The promising future of microalgae

Microalgae is one of the most promising food for the future: easy to cultivate, offering an abundance of protein and other nutrients, whilst maintaining biodiversity.

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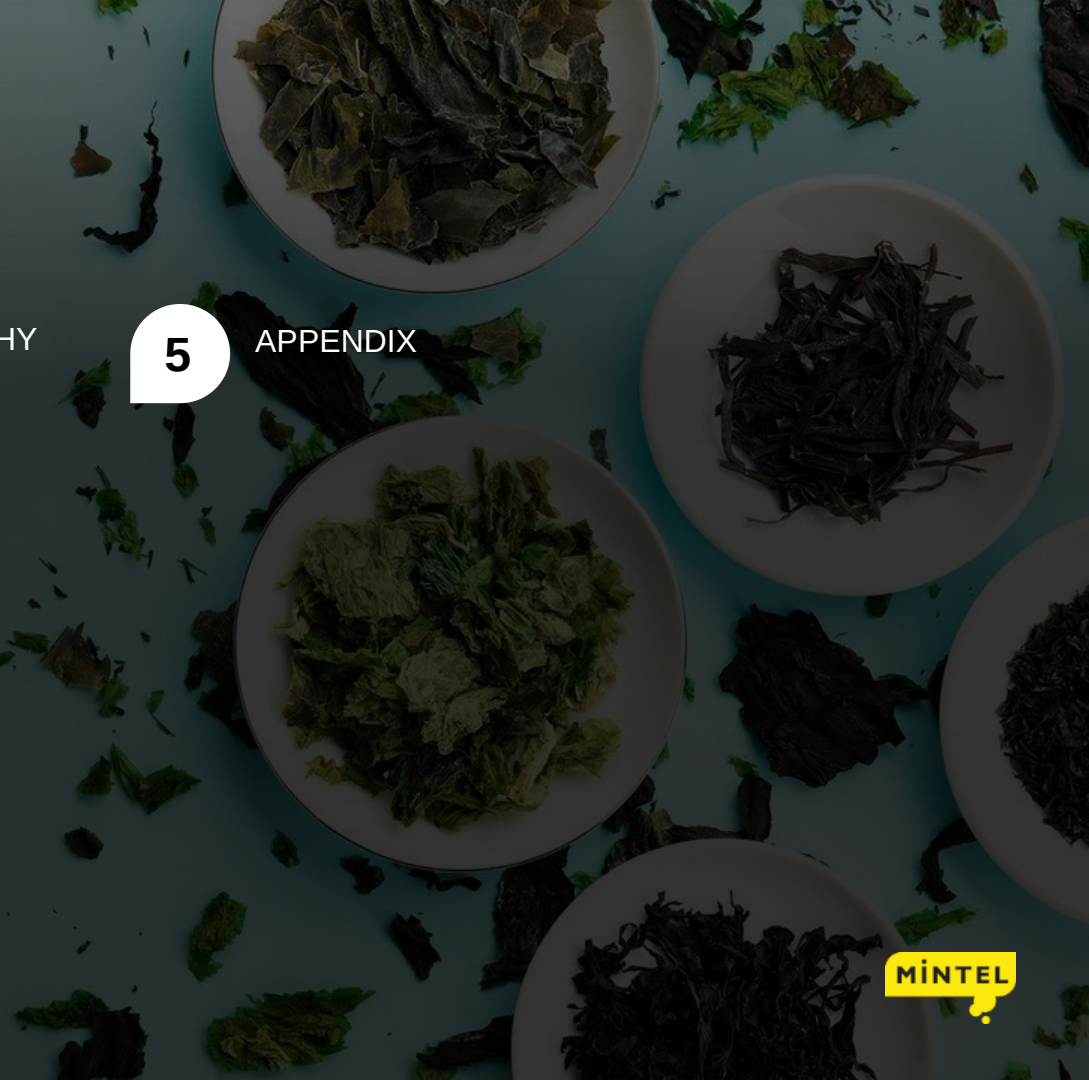


At a glance

What consumers want and why

Concern over limited nutritional resources and increased awareness of natural and sustainable nutritional sources have a major impact on consumers' acceptance of using microalgae as a food source.

Product innovation trends

The abundance of proteins and other essential nutrients found in microalgae is a positive for the development of an algae-based food industry, dedicated to commercialization of healthy and functional foods.

The patent landscape

Recent patent activity for edible algae/microalgae focuses on improving the organoleptic properties of the algal protein and the use of microalgae as a nutritional source in food/drink.

Pigments present in non-toxic microalgae provide an opportunity for use as a natural food colour.

Mintel's perspective

1

Microalgae as a sustainable protein source

Microalgae is a promising and sustainable protein source.

This is due to its high protein content and the presence of essential amino acids in its composition, combined with the fact that it needs minimal resource requirements for growth.

2

Micronutrients from microalgae to combat malnutrition

Micronutrient deficiency is an important global health issue, affecting both physical and mental health and immunity.

The abundance of micronutrients (vitamins and minerals) make microalgae one of the most important ingredients to overcome malnutrition economically.

3

Microalgal pigments as a natural food colour

Microalgal pigments are gaining interest especially as a natural blue or green food colour due to the health issues linked to synthetic food colours.

Phycocyanin pigments give microalgae a blue-coloured appearance, are non-toxic in nature, and can be used as a non-allergic, food-safe and stable natural blue colour in food and drink.

Source: *University of Oxford*

WHAT CONSUMERS WANT AND WHY

Concern over limited nutritional resources and increased awareness of natural and sustainable nutritional sources have a major impact on consumers' acceptance of using algae/microalgae as a food source. Experimental attitudes and exposure to international cuisines also has an indirect effect on the acceptance of microalgae-based food and drink.

Algae/microalgae will benefit from the demand for natural ingredients

Demand for 'better for me, better for the planet' ingredients should open opportunities for algal/microalgal ingredients

INTEREST IN NATURAL INGREDIENTS

53%

of German consumers are interested in cooking/pasta sauces that contain all-natural ingredients

INTEREST IN SUPERFOODS

22%

of UK consumers are interested in cooking/pasta sauces that contain superfood ingredients

Base: *826 internet users aged 16+; 1,000 internet users aged 16+; 1,659 internet users aged 16+*

Source: *Lightspeed/Mintel*

Consumers are interested in free-from artificial flavour and colour claims

Algal/microalgal ingredients can deliver visual and sensory characteristics (flavour and colour) while maintaining clean labels

FREE OF ARTIFICIAL FLAVOURS

35%

of US consumers agree that an artificial flavour free food claim is important

REDUCE MSG CONTENT

37%

of Chinese consumers who are responsible for cooking at home have used less MSG when cooking, to reduce salt intake

FREE OF ARTIFICIAL COLOURS

31%

of US consumers agree that an artificial colour free food claim is important

Base: *2,000 internet users aged 18+; 2,100 internet users aged 20-49 who are responsible for cooking at home; 2,000 internet users aged 18+*

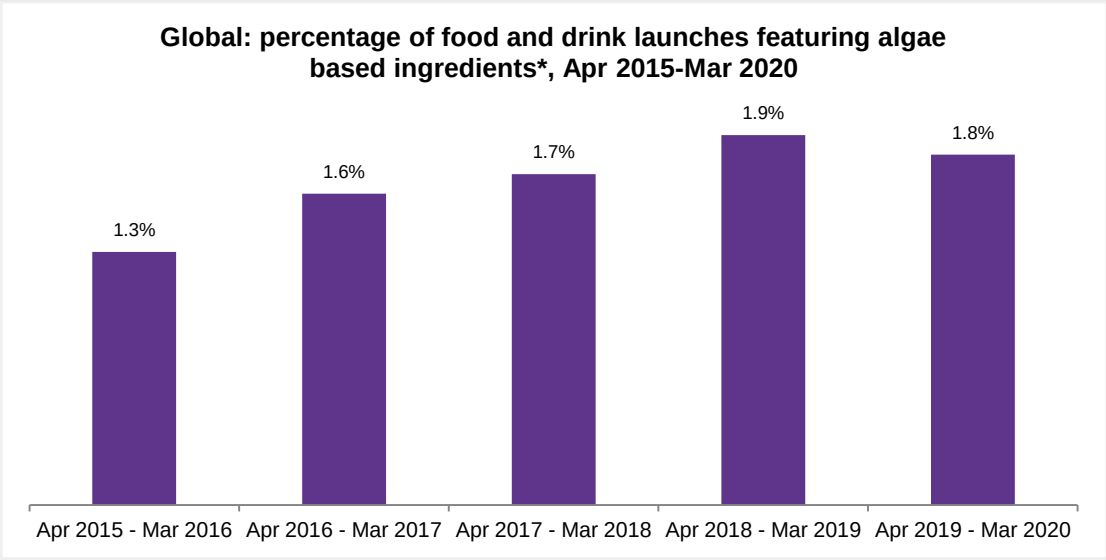
Source: *Lightspeed/Mintel; KuRunData/Mintel*

PRODUCT INNOVATION TRENDS

The abundance of proteins and other essential nutrients found in algae is a positive for the development of an algae-based food industry, dedicated to commercialization of healthy and functional foods. Consumer willingness to experiment with new food sources creates opportunities for a variety of algae-based products.

Rise in food and drink launches containing algae

Although algae (carrageenan and agar) has been widely used in edible categories as a thickener, gelling or bulking agent, there has been an increase in use of algae-based ingredients as a micronutrient, protein and omega fat in recent years.



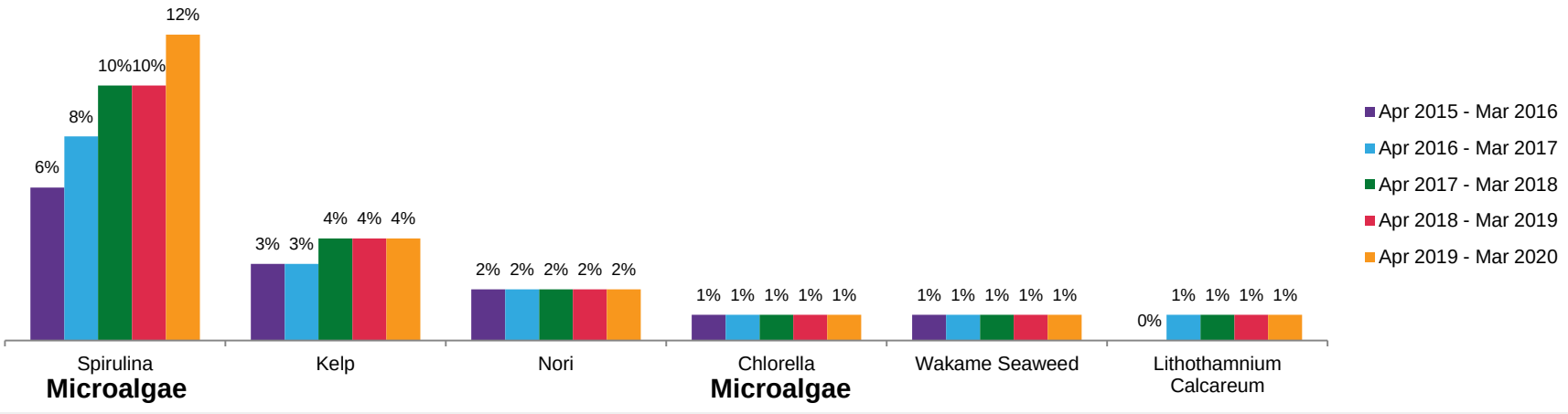
Base: ** excluding the use of carrageenan/agar as an emulsifier/stabilizer; including the use of algae as protein, algal oil, and other minerals of algal origin*

Source: *Mintel GNPD*

Spirulina is the most popular edible algae in food, drink and healthcare categories

Although the use of algae is more popular in Asia, in the last five years it has also become more mainstream in the European market. *Spirulina* is the leading ingredient used.

Global: percentage of algae* containing food, drink and healthcare launches, by selected edible algae variety, Apr 2015-Mar 2020



Base: ** excluding use of algae as carrageenan & agar*

Source: *Mintel GNPD*

There is growing interest in microalgae-based colours, functional food and drinks

Green tea with extra antioxidants
Wissotzky Super Green Green Tea with Spirulina and Green Herbs contains antioxidants from *spirulina* seaweed combined with green tea leaves (Israel).

Juice with a natural blue twist
Frank Juice Blue Spirulina Water with Lemongrass, Lemon & Honey contains (<1.0%) blue coloured *spirulina* extract as a colouring agent (Germany).

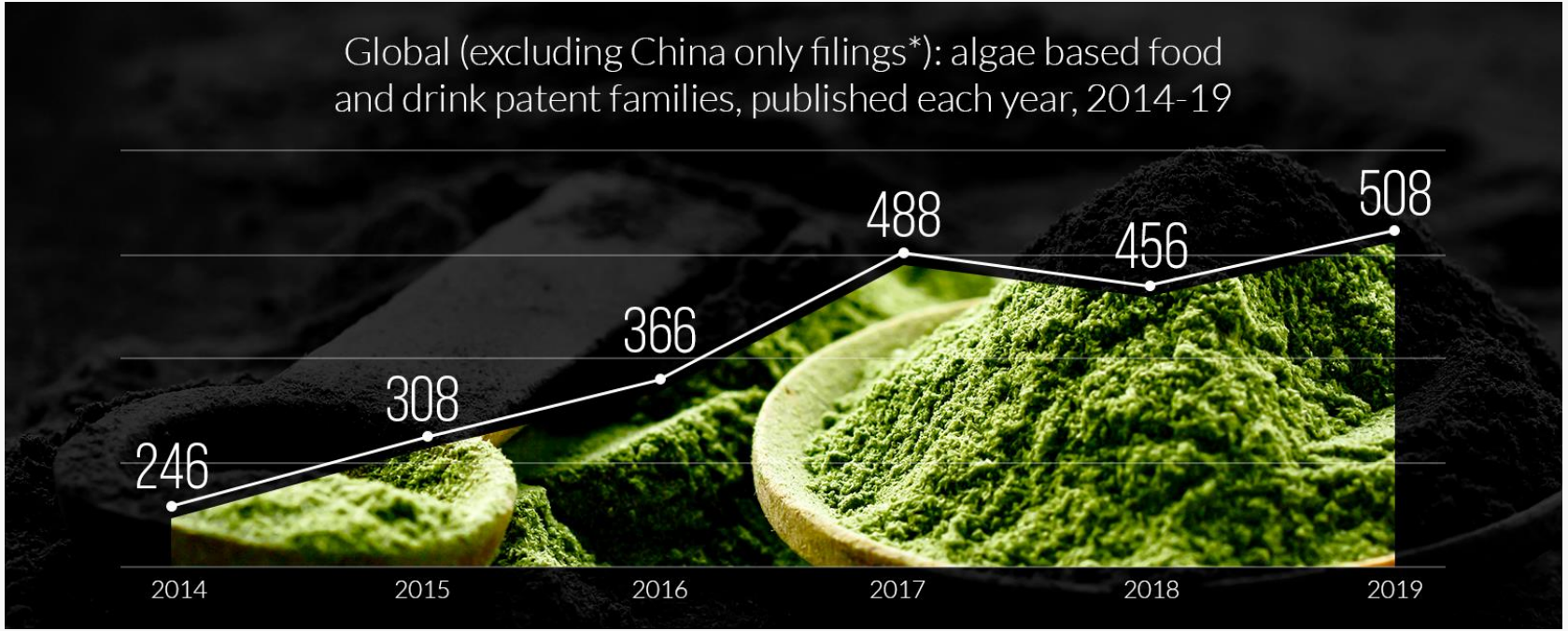
Protein rich, low cholesterol porridge
Lima Gluten-Free Oat Flakes with Matcha and *Spirulina* is rich in fibres and protein, and made without added sugars (Netherlands).

Source: *Mintel GNPD*

THE PATENT LANDSCAPE

Recent patent activity for edible algae focuses on improving the organoleptic properties of the algal/microalgal protein, and its use as a nutritional source in food and drink. Pigments present in non-toxic microalgae provide an opportunity for use as a natural food colour.

Patent activity for algae-based food and drinks continues to grow

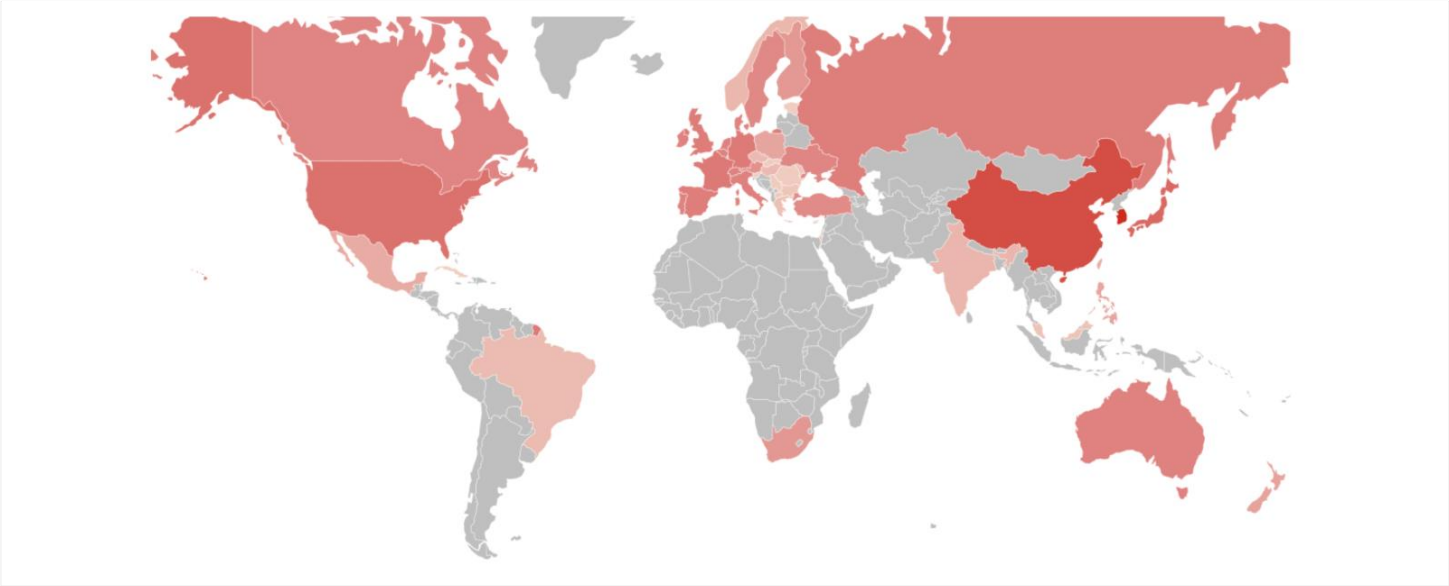


Base: *Includes all published patents whether they have been granted, are pending, inactive or expired; * excludes patents filed only in China given the distorting number of these (in 2019 alone, 639 patent families have been published in China)*

Source: *Cipher/Mintel*

Algae are an important source of food in some Asian countries and patent activity also shows their importance in these areas (including China)

The leading countries for granted patents are South Korea: 23%, China: 14%, Japan: 8%, USA: 6%, France: 4%



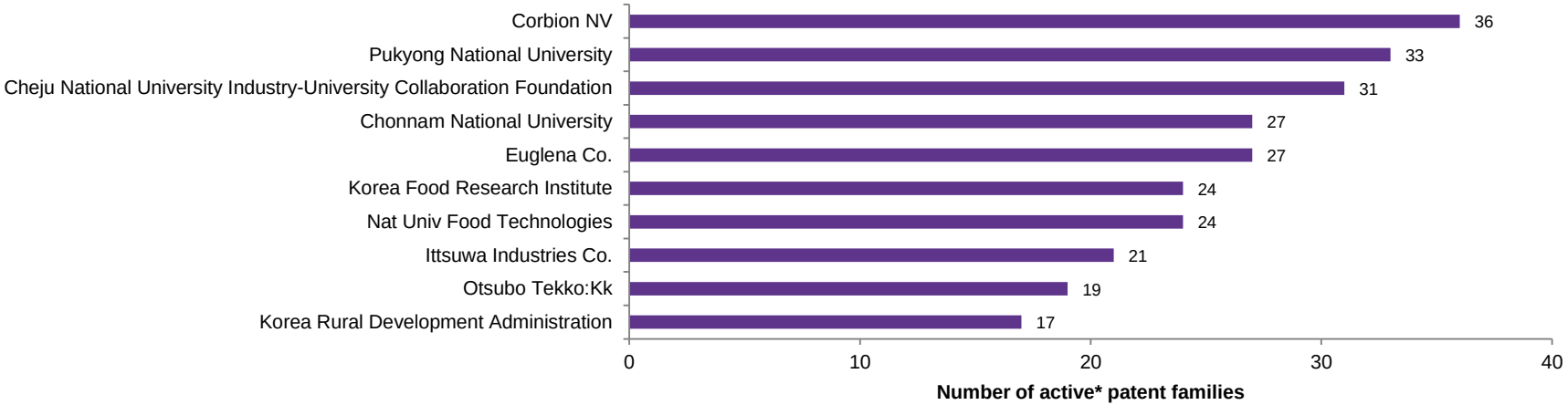
Base: *currently active individual patent grants per country; numbers are aggregated if multiple organisations are selected*

Source: *Cipher/Mintel*

Corbion NV, a Dutch food and biochemical producer, leads in algae-based ingredient innovation

Other than Corbion NV, algae-based food and drink related patent filings are dominated by Korean universities and research institutes.

Global (excluding China only filings): top 10 organisations with currently active* patent families for the use of algae in food & drink, Jan 2020



Base: ** active patent families refers to currently granted or pending patents; excludes patents filed only in China*

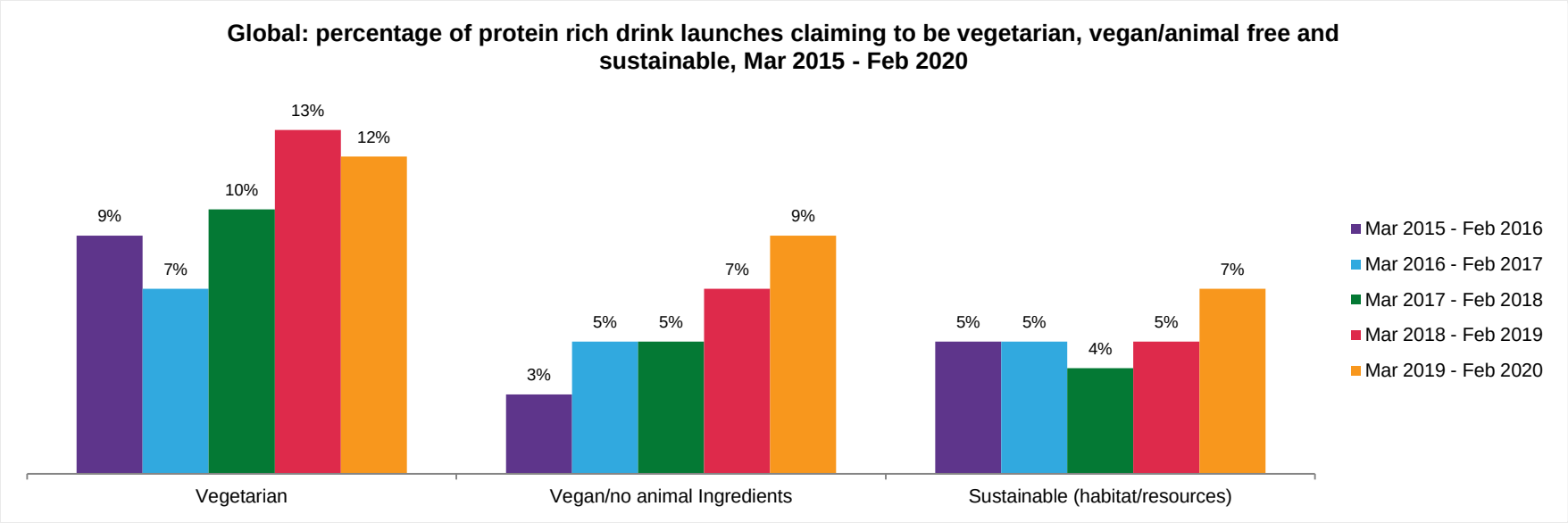
Source: *Cipher/Mintel*

Microalgae as a sustainable protein source

Microalgae is a promising and sustainable protein source. This is due to its high protein content and the presence of essential amino acids in its composition, combined with the fact that it needs minimal resource requirements for growth.

Consumer interest in 'better for me, better for the planet' food and drink should continue to drive demand for plant proteins

Growing consumer interest in vegan/animal-free and sustainable protein sources will lead to more incorporation of algal protein in food and drink products.



Source: *Mintel GNPD*

Consumers show interest in algae-based protein

The consequences of poor eating habits and the high cost of animal protein attracts consumers to consider algae as a sustainable and economical protein source.

IN THE US

36%

of consumers either claim to be currently eating algae as a protein source (8%) or are interested in trying it (28%)

IN CANADA

40%

of consumers either claim to be currently eating algae as protein source (10%) or are interested in trying it (30%)

IN FRANCE

38%

of consumers perceive that marine protein/algae (eg. *spirulina*) is a healthy non-traditional protein source

Base: *2,000 internet users aged 18+; 2,000 internet users aged 18+; 1,000 internet users aged 16+*

Source: *Lightspeed/Mintel*

Demand for proteins that are compatible with both plant-based and gluten-free dieting could open opportunities for microalgal proteins

Microalgal protein contains essential amino acids and is recognized as a substitute for animal protein.

Nüber Food Ltd has a pending patent for baked food products prepared using vegetables, pulses, nuts, fruits and **algae flour to increase the protein content of the final product**, especially for consumers who want **protein-rich, gluten-free food** products.

Zivo Bioscience's pending patent covers high-protein algal biomass from genus *Klebsormidium (NCMA Deposit # PATENT201602001)*, for use in the manufacture of **dietary supplements and food including snacks (eg, chips, crisps, puffs, crackers, etc**) to provide adequate levels of dietary protein requirement.

Corbion Biotech has a pending patent for making **high-protein and low-pH food products (such as fruit juice, salad dressing or sauce)** using microalgal flour obtained from *Chlorella prototheco*ides.

Gluten- and soy-free protein bar
Simply Raw Protein RAW BA Raw Fruit Bar with *Spirulina* and Lemon Oil is a 100% organic bar with 20% protein, and is free from lactose, gluten, dairy, egg, soya palm oil and preservatives (Germany).

Source: *Cipher/Mintel; Mintel GNPD*

THERE ARE OPPORTUNITIES FOR SCIENCE TO HELP PRODUCERS TO OVERCOME THE SENSORY CHALLENGES OF MICROALGAL PROTEINS

Despite the many advantages of microalgal protein, its intense green colour, strong odour and unacceptable organoleptic properties are the major barriers that limit its application in food preparations. However, recent scientific developments are looking to overcome the smell, colour and taste profile issues of microalgal protein.

Combat unpleasant odour, taste and unacceptable colour profiles of algal proteins

Pre-treatment of algal biomass

Synthetic Genomics Inc's pending patent claims a method to produce algal protein (from *Labyrinthulomycetes*) that are nutritionally superior to other available vegetable proteins and **have organoleptic properties acceptable to humans**. The method includes delipiding and treating the biomass under a series of varied acidic conditions.

Acidic treatment of algal biomass

Smallfood Inc has a pending patent for a method of producing protein material from algal biomass by treating it under an acidic environment for 30 minutes. The claimed process **improves the organoleptic properties and unpleasant smell of algae-based protein**, so as to make it applicable to be used in a wide range of food products.

Decoloration & smell-reduction

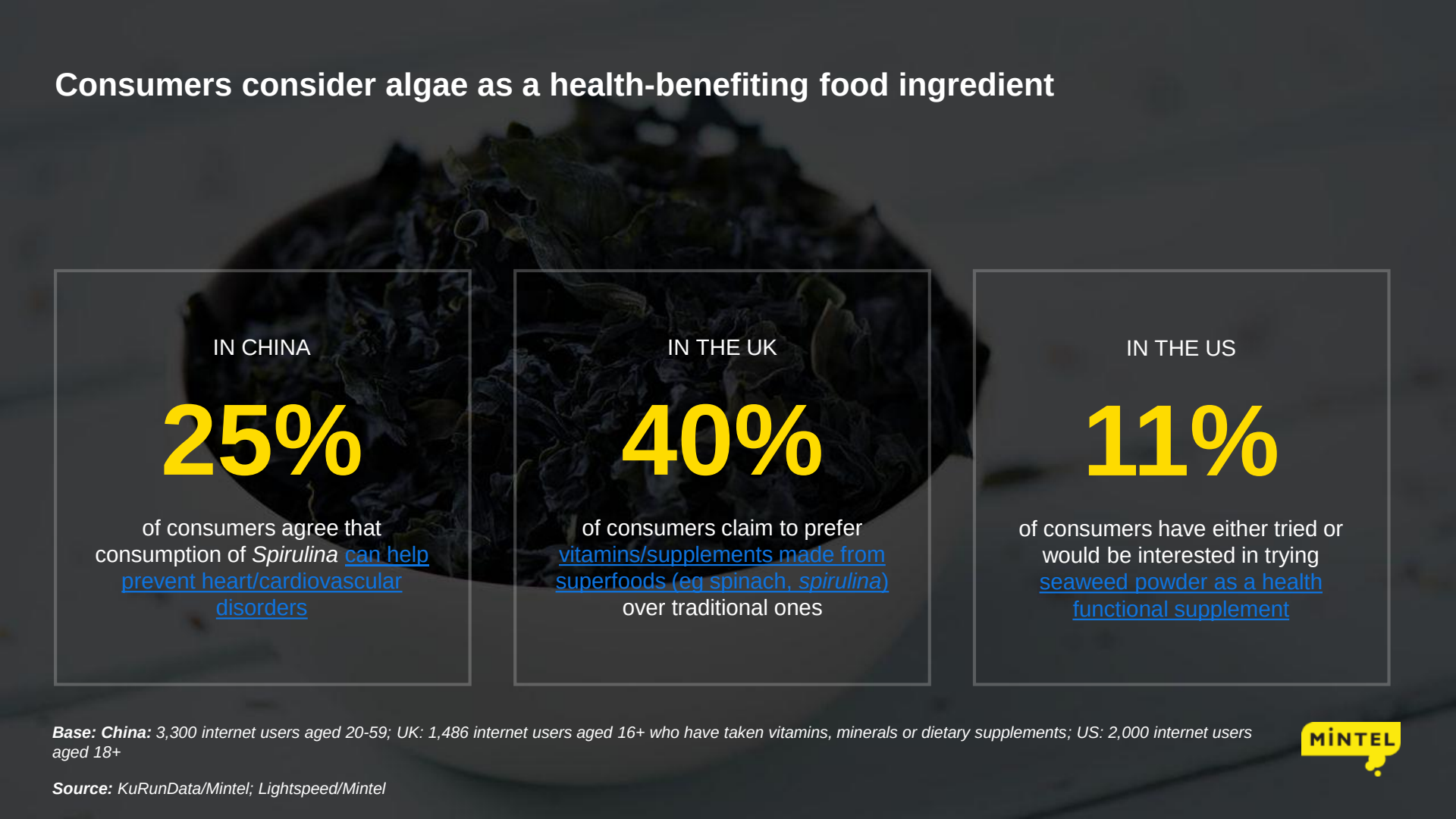
A PCT publication by Tavelmout Corp covers a method of cultivating algae in a medium having nitrogen content (500mg or less/liter of medium) at 23-30°C for 5 days to 6 months, followed by treatment with organic solvent. The claimed method **suppresses the colour and smell of algal protein**, making it acceptable for use in food/drink.

Source: *Cipher/Mintel*

Micronutrients from microalgae to combat malnutrition

Micronutrient deficiency is an important global health issue, affecting both physical and mental health and immunity. The abundance of micronutrients (vitamins and minerals) make microalgae one of the most important ingredients to overcome malnutrition economically.

Consumers consider algae as a health-benefiting food ingredient



IN CHINA

25%

of consumers agree that consumption of *Spirulina* can help prevent heart/cardiovascular disorders

IN THE UK

40%

of consumers claim to prefer vitamins/supplements made from superfoods (eg spinach, *spirulina*) over traditional ones

IN THE US

11%

of consumers have either tried or would be interested in trying seaweed powder as a health functional supplement

Base: China: *3,300 internet users aged 20-59; UK: 1,486 internet users aged 16+ who have taken vitamins, minerals or dietary supplements; US: 2,000 internet users aged 18+*

Source: *KuRunData/Mintel; Lightspeed/Mintel*

Microalgae as a promising source of prebiotics

Beta-1,3-glucan

A pending patent by F3 Platform Biologics covers a method for **producing a purified beta-1,3-glucan from *Euglena* lysate** using improved fermentation techniques. *Euglena*-derived beta-glucan acts as a prebiotic for GI micro-flora to improve immune response and also claims to have other health-promoting properties.

Phycocyanins as a prebiotic

A pending patent by individual inventors covers the use of the **phycocyanins, from the *Aphanizomenon flos-aquae* micro-algae as a prebiotic** to enhance the GI probiotic strain's viability, growth, resistance to bile and acid conditions, and ability to kill intestinal pathogens (*E. Coli, Staphylococcus aureus* and *Candida albicans).*

Source: *Cipher/Mintel*

Microalgal oil as a cruelty-free omega fatty acid source

Algae-Based Omega-3 EPA+DHA Daily Support Softgels

Omega fatty acids (omega-3, omega-6, omega-9, etc), are important for human health. The human body cannot produce these fatty acids and depends on external sources like fish oil to fulfil requirements. Algal oil is rich in omega fatty acids and can be a great animal-free alternative for those who don't eat seafood or can't tolerate fish oil.

Qingdao Institute of Bioenergy and Bioprocess Technology CAS has a granted patent for the method of cultivation of *Tribonema sp.* under specific culture conditions for **large scale production of omega-7 fatty acids** that have a wide range of food, cosmetic and pharmaceutical applications.

A pending patent by Devenish Nutrition Ltd covers algal omega-3 PUFA-enriched animal meat for human consumption. The claim is that it increases the omega-3 PUFA levels in human plasma and **reduces the risk factors of cardiovascular disease**.

Source: *Mintel GNPD; Cipher/Mintel*

Microalgae-based carotenoids for health and wellness

Carotenoids are the potent biological antioxidants that protect human tissue from chemical damage caused by free radicals.

Algae, especially marine microalgae, are a natural and economic source of a variety of carotenoids (for example, β-carotene, lutein, zeaxanthin, etc) that play important roles in prevention and treatment of human diseases and health conditions.

β-carotene, lutein, and zeaxanthin are associated with improving and maintaining eye health. Korea Research Institute's granted patent claims novel microalgae (*Chlorella HS3 KCTC 13133BP*) with high lutein productivity, used to treat age-related macular degeneration and **prevent eye disease**.

Another PCT publication by University De Antofagasta covers the microalgae cultivation method to produce high lutein content and low metal content. Lutein can be used as an antioxidant in functional foods and animal feed.

72%

of Brazilian consumers are interested in vitamins and supplements (for example lutein) for eye health

Base: *1,500 internet users aged 16+ (Aug 2019)*

Source: *Lightspeed/Mintel*

Microalgae: an exciting nutritional source to overcome micronutrient deficiency

Neal's Yard Remedies SuperNutrient Vitamin B Supplement is a vitamin B supplement sourced from *Spirulina* for normal brain functioning, maintaining normal energy metabolism, and reducing tiredness and fatigue (Sweden).

In addition to the presence of a significant amount of protein content, microalgae is also high in dietary fibre, polyunsaturated fatty acids, β-carotene, antioxidants, sulphated polysaccharides, sterols, vitamins and minerals (iodine, zinc, calcium and magnesium, etc), making it an exceptional nutritional source, especially for vegans or vegetarians.

A granted patent by Mosterei Ketzuer GmbH cover the use of **powdered *Chlorella Vulgaris* as a source of vitamin B12** in fruit juices.

Another PCT publication by inventor Scoglio Stefano covers ***Aphanizomenon flos aquae* microalgae (from Klamath Lake, Oregon US) based vitamin or mineral supplements** to prevent or treat the nutritional deficiencies in humans.

Source: *Mintel GNPD; Cipher/Mintel*

Microalgal pigments as a natural food colour

Phycocyanin pigments give microalgae a blue-coloured appearance, are non-toxic in nature, and can be used as a non-allergic, food-safe and stable natural blue colour in food and drink.

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Microalgal pigments as a safe and natural food colour

IN THE US

39%

of consumers consider the presence of natural ingredients (for example no artificial colours) as important when buying food.

Generally, synthetic chemicals are used in food and drink to enhance their visual appearance by giving it artificial colour. Sometimes these affect the taste of food and certain artificial colours are linked to hyperactivity in children. Demand for natural food colours is growing and as a result, many fruit and vegetable pigments (e.g. from beetroot, berries, turmeric, carrot) are used to replace synthetic colours. However, replacing a synthetic vibrant blue colour with a natural alternative has been challenging.

Although red cabbage, blue coloured edible flowers, and blueberries are used to produce natural blue colours for food, these colours suffer from stability issues, at different temperatures and pH levels.

A granted patent by Rheinländer Thomas covers a method to stabilize blue coloured spirulina extract by the addition of alkanediols and/or alkanetriols. The claimed blue coloured extract can be used as a **natural blue colour** in a wide range of food products.

Fermentalg has a PCT publication for the method of cultivating red algae and extracting the **coloured pigments phycocyanins** from algae for its use as a natural food colourant.

Base: *2,000 internet users aged 18+ (Nov 2019)*

Source: *Lightspeed/Mintel*

MINTEL

Algae-based natural blue colour has gained popularity among food manufacturers

Consumer demand for natural blue colours for food and drink leads manufacturers to explore algal-derived blues

Go blue to reduce fatigue
Innocent Bolt from the Blue Juice is a blend of fruit juices (guava, lime and apple), coconut water, and 0.8% blue spirulina extract that gives blue colour to the drink and claims health benefits (reducing tiredness and fatigue) (Ireland).

Natural clean food
Wholey Ocean Bowl Premium Smoothie Mix gets its blue colour from the superfood algae spirulina, is free from artificial colour, suitable for vegans and those allergic to gluten (Germany).

Blue spoonable yoghurt
7-Eleven Yogurt & Skyr Blue Spirulina Bowl. Contains: blue spirulina powder 1%, for a blue colour, and potentially also for 'perceived' health benefits. (Denmark).

Source: *Mintel GNPD*

SUMMARY

Recent developments in improving the taste, odour and colour profile of microalgal protein might disrupt the existing plant protein market

An increase in awareness of the health benefits of microalgae-based ingredients is the main driver that supports algae-based food and drink trends. The presence of essential amino acids makes microalgae protein superior to some other plant proteins and this might disrupt the plant-based protein market and see the rise of algal protein as a vegan, gluten-free, soy-free, sustainable and non-GMO protein.

Recent patent development focuses on techniques to remove the unacceptable fishy odour and colour of microalgal protein to increase its application in protein shakes and other food and drink items.

Vibrantly coloured food and drinks are more popular among the younger generations. Additionally, consumers are demanding naturalness in the food colour category and this may attract big brands to incorporate microalgae-based natural vibrant colours in food and drink.

APPENDIX

Research Methodology

Patent analysis methodology

The patent analysis contained within this report is based on Mintel's partnership with Cipher, the world’s most sophisticated patent analysis system; it uses artificial intelligence to analyse global patents and classify them under specified topics. Having designed the topic of classification, Mintel's expert team of global analysts have then analysed the output from Cipher, assessing the key patents of interest and the trends they represent, identifying the implications using our in-depth understanding of consumer and industry trends.

Consumer research methodology

Mintel continuously commissions consumer research across the globe for it's syndicated research solutions. Research is carried out by a variety of research providers as detailed in the sources.

Innovation tracking methodology

Via a network of shoppers across 86 countries, Mintel's Global New Product Database tracks new product launches in the food, drink, beauty and personal care, health and hygiene, home care and pet markets.

Meet the Expert

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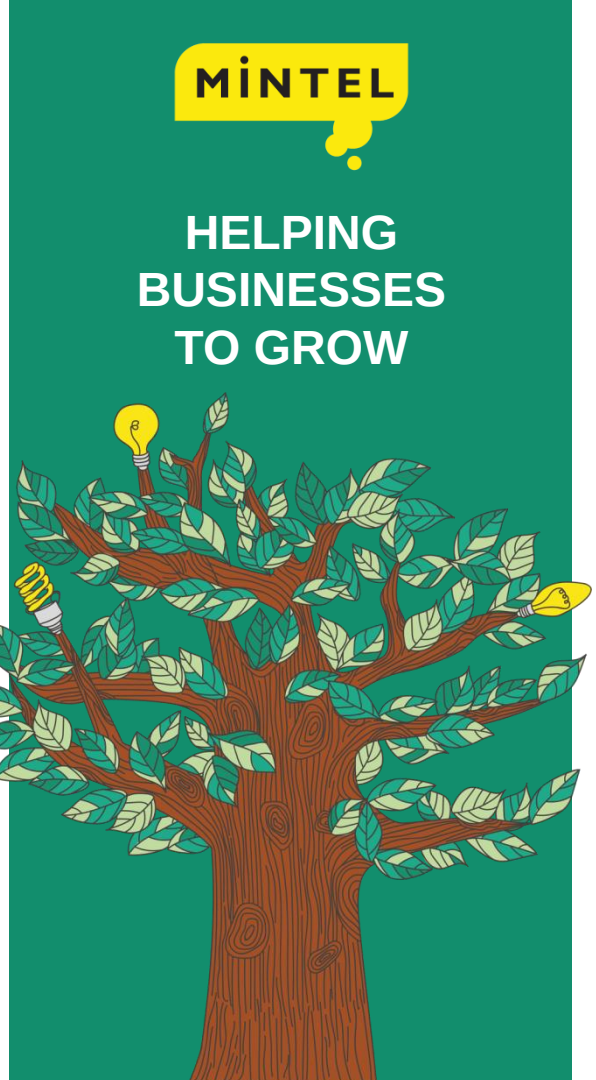

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