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### Editor's Note:

Deanna Utroske kicks off her regular Global Perspectives column with this article on Microalgae in the Beauty Industry. The article includes quotes and comments from subject matter experts such as CEO and Co-Founder of the Swedish Algae Factory Sofie Allert; Cyrielle Houdin, Cosmetic Ingredients Marketing Manager at Microphyt; Juliana Mancini Gomiero, Global Hair Care Market-ing Manager at Lubrizol; Lucyanna Barbosa Barros, PhD, CEO at Bicosome; and Brian Grady, Senior Marketing Specialist at DSM Personal Care in North America. They provide insights into the world of microalgae and how they can be used in the beauty industry.

*“There is a huge untapped potential of the use of microalgae in the beauty industry,” says **Sofie Allert, CEO and Co-Founder of the Swedish Algae Factory**, a company best known for its multi-functional cosmetic and personal care ingredient called Algica.*

***Allert** “fell in love with algae” while writing her bachelor’s thesis in biotechnology. “For me,” she says, explaining the appeal of microalgae, “it was an extremely sustainable underused resource, since algae grow fast and can be cultivated on saltwater and wastewater.”*

*However, “back then, most algae species that had been studied for industrial use preferred warm and sunny climates.” So when, in 2013, **Allert met Professor Angela Wulff**, who “had recently joined a research expedition to Antarctica, sampling ice-inhabiting microalgae,” they recognized that it would “be possible to create an algae industry in the cold and dark climates of the Nordics.” And that’s precisely what they’ve done. **As Allert puts it**, “we decided to set out to show that it is possible to create a climate-positive industry with the help of algae.”*

# Ingredient Innovation

## Microalgae are hardy, plentiful, and full of possibility

As many as one million species of microalgae are living on Earth today. And the practical implications and commercial potential of these single-cell organisms are even greater than that figure suggests. The global market for microalgae is estimated to reach 56.5 billion US dollars by 2027, according to a recent article published in *Algal Research*.

*"Each microalgae is a world in itself, with its own shape, its own color, and its own way of life. They are at the origin of life on Earth and therefore of all terrestrial plants. Their presence on Earth goes back more than three billion years; and they are found on almost the entire surface of the Earth,"* explains **Cyrielle Houdin, Cosmetic Ingredients Marketing Manager at Microphyt**, a France-based company specializing in microalgae-based bioactives for the cosmetics and nutraceuticals market.

Like all organisms, microalgae require water; and yet, some species live *"in environments that are ... incompatible with life in general, such as glaciers, hydrothermal springs, and even deserts,"* notes **Houdin**. *"As surprising as it may seem,"* she says, *"some microalgae have the ability to colonize the most arid land environments."*



This ability of microalgae to thrive in a wide variety of climates is all the more apparent when we take a look at how beauty ingredient suppliers around the world are using these tiny photosynthetic organisms to innovate for the future.

## Diatoms from Swedish oceans advance innovations in protective beauty

The Swedish Algae Factory makes its signature Algica ingredient by working with diatoms *"originally ... sourced from Swedish oceans and ... thereafter cultivated to larger scales in our 2,600 square-meter greenhouse on the Swedish west coast,"* company **CEO Sofie Allert tells me**. *"In an adjacent facility,"* she says, *"we extract Algica from the rest of the algae biomass."*

Algica is an odorless white powder and a delightfully multifunctional beauty ingredient. **As Allert explains it**, *"Algica is the shell of the microalgae group [called] diatoms. This shell is designed for efficient uptake of nutrients and maintenance of optimal water levels in the algal cell. The shells also protect the algae from harmful substances and UV light."*

*"These natural traits create a personal care product that works as an efficient moisturizer, cleanser, booster of other actives, anti-pollution agent, and SPF booster. Algica also provides sensory modifying properties to personal care formulations, making [them] smoother and perceived as more luxurious, according to external studies."*

*"Algica is today used in facial masks, face creams, serums, sunscreens, deodorants, shampoos, etc. by customers all over the world. In-house,"* says **Allert**, *"we spend a lot of time making formulations with Algica to be able to provide our customers with valuable formulation guidelines."* The vegan ingredient can be used in both hydrophobic and hydrophilic product formulations, is not sensitive to heat or changes in pH, is globally compliant, COSMOS approved, and ocean-safe.

## Hair care formulations get help from microalgae found in Germany

*"The original algae strain used to produce the HSHO was isolated from [the sap of] a chestnut tree in Germany,"* explains **Juliana Mancini Gomiero, Global Hair Care Marketing Manager at Lubrizol**.

The Lubrizol Corporation (a Berkshire Hathaway company) is a specialty chemicals operation based in the United States that serves multiple industries, including personal care.

**Mancini Gomiero tells me that,** “Lubrizol partnered with Corbion to create AlgaPur™ HSHO algae oil,” an ingredient “with proven sensory and performance benefits in hair, skin, and scalp applications.” She also notes that her colleagues have developed “a full complete hair and scalp-skin routine with ready-to-go formulations ... available for a fast go-to-market strategy.”

## Antiaging skincare benefits from saltwater and freshwater microalgae

Based in the Netherlands, DSM is working with several species of microalgae for its line of PEPHA® ingredients.

The company's PEPHA®-TIGHT CB (CB for ‘clean beauty’) is extracted from “*Dunaliella salina*, [a microalgae] which is known to survive in the extreme environment of salt lakes” and promises “facial skin tightening and anti-wrinkle” benefits, **according to Brian Grady, Senior Marketing Specialist at DSM Personal Care in North America.**

While PEPHA®-AGE CB is an extract of the freshwater microalgae *Scenedesmus rubescens* and “has a unique composition of valuable components including algal monosaccharides, trace elements, and vitamins. PEPHA®-AGE CB,” **Grady tells me,** “protects the skin against the harmful effects of sunlight, in particular UV and blue light ... In personal care applications, PEPHA®-AGE CB can be used in day care products in addition to UV filters, sun care and after sun formulations, regenerative night care and antiaging products.”

## Tahitian golden microalgae for sensitive skincare applications

France-based Mycophyt has studied and worked with some 40 species of microalgae. And the company's two most recent ingredient launches for the cosmetics and personal care industry are derived from a species of Tahitian golden microalgae called *Tisochrysis lutea* and from the red microalgae *Porphyridium cruentum*.

**As Cyrielle Houdin, Cosmetic Ingredients Marketing Manager at Mycophyt, tells me,** the golden microalgae “*Tisochrysis lutea* ... has an extraordinary ability to adapt since it is considered sensitive yet it lives in a stressful environment, i.e. hot waters with a high salt and acidity content.” Luteana™, the beauty ingredient the company developed using this algae is, “a precious oily extract containing powerful compounds such as omega-3 fatty acids, sterols, and xanthophylls, namely fucoxanthin.” This ingredient promises to “relieve sensitive skin to improve well-being.”

Mycophyt's Renouvellance™ ingredient, made using the red microalgae *Porphyridium cruentum*, boasts protective benefits and is meant for use in “antiaging or sun care products to protect the skin from daily environmental aggressors,” **according to Houdin.**

“By exploring the defense mechanisms of red microalgae elaborated millions of years ago and shared with humans, Mycophyt has designed Renouvellance™ [to be] able to activate the skin's natural defense response and shield cells against the harmful effects of UV rays and pollution for a healthier complexion.”

The key to this functionality comes from “Phycoerythrin, a pink antioxidant pigment able to absorb light energy and boost natural defenses, and Exopolysaccharides, a marine polymer able to chelate heavy metal and maintain cells' structure,” she **says, explaining the ingredient further.**

## The production processes behind microalgae beauty ingredients

Each of the cosmetics and personal care ingredient suppliers I spoke with has a distinctive production process that results in microalgae beauty ingredient innovation – as do countless others around the globe: Purissima in the US; Euglena and Panac, as well as DiC in partnership with Checkerspot all in Japan; BGG (Beijing Ginkgo Group) in China; Algenuity (a division of Spicer Consulting) in the UK; Archimede Ricerche in Italy; Microalgae Solutions in Spain; Yemoja in Israel; and the list goes on.

### Let's look at some of the technologies and processes in action:

At the start of this article, **Sofie Allert of Swedish Algae Factory,** mentioned that microalgae grow fast and can be cultivated using wastewater. Well, not only does the Swedish Algae Factory use wastewater to grow its diatoms; the beauty ingredient maker also leverages algae's ability to filter that water to facilitate sustainable, circular production.

**Allert succinctly describes how** her team actually makes Algica saying, “The diatom shell is extracted from the rest of the algae in a gentle COSMOS-approved manner. The production process is ... inspired by nature. It absorbs carbon dioxide, cleans water, and produces a valuable organic byproduct. Nutrient-rich wastewater from a nearby food industry constitutes the food for the algae. When the algae take up the nutrients from the water, the water is cleaned. The clean water can thereafter be transferred back to the food industry. The organic algae biomass that remains after the extraction of Algica is used to produce energy, fertilizers, and feed.” **And she emphasizes that the,** “Swedish Algae Factory is constantly pushing the boundaries towards an even more sustainable production process that is climate positive.”

Lubrizol works with an increasingly common ingredient production technology: fermentation. **As Juliana Mancini Gomiero, Global Hair Care Marketing Manager for the company, explains,** “Actual production using that [microalgae] strain occurs in Brazil using locally sourced sugarcane. The algae feed on sugarcane





in large industrial fermenters. Under the right growth conditions, the algae convert these sugars into triglyceride oils in less than a week.” And she adds that, “[our partner and] producer Corbion ensures our raw materials are sourced responsibly.”

Mycrophyt was founded on their own particular brand of microalgae cultivation tech. The company, **Houdin tells me** “was created in 2007 by Arnaud Muller-Feuga, an international expert with more than 25 years of academic expertise in microalgae biotechnology, and Michel Lemar, an expert in industrial bioprocesses. It’s together that they designed Microphyt’s original patented technology, hydro-biomimetic tubular photo-bioreactors based on a ... two-phase flow process, making it possible to reproduce the natural environment of microalgae.”

“The photo-bioreactors that we use,” **she says**, “have the particularity of recreating the natural movement of water by gently optimizing the contact of microalgae with light and CO<sub>2</sub>. Thus, the mechanical stresses are reduced, the cellular integrity of the microalgae is preserved and photosynthesis is increased. In addition, these closed photo-bioreactors allow a high degree of control of all culture parameters: such as water, nutrients, and gases. This makes it possible to produce high quality biomass, biochemically characterized, in a safe and reproducible way, preserving biodiversity because we do not touch the marine ecosystem.”

## Innovating with microalgae as nutrition for the skin

For **Lucyanna Barbosa Barros, PhD**, microalgae beauty ingredient innovation isn’t so much about places and processes as it is about the nutrients that these intriguing species can provide. **Barbosa Barros is CEO of Bicosome**, a beauty ingredient maker based in

Barcelona, Cataluña, Spain. The company’s microalgae ingredients all leverage a proprietary skincare-actives delivery system known as Bicosome® Technology.

“I was introduced to the potential of these amazing organisms when I was studying nutrition seven years ago and was truly impressed with their effects and benefits as superfoods,” **she tells me**.

“Being a skin delivery researcher, I knew how difficult it is to visually observe the effects of nutrition on the skin. Hence, I thought, ‘What if we could feed the skin directly with microalgae superfoods?’”

“By that time,” **she says**, “we already had patented our nanostructured skin delivery transporter, the Bicosome® Technology. Incorporating the microalgae into Bicosomes for efficient skin delivery of superfoods was a perfect match to explore. And this is how everything began.”

“Six years ago, we started to collaborate with a start-up in Gijon (Asturias, Spain) named Neoalgae. At the time, they grew, harvested, and produced microalgae extracts mainly for the nutrition sector. Given the identified need to deliver microalgae to the skin, we saw the synergies and potential of working together developing microalgae-based cosmetic active ingredients. We worked together for two years on this research, producing many valuable results for both companies,” **explains Barbosa Barros**. “Among them, ... our microalgae-enriched Bicosome® ingredients: Bicoalgae®. Currently, we have a full Bicoalgae® line being developed with different microalgae species.”

“Because microalgae are organisms very rich in proteins, microelements, and bioactives with very high antioxidant power, [they] can potentiate tremendously the skin functions and repair some

defective processes,” according to **Barbosa Barros**. Ingredients in company’s line of microalgae beauty ingredients promise benefits such as age deceleration and improving signs of inflammation or inflamaging.

## Less waste, less space, and the environmental advantages of microalgae

The preservation of nature’s biodiversity and the environment more broadly is an important part of the microalgae beauty ingredient innovation story. Of course each company’s business practices and their telling of that environmental sustainability or circularity story will be a bit different, one from the next.

But some of the central environmental advantages of developing (and formulating with) microalgae beauty ingredients are that each species of microalgae need only be harvested or sourced from nature once and thereafter can be industrially cultivated in perpetuity – an advantage that microalgae tech has in common with biotech that leverages plant stem cells.

Also, the waste of many microalgae ingredient production processes is predominantly biomass, the remains of spent organisms, and can be repurposed. And the water used in microalgae cultivation as well as the water removed from the organisms in advance of ingredient extraction (a process called dewatering) can be re-used safely.

Since microalgae are photosynthetic organisms, taking in carbon dioxide and releasing oxygen, the cultivation of microalgae could be said to improve air quality. And many of the ingredients are water soluble or otherwise degradable; and thoughtfully developed bio-based ingredients can be less likely than some conventional inputs to cause environmental harm following consumer use.

*“The demand is driven by the unique properties of these ingredients and the potential of producing a more sustainable, emission-reducing ingredient. By using marine-derived ingredients you can also contribute to healthier oceans since these ingredients, when released to these ecosystems, are naturally designed to not damage these habitats,”* affirms **Sofie Allert of the Swedish Algae Factory**.

Clearly the impact of the production facilities and logistics figure into the true sustainability of any ingredient. And suppliers are taking this into consideration. Lubrizol, for instance began working with microalgae because of its sustainable potential: *“Lubrizol’s sustainability strategy drives us to look for ingredients created with biotechnology that provide specific cosmetic benefits obtained from living microorganisms through sustainable bio-processes,”* says **Mancini Gomiero**.

And the company has commissioned studies to demonstrate that their AlgaPur™ HSHO algae oil is more environmentally sustain-

able than available alternatives. *“The LCA [Life Cycle Assessment] found that oils produced at Corbion’s facility have lower carbon and water footprints than nearly all major commercial bio-based oils,”* **Mancini Gomiero tells me**, adding that, *“The study also included a comparative analysis of algae oil with other major commercial bio-based oils: palm and palm kernel, soybean, canola/rapeseed, olive, sunflower, and tallow. Oil produced at the Corbion facility requires less water consumption than most major bio-based commercial oils. This is due to the fact that the sugarcane [feedstock] supply is primarily rain-fed and a contained fermentation process is used. Furthermore, much of the treated wastewater is placed back on the sugarcane fields as ‘fertigation’.”*

## Demand and value of microalgae beauty ingredients is on the rise

All of the experts I spoke with see an increasing demand for cos-metics and personal care ingredients made from and with micro-algae.

**Brian Grady of DSM Personal Care** told me that, *“brands with prominent messaging on clean ingredients and sustainability are frequently contacting us to learn more about these ingredients.”*

*“In our company,”* says **Bicosome CEO Barbosa Barros**, *“we are experiencing a growing interest in the products with microalgae.”*

*“I consider this a direct reflection of the natural and vegan trends fueled by the growing evidence of their higher efficacy when compared with classical antiaging molecules,”* she says, emphasizing that, *“The scientific community is also bringing growing evidence of microalgae efficacy and benefits also for chronic inflammation, photoaging, melasma, acne, and dandruff, among others.”*

*“Altogether, [this] indicates that products containing microalgae will continue to expand and increase their presence in the market,”* believes **Barbosa Barros**. *“With the proper selection of producers, choosing microalgae benefits all of us: companies, consumers, the environment, and the society.”*

At Microphyt, **Houdin** points to *“[Microalgae’s] biodiversity [as] proof of an immense capacity for adaptation and also of an important source of innovation. It’s thanks to the synthesis of powerful metabolites (carotenoids, pigments, fatty acids, etc.) that microalgae resist different environments. Thus, microalgae produce certain molecules which are specific to them and which are not found in other plants. They then open up a very important field of possibilities for cosmetics.”* And she thinks *“it’s important to note that microalgae, in addition to providing innovative solutions, have real potential to meet the current needs of consumers to have natural, ethical and sustainable products.”*

**Houdin concludes**, saying that, *“We are just beginning to use this unique and sustainable natural resource.”*