPSA2.0 was coordinated by the Neoalgae biotechnology company in Spain. "The idea was to develop an extraction approach that is both environmentally friendly and can produce the tonnes of omega-3 and astaxanthin required every year," explains project coordinator María Álvarez.

Culturing algae to industrial scale

By culturing sea algae, researchers managed to scale up the process to industrial scale while leaving marine resources unaffected. Microalgae have a growth rate similar to bacteria or yeast, allowing big biomass production in a short period of time.

To extract omega-3 and astaxanthin from microalgae dry biomass, researchers developed a method of supercritical extraction with carbon dioxide, which bypasses the dangerous use of traditional organic solvents. This approach facilitated the separation of highly pure omega-3 and astaxanthin compounds free of pollutants, without aftertaste and suitable for vegans. Importantly, the entire process was achieved with competitive and stable production costs.

In vitro testing of the microalgae-produced omega-3 and astaxanthin validated their safety for dermatology use and led to the launching of a new brand of cosmetic products in Neoalgae, called Alskin. The collaboration with the VOPSA partner Bicosome led to the development of a breakthrough mechanism for skin delivery of the microalgae using lipid smart technology. This new system, which gave rise to a new brand called Bicoalgae®, has the capacity to penetrate the skin epidermal layers and deliver the omega-3 and astaxanthin superior antioxidant and anti-inflammatory effects where needed.

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Taking the VOPSA2.0 products to the market

Neoalgae plan to commercialise the extracts and their Alskin line, while Bicosome will commercialise the products Bicoalgae® Xanthin and Bicoalgae® omega-3 for treating acne, atopic skin disorders and aging. Furthermore, astaxanthin and omega-3 oils have been produced alongside Spirulina and astaxanthin capsules as nutritional supplements.

Overall, the VOPSA2.0 project demonstrated the possibility of sustainably producing high-quality skincare products from marine algae. Apart from their natural origin, these products can be delivered into the skin through a stable, safe and effective formulation. Álvarez is confident that "these products will be a breakthrough in the history of both companies and promote a long-term and successful collaboration."

VOPSA2.0 allowed Neoalgae to improve their facilities and technological capacity and establish a new industrial plant for the production of omega-3 and astaxanthin. In view of the future, Álvarez emphasises the need for financial support by investors or investment funds to bring the innovative VOPSA2.0 products to the consumer.

PROJECT
VOPSA2.0 - Value Omega 3 and Astaxanthin products from SeaAlgae

COORDINATED BY
Neoalgae Micro Seaweed Products SL, Spain

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Editorial coordination
Zsófia TÓTH, Silvia FEKETOVÁ

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