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Algal eating habits of phycologists attending the ISAP Halifax conference and members of the general public

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Abstract

Abstract

A short questionnaire was devised during the 4th ISAP conference in Halifax (2011) to gather some information on the algal eating habits of the participants. Responses were also collected from random members of the general public in Galway and Copenhagen. Most phycologists had eaten algae before (93%), but few participants ate it more regularly than per month. The general public responses were similar. A probability model tested the likelihood of a participant eating algae. Neither age nor nationality significantly influenced this probability, although gender increased the probability of eating algae regularly by 9% if the participant was male (at the 90% confidence limit). As hypothesised, being a conference attendee highly significantly increased the probability of eating algae by 22%, in comparison with non-conference attendees (i.e. the general public). The type of phycological research studied also had a significant effect. Researchers working with macroalgae were 22% more likely to eat algae, whereas microalgal researchers 15% less likely to eat algae on a monthly or more regular basis. The main reasons for eating algae by both groups were 'taste', followed by 'other' (undefined) reasons. Phycologists also ate algae for the perceived 'health benefits', whereas few members of the general public chose this option. The difference in eating habits between the groups may be attributable to the lack of algal knowledge within the general public group.

Keywords: Algae; Macroalgae; Microalgae; Questionnaire; Porphyra; ISAP; diet

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1. Introduction

The International Society of Applied Phycology (ISAP) aims to:

"…promote research, preservation of algal genotypes, and the dissemination of knowledge concerning the utilisation of algae."
(ISAP website, http://www.appliedphycologysoc.org/ accessed 23/7/11)

In order to promote such research, the society holds a triennial conference, and publishes a peer-reviewed journal – the Journal of Applied Phycology (JAP). This year, the 4th ISAP conference was held in Halifax, Canada (19-24th June, 2011), with *310* international delegates in attendance. Some of the many research groups that attend the ISAP meetings do so because of the applied, worldwide use of algae as a human foodstuff. The majority of the world's cultivated kelps and *Porphyra* sp. for example, are used in Asian countries as a central part of their traditional cuisine (McHugh, 2003).

The menu for the Halifax conference gala banquet contained the cultivated red macroalga *Chondrus crispus* produced in Nova Scotia by the company Acadian Seaplants. This is an edible seaweed and is well known as such by a handful of countries that border the North-Atlantic Ocean. However, it is better known internationally as a carageenophyte. Two of the authors of this paper (Holdt and Edwards) used the opportunity of the gala banquet to gather some information about the algae that phycologists choose to eat. It was hypothesised that researchers of algae would be aware of the multiple health and taste benefits of regularly including algae

in their diets. This study compares the algal eating habits of phycologist and non-algal specialists with members of the general public.

2. Materials and Methods

Questionnaire and Respondents

A short questionnaire was designed to collect information on the algal eating habits of ISAP conference delegates, and was distributed to those attending the gala banquet. The questionnaire collected some personal information (nationality, gender, age to nearest decade, and type of algal research the respondent carried out – 'macro', 'micro', 'both' or 'none'). The question 'Have you eaten macro/microalgae before?' divided the remainder of the questionnaire into a shorter 'no' response, and a more detailed 'yes' response. Respondents who answered 'no' were asked to choose from a list of reasons containing taste, lack of availability, lack of culinary knowledge, or some other reason. Respondents who answered 'yes', were asked to record the frequency of eating algae (daily, weekly, monthly or more rarely). These respondents were also asked why they ate algae. The list included the following reasons: health benefits, tradition, taste, or other reason. The number of species eaten was also requested, along with the respondent's favourite three species of algae eaten. To understand how the algae were obtained for consumption, respondents were asked to circle 'shop', 'collected' or 'both'.

The same questionnaire was used to poll random members of the public in Galway city (Ireland) and Copenhagen (Denmark) with the exception of the question in relation to the type of algal research carried out. The responses from Galway (58) and

Copenhagen (46) were pooled, and were used as a comparison with the phycologist responses.

Logit model - Modelling the Probability of Eating Seaweed on at least a Monthly Basis

The probability of eating seaweed on at least a monthly basis was modelled, based on a mixed sample of 273 conference attendees and 104 random members of the public. The response variable of interest in the survey (and the dependent variable in the model) was dichotomous, taking the value 0 if the respondent did not eat seaweed on at least a monthly basis and 1 if they did. The response variable was modelled as a function of gender, age, whether the respondent works with macro or micro algae, and whether the respondent is a conference attendee and whether they are from Europe or Asia. Since the dependent variable in the model can only take the value 0 or 1 a nonlinear estimating method of maximum likelihood must be used. The logit modelling approach was used (Greene, 2008) to do this, using the statistical software package STATA. More formally the logit model can be written as:

$$L_i = \beta_1 + \beta_2 Gender + \beta_3 Age + + \beta_4 Macro + \beta_5 Micro + \beta_6 Conference + \beta_7 Europe + \beta_8 Asia + \mu_i$$

where β represents the variable coefficients, β_1 is the constant term and μ_i is the error term associated with individual *i*. In the model, *gender* is a dummy variable where female is taken as the base case (male = 1); for the dummy variables of *macro* and *micro* the base case is does not work with either macro or micro algae; for the dummy variable *conference*, the base case is not a conference attendee (i.e. the respondent

was sampled randomly in Galway or Copenhagen). Finally, for the dummy variables of *Europe* and *Asia* the base case is not from either.

3. Results

Algal eating habits of phycologists and the general public

Summary statistics of responses to the questionnaire are described in Table 1. The number of responses gathered from phycologists attending the conference was 273, while 104 responses were gathered from members of the general public. Responses were gathered from 35 countries during the conference, and 25 countries during the poll of the general public. Most phycologists answered the question 'Have you eaten algae before' positively (93%), whereas fewer members of the general public did so (64%; Table 1).

Table 1. Questionnaire summary statistics.

	Conference	**General Public**
Variable	Mean (Std. Dev.)	Mean (Std. Dev.)
gender	0.57 (0.5)	0.44 (0.5)
age	41.48 (12.16)	39.16 (14.23)
macro	0.29 (0.45)	0
micro	0.47 (0.5)	0
both	0.12 (0.33)	0
none	0.10 (0.29)	0.44 (0.5)
Have eaten algae before	0.93 (0.25)	0.64 (0.48)
Number of Nationalities	35	25
Number of Observations	273	104

A large proportion of both phycologists and the general public only very rarely eat algae (Table 2; 45% and 55%, respectively). It is quite common for both groups to eat algae on a monthly basis, but few people eat algae daily or weekly (Table 2; less than

10% and 20%, respectively).

Table 2. The frequency of eating algae (proportion of the sample who have previously eaten algae falling into each reason category).

Frequency of consumption	Conference	General Public
Daily	0.07	0.03
Weekly	0.18	0.17
Monthly	0.31	0.25
More rarely	0.45	0.55

The most popular reason for eating algae within the phycologist and general public groups was 'taste' (Table 3; 44% and 57%, respectively). Phycologists also ate algae because of (perceived) health benefits (36%), whereas very few of the general public stated health as a reason to eat algae (only 13%). The proportion of both groups choosing 'tradition' as the reason for eating algae was low (less than 20% in both groups; Table 3). A large proportion of both phycologists (39%) and the general public (42%) chose another reason for eating algae other than taste, (perceived) health benefits or tradition.

Table 3. Reasons given for eating algae (proportion of the sample who have previously eaten algae falling into each reason category).

Reason	Conference	General Public
Health	0.36	0.13
Traditional	0.18	0.15
Taste	0.44	0.57
Other	0.39	0.42

Results from both phycologists and the general public indicate that the lack of availability of algae is the greatest reason why algae haven't been eaten before for

most people (50% of phycologists, 49% of the general public; Table 4). Lack of culinary knowledge was an important factor in not eating algae for the general public, whereas fewer phycologists cited the same reason (Table 4). Few of the general public had any other reasons other than taste, lack of availability or lack of culinary knowledge for not eating algae (only 5%), whereas 'other' reasons accounted for 39% of responses from phycologists. 'Taste' as the reason for not eating seaweed accounted for 22% of phycologists and 30% of the general public (Table 4).

Table 4. Reasons given for *not* eating algae (proportion of the sample* who have not previously eaten algae falling into each reason category).

Reason	Conference	General Public
Taste	0.22	0.30
Lack of Availability	0.50	0.49
Lack of Culinary Knowledge	0.11	0.35
Other	0.39	0.05

*n = 18 for conference attendees, and n = 37 for general public responses

The Logit model - Modelling the Probability of Eating Algae at least Monthly

Rather than showing the coefficients of the logit model, which can be difficult to interpret, the marginal effects of each of the independent variables are presented. A Likelihood Ratio test was performed to test whether the parameters of the fitted model are jointly equal to zero. The $\chi 2$ statistic (with 7 degrees of freedom) of 50.56 shows that, taken jointly, the coefficients in the chosen specification are significant at the 1% level.

In terms of coefficient interpretation, and following conversion to marginal effects, it appears that being male increases the probability of eating algae by 9% at the 90%

level (Table 5). Age and nationality were found to have no significant impact on the probability of eating algae on a monthly basis although it is interesting to note that the marginal effect of being European has a negative sign. If participants work with macroalgae his/her probability of eating algae on at least a monthly basis is increased by 21% while the reverse is true for participants working with microalgae. The probability of participants working on microalgae eating algae on at least a monthly basis is actually decreased by 15% (Table 5). Both these variables are significant at the 95% level. Finally, conference participants are highly significantly more likely to eat seaweed on a monthly basis, with a 22% increase in this probability (Table 5).

Table 5. Logit Model of eating seaweed on at least a monthly basis.

Variable	Marginal Effects
Gender (male)	0.09 (0.06)*
Age	0.001 (0.002)
Work with macroalgae	0.21 (0.08)**
Work with microalgae	-0.15 (0.07)**
Conference attendee	0.22 (0.08)***
Europe	-0.07(0.06)
Asia	0.10 (0.08)
Observations	377

Standard errors in parentheses, *** indicates significant at 1%, ** indicates significant at 5%, * indicates significant at 10%.

The edible algae of choice

To estimate the variety of algal species commonly eaten, participants in the questionnaire were asked to record the number of species that they ate. Figure 1 shows that the general public ate approximately 1 to 3 different species across their age range, whereas phycologists typically ate between 1 and 6 species of algae (Figure 1). Phycologists in their forties and fifties ate significantly more algae than their counterparts in the general public (Figure 1; $p<0.05$).

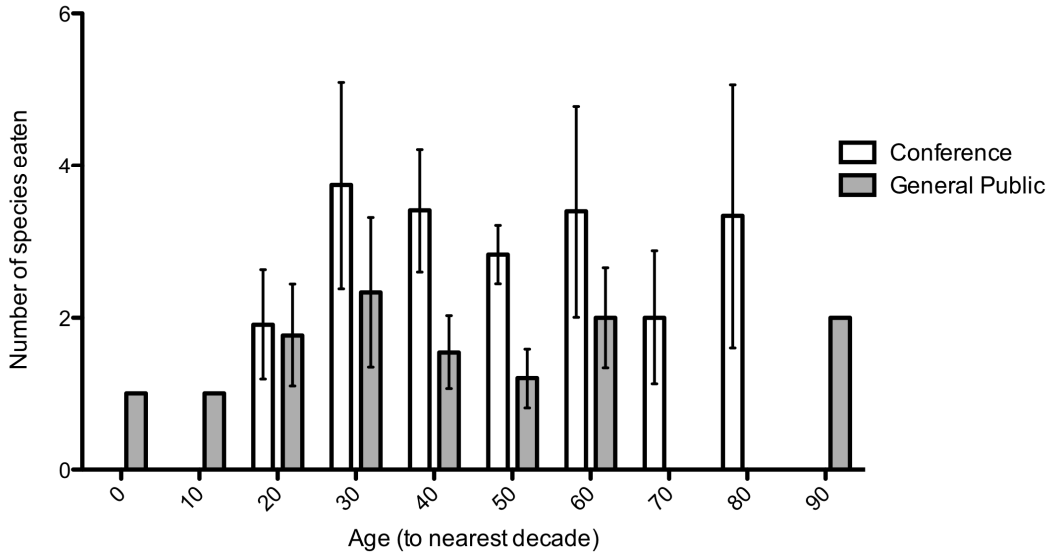

Figure 1. Number of species of algae eaten by conference participants (phycologists) and the general public within each age class to the nearest decade. Error bars represent 95% confidence limits.

The three favourite, or 'top three' species of algae were recorded for questionnaire participants. Approximately 27 genera were recorded in total (Figure 2). Most of the genera represented macroalgal species, while 6 of the genera were for microalgae. Many responses were colloquial e.g. 'dulse' for *Palmaria palmata*, hence the reporting of both terms. This made it impossible to estimate the total number of species that were eaten, as responses such as '*Laminaria',* 'kombu' or 'kelps' were sufficiently ambiguous. In this case, all responses were reported together for ease of comparison with other species or genera (Figure 2). Species of *Porphyra* were by far the most popular recorded in both groups, however the genus accounted for a greater percentage of the general public's responses (57%) compared those from phycologists (35%). Other popular genera/species in both groups included *Laminaria* and *Saccharina* spp.,

P. palmata and *Chondrus crispus*. Of the microalgal genera present, *Spirulina* sp. was the most popular, accounting for nearly 5% of phycologist's choices (Figure 2; *Spirulina* sp. not recorded in the general public choices).

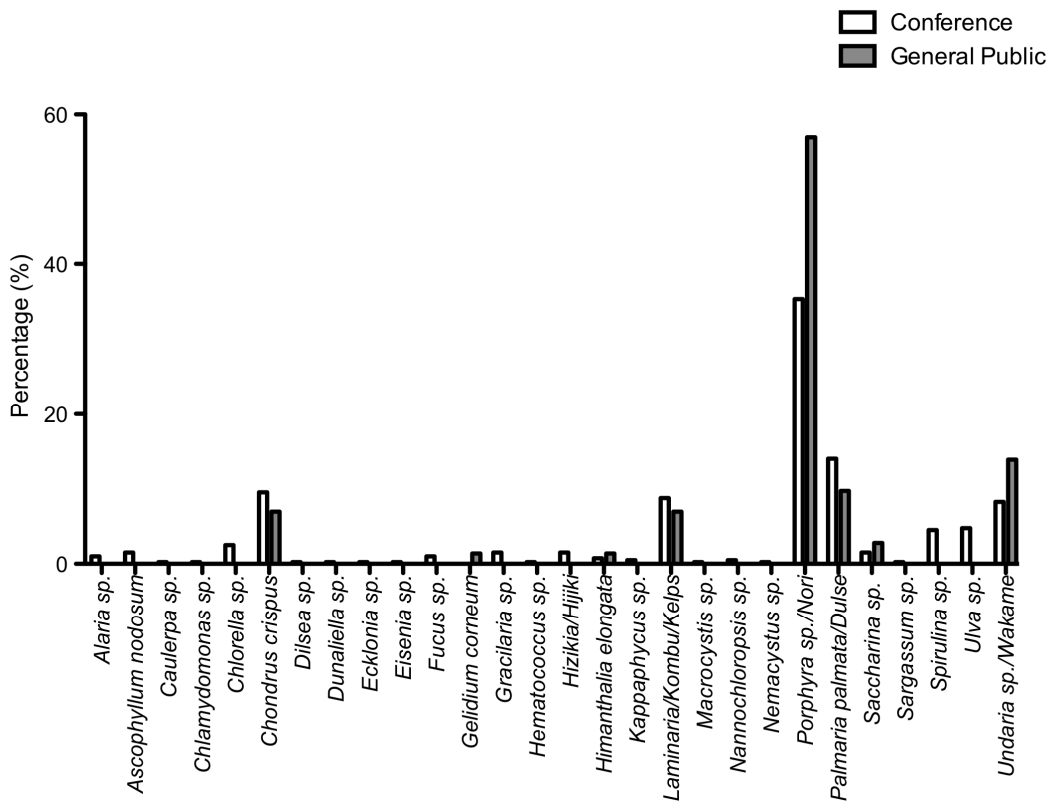

Figure 2. Algal species chosen as the 'top three' species eaten by conference participants (phycologists) and the general public, expressed as a percentage of all choices.

Broadly divided into their representative groups, red seaweeds are the most popular species of choice within the phycologist and general public groups (Figure 3). 60% of phycologists recorded red seaweeds in their 'top 3', whereas the general public recorded even more (71%). Brown seaweeds were equally popular with phycologists and the general public, and accounted for approximately 30% of all choices. Green seaweeds were chosen by relatively few participants from both groups. Green seaweeds were as

popular as varieties of microalgae (amongst phycologists), whereas no microalgae are consumed amongst the general public at all (Figure 3).

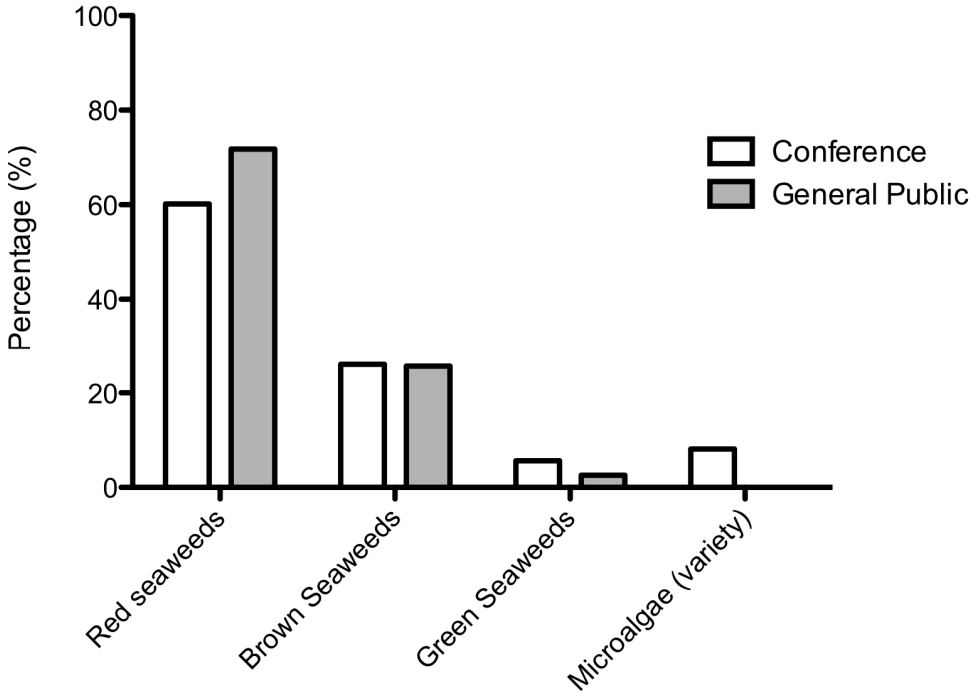

Figure 3. All recorded algal 'top 3' algae chosen for eating. Species grouped according to type – marine macroalgae divided into red, brown and green seaweeds. All microalgae are grouped into one. Groups expressed a percentage of all species/genera recorded.

The data were also interrogated to see how many respondents chose Nori/*Porphyra* as one of their 'top 3 algae' after answering 'yes' to eating algae, and citing some 'other' reason rather than eating algae for taste, tradition or (perceived) health benefits. 52% of all phycologist responses, and 75% of all general public responses were 'yes', 'other' and 'Nori/*Porphyra*'.

4. Discussion

A simple poll asking phycologists and members of the general public whether they had eaten algae before shows encouraging results (Table 1). As expected, the vast majority of phycologists (93%) and approximately two thirds of the general public had consumed algae. However, on closer inspection, when asked how often algae were included as part of their diet, both groups showed similar trends of only eating algae on a monthly or more rarely basis (Table 2). It might be expected that the proportion of phycologists eating algae more regulary (than 'more rarely') would have been higher, given the exposure to scientifically researched information on umami, health benefits, and historical and/or geographical traditional uses of seaweeds.

Interestingly, both phycologists and the general public stated 'lack of availability' as one of the main reasons for *not* eating algae (Table 4). Perhaps algae would be included in diets of more people if a wider range of algae were made readily available.

This poll did not distinguish between the different flavours, why the taste of algae is appealing, or how the algae are used for the reason of taste. However, participants from both groups cited 'taste' as the top score reason they *do* eat algae (Table 3). Seaweeds are known especially for their many flavours and are applied in food. They are included in particular because of the K salt or for the fifth taste and for the enhancement of the flavors of the rest of the food (Mouritsen, 2009; Mouritsen and Styrbæk, 2011). A project with a newly trained seaweed flavour-sensoric panel has recently published a report about the taste and possibilities of application of Irish seaweeds. This report argues that 9 g of kombu is needed to match the sodium content

in 1 g of table salt (although users must be aware of the potential high iodine content in this amount of kombu). Furthermore, the flavour potential and best application of dry and fresh seaweed are evaluated, together with what type of food they fit the best (e.g. bread, soup; Hotchkiss, 2010). The brown kelps in particular contain high amounts of "the fifth taste", monosodiumglutamate (MSG, also known as umami). Nordic *Alaria*, *Palmaria* and *Saccharina* have been investigated in both the Nordic Food Lab, and the scientific kitchen of the best restaurant in the world, Noma. This investigation was based on the search for the synergetic effects of tastes with other foods such as dried ham or chicken to create a Nordic version of the Japanese *dashi* (Mouritsen *et al*., 2011; Mouritsen and Styrbæk, 2011).

Although many genera were represented in the preferred 'top 3' edible algae (Figure 2), records from the general public only represent some of the most common and commercially available species i.e. mainly *Porphyra sp.*, *P. palmata*, *Chondrus crispus,* and various species of kelps. Figure 1 also shows that for members of the general public appear to eat fewer algae species than phycologists, especially in their forties and fifties. Therefore in addition to making algae more readily available in shops, further education may be required to encourage more people to eat a wider range of seaweeds and microalgae.

A strong trend amongst participants shows that 52% and 75% of phycologists and the general public, respectively, eat algae, but choose 'other' as their reason for doing so. Citing Nori or *Porphyra* as the algae eaten followed this particular pattern of response. The results suggest that the 'other' reason that participants eat *Porphyra* may be due to the popularity of Japanese cuisine across the world (e.g. in its most familiar form –

sushi). It is suggested that these respondents may not necessarily 'choose' to eat algae per se; the *Porphyra* is simply present as part of the food served.

One difference in responses from phycologists and the general public relate to eating seaweed for the perceived health benefits (Table 3). Health benefits (e.g. anti-inflammatory, anti-viral, anti-obesity) are numerous as shown in recent reviews (Chacon-Lee and Gonzalez-Marino, 2010; Plaza *et al*., 2009; Stengel *et al*., 2011; Holdt and Kraan, 2011). The daily consumption of seaweed has in several studies shown to reduce the Insulin-like growth factor 1 (IGF-1) and estrogen level in postmenopausal healthy women. The daily seaweed consumption and the favourable effect of seaweed on IGF-1 and the estrogen metabolism are likely to be involved in the significantly lower breast cancer rates of Japanese postmenopausal women (Teas *et al*., 2011; Teas *et al*., 2009). Furthermore, a pilot study has shown that daily intake of microalgae, seaweed or both is safe, improves quality of life and may help patients with HIV to remain healthy and postpone the need for antiretroviral therapy (Teas and Irhimeh, 2011).

While not conclusive in a small survey, it may suggest that phycologists are more aware of the health benefits of eating algae (36%) than the general public (13%). However, this awareness by the phycologists makes it even more striking that only 10% and 20% of the phycologists eat algae daily or weekly, respectively. Clinical researchers such as Teas *et al*. (2009) and Teas and Irhimeh (2011) shows that the effects of algae on estrogen level and HIV were shown to be reversible, which suggests *that the daily/regular intake of algae is needed.*

It would be interesting to note if there would be changes to the proportions of phycologists and general public eating seaweed for the perceived health benefits if a variety of algal products were marketed more visibly than they are currently. The proportion may also increase if the general public were educated to a greater extent about the positive effects of adding algae into the daily diet. Indeed, microalgae are most often marketed as a health product, and yet no general public participants chose to eat (or were aware that they ate) microalgae (Figure 3).

The results of the probability model (Table 5) analysing the likelihood of participants eating algae on at least a monthly basis were as remarkable for the non-significant results as for the significant ones. Compared across all respondents, neither age nor nationality affected the likelihood of eating seaweed. This is somewhat surprising as Asian countries such as China, Korea and Japan are not only some of the greatest producers of seaweeds but the populations of these countries are also well-documented as having a long tradition for daily consumption of algae as food, as well as for the use as medicine (Murata and Nakazoe, 2001; Arasaki and Arasaki, 1983). The association is so established that bacterial genes coding for enzymes that break down red algal polysaccharides in the genus *Porphyra* have recently been discovered in the bacteria of the digestive tract of Japanese seaweed consumers (Hehemann, 2011).

However, it is encouraging to think that eating algae is independent of age and nationality, which might in turn suggest a certain ‘open-mindedness’ to consumption, even if algae don’t form a traditional part of the diet (Table 3 and 5). With an ever-increasing global human population, seaweed production from cultivation (along with

other marine aquaculture species) may become increasingly important as a source of nutrition (FAO, 2010). The highly significant probability that conference attendees are more likely to eat algae regularly than the public is almost certainly attributable to the availability of algal knowledge through research. This result may reinforce an earlier point, that with increased available information on the topic (e.g. improved culinary and health benefit knowledge; Table 4) the general public may choose to eat more algae. In an improved questionnaire, participants should be asked to rank *why* they choose to eat algae. In a further question, participants should also be asked whether they would eat more algae if it were easily accessible/ available (using a scale to agree or disagree with the question).

Finally, of the phycologists who answered the questionnaire, it is most interesting to note that a 'macro/micro' debate also exists for the consumption of algae. Macroalgal researchers are significantly more likely to eat algae regularly, perhaps given that most algae consumed are seaweeds (Table 5, and Figures 2 and 3). Perhaps microalgal researchers do not generally consider the organisms with which they work as a source of food. This may be especially prevalent within groups where for example, microalgae are studied as a source of biofuel, and as sources of harmful algal blooms (therefore shellfish poisoning). Perhaps this hypothesis could be extended to mycologists in a similar questionnaire to see whether the type their research carried out influences the types and amounts of fungal fruiting bodies (i.e. mushrooms) consumed. Those researchers who work on a 'micro' scale with moulds, mildews, and other pathogenic fungal organisms may be less likely to eat mushrooms than for example, field taxonomists.

The questionnaire described in this paper was designed to be as brief as possible. The design of future questionnaires could and should be improved and enlarged in order to better understand why participants do or don't eat algae and to use the available data more fully.

5. Conclusion

In conclusion, this survey finds that phycologists attending the ISAP conference in Halifax are more likely to eat algae compared to the general public but 'only' by 22%.

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References

Arasaki S, Arasaki T (1983) Low calorie, high nutrition vegetables from the sea to help you look and feel better. Japan publications, Tokyo, 196 pp

Chacon-Lee TL, Gonzalex-Marino GE (2010) Microalgae for "healthy" foods-possibilities and challenges. Compr Rev Food Sci F 9: 655-675

FAO (2010) State of the world fisheries and aquaculture. Rome, 197p.

Greene WH (2008) Econometric Analysis, 6th ed., Chapter 21. New Jersey: Prentice Hall 1178p.

McHugh DJ (2003) A guide to the seaweed industry. FAO Fisheries Technical Paper.

No.

441. FAO, Rome. 105p.

Hehemann J-H, Correc G, Barbeyron T, Helbert W, Czjzek M, Michel G (2010) Transfer of carbohydrate-active enzymes from marine bacteria to Japanese gut microbiota. Nature 464; 908-912. DOI: 10.1038

Holdt SL and Kraan S (2011) Bioactive compounds in seaweed: functional food applications and legislation. J Appl Phycol 23: 543-597

Hotchkiss S (2010) Investigation of flavouring and taste components of Irish Seaweeds. Marine research sub-programme (NDP 2007-'13) series. Project number ILA/07/004. ISSN:2009-3195. http://www.marine.ie/home/Publications/Publications/Marine+Research+Sub-Programme+%28NDP+2007-2013%29.htm (accessed 31 July 2011).

Mouritsen OG, Styrbæk K (2011) *Umami. Gourmet*aben & den femte smag. Nyt Nordisk Forlag Arnold Busck A/S, Denmark. pp 256 (in Danish)

Mouritsen OG, Vildgaard T, Westh S, Williams L (2011) Smagsdommere på Nordic Food Lab. http://www.umamibog.dk/wp-content/uploads/2011/03/gastro-51-72-75-2010.pdf (accessed July 2011; in Danish)

Mouritsen OG (2009) Tang - Grøntsager fra havet. Nyt Nordisk Forlag Arnold Busck A/S, Denmark. pp 304 (in Danish)

Murata M, Nakazoe J (2001) Production and use of marine algae in Japan. Jpn Agr Res Q 35: 281–290

Plaza M, Herrero M, Cifuentes A, Ibanez E (2009) Innovative natural functional ingredients from microalgae. J Agric Food Chem 57: 7159-7170

Stengel DB, Connan S, Popper ZA (2011) Algal chemodiversity and bioactivity: Sources of natural variability and implications for commercial application. Biotechnol Adv. doi:10.1016/j.biotechadv.2011.05.016

Teas J, Hurley TG, Hebert JR, Franke AA, Sepkovic DW, Kurzer MS (2009) Dietary Seaweed Modifies Estrogen and Phytoestrogen Metabolism in Healthy Postmenopausal Women. J Nutr 139: 939–944

Teas J, Irhimeh M, Druker S, Hurley T, Hebert J, Savarese T, Kurzer M (2011) Serum IGF-1 concentrations change with soy and seaweed supplements in healthy postmenopausal American women. Nutr Canc (accepted)

Teas J, Irhimeh M (2011) Seaweed in the time of AIDS: pilot study data. 4th Congress of the Phycological Society of Applied Phycology, Halifax Canada, June 19-24. Abstract for oral presentation


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