Algae: Coming soon to a menu near you

In addition to their proven nutritional value, algae are increasingly being marketed as functional foods. As research and development into its production continues apace, *Andrew Dahl* looks at what they have to offer to both manufacturer and consumer.

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THE year is 2038. You enter a restaurant, sit down and open the menu. If fresh-pressed juices are available, that celery/carrot/kale mix might contain flavourful algae. When you order a seafood or vegetarian salad, its colour and flavour could be due to ribbons of dried algae. The spinach in your bowl of soup might be augmented with algae rich in protein, fibre and vitamins, and you might enjoy some matcha tea that is half tea and half algae with potent antioxidants and immune enhancers.

Algae will be appearing on menus on a large scale over the next few decades, driven by exciting advances being made today. With interest in functional foods riding high, the myriad health benefits of various algae strains are being spotlighted as never before. Along with the realisation of algae's benefits and adaptability as a functional food ingredient, the pace of research and development in growing and processing algae is making it an ever-more-attractive proposition for food manufacturers looking to expand their offerings.

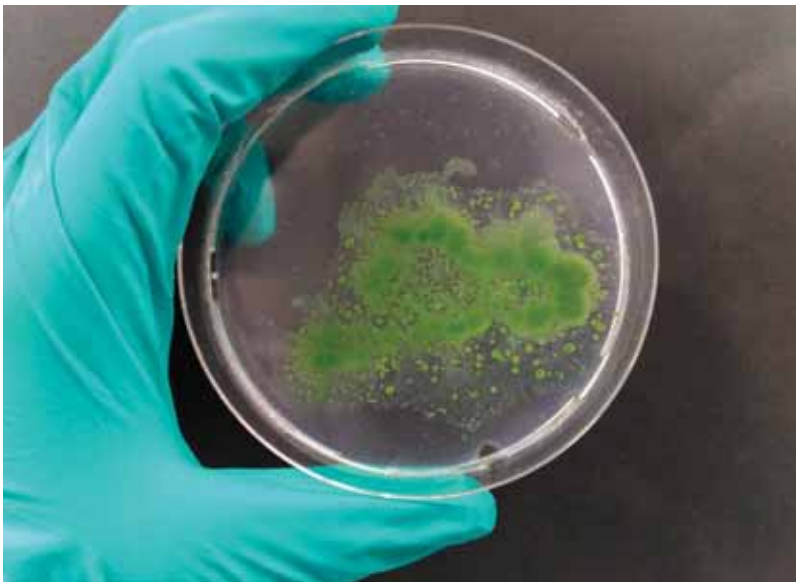
The benefits of algae-based foods

Microalgae have been utilised as a source of human nutrition for thousands of years[1]. In addition to their proven nutritional value, algae are increasingly being marketed as functional foods or nutraceuticals, terms that describe foods that contain bioactive compounds, or phytochemicals, that may benefit health beyond the role of basic nutrition[2].

For example, as many modern health-conscious consumers are aware, two of the key factors in achieving metabolic efficiency or optimal health are managing oxidative stress and minimising low-level, systemic inflammation in the body. These effects can be mitigated with carefully managed diets, exercise, hydration and sleep – but by ingesting a gram of the right strain of algae, this regimen can be relaxed to an extent not possible otherwise.

This is because algae are known to produce a great variety of biologically active compounds not commonly found in other individual organisms. In addition to antioxidant and anti-inflammatory properties, algae have also been studied for antitumour, anti-obesity and neuroprotective effects. Focusing on merely the first of these benefits, it is the sulphated polysaccharides from algae that have potential antioxidant activities, with fucoidan, ulvan, laminaran and alginic acid particularly shown to be potent antioxidants; fucoidan is also an inhibitor of inflammation[3]. Indeed, algae contain large amounts of polysaccharides and oligosaccharides. Interestingly, over the past half-decade, we have learned more about the abundance and variety of non-starch polysaccharides provided by algae that have functional properties relevant to gut health and digestive efficiency.

Overall, as a source of functional food ingredients, algae can be a significant source of Omega 3 oils, proteins and peptides, carotenoids, phenolic compounds and alkaloids. In general, algae contain up to one to three per cent in dry weight of lipids, with glycolipids being the major lipid class in all algae, followed by neutral lipids and phospholipids. The Omega 3 polyunsaturated fatty acids in algae (such as EPA, DHA and ARA) are claimed to have a range of beneficial effects such as improved heart health and reduced inflammation[4]. The protein content in algae can be as high as 60 per cent of the dry weight, depending on the season and the species involved. Further, great interest has been raised regarding microalgae protein as a source of bioactive peptides because of their therapeutic potential in the treatment of various diseases.



ABOUT THE AUTHOR

ANDREW DAHL is the President and CEO of ZIVO Bioscience, a biotech/agtech R&D company engaged in the commercialisation of nutritional and medicinal products derived from proprietary algal strains. He was formerly a principal consultant and managing director of Great Northern & Reserve Partners, LLC, a marketing strategy and business planning consultancy focused on the biomed and biotech sectors, since 2005.

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In terms of total fibre, some edible algae contain a level that is higher than that found in more highly evolved plant species. As for carotenoids, the major varieties that occur include beta-carotene, lutein, violaxanthin, neoxanthin and zeaxanthin, to name a few. The presence of iron and iodine in various algal strains may also be beneficial in preventing the conditions that are triggered by deficiencies in these elements[5]. Algae-based food may also prove to be a superior choice to soy, since the lecithin soy contains is a common allergen, while its estrogen-like metabolites may also create hormone imbalance issues.

Meanwhile, the most highly consumed microalgae on the market today, *Spirulina*, has been shown to incorporate high protein content and added nutritional benefits, including anti-hypertension, renal protective, anti-hyperlipidemia and anti-hyperglycemic properties. As well as being a rich source of proteins, it also contains high levels of GLA, B-vitamins, and free-radical-scavenging phycobiliproteins[6].

Progress in algae research

Companies are building and refining production methodologies to drive down the cost of growing algal biomass and driving up yields. The biggest hurdle is startup, with the cost of building a one-acre pond potentially exceeding US$80,000 including necessary water management equipment. Yet, a one-acre algae pond can out-produce one acre of soybean by a factor of 10 in terms of available protein, vitamins and micronutrients.

There are a range of companies working in this sector engaged in a wide variety of algal cultivation and production research. For example, at one company, a bioreactor has been developed that can be operated indoors to shield algae from certain wavelengths of sunlight detrimental to algae growth; the sunlight is substituted with LED light, which allows a continuous production cycle. Elsewhere, algae are being cultivated under heterotrophic conditions in fermentation tanks rather than being photosynthetically grown in open ponds. Separately, paddle wheels are being used to enhance sun exposure in open culture ponds, with baking soda added to a mixture of fresh and ocean water to avoid contamination.

Some phototrophic growers have eschewed costly, complex fermentation systems and bioreactors in favour of a more basic and capital-efficient model – a covered, shallow pond constructed of inexpensive, readily available materials. This approach favours optimised, phototrophic, filamentous green freshwater microalgae strains that can efficiently capture solar energy and offer above-average production yields.

Algae produced for nutritional applications can be spray-dried, belt-dried, drum-dried or freeze-dried depending on the product formulation requirement, ranging from a fine powder for better mixing properties to a flaked form that looks and blends like pesto, parsley flakes or dried seaweed.

As demand builds, algal biomass can be grown by contracted cultivators and shipped to licensed drying facilities. From there, the product would be shipped to food manufacturers for use as a protein-enhancing food ingredient. Algal strains optimised for commercial production promise low startup cost and offer sustainability, high yield, continuous harvest, optimal levels of protein, micronutrient and non-starch polysaccharides (NSPs), ease of post-processing and the potential of multiple applications across animal species. Some commercial algae strains offer a significant fiber component, as well as natural, bioavailable vitamins A and C. A very few are developed to be nearly odourless and tasteless. Extracts and supernatants (consisting of non-starch polysaccharides, peptides and bioactive compounds secreted by the algae during the grow cycle) can be separated and concentrated to create high-value nutritional ingredients.

Advances are also occurring in academia, at notable centre of algae research such as the National University of Ireland in Galway. Over the past decade, NUI Galway has developed technical expertise in open-sea cultivation of macroalgae. For example, the institution has

REFERENCES

1. Bleakley S, Hayes M. Algal proteins: extraction, application, and challenges concerning production. Foods. 2017;6(5):33.
2. Wells ML, Potin P, Craigie JS, *et al.* Algae as nutritional and functional food sources: revisiting our understanding. J Appl Phycol. 2017;29:949-982.
3. Figueiredo F, Encarnação T, Campos MG. Algae as functional foods for the elderly. Food Nutr Sci. 2016;7:1122-1148.
4. Ibañez E, Cifuentes A. Benefits of using algae as natural sources of functional ingredients. J Sci Food Agric. 2013;93(4):703-709.
5. Wells ML, Potin P, Craigie JS, *et al.* Op cit.
6. Bleakley S., Hayes M. Op. cit.
7. National University of Ireland, Galway. Available at: http://www.enalgae.eu/ireland-galway.htm
8. Ibid

developed a large-scale macroalgal pilot facility and is seeking greater insight into how macroalgal yield is influenced by surrounding habitat[7].

These advances certainly appeal to food manufacturers, who will look at the cost and nutritional density per kilogram of algae compared to other sources of protein, fibre and micronutrients that they would need to purchase separately and blend into their products. While roughly on par cost-wise with other sources, algal strains allow manufacturers to simplify the ingredients list, minimise unwanted interactions and streamline in-plant processes – while also touting algae as sustainably grown, non-GMO, non-animal and non-soy; and herbicide-, pesticide- and antibiotic-free.

Numerous scientific and logistical challenges remain before the algae era truly gets into full swing. For one thing, researchers are continuing to assess the extent to which algae's benefits, as measured in the raw product, can be incorporated into finished food items[8]. The taste of various algae strains is also being studied, with work being done to keep it as palatable as possible for the average consumer. But there is little doubt that the overwhelming positive features of algae will make it a mainstay of our diets in years to come. So, when you sit down for that meal in 2038, the thought running through your head probably won't be, "Why am I eating algae?" but rather, "This food is delicious!" And the experience will be a treat not only for your taste buds but for your entire body as well.

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