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## Seaweed as food – Attitudes and preferences among Swedish consumers. A pilot study

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## ABSTRACT

The demand for vegetarian food is increasing and seaweeds are promising raw materials with interesting nutritional and sensory profiles. The aim of this study was to investigate the attitudes and preferences of Swedish consumers regarding seaweed as food and study differences and similarities between different consumer groups. Data from 120 adult consumers showed an overall positive attitude. More young men than women preferred seaweeds in snack products and fast food. Products containing seaweed should preferably be bought in a food store and eaten at home or in a restaurant. The most popular serving alternatives were in snacks, bread and dishes.

## Study

The demand for vegetarian food is increasing (Lusk, 2017) as is the awareness of health issues and environmental sustainability in relation to food choices (De Boer et al., 2007). Food convenience is also an important factor. Vehmas et al. (2019) showed, for example, that consumers preferred snack products that were healthy, tasty, satiating and suitable for on-the-go eating. Products with a high protein content were preferred over those with a lower protein content.

Seaweeds have been identified as promising raw materials from which highly nutritious ingredients and food products may be developed. Besides being good sources of high quality protein, seaweeds are rich in polyphenols and minerals as well as carbohydrates such as carrageenan and alginate. Many species are also rich in vitamins such as C and B<sub>12</sub> (Holdt and Kraan, 2011; McHugh, 2003; Watanabe et al., 1999) and contain lipids that are high in long-chain n-3 polyunsaturated fatty acids (LC n-3 PUFAs) (Harrysson et al., 2018). The potential health aspects of these components have been shown to be of importance for the consumer (Birch et al., 2019). Seaweeds are regarded as sustainable since they do not need a fresh water supply, nor do they require arable land to grow (Murty and Banerjee, 2012). Furthermore, they can remediate nitrogen and phosphorus from coastal waters.

In Japan, Korea and China, seaweeds have served as important dietary components over past centuries (Choi et al., 2012; McHugh, 2003).

Historically, they have also been consumed in maritime communities across Europe and North America (Birch et al., 2019; Mouritsen et al., 2012), mainly in the diet of poor people living along the coastlines (Mithril et al., 2012). Today, however, seaweeds are not commonly used as foods in either Sweden or other European countries, although there is a rapidly growing interest in this area. From an earlier study, it is known that Swedish consumers generally have a positive attitude to including seaweed in their diet (Persson, 2017). There is also a growing interest among restaurants in the Nordic countries regarding the inclusion of seaweed in dishes (Mouritsen et al., 2012). Attitudes and preferences are known to often differ between consumer groups. Sustainability aspects, for example, are more important to women, mainly younger women, than to men (Wendin et al., 2019). With the growing trend for the use of plant-based food products, products containing seaweed could be an inspiration for both healthy and sustainable eating habits (Vasvada, 2019). However, taste, flavor, and the appearance of food are important factors for determining food preferences, choices and eating behaviors (Hartvig et al., 2014). In this respect, seaweeds are especially well-known for their umami taste, which can also enhance the intensity of other tastes and flavors (Zhang et al., 2019). For the inclusion of seaweed as part of a daily diet, more knowledge is needed about how, where and when different groups of consumers would like to eat seaweed. This information could guide the development of new and innovative foods based on seaweed. The overall aim of this study was to

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**Table 1**  
Questionnaire with questions and answer options.

Question no	Question	Answer options
1	How old are you?	One choice • 18–40 years • 41 years or older
2	What is your gender?	One choice • Woman • Man • Neutral
3	How would you specify your diet?	One choice • Mainly vegetarian • Fish and vegetables, but no meat • All kind of foods, meat included
4	Are you familiar with seaweed being used as food?	One choice • Yes • No
5	Would you consider eating seaweed?	One choice • Yes • No
6	If Yes, why?	Multiple choice • Tasty • Healthy • Good for the Environment • Exciting • New • Vegetarian • From the Sea • Others, give example ...
7	If No, why?	Multiple choice • Not Tasty • Cannot Cook • Dare Not • Dangerous • Others, give example ...
8	Where would you like to buy seaweed?	Multiple choice • Internet • Food Store • Restaurant • Others, give example ...
9	Where would you like to eat seaweed?	Multiple choice • Home • Restaurant • On the Go • Others, give example ...
10	How would you like to eat seaweed?	Multiple choice • Fresh • As Flour for Adding to Product • Dry Spice • Snacks • Added as Nutrient • Dish • Others, give example • Not At All
11	Would you pay extra for food products containing seaweed?	One choice • Yes • No
12	To which food products would you like seaweed to be added?	Multiple choice • Cookies • Ice-Cream • Snacks • Bread • Drink • Breakfast Product • Dairy Product • Fast Food • Dish • Others, give example ... • No Product At All

investigate the attitudes and preferences of Swedish consumers regarding seaweed as food. More specific objectives were to study differences and similarities in attitudes between different groups of consumers, such as younger and older consumers and men and women, as well as explore their preferences for specific seaweed products.

Swedish consumers were invited to answer a questionnaire concerning attitudes and preferences regarding the use of seaweed as food via social media platforms such as Facebook or via web pages belonging to Kristianstad University, Chalmers University of Technology and the companies VegMe and Oatly. Participation was anonymous and voluntary. The aim was to recruit a minimum of 100 adult consumers, consisting of men and women aged 18 years or older, to gain enough data for statistical calculations (Lawless and Heymann, 2010). The web-based survey was launched in November 2019. The software Eye Question 2018, The Netherlands, was used for the data collection. The survey consisted of 12 questions given in Table 1.

The data collected were processed using descriptive statistics. Mean values and standard deviations were calculated and  $\chi^2$ -tests were performed to compare groups of consumers using SPSS (IBM SPSS Statistics, version 23, US). Excel (Microsoft Office) was used for calculation of significant ( $p \leq 0.05$ ) frequency using a two-tailed paired preference test (Roessler et al., 1978).

Consumer data from a total of 120 Swedish adult respondents (18 years and older) were obtained during the test period. Of these, 73% were women, 25% men and 2% of neutral gender. With regard to age, 36% of the participants were in the younger age group (18–40 years) and 64% in the older age group (41 years and older). Dividing the respondents further into subgroups, 22% were younger women, 51% older women, 11% younger men and 14% older men. A significant majority of the respondents ( $n = 101$ ) ate a diet consisting of a variety of foods.

The results showed that all consumer groups had positive attitudes to seaweed as food. However, with regard to specific preferences, significant differences were observed between the responses of the subgroups.

Overall, 82% of the respondents were familiar with the possibility of seaweed being used as food and almost all, 114 out of 120, would consider eating seaweed. This positive attitude to the use of seaweed as food is in line with earlier results (Persson, 2017). Furthermore, 60% of the respondents who answered the question about *why* they would consider eating seaweed gave the response that it was “good for the environment”. Approximately the same proportion of the respondents stated that seaweeds were considered “tasty” and “healthy”. Other studies have shown that it is mainly younger women who are positive towards more sustainable food supplies, while older age groups, both men and women, are more concerned about health issues (Wendin et al., 2019; Lassen et al., 2016). In this study, however, there were no significant differences between the age and gender groups. Most consumers are highly driven by their taste preferences when it comes to food choices (Holmer et al., 2012; Hartvig et al., 2014) and seaweeds are well known for their salty and umami-rich taste due to them containing an abundance of minerals and glutamic acid (Vilar et al., 2020; EU, 2020; Mouritsen et al., 2012). As stated initially, seaweeds are also considered healthy due, for example, to their high contents of minerals, vitamins, fiber, protein and antioxidants (Cabrita et al., 2017). This may explain the overall positive attitude towards seaweed as food and is an angle that can potentially be further enhanced if producers of seaweed products investigate the possibilities of making health or nutrition claims about their products (EFSA, 2020). For those few respondents who answered that they would not consider eating seaweed, the reason given was that foods based on seaweed were “not tasty”.

Clear results from the questionnaire revealed that the respondents would prefer to buy products based on seaweed in a food store, since almost all respondents, 114 out of 120, were positive to this. A significant proportion of all the respondents, in particular young men, were also positive to buying dishes containing seaweed in restaurants. It was also clear that the respondents preferred equally to eat seaweed at home or at a restaurant, since almost all respondents, 114 and 107,

**Table 2**

Results divided into different categories showing the different consumer groups' preferences for how to eat seaweed and to which products seaweed could be added. Significance level  $p \leq 0.05$ .

Question	All (n)	Gender		Age		& Age		Gender	
		Women	Men	Young	Old	Young Women	Older Women	Young Men	Older Men
<b>How would you like to eat seaweed?</b>									
Fresh	60	44	66	58	45	52	41	69	65
As Flour for Adding to Products	62	50	53	60	47	63	44	46	59
Dry Spice	<b>83</b>	65	80	77	65	70	63	84	76
Snacks	68	50 <sup>a</sup>	73 <sup>b</sup>	65	52	52 <sup>a</sup>	49 <sup>a</sup>	85 <sup>b</sup>	65 <sup>a</sup>
Added as Nutrient	60	49	50	58	45	67 <sup>a</sup>	41 <sup>b</sup>	30 <sup>b</sup>	32 <sup>b</sup>
Dish	<b>86</b>	74	63	72	71	67	77	77	56
Others, give example	10 <sup>a</sup>	6	10	12	6	7	5	8	12
Not At All	4	5	0	2	4	4	5	0	0
<b>In which food products would you like to add algae/seaweed?</b>									
Cookies	29	18	27	37 <sup>a</sup>	17 <sup>b</sup>	26 <sup>a</sup>	20 <sup>a</sup>	46 <sup>b</sup>	12 <sup>a</sup>
Ice-cream	26	22	27	28	18	15	20	33	18
Snacks	<b>75</b>	59	72	70	74	56 <sup>a</sup>	59 <sup>a</sup>	92 <sup>b</sup>	59 <sup>a</sup>
Bread	<b>79</b>	67	60	58	70	59	70	49	71
Drink	44	34	40	44	32	58	39	54	40
Breakfast Product	51	43	37	52	37	48	41	54	44
Dairy Product	20	12	22	19	16	7	15	13	18
Fast Food	62	44 <sup>a</sup>	70 <sup>b</sup>	58	48	44 <sup>a</sup>	44 <sup>a</sup>	77 <sup>b</sup>	54 <sup>a</sup>
Dish	<b>107</b>	86	97	91	88	89	85	92	100
Others, give example	9 <sup>a</sup>	7	3	7	8	0	10	8	0
No Product At All	6	7	0	2	6	4	8	0	0

Different letters indicate significant difference  $p \leq 0.05$ .

Bold figures indicate significant amount of consumers,  $p \leq 0.05$ .

<sup>a</sup> No examples given.

respectively, responded positively to these options, which compares well with the results by Mouritsen et al. (2012).

The results in this study also revealed that the significantly most popular options for eating seaweed were as snacks, spice, bread and in dishes, with snacks being significantly more popular among young men than among the other respondent groups, Table 2. Wouters et al. (2018), who studied snack behavior, found that men and mainly young adults were more positive to the intake of snacks than women. This also corresponds well with the results in this study showing that, compared to the other groups, younger women had a significantly higher preference to add seaweed as a nutrient to various foods. It is also worth mentioning that the addition of seaweed to fast foods was of significant interest to men, especially young men, but not to women. Young men also had a significantly higher preference for using seaweed in cookies than the other groups. These results may also be related to the greater interest in health issues among women and older age groups (Wendin et al., 2019; Lassen et al., 2016). However, according to Vehmas et al. (2019), a large proportion of consumers has a positive attitude towards snacks if they can be regarded as healthy foods.

In order to successfully increase the use of seaweed as a food raw material, product and dish development and also product design and sensory analysis need to be combined (Naes and Nyvold, 2004).

One of the limitations of this study was the uneven distribution of sample sizes regarding men and women. To be able to compare the frequencies of groups, the percentages of frequencies were calculated. It should, however, be noted that a larger sample size of women is common in consumer studies (Chakravarty, 2018; Fibri and Frøst, 2019; Normann et al., 2019). Another limitation was the neutral gender group (unidentified sex) consisted of only two respondents, thus this group was too small to imply any relevant results and was, therefore, kept out of analysis.

Overall, Swedish consumers are positive towards, and have a great interest in, including seaweed as part of their diet, mainly due to sustainability reasons. Differences in preferences were observed between the consumer groups. The results show that young men were more positive to including seaweed in snack products and fast food than

women. Products containing seaweed should preferably be bought in a food store, while being eaten at home or in a restaurant was equally preferred. The results revealed that the most preferred forms of consuming of seaweed were as snacks, bread and in various dishes. The results from this study may be used as a basis for the development of new food products that contain seaweed.

#### Statement of conflict of interest

There are no conflict of interest.

#### CRediT authorship contribution statement

**K. Wendin:** Conceptualization, Formal analysis, Data curation, Investigation, Methodology, Writing - original draft. **I. Undeland:** Funding acquisition, Project administration, Resources, Validation, Writing - review & editing.

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