Creating consumer demand for algae-based products

eit Food

Co-funded by the European Union

CONTENT

About the study

Algae* are high in protein, omega oils and a range of vitamins and minerals. They grow in salt water, double in size every day and absorb CO_2. Despite all this, algae haven't really made it yet as a dietary product. They have great potential, but do we really want them on our plates?

Algae have a strong nutritional profile and typically contain essential amino acids, essential fatty acids, including omega-3, as well as vitamins, such as A, D and E. Certain types of algae can contain up to 70% of their dry weight in protein, which is higher than soy. Furthermore, algae crops have the ability to fix CO_2, meaning they absorb it from the atmosphere and convert it to organic matter, and they are 10 to 50 times more efficient at doing this compared to terrestrial plants. At the same time, algae do not require chemical fertilisers which reduces their environmental impact further, and in some cases algae could even have a positive impact on the environment.

These qualities mean algae are the perfect candidates to be a future staple of a healthy diet and an integral component if we are to build a more sustainable food system.

To fulfil the huge potential that algae have, we need to explore how food system actors can turn consumer perceptions into consumer preference.

In this study we discussed the perception of algae as a food, experience of eating algae and algae-based products, and the role that algae could play in making the food system more sustainable. We did this with 111 consumers from 18 different countries, and with 7 experts from different organisations working with algae. The goal was to obtain insights on how consumers perceive algae to enable actors in the food chain to develop more tailored consumer-centric product propositions and campaigns, as a step towards achieving a healthier, more sustainable food system.

This work forms part of a series of studies to gain consumer insights which are important for EIT Food and the EU.

***Algae referred to in this report include both macroalgae (e.g. seaweed) as well as microalgae (e.g. plankton, blue-green algae).**

1

Executive summary

The potential for algae as a novel food

Participants were familiar with algae as a food. Algae were mostly considered healthy and versatile ingredients, but ingredients which currently make up a very small proportion of the participants' diets, if at all. Furthermore, algae were seen as a rich source of vitamins, but were less known for their other health properties.

Although some health benefits of algae were recognised by consumers, the positive environmental impact of farmed algae was not, with consumers not aware of the potential benefit for reducing atmospheric CO_2. However, on learning this information, our study participants found it to be very appealing and a good reason to try algae as a dietary product.

Taste is a great predictor of food acceptance, and consumers are not yet convinced of the taste of algae. Those who have eaten it before are mostly positive, however those who haven't, are not certain they will enjoy it.

This study confirms that there is potential for algae to become a healthy dietary staple for more people. Our findings suggest that with the right messaging and the right products, consumers are likely to be interested in incorporating specific types of seaweed and microalgae to their meals.

Key findings: Seven lessons for making algae-based product innovations a success

1. Emphasise the nutritional properties of algae

Strong nutritional profile was found by the majority of study participants to be the most convincing argument for eating algae. This is compared to other features of algae, like their sustainable production methods and taste, and is partly because many consumers already knew or at least had heard about specific types of algae being healthy, for instance spirulina.

2. Educate consumers on the environmental benefits of algae

The environmental benefits of algae were mainly unfamiliar to consumers. Often algae were (wrongly) viewed as something harmful for the environment, for example algal blooms that make lake water undrinkable, or at the very best neutral. Consumers were mainly unaware of how algae are produced or farmed.

3. Collaborate with restaurants and chefs

Consumers were generally unsure about how to include algae in their diets. Having algae on the menu in restaurants would make them visible and easily accessible to more people, as a dish prepared by a chef provides a certain guarantee that it will taste good. This will help to lower the purchasing barrier, as well as provide inspiration on ways to prepare algae.

4. Back up claims and don't make exaggerated promises

Consumers felt they are bombarded by 'green claims' and want to see proof. Claims about the nutritional value and sustainability of algae need to be backed up by scientific evidence. Consumers were also sceptical about claims that sound 'too good to be true'. They were reluctant to believe in yet another superfood and want to see a realistic picture of algae, which may include the cons as well as the pros. An example of this would be high iodine levels in kelp.

5. Create opportunities for consumers to try algae

Consumers who have never eaten algae before are sceptical about the taste. Yet, taste remains a leading component for making food choices. Organising tastings in supermarkets or supplying free trial samples will help to provide consumers with an opportunity to change their opinion on taste.

6. Encourage consumers to incorporate algae in their diets as an addition, rather than a replacement

As most consumers are unfamiliar with the taste of algae or how to best prepare it, it can be overwhelming to hear that it can be used to replace meat, fish, or even soy-based products. It may instead be more beneficial to introduce algae as a complementary ingredient that will enrich diet, rather than a replacement ingredient. Consumers also wanted to see exactly how they could use algae, so promoting specific recipes is helpful.

7. Promote the specific species with their concrete benefits, instead of promoting algae as a category

The category 'algae' as whole is currently not associated with many positive connotations and is too broadly defined, however certain types of algae, such as spirulina, are already known for their benefits. It would be more effective to promote specific species of algae with specific benefits and specific applications.

Using the right message to promote algae as a novel food

In order for algae to successfully becoming part of more people's diets, the right promotional message is key.

Through this study we found that the following four different messages, were the most convincing:

1. It's good for you

The most appealing message is the health benefit of consuming algae. Even though consumers had a general impression that algae are healthy, they were not certain about the specifics. Stressing the health properties of specific kinds of algae, like spirulina and chlorella, and how they benefit health can be a great first step in promoting the consumption of algae.

2. It's good for the planet

Consumers generally felt that algae might fit into a sustainable diet, such as a plant- based diet. However, they did not know enough about the potential that algae have for positive environmental impact. For instance, the fact that algae are great at removing carbon from the atmosphere, and do not require fertilisers to grow, is not very well known.

3. It's an engaging experience

The fact that algae are tasty and versatile needs to be part of the messaging, as many consumers who have not tried algae in the past are reluctant to try because of negative taste expectation and not knowing what to make with them. Promotion needs to give consumers the tools to be able to prepare algae themselves, and specific, easy to prepare products, including recipes are necessary.

4. You are already eating algae

Not many consumers knew that it is likely that they had already eaten algae, for instance agar-agar is a gelling agent in processed foods made from algae. This information can help normalise the idea of algae as a food. However, it is not a major motivator for trying algae for the first time.

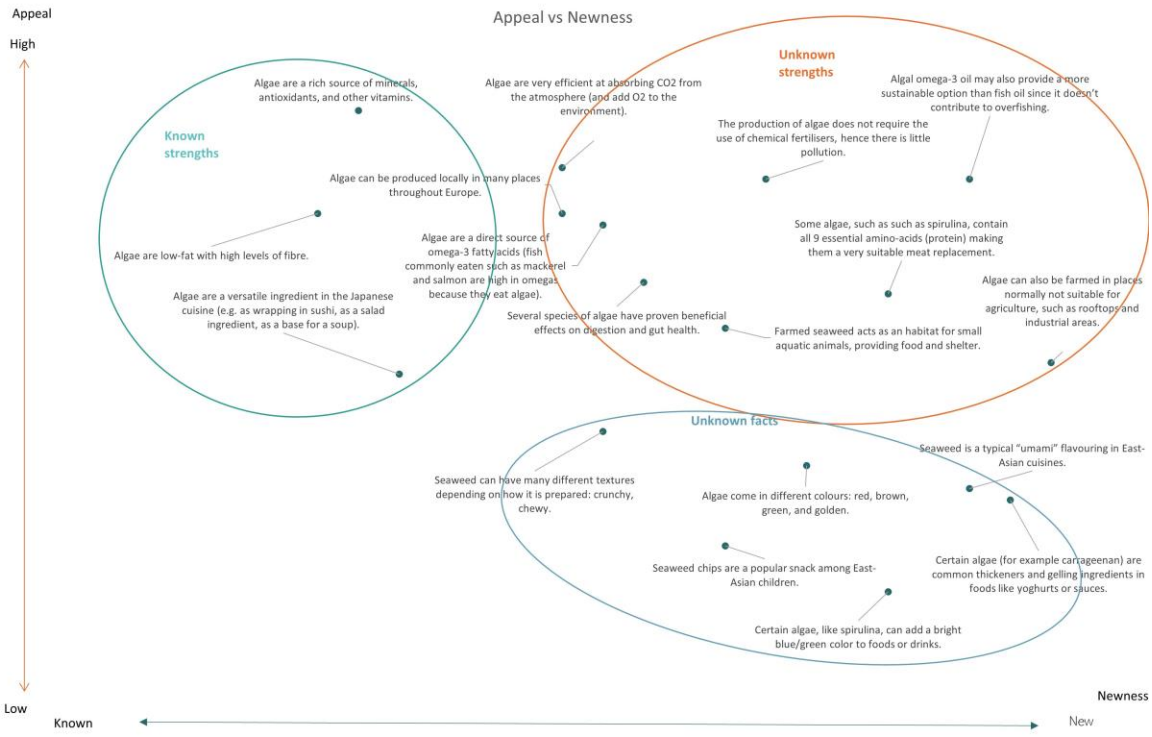
2

Current consumer attitudes towards algae as a food

Appeal and newness: what characteristics of algae strike a chord?

During the first activities, we aimed to better understand the perception of algae as a food. We asked participants to rate a series of statements about algae on how appealing they find them, as well as to what extend this is new information to them.

Based on their responses, we grouped the statements of algae as 'known strengths', 'unknown strengths' and 'unknown facts'.



This exercise led to the development of three groups of messages:

Known strengths

These are facts about algae that are mostly known, and highly appealing. These can be facts which are considered 'common knowledge' and are the current reasons why people are interested in algae-based products.

Algae are currently known for being a rich source of minerals, antioxidants and other vitamins and being low in fat and high in fibre. It was also widely known that they are used in Japanese cuisine.

Unknown strengths

These are facts about algae that are mostly unknown, and highly appealing. Making these characteristics better known and using them as a foundation for innovation, could increase the interest in algae-based products.

Most of the sustainable characteristics of algae were new to consumers (and at the same time considered highly appealing):

- Algae can be produced locally in many places throughout Europe.
- The production of algae does not require the use of chemical fertilisers, hence there is little pollution.
- Algal omega-3 oil may also provide a more sustainable option than fish oil since it doesn't contribute to overfishing.
- Algae are very efficient at absorbing CO_2 from the atmosphere (and add O_2 to the environment).

Also, some of the health benefits of eating algae were also unknown, but very interesting:

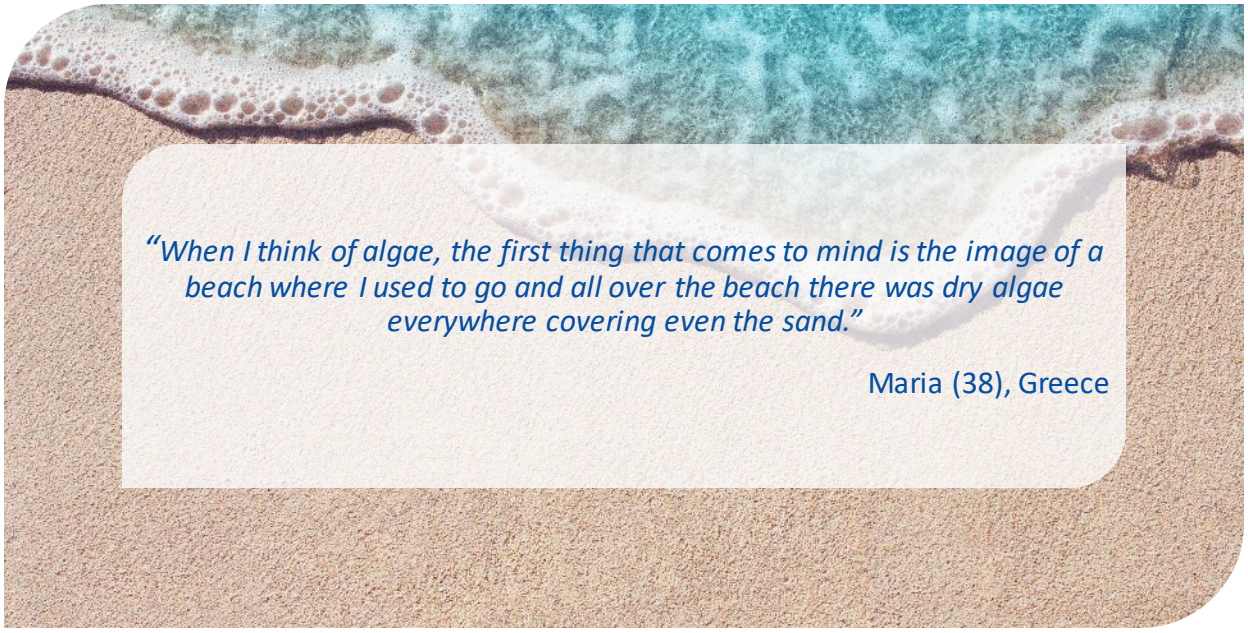
- Algae are a direct source of omega-3 fatty acids (fish commonly eaten such as mackerel and salmon are high in omega-3).
- Some algae, such as spirulina, contain all 9 essential amino-acids (protein) making them a very suitable meat replacement.
- Several species of algae have proven beneficial effects on digestion and gut health.

Unknown facts

These are facts about algae that are mostly unknown, but not very appealing. Promoting these characteristics is not likely to increase demand for algae to a substantial extent.

All the characteristics that fall into this category are directly related to the already existing use of algae in food production. Participants did not consider the fact that algae are already used as ingredients or food as being very relevant for them. In addition, the fact that they add colour or texture to food was not considered appealing.

Associations with algae



"When I think of algae, the first thing that comes to mind is the image of a beach where I used to go and all over the beach there was dry algae everywhere covering even the sand."

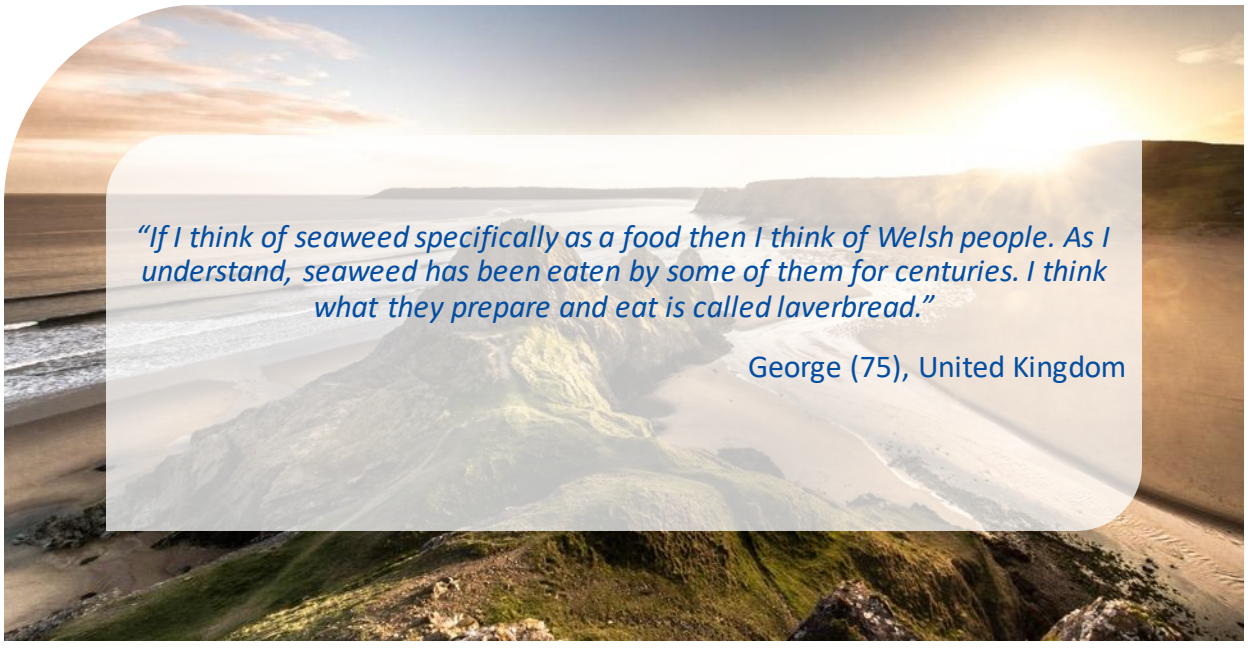
Maria (38), Greece

For many participants, when asked to think about seaweed and algae, the first associations that came to mind were with nature and the sea. Associations were mainly visual; however, associations with (bad) smell were also mentioned frequently.

About half of the participants immediately mentioned algae as a food. Most referred to algae in the form of sushi.

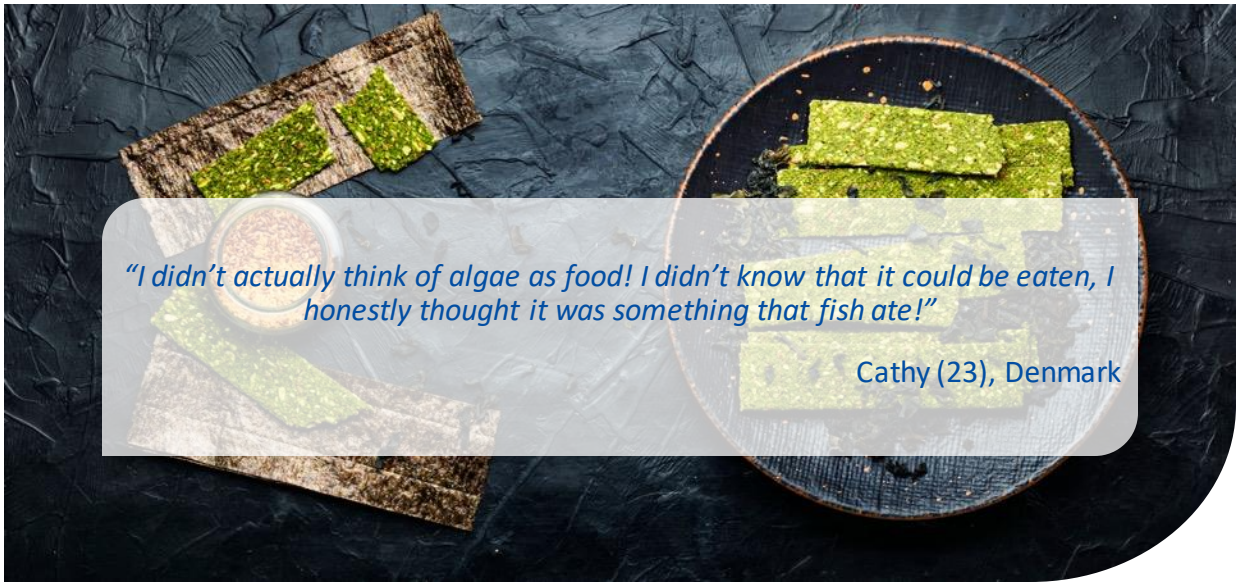
In general, most participants were aware that some kinds of algae can be eaten and predominantly associate algae with traditional, culture-specific foods. Most frequently, sushi and Japanese cuisine was mentioned. But sushi was not the only food participants knew about, other foods mentioned included Welsh laverbread and French Salicornia. A few participants associated algae with gourmet cuisine.

When thinking about eating algae, most participants thought of seaweed rather than microalgae, with the exception of spirulina.



Furthermore, some participants also recognised algae as a superfood and associated it with food innovation. For instance, one participant mentioned that algae have become a food trend and appear more and more in food items such as chips, burgers and salads.

However, not all participants were aware that some types of algae are edible, and only heard of eating algae for the first time during this study.



Experience eating algae

60% of participants reported they had eaten algae or an algae-based product.

Most participants had tried algae for the first time in Japanese or Chinese restaurants. The most-tried type of algae was nori, in sushi. Participants also mentioned wakame (also in sushi or as a salad), and kelp or kombu as a broth base. Others had experience eating it in smaller quantities, as a garnish rather than a main ingredient.

A couple of participants reported they had experience with algae supplements in the form of pills or powder.

Western and Southern Europeans were in general more familiar with algae as a food. Many have eaten sushi before or have seen algae in their local supermarket.

Perceptions of algae

Taste

"I have only tried fried seaweed once but I don't know what kind. The seaweed was crunchy, tasty, flavourful but I can't tell what food they look like. They have a unique flavour that I like."

Antonio (56), Italy

Many participants who had tried algae found the taste appealing, particularly when it was prepared in restaurants.

The taste was most often described as salty, fishy, and reminiscent of the sea. The word 'umami' was also used to describe the flavour of seaweed. Finally, comparisons were made to vegetables (greens) and even grass.

In terms of texture, participants perceived a lot of variation between different kinds of seaweed and algae.

However, not all experiences have been positive. A couple of participants who had previously taken part in product tests of algae-based chips did not appreciate the taste and expressed reluctance to try again.

Health

"I know it's healthy and natural, but not sure of the specifics!"

Rachel (25), Ireland

Algae were perceived to be healthy, even by those with little specific knowledge.

Also, when it came to nutritional values, participants draw parallels to vegetables and salad greens. They considered algae as something natural and associated it with healthy food. Most of the participants perceived algae to have nutritional benefits, even if they did not know exactly what those were.

A small number of participants were familiar with algae as a dietary supplement for better health. The focus was on vitamins and minerals, and less on protein. Most participants believed that the nutritional benefits of algae is due to vitamins and minerals. Others mentioned fibre and lack of fat as an (expected) benefit. A small number of participants said that they knew algae to contain protein but only a couple of participants considered it an alternative to animal protein, particularly for meat eaters.

There was some concern that algae could be toxic due to pollution in the sea - it was seen as a food one should not just forage. Despite this, there was trust that the algae that is available in shops must be safe to eat.

Enviromental impact

"The environmental impact would be positive because algae is a natural product thus its production would not generate pollution to our environment."

Daniel (33), Czech Republic

Overall, algae were seen as an environmentally friendly food.

Because consumers view algae as plant-like, they directly associated them with sustainability. Even though consumers did not have much knowledge about the ecological footprint of algae, the fact that they are not animal-based products and are not associated with highly processed foods, gave the impression of algae being at least somewhat sustainable.

There was some confusion about how algae are grown. Many participants believed that algae are foraged from the sea and were unaware that algae can be farmed in contained and controlled environments.

Because of this misperception, there was some concern that producing algae may affect the ecosystems they grow in. Some participants mentioned that they did not want to disturb natural marine ecosystems by removing algae. A couple of participants also mentioned that they thought that processing, packaging and transportation negatively affects the overall sustainability of algae as a food.

All in all, participants were unaware of the benefits associated with producing algae. Only three participants mentioned the ability of algae to absorb CO_2 and produce O_2, however the majority did not know about this aspect of growing algae.

Availability

"For now, algae are rather poorly available. At least in my area, in the stores where I most often do my grocery shopping, it is invisible on the shelves. They may be ingredients, or additives to products that you can buy, but they are not foods that most people buy knowing their contents."

Daniel (33), Czech Republic

Western and Southern Europeans were overall more familiar with algae as a food. Many had eaten sushi before or had seen algae in their local supermarket.

Participants in larger cities who had access to Asian supermarkets were more familiar with seaweed and algae. Participants who had not seen algae in their local shops or restaurants were consequently much less likely to have tried it.

Price

"I bought some 'wakame' some time before as a special offer. But I find it a bit expensive just to give it a try to see if I like it."

Matthias (40), Germany

Participants who regularly consumed algae did not find the price to be a barrier. However, participants who had little to no experience of algae, perceived algae, and algae-based products to be rather expensive. When they were asked to have a look for such products in their local shops, many mentioned that they found them too pricey. The (perceived) high price was a barrier for many participants, particularly because they were uncertain about whether they would like the taste and how they could use and prepare algae to incorporate them in their diet.

Participants also mentioned that they do not want to pay more money for a product that is being marketed as a 'trendy food' when the production cost is low (at least in their perception).

What kind of consumer would try algae?

When asked about who they could imagine trying algae, participants commonly mentioned vegetarians and vegans. Also, individuals who do not necessarily follow a plant-based diet but care about their environmental footprint and consider this when making food choices were thought to be likely to be interested in algae as a food. Another group of people that were frequently mentioned were people who place great importance on eating healthily, who want to maintain a balanced diet and pay attention to what they eat.

Aside from individuals valuing sustainability and health, participants also mentioned people who like fish and seafood or are generally interested in Asian cuisine.

Often when participants tried visualising the person they could imagine eating algae, they envisioned someone young, educated, living in the city, who likes to travel and follows food trends. Participants also mentioned that this person would need to be brave, adventurous and curious to try new things.

These perceptions from the user group highlight that currently algae are not yet suitable for mainstream consumers.

"I can attest to myself that I was interested in trying algae or an algae-based product. I consider myself a person who is looking to eat healthy food and is willing to try new things if they seem right to my body. I occasionally read articles on nutrition and if I am convinced that there is a new food that is good for me I am willing to try it. It is important for me to stay healthy and include healthy ingredients in my diet."

Maya (45), Israel

3

Finding the right message

Four directions for insight-led algae innovation

To find the approach with the most potential we presented the participants with four different ways in which algae-based products can be communicated. We call these directions 'platforms'. Each platform represents a different approach for innovation and communication of algae-based products. We used an approach commonly employed in product concept development, where we showed the participants a concept description which was improved over several rounds of feedback.

The concept description or platform consisted of:

Consumer insight - information about the target group's specific needs, beliefs, or feelings.

Benefit - the product's response to the tension that has been described in the insight.

Reason to believe - credible proof that the product can offer the benefit.

The four platforms developed were:

The Nutrition Powerhouse - a description of algae focusing on healthiness.

The Sea Vegetable - a description of algae focusing on taste and ways to incorporate in diet.

The Sustainable Ingredient - a description of algae focusing on positive impact on the environment.

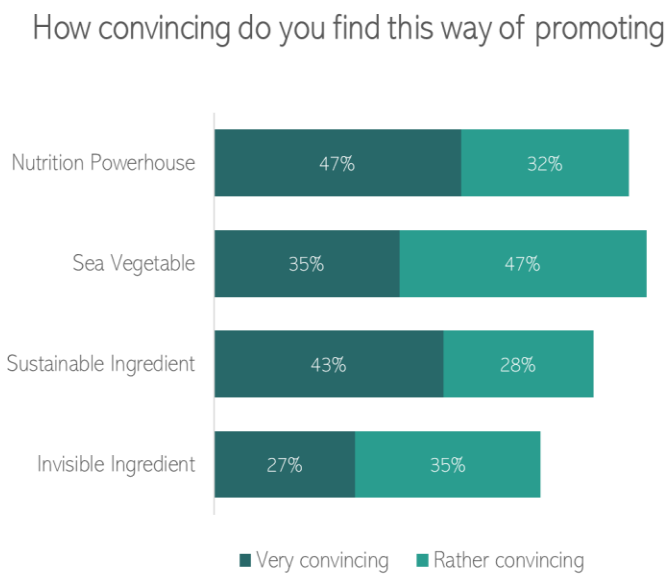
The Invisible Ingredient - a description of algae focusing on the fact that algae are already widely used as additives in popular foods.

Overall strength of the platforms

To determine the overall strength of the platforms, we asked participants:

- To what extent does this way of promoting algae make them want to add algae to their diets.
- To distribute €10,000 among the four promotional messages based on their perceived effectiveness.
- How convincing they thought the message was.

	Nutrition Powerhouse	Sea Vegetable	Sustainable Ingredient	Invisible Ingredient
Average rating on 0-10 scale	7.4	7.2	7.1	6.9
Average amount allocated to each promotional message	€3062	€2671	€2649	€1617



In general, we can conclude that all four platforms resonated positively with the target group. In the next chapter we highlight specific findings per platform in order of overall strength.

The Nutrition Powerhouse

Insight

It is difficult to maintain a healthy and balanced diet, which includes all essential nutrients and vitamins. There are hardly any foods that contain everything that you need.

Promise

Algae are a nutrition powerhouse! They provide many essential nutrients and vitamins. They are good for your body in general, including for your gut and for your skin. In Asia, this has been known for centuries. Algae can be a valuable addition to your diet in the form of a supplement or a main dish, as they come in many different forms.

Reasons to believe

- Some algae, such as spirulina, contain all 9 essential amino-acids (protein) making it a very suitable meat replacement.
- Algae are a direct source of omega-3 fatty acids (fish commonly eaten such as mackerel and salmon are high in omegas because they eat algae).
- Algae are a rich source of vitamins, minerals, antioxidants and fibre, and are low in fat.
- Research shows that many species of algae have beneficial effects on digestion, gut health and cardiovascular health, and that regular consumption of seaweed can prevent some types of cancer.

A portion of algae a day, keeps the doctor away!

The Nutrition Powerhouse was found to be the most convincing way of promoting algae.

This description emphasises the nutritional value of algae and the health benefits they provide. It offers participants nutritional facts and research findings concerning the impact of regular consumption.

There was a consensus that the information provided by this description was clear and relevant. The description particularly highlights the benefits of consuming algae for individuals, which was considered to be very important. The majority of participants stated that health benefits were an important motivator when making food choices. Many reported that they were interested in maintaining a healthy and balanced diet and were therefore open to products that can prove to be beneficial for your health.

Participants raised a few concerns regarding the accuracy of the description. While the majority felt that the information provided was believable and convincing, some participants mentioned that they felt it sounded exaggerated and 'too commercial'. In general, most participants would like to have more specific and detailed information on the health benefits of algae, and agreed that further information provided by scientists would make the platform more believable and trustworthy. Furthermore, participants felt they were lacking information on how to include algae in their diets.

"If I understand the benefits well, the main questions would be: 'In what form can I find algae? How can I eat and cook them?' This would open many doors about the way to use them."

Michael (42) France

"The text is clear, however I do want to get more info on what are the healthy benefits. For example: several species of algae have proven beneficial effects on digestion and gut health. I'm missing which species. What specifically I need to buy, 'algae' is too general."

Mila (42), Israel

The Sea Vegetable

Insight

It is difficult to eat a delicious, but still healthy and versatile diet without extensive meal preparation. Let's try something new.

Promise

You can make all sorts of dishes from different types of seaweed, there are endless possibilities. A few popular recipes for seaweed (other than sushi) include hijiki seaweed salad, sesame-oil baked seaweed chips, blue (spirulina) smoothie bowls, Welsh laverbread, and miso soup. Seaweed can be delicious, fast, healthy, convenient and it offers something new and exciting.

Reasons to believe

- Algae have a rich umami flavour, and can replace fish or mushrooms as a flavouring
- Algae are incredibly versatile and can be added to nearly any kind of meal, from soups and salads, to smoothies, breads, or simply as a snack
- Algae can have many different textures depending on how they are prepared
- Algae are a great source of vitamins, minerals, antioxidants, fibre, omega-3 fatty acids and amino-acids.

Seaweed, the surprising vegetable from the sea!

"Reading this description really makes your mouth water . For me, it is the description that makes you want to try it the most, because we can imagine the taste and the use of it. I think that it makes the imagination work more than the others, that implies more."

Michael (42) France

This description spotlights the taste, texture, and versatility of algae as an ingredient. Its strength lies in the direct benefits it offers the consumer, namely delicious taste and ability to add it into many different recipes.

Nearly all participants responded positively to this description, and 82% of participants said that they found it rather or very convincing.

Participants expressed that they felt they needed help to learn how to prepare algae as a food. Simply stating that it can go into soups or salads was not considered to be enough. Participants indicated that they would like to learn specific recipes and names of dishes. As they were not entirely familiar with the taste of algae, they also wanted to find out which types of algae to use and how best to prepared them to be delicious.

"I think words that are describing how tasty it is would help, rather than merely being healthy and 'saving the planet'."

Eduardo (33), Spain

Some participants were not convinced that the word 'vegetable' should be used to describe algae, as they do not taxonomically belong to that category, and a couple felt that the word 'sea' was too limiting as algae can be grown in other environments too.

The Sustainable Ingredient

Insight

You want to reduce the footprint of the food you eat, but it is often difficult to be certain that what you eat is indeed sustainable. Most foods seem to have a negative impact on the environment.

Promise

Algae are not only produced sustainably, but they also even benefit our environment. On top of that, they are a delicious addition to any meal, from a salad, to soup, even in your breakfast smoothie! So when you eat products made of algae you can rest assured you are doing a good thing, both for the environment and for you too!

Reasons to believe

- Algae are very efficient at absorbing CO_2, and reducing the amount of greenhouse gases in the atmosphere (and adding O_2 to the environment).
- The production of algae does not require the use of chemical fertilisers and pesticides, hence there is little pollution.
- Algae can be farmed in places where no other food can grow normally, such as open seas, rooftops and industrial areas.
- They can be produced locally in many places throughout Europe so do not need to be transported from far away.

Eat algae and clean the atmosphere!

The focus of this direction is sustainability and positive environmental impact. It gives very specific reasons as to why increasing consumption of algae could be valuable for the environment.

This description was quite popular as 71% of participants considered it to be rather or very convincing.

At the same time, it triggered a lot of critical thinking. Many questions came up about the specifics of the sustainability. Questions such as *'Does it need processing?'*, '*What energy consumption is involved in processing?*' and '*How far does it need to travel?*'. A couple of participants even wondered about local legal requirements that need to be complied with in order to start production in Europe. In other words, a description which focuses on very factual information rather than subjective experience (taste and enjoyment) resulted in more questions from participants.

"We all need to do our bit to help the planet, and the description gives a very strong argument towards sustainability."

Neil (53), United Kingdom

The Invisible Ingredient

Insight

It is often difficult to trust foods containing unknown, 'chemical-sounding' ingredients and additives.

Promise

Algae form a safe, natural, sustainable, healthy and unnoticeable but useful ingredient that is already being used for many diverse purposes in numerous products. Did you know that algae already give products like ice cream, yoghurt, biscuits, and toothpaste their 'gel' texture? Spirulina on the other hand is used as a natural colourant.

Reasons to believe

- Ben & Jerry's use carrageenan in their ice cream as a naturally-derived stabiliser.
- Many useful ingredients can be extracted from algae in a natural, non-chemical way.
- Research shows that several species of algae (such as spirulina) can have beneficial effects on digestion, gut health, and cardiovascular health.

Look for 'Made from algae' on the back of the pack!

The invisible ingredient was well-received by participants but ended up being the least convincing.

The description of the invisible ingredient informs participants about the presence of algae in various products and points out how versatile it can be. It presents algae as a natural and beneficial ingredient that is safe to use as an alternative to various chemical or non-vegetarian ingredients.

Overall participants were surprised to find out that algae are already common ingredients in common foods. Participants liked the idea of using algae as a substitute for animal products such as gelatine. In particular, the health claims and the sustainability factors were most appealing to participants.

"I have a hard time thinking of consuming algae as food on its own, so it will be easier for me to recommend consuming products that I already consume and contain algae components and until now I did not know about it."

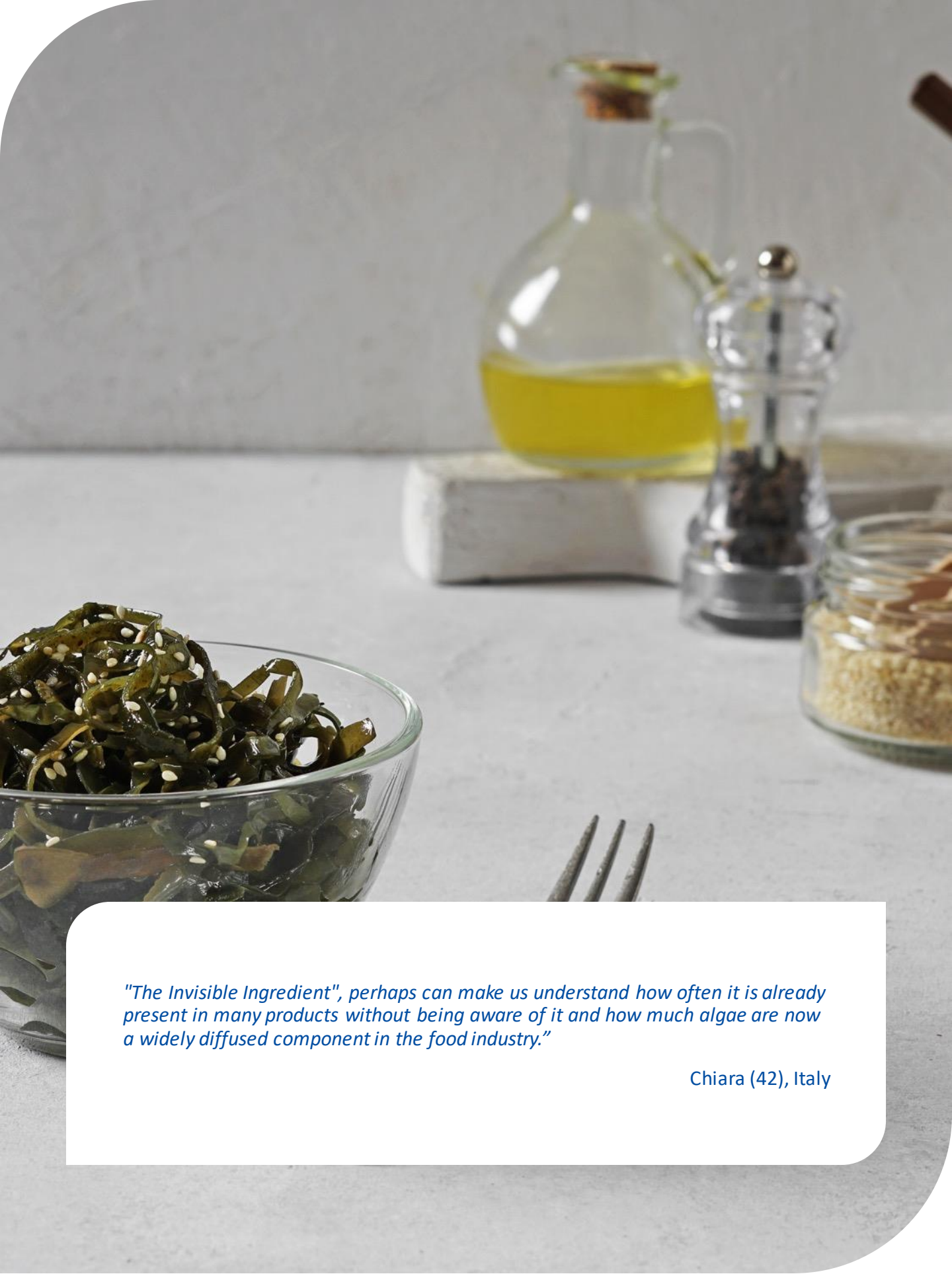
Dudi (44), Israel

Participants who disliked the taste of algae suggested that having algae as an unnoticeable ingredient or consuming it as a supplement is a good solution, allowing people to experience the benefits of algae whilst avoiding eating algae as a food itself.

Furthermore, it was suggested that this description raises awareness about the use of algae in multiple products, making the product appear more normal.

When discussing how to improve the description, participants mentioned that it sounded 'too good to be true'. The credibility of the description was diminished as participants felt that someone was just trying to sell them something.

Some participants were not convinced that algae can be used as an ingredient in ice cream. It was mentioned that these products seem too unrelated.



"The Invisible Ingredient", perhaps can make us understand how often it is already present in many products without being aware of it and how much algae are now a widely diffused component in the food industry."

Chiara (42), Italy

4

Attributes of a successful algae-based product innovation

Rogers' Diffusion of Innovations Theory

The Diffusion of Innovations Theory was developed by Everett Rogers and first published in 1962 . Since then, it has been one of the most popular theoretical models to be used to analyse and predict how innovative ideas and technologies spread.

According to this theory, for an innovation to be adopted, it must have the following five characteristics:

- **Relative advantage** is the extent to which an idea or product is perceived as better than the existing options. *How much of an improvement is it?*
- **Compatibility** is the extent to which an innovation fits with the existing values, past experiences, and needs of potential adopters.
- **Complexity** is the extent to which an innovation is perceived as easy or difficult to understand and use. *How understandable is it?*
- **Trialability** is the extent to which it is possible to try out an innovation before committing to it. *How much time, effort, or money do I need to invest to find out if this is for me?*
- **Observability** is the extent to which the innovation is visible to potential adopters. The more visible the innovation is to consumers, the more likely it is to be adopted. *Do my friends use it? Do I see it in the supermarket?* [1]

1. Rogers, Everett M. (1962). Diffusion of innovations (1st ed.). New York: Free Press of Glencoe.

We used these five characteristics to determine how innovations based on algae can be optimised in order to achieve the maximum interest from consumers.

	Nutrition Powehouse	Sea Vegetable	Sustainable Ingredient	Invisible Ingredient
Overall appeal	✓✓	✓	=	=
Relative Advantage: The extent to which an idea or product is perceived as better than the existing options. How much of an improvement is it?	✓	✓	✓	✓
Compatibility: The extent to which an innovation fits with the existing values, past experiences, and needs of potential adopters.	✓✓	✓	=	=
Complexity: The extent to which an innovation is perceived as easy or difficult to understand and use. How understandable is it?	=	✓✓	✓✓	=
Trialability/ Observability: Is the extent to which it is possible to try-out an innovation before committing to it. The more visible the innovation is to consumers, the more likely it is to be adopted. How much time, effort, or money do I need to invest to find out if this is for me? And to what extent is this innovation visible?	✓	✓	=	=

= not an area of concern, but an area where the approach does not perform well enough.
✓ An area where the approach performs reasonably well.
✓✓ An area where the approach performs very well.

The values in the table were determined by the researchers and were based on the scores the different approaches received in the questionnaire filled in by the participants at the end of the study, as well as a qualitative analysis of the input.

Relative advantage

	Relative advantage
The Nutrition Powerhouse	✓
The Sea Vegetable	✓
The Sustainable Ingredient	✓
The Invisible Ingredient	✓

In order to determine the relative advantage of algae, we asked participants to imagine what kinds of foods they would replace algae with. Even though most participants came up with various examples including fish, meat, vegetables or salad, others noted that they would not be able to see themselves completely removing ingredients from their diet to make space for algae. This was partly because they lack experience with different kinds of algae, and are uncertain about the taste, texture and satiation.

There were no significant differences between the different groups regarding their perception of the relative advantage of algae. Most participants agreed to some extent that algae are an improvement over some foods they eat and are a better alternative to similar foods.

"I don't think algae can or should replace any kind of food. I prefer a situation where eating more algae translates to eating less of certain foods."

Kah Ying (43), Finland

Compatibility

	Compatibility
The Nutrition Powerhouse	✓✓
The Sea Vegetable	✓
The Sustainable Ingredient	=
The Invisible Ingredient	=

To examine the compatibility of the different descriptions, we investigated to what extent eating algae would suit the lifestyle of the participants and what values they associate with algae consumption.

Here the description of the Nutrition Powerhouse performed best. The vast majority of participants indicated that eating algae would suit their lifestyle and that algae provides what they look for in food. Most of the participants stated that they identify with the goal of eating healthily and maintaining a balanced diet. As such, this description was particularly appealing to many.

The Sea Vegetable was also appealing. Participants were generally convinced by algae as a food, but many were unsure of how to include them in their diet. The description of Sea Vegetable provided ideas on how to do so, therefore meeting the needs of many.

Both the Sustainable Ingredients as well as the Invisible Ingredient platforms ranked relatively low on compatibility. Though consumers identified with the ecological aspect of Sustainable Ingredient it was not a strong predictor of willingness to try. Similarly, Invisible Ingredient failed to appeal to the needs of consumers.

Complexity

	Complexity
The Nutrition Powerhouse	=
The Sea Vegetable	✓✓
The Sustainable Ingredient	✓✓
The Invisible Ingredient	=

When it comes to the complexity of the four descriptions, it became clear that Sea Vegetable was the most straightforward and clear. Without any technical jargon, most participants felt it was understandable.

Sustainable Ingredient was also very clear, which was somewhat surprising as the description does include some technical information about environmental sustainability.

The Nutrition Powerhouse ranked lower: the description is quite specific about the nutritional values and health benefits algae can offer, which could cause some confusion to consumers who are not very savvy when it comes to nutrition. However, consumers who do not know very much about nutrition, might still be persuaded by the specific health benefits even if they do not understand them completely.

Promoting algae as an 'invisible ingredient' caused a bit of confusion for the participants, particularly those who are not very interested in additives in their food. It was felt that consumers who do not regularly check ingredient labels might be more confused than convinced by this description.

Trialability and Observability

	Trialability and Observability
The Nutrition Powerhouse	✓
The Sea Vegetable	✓
The Sustainable Ingredient	=
The Invisible Ingredient	=

The ability to test the properties of algae and their visibility (for example in the shop, or at a restaurant) had overall somewhat lower ratings for all four descriptions compared to the other characteristics explored. This does not necessarily indicate a negative effect on the overall success of these promotional messages, as these two criteria are the least strong predictors according to E.M. Rogers' research.

The descriptions that focused on taste (Sea Vegetable) and healthiness (Nutrition Powerhouse) scored somewhat highly on this, because consumers felt it was easier to test these aspects of algae. Taste in particular is easy for consumers to try and find out.

Algae as an 'invisible ingredient' was obviously less easy to check as it is indiscernible in a food.

The sustainability of algae was also considered more difficult to test or see.

"We are likely to try something new if it's already cooked and ready to eat (hence the restaurants), rather than cooking it from scratch. Of course if we try/eat it and like it, we are more prone to make an effort to cook it ourselves."

Cristina (36), Portugal

5

Methodology

This report is based on findings of a two-stage study that took place in the Citizens Participation Forum, an online community of consumers, with 111 community members from 18 countries participating. As part of the study, they completed online assignments, including forum discussions, questionnaires, polls, and photo assignments.

In the first stage, participants discussed their perceptions and experiences of eating algae. To prepare for the second part of the study, we interviewed seven experts in algae and algae-product production and marketing on their knowledge of consumer perceptions of algae. Based on these findings, we selected a series of statements that could form a basis upon which to promote algae as a new food.

In the second stage of the study, a fresh group of participants rated these statements on several criteria, including novelty and appeal. Based on their ratings we designed the four descriptions, or 'ways to promote' algae. These were then discussed and commented on by the participants in four separate subgroups. Using this insight, the study team rewrote the descriptions to include relevant feedback. The new descriptions were then evaluated by the participants of the second study. The final results of these refined descriptions can be seen in the 'Four directions for insight-led algae innovation'.

Participants

A total of 111 participants from 18 countries took part in this study.

The participants in this study are front-runners when it comes to food. They are particularly interested in food and are open to trying new foods.

They are generally well-informed about their food and think about aspects of health and sustainability when making food choices. Many of them engage with media on food-related topics.

In other words, the participants in this study are more likely to be early adopters when it comes to food innovation compared to the average consumer. Understanding what this segment of consumers feels and needs is critical for gaining traction when it comes to food innovation, as they can have a strong influence on the success or failure of a product introduction.

Country	No. of participants
Belgium	5
Czech Republic	6
Denmark	7
Finland	7
France	7
Germany	7
Greece	6
Ireland	8
Israel	7
Italy	6
Netherlands	6
Poland	7
Portugal	5
Romania	6
Spain	7
Switzerland	7
Turkey	1
United Kingdom	6
Total	111

Experts in algae and algae-product production and marketing from the following companies were interviewed as part of this study:

Duplaco	Netherlands	Spirulina Nord
Phycom	FUL Foods	SeaFlavours
Algae Innovations	Algaia	

The Future of Food Institute has been commissioned by EIT Food to carry out this study.

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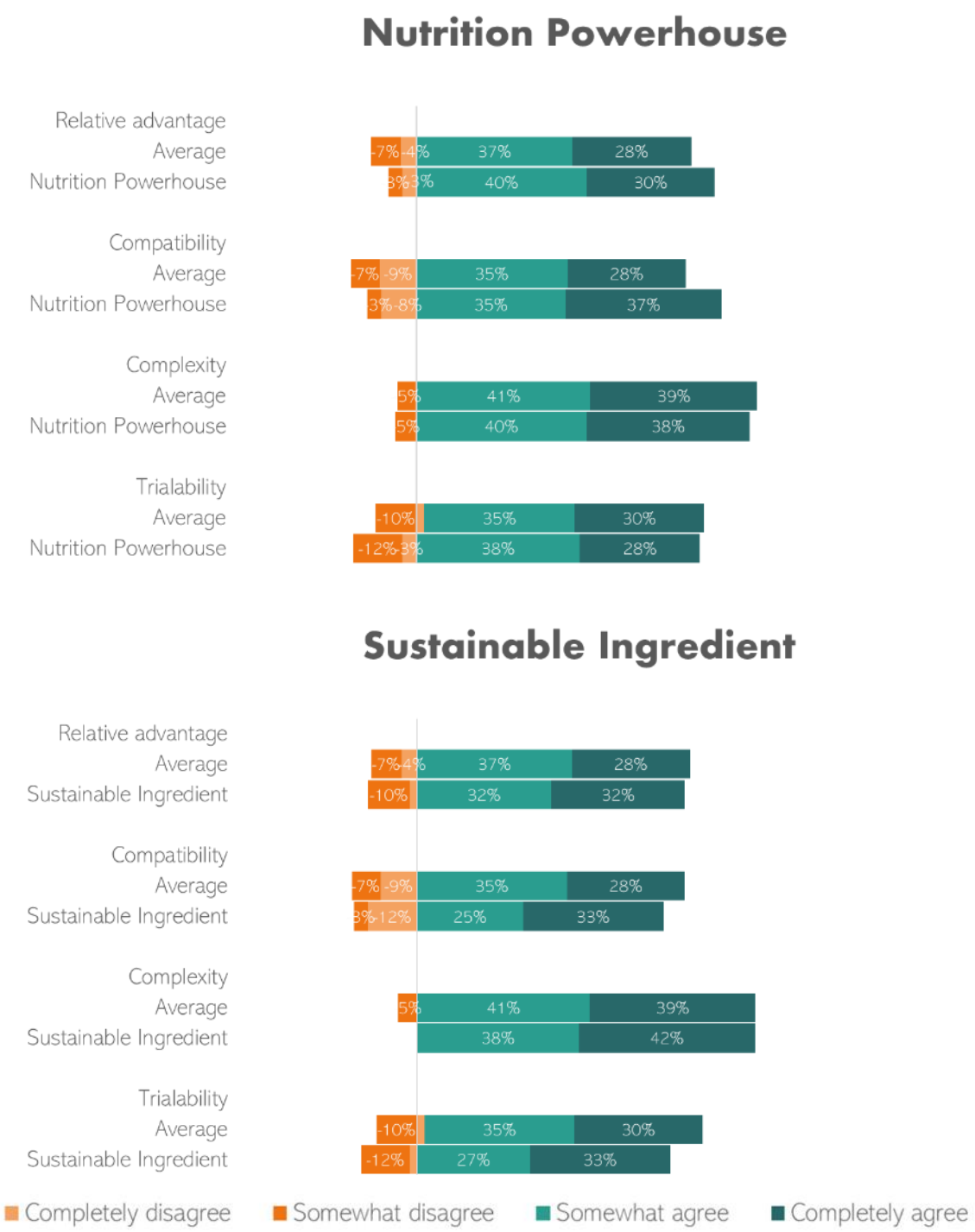
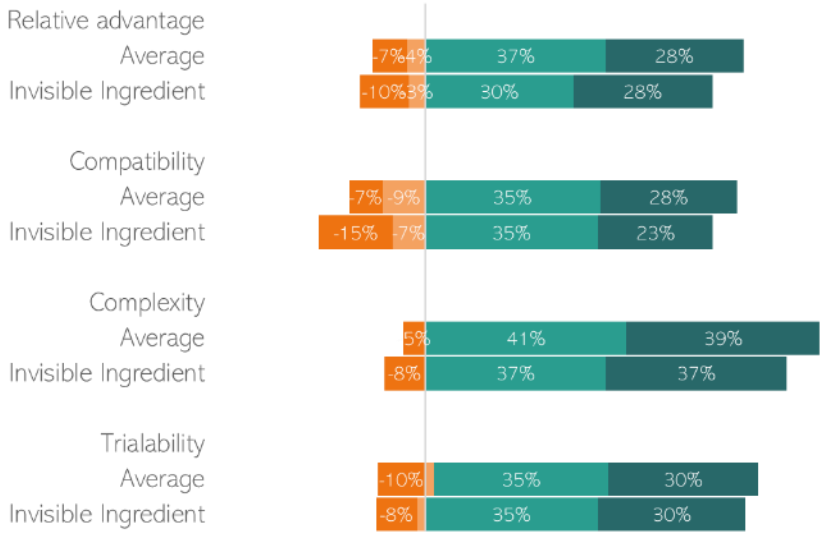
Appendix

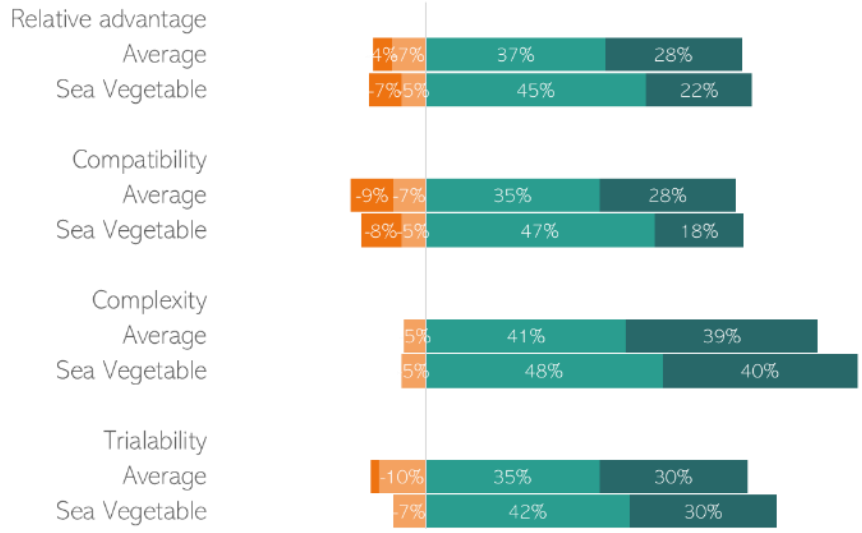
The following graphs indicate participants' perception of 'relative advantage', 'compatibility', 'complexity', and 'trialability' of the four descriptions. In all four graphs, the rating of each characteristic is compared to the average rating of the characteristic in the four descriptions



Invisible Ingredient



Sea Vegetable



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