

Who eats seaweed? An Australian perspective

Journal:	<i>Journal of International Food & Agribusiness Marketing</i>
Manuscript ID	WIFA-2018-0057
Manuscript Type:	Institute of Food Products Marketing Research Conference
Keywords:	Seaweed consumption, Australia, consumer behaviour, drivers, barriers

SCHOLARONE™
Manuscripts

Review Only

Who eats seaweed? An Australian perspective

Abstract

Current seaweed consumption, and attitudes and preferences towards seaweed food products in a Western society are investigated to inform the seaweed industry regarding product development and marketing strategies. A national survey of 521 Australian consumers was conducted. About 75% of respondents had eaten seaweed, however only 37% had consumed seaweed regularly over the past 12 months. Key drivers include health and nutritional benefits, taste, and being natural, safe and fresh. Critical barriers are lack of knowledge and familiarity, and the perception that seaweed is expensive. Females and younger, health conscious consumers with higher household incomes and levels of education, who are more adventurous with food (neophilic), and who tend to snack and assign symbolic value to food are more likely to consume seaweed. Recommendations for the emerging seaweed industry in terms of target markets and relevant marketing strategies are presented and areas of further research proposed.

Key words: seaweed consumption; Australia; consumer behaviour; drivers; barriers

Who eats seaweed? An Australian perspective

Introduction

While not being a part of the traditional diet, seaweed is becoming increasingly popular in Western societies, featuring in television cooking shows, restaurant menus, food blogs and recipe books and websites. Internationally renowned UK chef Jamie Oliver recently described seaweed as “the most nutritious vegetable in the world” and devoted an entire episode of his television cooking show “Jamie and Jimmy’s Friday Night Feast” to seaweed (Matthews, 2018). Seaweed consumption, in particular that associated with sushi and as an ingredient in snack foods, such as seaweed flavoured crackers, has experienced significant growth in recent times (Altintzoglou, Heide, Wien, & Honkanen, 2016). Of the estimated 12,000 species of seaweed across the globe, about 500 are currently used for human consumption (Prager, 2017). While consumers in Asian countries frequently consume seaweed, it is typically not part of the traditional diet for most Western countries (Brownlee, Fairclough, Hall, & Paxman, 2012; Chapman, Stevant, & Larssen, 2015; Fleurence, 2012; Prager, 2017). There is, however, growth in the seaweed food market in Western societies. In the UK, for example, more than 200 different seaweed food products can be purchased, of which 63% are produced from locally UK sourced seaweed (Bouga & Combet, 2015). Likewise, there are opportunities for the growth of the seaweed industry in other typically Western societies, such as Australia.

Australia has an extensive coastline with over 6,000 different varieties of seaweed, representing a significant opportunity to take advantage of the growing popularity of seaweed by making domestic products. However, before making substantial investment, the emerging seaweed industry needs to develop an understanding of consumers’ perceptions of seaweed as a food product and hence, demand and preferences. Gaining acceptance of unfamiliar food

1
2
3 products, such as seaweed, which some consumers may find confronting, will be challenging
4
5 and thus consumer insight is critical for developing appealing product offerings and
6
7 developing appropriate branding strategies.
8
9

10 Little is known about Western consumers' attitudes towards seaweed as a food product other
11
12 than inferential data from the categories of product available for purchase. A search of extant
13
14 literature revealed very few articles examining consumers and seaweed. In 2017, Prager
15
16 (2017) published a conceptual article focusing on consumers' perceptions of seaweed food
17
18 products, and prior to this, Chapman et al. (2015) reported on the potential for including
19
20 seaweed enhanced products in the Nordic diet. This research aims to address this gap in the
21
22 body of knowledge by investigating current seaweed consumption and preferences, and
23
24 understanding consumers' behaviour toward seaweed, along with drivers and barriers of
25
26 seaweed consumption in one typical Western society, namely Australia.
27
28
29
30
31
32

33 **Drivers and barriers of seaweed consumption**

34 *Health and nutritional benefits*

35
36
37
38 Consumers are increasingly more health-conscious, with research indicating that women tend
39
40 to be more health-conscious than men (Beardsworth et al., 2002; Fagerli & Wandel, 1999;
41
42 Gould, 1988; Kubberød, Ueland, Rødbotten, Westad, & Risvik, 2002; Verbeke, 2005).

43
44 Seaweed is a functional food that delivers numerous health benefits, including improved
45
46 digestive track and bone health, and aids prevention of chronic conditions and diseases, such
47
48 as cardiovascular disease, cancer, diabetes and metabolic syndrome (Bouga & Combet,
49
50 2015). There is now clear evidence that the edible varieties of seaweed are highly nutritious,
51
52 rich in antioxidants and contain beneficial micronutrients (Bouga & Combet, 2015; Gupta &
53
54 Abu-Ghannam, 2011; Roohinejad et al., 2017). In addition, seaweed is high in dietary fibre
55
56
57
58
59
60

1
2
3 and has been found to aid weight loss through enhanced satiety and reduced fat absorption
4 leading to lower risk of cardiovascular disease (Brownlee et al., 2012; Hall, Fairclough,
5 Mahadevan, & Paxman, 2012). However, little is known about Western consumers'
6
7 understanding of the potential health and nutritional benefits of seaweed or how they could be
8
9 delivered via various seaweed product lines.
10
11
12
13
14
15
16

17 *Responsibility with food and food safety concerns*

18
19
20 In addition to a desire for healthier food, consumers are also becoming increasingly conscious
21 of where their food comes from and how it is produced (Pieniak, Verbeke, Scholderer,
22 Brunsø, & Olsen, 2008). For example, studies of fish consumption have indicated that some
23 consumers are concerned about risks associated with seafood consumption due to chemical
24 and bacterial contamination, and the possibility of being allergic or getting ill from eating fish
25 (Pieniak et al., 2008). Likewise, concerns about food safety associated with seaweed include
26 the potential presence of allergens and pathogens (van der Spiegel, Noordam, & van Der
27 Fels-Klerx, 2013). However, allergens linked to seaweed are rare as compared to fish
28 (Fleurence et al., 2012). There are some risks of toxicity from seaweed consumption linked to
29 high iodine levels, arsenic, heavy metals and contaminants, for example, high levels of
30 arsenic in brown seaweed (Food Standards Australia New Zealand, 2013, 2016). However,
31 these risks are easily mitigated through monitoring of seaweed species and the water within
32 which it is produced (Bouga & Combet, 2015).
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Environmental benefits

Concerns that diets high in red meat lead to health risks, and the associated environmental impacts of livestock farming (e.g. climate change, greenhouse emissions, arable land usage, water usage, etc.), have encouraged consumers to consider replacing meat with healthier, more sustainable and ethical protein, including plants, insects and seaweed (Aiking, 2011; Arioli, Mattner, & Winberg, 2015; de Boer, Schösler, & Boersema, 2013; Duarte, Wu, Xiao, Bruhn, & Krause-Jensen, 2017; Fleurence et al., 2012; Prager, 2017; Verbeke, 2015). For example, research conducted by Mintel (2016) revealed that 58% of German consumers and 44% of UK consumers had “either tried or would like to try algae as a protein source”. Not all species of seaweed will be appropriate substitutes as the protein content varies considerably (A. Angell, S. Angell, de Nys, & Paul, 2016; Angell, Mata, de Nys, & Paul, 2016). For instance, protein content can be up to 47% in the nori species used for sushi (Warwicker & Taylor, 2012).

Sensory characteristics

Taste is a key driver of food choice and has been attributed to increased interest in seaweed as a food (O. Mouritsen, Johansen, & J. Mouritsen, 2013; Tan, Fischer, van Trijp, & Stieger, 2016; Tinellis, 2014). Different species of seaweed have different sensory profiles and respond differently when cooked or processed (Chapman et al., 2015). However, adding seaweed to traditional Nordic dishes, for example, did not negatively impact flavour and even revealed potential for improving texture, appearance and the colour of foods (Chapman et al., 2015). Conversely, other studies have found that the addition of seaweed reduces product acceptability (Fernández-Martín, López-López, Cofrades, & Colmenero, 2009; Jiménez-Colmenero et al., 2010). Research indicates that consumers typically report reduced sensory

1
2
3 appeal for less familiar or novel foods (Arvola, Lähteenmäki, & Tuorila, 1999; Raudenbush
4 & Frank, 1999). Consumers may reject an unfamiliar food, such as seaweed, based purely on
5 its appearance and smell, or due to what Tan et al. (2016) describe as negative “non-sensory
6 associations” (e.g. it is “simply gross”).
7
8
9
10

11 12 13 14 15 *Lack of familiarity and neophobia*

16
17 Food consumption is highly habitual, complex and multidimensional (Brunso, Verbeke,
18 Olsen, & Jeppesen, 2009; Köster 2009). Consumer familiarity with a food category reduces
19 uncertainty and perceived risk associated with the potential negative effects of consumption
20 and reduces consumers’ scepticism of a product category (Borgogno, Favotto, Corazzin,
21 Cardello, & Piasentier, 2015; Verbeke, Scholderer, & Lähteenmäki, 2009). Hence, despite
22 evident health and environmental benefits, getting consumers in Western societies to replace
23 traditional meats with alternative and unfamiliar sources of protein such as seaweed will be
24 challenging (Chapman et al., 2015; Prager, 2017; Schösler, de Boer, & Boersema, 2012).
25
26
27
28
29
30
31
32
33
34

35 Neophobia or the unwillingness to try new or unfamiliar foods results in high failure rates for
36 innovative food products (Barrena & Sánchez, 2012; Gresham, Hafer, & Markowski, 2006;
37 Moreau, Lehamann, & Markman, 2001; Pliner & Hobden, 1992; Tuorila, Meiselman, Bell,
38 Cardello, & Johnson, 1994). Neophobia has been found to differ across age groups, with
39 lower levels of neophobia associated with younger people (Loewen & Pliner, 2000; Tuorila,
40 Lähteenmäki, Pohjalainen, & Lotti, 2001); more educated consumers (Flight, Leppard, &
41 Cox, 2003); males (Meiselman, Mastroianni, Buller, & Edwards, 1999; Nordin, Broman,
42 Garvill, & Nyroos, 2004); and urban consumers as compared to rural consumers (Flight et al.,
43 2003; Tuorila et al., 2001).
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Perceptions of affordability and availability

Price and lack of perceived availability are common barriers to consumption of fresh seafood (Trondsen, Scholderer, Lund, & Eggen, 2003) and fresh fruit and vegetables (Haynes-Maslow, Parsons, Wheeler, & Leone, 2013). Novel foods are typically less readily available and are often perceived to be exclusive and more expensive, thus representing higher purchase costs (i.e. price and effort) for the consumer leading to lower perceptions of customer value (Papista & Kyrstallis, 2013; Perrea, Krystallis, Engelgreen, & Chrysochou, 2017). For example, Verbeke, Sans and van Loo (2015) found that price along with sensory expectations explained consumer lack of acceptance of cultured meat as an alternative source of protein.

Propensity to snack

Demand for convenient snacks with nutritional and functional benefits has increased in recent times (Potter, Stojceska, & Plunkett, 2013; Rathod & Annapure, 2016). Snacks are a strong growth market estimated to be valued globally at US\$635 billion by 2020, with an increasing demand for functional, organic and natural snacks (Global Industry Analysts, 2015). This propensity for seeking convenient, healthier snack foods represents a real opportunity to introduce seaweed into the Western diet. A research report from Mintel (2016) revealed that food and drink product launches with seaweed flavours increased by 147% in Europe between 2011 and 2015, with 37% of these products being in the snack category.

Symbolic value

Consumption of certain “trendy” or novel foods can serve an image and social “status” function, and thus seaweed consumption may have some symbolic value for the consumer (Elliot, 2014; Jain & Srinivasan, 1990; Laurent & Kapferer, 1985; Perrea et al., 2017). For example, Brunsø et al. (2009) found that Belgians considered cooking fish to be “chic”, and Juhl and Poulsen (2000) suggested that “it tells something about a person if he/she eats fish”. A comparison of Norwegian and Japanese sushi consumers revealed that in addition to health benefits and convenience, eating sushi is considered to be “trendy” (Altintzoglou et al., 2016).

Given the lack of literature on the subject of seaweed consumption, an exploratory model of seaweed consumption (Figure 1) was developed to guide this inquiry. In this research, it is proposed that consumers’ intentions to consume seaweed will drive consumption frequency. Consumption frequency and purchase intentions will be associated with key drivers and barriers. However, this association will be mediated by psychological influences over seaweed consumption, including health-consciousness, responsibility with food and concerns about food safety, neophobia, snacking behaviour and symbolic value. It is also proposed that demographic differences may influence purchase intentions and, therefore, seaweed consumption frequency.

INSERT Figure 1: An exploratory model of seaweed consumption.

Materials and Methods

Data collection and sample

A national online survey of Australian consumers (n = 521) was administered in November 2017 through a professionally managed Qualtrics online consumer panel (Qualtrics Pty Ltd, Sydney). Because the Qualtrics panel sample is not a “probability sample”, meaning that it will not provide a national representation, we aimed for at least 500 respondents to ensure that there were sufficient numbers (>100) in each age demographic. The survey took approximately 15 minutes to complete. The survey contained questions regarding current seaweed consumption, attitudes towards seaweed as a food product, perceptions of benefits and risks, drivers and barriers to seaweed consumption, preferences and consumption occasions.

A profile of the respondents is provided in Table 1. Given respondents were screened for being at least a joint grocery shopper for the household, responses are skewed towards females. In line with the ethnic make-up of the Australian society, nearly three-quarters of the respondents (73.5%) identified as white Australian, 8.8% identified as being Asian, and 7.1% as European.

INSERT Table 1: Respondent profile.

Questionnaire and scaling

In order to distinguish seaweed consumption from sushi consumption, which we suspected was the most prominent form of seaweed consumed in Australia, the respondents were first introduced to the purpose of the survey. After responding to socio-demographic

1
2
3 questions, a series of open-ended questions related to seaweed were asked (i.e., “What is the
4 first thing that comes to mind when you hear the word “seaweed”?, ”Complete the following
5 sentences: “When I think about eating seaweed, I ...”, and “Eating seaweed is ...”. The wide
6 range of responses indicate that the respondents were or became aware of seaweed as a
7 wider food category than just sushi wrappings (i.e., as a proxy for self-reported familiarity).
8
9
10
11
12

13
14
15
16
17 Seaweed consumption was measured on three variables: (1) Have you ever eaten or tasted
18 seaweed? (Yes/No); (2) How often seaweed was consumed in the past 12 months (ranging
19 from never to daily); and (3) Likelihood to consume seaweed in the next 12 months (7 point
20 scale). We asked respondents if they were aware that sushi wrappers were made from
21 seaweed.
22
23
24
25
26

27
28 To better understand the market for seaweed, relevant constructs such as neophobia, health-
29 consciousness, responsibility with food and concern about food safety, symbolic value when
30 making food choices, and snacking behaviour were measured. Food neophobia was measured
31 on four items, with three selected from Pliner and Hobden’s (1992) Food Neophobia Scale
32 (FNS) and one item from the original Food Related Lifestyle (FRL) instrument (Brunso &
33 Grunert, 1995). To measure health consciousness, four items were selected from Gould’s
34 (1990) health-consciousness scale. Responsibility with food and food safety concern items
35 were based on items from the Modular Food Related Lifestyle (MFRL) Instrument currently
36 under scale development (Birch, Brunso, Grunert, & Memery, 2017). To measure symbolic
37 value, three items were used from Laurent and Kapferer’s (1985) and Jain and Srinivasan’s
38 (1990) consumer involvement profile (CIP) scales. Measures for snacking behaviour were
39 based on three items in the original FRL instrument (Brunso & Grunert, 1995). The items are
40 shown in Appendix 2.
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56

1
2
3 Based on the literature and media articles about benefits and risks of seaweed consumption,
4 respondents were also asked to indicate on a five point Likert-type scale the relevance of a
5 range of reasons for eating or not eating seaweed (Tables 7-8).
6
7
8
9

10
11 Exploratory factor analysis was conducted on the 25 psychological influence items. After
12 removing six non-discriminant and non-converging items, five factors were retained with
13 Cronbach's Alpha values ranging from .85 to .88 (see Appendix 2). Summated scales were
14 made from the factors and used in the subsequent analyses. Statistical analyses were
15 performed using the statistical software SPSS Version 24. Bivariate analyses includes cross
16 tabulation with chi-square statistics and independent sample T-tests.
17
18
19
20
21
22
23
24
25
26

27 **Results**

28 *Seaweed Consumption*

29
30 For analysis purposes, respondents who indicated that they did not know if they had eaten
31 seaweed were removed. Most of the respondents (83.9%) were aware that sushi wrappers
32 were made from seaweed. Of those respondents who were sure that they had or had not eaten
33 seaweed (n= 502), nearly three quarters (74%) reported that they had eaten or tasted seaweed
34 (Table 2). Consumption frequency of seaweed is relatively low with only 37% of the
35 respondents eating seaweed more than once a month in the past 12 months. However, 62%
36 indicated that they would be likely to eat seaweed in the next 12 months. Those who had
37 eaten or tasted seaweed in the past were more likely to eat seaweed in the next 12 months
38 (77%) than those who had not tasted seaweed in the past (8%) ($\chi^2 = 149.84, p = .000$). The
39 demographic differences associated with seaweed consumption were then tested (Table 2).
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 *INSERT Table 2: Demographic differences associated with seaweed consumption.*
4
5
6
7

8
9 There were no differences on the basis of gender for having eaten or tasted seaweed or for the
10 likelihood of consuming seaweed in the next 12 months. However, more females (41%) than
11 males (32%) reported having consumed seaweed more than once per month in past 12
12 months ($\chi^2 = 4.52$, $p = .03$). Respondents with the main role of shopping and cooking for
13 their household were more likely to have eaten or tasted seaweed (76%) than those who
14 indicated a joint role (66%) ($\chi^2 = 4.08$, $p = .04$). However, there were no differences with
15 respect to frequency of consumption in the past 12 months or the likelihood of consuming
16 seaweed in the next 12 months on the basis of shopping and cooking role.
17
18
19
20
21
22
23
24
25

26
27 More highly educated people were more likely to have eaten or tasted seaweed ($\chi^2 = 9.84$, $p =$
28 $.02$), had consumed seaweed more frequently in the past 12 months ($\chi^2 = 25.57$, $p = .00$), and
29 were more likely to consume seaweed in the next 12 months ($\chi^2 = 21.90$, $p = .00$). People
30 with higher household incomes were more likely to have eaten or tasted seaweed ($\chi^2 = 19.07$,
31 $p = .00$), had consumed seaweed more frequently in the past 12 months ($\chi^2 = 17.01$, $p = .00$),
32 and were more likely to consume seaweed in the next 12 months ($\chi^2 = 9.24$, $p = .03$).
33
34
35
36
37
38
39
40

41 Younger people were more likely to have eaten or tasted seaweed ($\chi^2 = 12.09$, $p = .01$), and to
42 have consumed seaweed more frequently in the past 12 months ($\chi^2 = 20.62$, $p = .00$).
43
44

45 However, younger consumers were no more likely to consume seaweed in the next 12
46 months than older consumers.
47
48
49

50
51 Respondents were asked to indicate what seaweed products they had consumed (Table 3) and
52 which products they would be willing to eat. The most commonly consumed seaweed product
53 is sushi (70.6%), followed by seaweed flavoured crackers (48.6%), seaweed soup (35.3%),
54
55
56
57

1
2
3 and seaweed flavoured snacks (22.6%). Less frequently consumed seaweed products include
4
5 fresh seaweed in a salad (18.8%) and seaweed flakes or sprinkles (13.6%). Seaweed
6
7 supplements (5.8%), drinks (3.8%) and jelly/lollies (2.9%) are rarely consumed. There were
8
9 no significant differences across gender or age in terms of consumption of the different
10
11 seaweed products.
12

13
14
15
16
17
18 *INSERT Table 3: Seaweed products consumed.*
19

20
21
22
23 Respondents indicated that they were most willing to consume sushi wrapped in seaweed
24
25 (62%), followed by seaweed flavoured crackers (60%), seaweed flavoured snacks (54%), and
26
27 seaweed soup (52%) (Appendix 1). Less than half of the respondents were willing to
28
29 consume seaweed flakes or sprinkles (47%) or fresh seaweed in a salad (47%). About one-
30
31 third (33%) indicated that they were willing to consume a seaweed supplement, while about
32
33 one-quarter would be willing to consume seaweed as a drink (28%) or in a jelly or sweet
34
35 (25%).
36
37
38
39
40
41

42 *Eating and dietary preferences* 43

44
45 Respondents were also asked about the foods they eat (Table 4). Respondents who had eaten
46
47 or tasted seaweed in the past were more likely to eat healthier foods such as vegetables,
48
49 salads, fish/seafood, lentils, pulses, quinoa and couscous. Likewise, increased frequency of
50
51 consumption of seaweed in the past 12 months was associated with these healthier food
52
53 choices, as was likelihood to consume seaweed in the next 12 months. Moreover, respondents
54
55
56
57

1
2
3 who eat chicken were more likely to agree that they would be likely to eat seaweed in the
4
5 next 12 months.
6
7
8
9

10 *INSERT Table 4: Dietary choices and seaweed consumption.*
11
12
13
14
15

16 The majority of respondents (58%) in this study indicated that they eat a varied diet
17 comprising red meat, fish/seafood, eggs and dairy. Another 23% indicated that they prefer red
18 meat, pork and chicken to fish or seafood, while 11% prefer fish and seafood to other meats.
19
20 Only 5% reported being vegetarian, while 2% reported being vegan or pescatarian
21
22 respectively.
23
24
25

26
27 There were significant differences in seaweed consumption across the dietary preference
28 groups (Table 5). In particular, people who prefer to eat red meat, pork or chicken rather than
29 fish or seafood were significantly less likely to have ever eaten seaweed ($\chi^2 = 9.56$, $p = .02$),
30 to have consumed seaweed in the past 12 months ($\chi^2 = 16.59$, $p = .01$) or to consume seaweed
31 in the next 12 months ($\chi^2 = 29.28$, $p = .00$). People who identified as being either vegetarian,
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

INSERT Table 5: Dietary preferences and seaweed consumption.

1
2
3 *Psychological influences on seaweed consumption*
4

5 Exploratory factor analysis revealed five factors (Eigenvalues greater than 1): neophobia
6 (alpha = .85); responsibility with food and food safety (alpha = .88); symbolic value (alpha =
7 .87); health consciousness (alpha = .85) and snacking behaviour (alpha = .85) (see Appendix
8 2 for details). People with higher levels of neophobia were less likely to have eaten seaweed
9 in the past, had consumed seaweed less frequently in the past 12 months and were less likely
10 to consume seaweed in the next 12 months (Table 6). People who are more mindful of their
11 food consumption (reflected by the factor - responsibility with food and food safety) were
12 more likely to have eaten seaweed in the past, had consumed seaweed more frequently in the
13 past 12 months and were more likely to consume seaweed in the next 12 months. Seaweed
14 consumption was more frequent and likely for those who assign symbolic value to food and
15 for those who are more health-conscious. While snacking behaviour did not influence having
16 eaten or tasted seaweed, people with a higher propensity to snack had consumed seaweed
17 more frequently in the past 12 months and are more likely to consume seaweed in the next 12
18 months.
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37

38 *INSERT Table 6: Psychological influences on seaweed consumption.*
39
40

41
42 *Reasons for eating or not eating seaweed*
43

44 The sparse literature on seaweed consumption revealed that drivers of seaweed consumption
45 are primarily associated with health, nutrition and environmental benefits, as well as taste
46 (Bouga & Combet, 2015; Chapman et al., 2015; de Boer et al., 2013; Prager, 2017). Barriers
47 to seaweed consumption are mostly linked to lack of familiarity and neophobia (Chapman et
48 al., 2015; Prager, 2017).
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 Based on the literature and media articles about benefits and risks of seaweed consumption,
4 respondents were asked to indicate on a five point Likert-type scale about the relevance of a
5 range of reasons for eating (Table 7) or not eating seaweed (Table 8). The most relevant
6 range of reasons for eating (Table 7) or not eating seaweed (Table 8). The most relevant
7 reasons for eating seaweed are linked to functional benefits including being healthy (64%),
8 nutritious (61%), and a natural source of Omega 3 (59%). This finding supports the literature
9 and reflects the consumption of sushi, for example, by Western consumers for health benefits
10 (Altintzoglou et al., 2016). Hedonic reasons such as being tasty (60%), liking seaweed (59%)
11 and considering seaweed to be pleasant (53%) are also relevant reasons for eating seaweed.
12 Other relevant functional reasons include seaweed being fresh (57%), safe to eat (57%), a
13 good source of protein (54%), low in calories (52%), and a good source of iodine (52%); diet
14 variety (51%); and versatility (51%). More than half of the respondents noted that being
15 environmentally friendly (53%) and sustainable (52%) were also relevant reasons for eating
16 seaweed. Respondents likely to eat seaweed in the next 12 months, scored significantly
17 higher ($p < .001$) on all the relevant reasons for eating seaweed (Table 7) as compared to the
18 respondents who were unlikely to eat seaweed in the next 12 months.
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

37 *INSERT Table 7: Relevant reasons (drivers) for eating seaweed. Mean scores and standard*
38 *deviations presented.*
39
40
41
42
43

44 In terms of reasons for not eating seaweed (Table 8), the key issues were the lack of
45 knowledge of the product category, including how to prepare it (45%), not having recipes
46 (41%), how long it can be kept (41%), what to serve it with (38%), how to store it (38%) or
47 where to buy seaweed (36%). More than one-third of the respondents (37%) considered
48 seaweed to be expensive. In terms of sensory characteristics, 39% indicated that smell would
49 be a relevant reason for not eating seaweed, while dislike of the taste (37%), not liking
50
51
52
53
54
55
56
57
58
59
60

1
2 seaweed (34%), dislike of the texture (33%), being unpleasant (33%), disliking the
3 appearance of seaweed (29%), or that it is “weird” (25%) are relevant reasons for not eating
4 seaweed. About one-third of the respondents indicated concern about chemical (37%) or
5 bacterial (36%) contamination, and whether it would be safe to eat (32%) as reasons for not
6 consuming seaweed. About one-quarter of respondents reported concern about seaweed not
7 being good for their health (25%) or being allergic to it (23%) as a reason for not eating
8 seaweed. When comparing the mean scores on the reasons not to eat seaweed (Table 8)
9 between respondents likely and unlikely to eat seaweed in the next 12 months, respondents
10 likely to eat seaweed, scored significantly lower ($p < .05$) on all reasons, except for not
11 knowing where to buy seaweed and that seaweed is expensive. This indicates that seaweed is
12 generally perceived to be an expensive, specialty product.

13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29 *INSERT Table 8: Relevant reasons (barriers) for not eating seaweed. Mean scores and*
30 *standard deviations presented.*

31 32 33 34 35 **Discussion and implications**

36 37 38 *Discussion*

39
40
41 The purpose of this study was to investigate current seaweed consumption and preferences,
42 and to understand consumers' attitudes toward seaweed, including key drivers and barriers of
43 seaweed consumption and psychological factors influencing seaweed consumption in
44 Australia. This understanding will allow the emerging seaweed industry in Australia to adopt
45 a demand-driven approach to developing relevant product offerings and targeted branding
46 strategies.

1
2
3 The majority of Australian consumers have eaten seaweed, with just over one-third of
4 respondents (37%) consuming seaweed at least once per month. However, an analysis of
5 seaweed products consumed indicates that consumption is primarily linked to seaweed as an
6 ingredient in sushi and flavouring in seaweed crackers, meaning that consumption levels in
7 terms of volume (i.e. actual weight) may be relatively low, as a single sushi wrapper weighs
8 about two grams and minimal quantities are incorporated into crackers. Hence, current
9 product formats are potentially not delivering health and nutritional benefits promised from
10 inclusion of seaweed in the diet. Moreover, about one-quarter of Australian consumers have
11 never (knowingly at least) eaten seaweed. Just less than two-thirds of Australian consumers
12 (62%) report that it is likely they will consume seaweed in the next 12 months, indicating that
13 Australian consumers are moderately receptive to seaweed products, in particular in the form
14 of more convenient products such as sushi, crackers and snacks.

15
16
17
18
19
20
21
22
23
24
25
26
27
28
29 Our findings indicate that younger consumers, people with higher household incomes and
30 those with higher levels of education are more likely to consume seaweed. Moreover, females
31 report higher levels of consumption in the past 12 months. Thus, the well-educated, younger
32 (under 35 years of age) female is the primary target market for seaweed products. Developing
33 convenient and sophisticated seaweed products with tailored branding that would appeal to
34 this demographic will be critical to the emerging Australian seaweed industry and potentially
35 that of other Western societies.

36
37
38
39
40
41
42
43
44
45 In keeping with the literature (Prager, 2017), health and nutritional benefits were identified as
46 the most relevant reason for consuming seaweed. More health-conscious consumers are a
47 primary market for seaweed meaning that new product development and marketing claims
48 need to be grounded in evidence and emphasise the significant health and nutritional benefits
49 that can be derived from seaweed consumption. We note the need to address the knowledge
50 gap of how much seaweed and which species must be used to deliver the desired benefits.

1
2
3 Furthermore, the environmental and sustainability benefits of seaweed are considered
4 relevant reasons for eating seaweed. This has been addressed in Australia and elsewhere in
5 demonstrating the benefits of integrating seaweed with other seafood production to minimise
6 environmental impacts (Lawton, Mata, de Nys, & Paul, 2013).
7
8
9

10
11 Our findings indicated that people who are more mindful in their food choices and the
12 environmental impacts of food, as well as food safety issues, are more likely to eat seaweed.
13 Hence, marketing claims and branding strategies need to reflect this desire for more
14 sustainable and safer food, and this should cover the whole supply chain of harvesting,
15 production and processing of seaweed products. While quite rare, there have been instances
16 where seaweed products have been recalled because of high levels of particular elements
17 (such as arsenic and iodine) (Canadian Food Inspection Agency, 2012; Food Standards
18 Australia New Zealand, 2011a, 2011b, 2018; Wong, 2010). However, there are two important
19 elements to food safety: the first is that it has been a conservative approach by food agencies
20 where the data (i.e. the variation in the elements) is not well understood, in particular, the
21 actual bioavailability to human consumers; the second is educational as all seaweed contains
22 different elements but only one or two species may do so to a problematic level. There are
23 roles for more regular and nuanced testing to be done as with any new industry scale up, and
24 also for aquaculture rather than wild-harvest as this will provide greater control of the
25 seasonal and environmental conditions of the product. That aside, Australian consumers do
26 not appear to be too concerned about the safety of seaweed or the potential for bacterial or
27 chemical contamination. Nevertheless, safety and quality procedures and regulations, such as
28 those developed in France (CEVA, 2014), will be required to remove potential risks of
29 consumption.
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52

53 Consumers of seaweed are more likely to be adventurous with food and willing to try new
54 products (Altintzoglou et al., 2016). This finding is in keeping with a study in Norway, which
55
56
57

1
2
3 revealed that younger consumers who are highly innovative with their food preparation are
4 more likely to consume a novel food product, such as sushi (Altintzoglou et al., 2016).

5
6 Providing opportunities for sampling the product and development of innovative seaweed
7 products will appeal to these neophilic consumers. Moreover, facilitating trial and
8 experimentation by ensuring seaweed products are featured on menus, cooking shows,
9 cooking websites and recipe books will encourage consumption by these more adventurous
10 food consumers (e.g. Jamie Oliver, Iron Chef and Nigella Lawson have all featured seaweed).

11
12 Conversely, neophobia has been identified as a major obstacle for consuming seaweed.

13
14 Managing the sensory characteristics of seaweed during product development including
15 smell, appearance and texture will be critical to wider market acceptance. Avoiding aversion
16 or disgust by including seaweed as a minor ingredient in other more familiar products may
17 overcome this barrier, however this brings with it the problematic mismatch between
18 perceived health drivers and ensuring sufficient consumption. Identifying more palatable
19 seaweed products will lead to consumer acceptance (Chapman et al., 2015).

20
21 Seaweed consumers are also more likely to assign symbolic value to food choices. Therefore,
22 capitalising on the associations of “you are what you eat” and the potential for seaweed to be
23 considered a “chic” or “trendy” food choice should drive branding strategies and promotional
24 appeals for new seaweed products. Finally, seaweed consumption is linked to a propensity to
25 snack, representing an opportunity for the seaweed industry to develop healthy, tasty and
26 convenient seaweed snacks that would appeal to key target markets. In this respect, snacking
27 may be the most transparent product development strategy, as it is unlikely that ‘snackers’
28 believe that they are going to gain direct health benefits, instead gaining indirect benefits by
29 substituting out “unhealthy” options.
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 Percentage agreement with potential reasons for not consuming seaweed was generally lower
4
5 than agreement with reasons for consuming seaweed, indicating Australian consumers
6
7 perceive seaweed consumption to be more associated with drivers or benefits than potential
8
9 barriers. The most critical barriers to seaweed consumption are lack of familiarity with and
10
11 lack of knowledge of the product category. Hence, utilising packaging, labelling, point of
12
13 purchase, and other marketing communication strategies (e.g. social media) to educate
14
15 consumers on where to buy the product, how to store it, how to prepare and serve it, and
16
17 providing appealing recipes are critical to increasing seaweed consumption. This will be
18
19 complicated as there are many different types of seaweeds (e.g. brown, red and green
20
21 taxonomic groups) and they all have different tastes, texture, appearances and biochemical
22
23 compositions. There is a risk that one seaweed species or product may deter consumers from
24
25 tasting others, so some care needs to be taken in differentiating between seaweeds in the
26
27 marketplace. This may be best be achieved through domestic production to complement the
28
29 increase in domestic processing of seaweed products using imported ingredients.
30
31

32
33 Other barriers to seaweed consumption include lack of availability and affordability. Hence,
34
35 overcoming these perceptions will rely upon developing affordable seaweed foods that
36
37 represent value for money in order to move beyond the present niche markets into wider
38
39 distribution in mainstream food outlets.
40
41

42 43 44 45 *Academic and managerial implications*

46
47
48 To the best of our knowledge, this is the first time that consumers' current consumption of
49
50 seaweed and the perceived drivers and barriers to seaweed consumption have been measured
51
52 and linked to the influence of key psychological variables. A model of seaweed consumption
53
54 is proposed, including key drivers (e.g. health, nutrition and taste) and barriers (e.g.
55
56

1
2
3 knowledge of how to use, prepare and store, and cost), along with moderating variables based
4
5 on demographic differences and mediating variables based on relevant psychological
6
7 influences, such as neophobia, health-consciousness, symbolic value, responsibility with food
8
9 and food safety, and snacking behaviour. This conceptual model will provide a framework
10
11 for further studies of seaweed consumption. In particular, it has strengthened understanding
12
13 of influences on consumption of novel and unfamiliar foods within the context of seaweed.
14

15
16 This research provides valuable insights into consumer preferences for a diverse range of
17
18 seaweed products. The findings have uncovered key barriers and drivers for expanding
19
20 seaweed consumption, allowing prioritisation of research agendas including new product
21
22 development, as well as marketing and branding efforts. A profile of the most important
23
24 seaweed consumer (i.e. female, under 35, highly educated) has been developed and will allow
25
26 for more targeted product development and branding strategies. A business case for the
27
28 potential for seaweed to become a new industry in Australia can be developed based on this
29
30 information and tailored to different business types.
31
32

33 34 35 36 37 *Limitations of the research and areas of future research*

38
39
40 This study is confined to an online national survey of 521 Australian consumers. While
41
42 representative of Western societies in general, future research involving larger samples and in
43
44 other Western societies across the globe will strengthen understanding. Future studies may
45
46 utilise other methodologies such as projective techniques to elicit top of mind associations or
47
48 focus groups to test new product/packaging concepts and associated marketing and branding
49
50 strategies including the use of marketing claims based on the benefits of seaweed
51
52 consumption. These qualitative techniques are valuable for gaining rich insights, in particular
53
54 around emotional responses to and acceptance of novel food.
55
56

References

- Aiking, H. (2011). Future protein supply. *Trends in Food Science and Technology*, 22(2-3), 112-120.
- Altintzoglou, T., Heide, M., Wien, A. H., & Honkanen, P. (2016). Traditional sushi for modern consumers: a comparison between sushi consumption behavior in Japan and Norway. *Journal of Food Products Marketing*, 27(6), 717-732.
- Angell, A. R., Angell, S. F., de Nys, R., & Paul, N. A. (2016). Seaweed as a protein source for mono-gastric livestock. *Trends in Food Science and Technology*, 54, 74-84.
- Angell, A. R., Mata, L., de Nys, R., & Paul, N.A. (2016). The protein content of seaweeds: a universal nitrogen-to-protein conversion factor of five. *Journal of Applied Phycology*, 28(1), 511-524.
- Arioli, T., Mattner, S. W., & Winberg, P.C. (2015). Applications of seaweed extracts in Australian agriculture: past, present and future. *Journal of Applied Phycology*, 27(5), 2007-2015.
- Arvola, A., Lähteenmäki, L., & Tuorila, H. (1999). Predicting the intent to purchase unfamiliar and familiar cheeses: the effects of attitudes, expected liking and food neophobia. *Appetite*, 32(1), 113-126.
- Barrena, R., & Sánchez, M. (2012). Neophobia, personal consumer values and novel food acceptance. *Food Quality and Preference*, 27, 72-84.
- Beardsworth, A., Bryman, A., Keil, T., Goode, J., Haslam, C., & Lancashire, E. I. (2002). Women, men, and food. The significance of gender for nutritional attitudes and choices. *British Journal of Food*, 104, 470-491.

1
2
3 Birch, D., Brunsø, K., Grunert, K., & Memery, J. (2017). *Modular food-related lifestyle: a*
4 *new instrument for consumer segmentation in food marketing*. Paper presented at the
5
6 International Food Marketing Research Symposium, 15-16 June, Dubrovnik, Croatia.
7
8

9
10 Borgogno, M., Favotto, S., Corazzin, M., Cardello, A., & Piasentier, E. (2015). The role of
11
12 product familiarity and consumer involvement on liking and perceptions of fresh meat. *Food*
13 *Quality and Preference*, 44, 139-147.
14

15
16
17 Bouga, M., & Combet, E. (2015). Emergence of seaweed and seaweed-containing foods in
18
19 the UK: focus on labeling, iodine content, toxicity and nutrition. *Foods*, 4(2), 240-253.
20
21

22
23 Brownlee, I., Fairclough, A., Hall, A., & Paxman, J. (2012). The potential health benefits of
24
25 seaweed and seaweed extract. In V. H. Pomin (Ed.), *Seaweed: ecology, nutrient composition*
26 *and medicinal uses. Marine Biology: Earth Sciences in the 21st Century* (pp. 119-136). New
27
28 York, NY: Nova Science Publishers.
29
30

31
32 Brunsø, K., & Grunert, K. G. (1995). Development and testing of a crossculturally valid
33
34 instrument: food-related life style. *Advances in Consumer Research*, 22, 475-480.
35
36

37
38 Brunsø, K., Verbeke, W., Olsen, S.O., & Jeppesen, L. F. (2009). Motives, barriers and quality
39
40 evaluation in fish consumption situations: exploring and comparing heavy and light users in
41
42 Spain and Belgium. *British Food Journal*, 111, 699-716.
43
44

45 Canadian Food Inspection Agency (2012). Inorganic arsenic and hijiki seaweed consumption.
46
47 Retrieved from [http://www.inspection.gc.ca/food/information-for-consumers/fact-sheets-and-](http://www.inspection.gc.ca/food/information-for-consumers/fact-sheets-and-infographics/products-and-risks/chemical-hazards/inorganic-arsenic/eng/1332268146718/1332268231124)
48
49 [infographics/products-and-risks/chemical-hazards/inorganic-](http://www.inspection.gc.ca/food/information-for-consumers/fact-sheets-and-infographics/products-and-risks/chemical-hazards/inorganic-arsenic/eng/1332268146718/1332268231124)
50
51 [arsenic/eng/1332268146718/1332268231124](http://www.inspection.gc.ca/food/information-for-consumers/fact-sheets-and-infographics/products-and-risks/chemical-hazards/inorganic-arsenic/eng/1332268146718/1332268231124).
52
53
54
55
56
57

1
2
3 CEVA (2014). Edible seaweed and French regulation - Synthesis made by CEVA

4 (31/03/2014). Retrieved from

5 <https://www.cybercolloids.net/sites/default/files/seaweed%20and%20regulation2014.pdf>.

6
7
8
9
10 Chapman, A., Stevant, P., & Larssen, W. (2015). Food or fad? Challenges and opportunities
11 for including seaweeds in a Nordic diet. *Botannica Marina*, 58(6), 423-433.

12
13
14
15 de Boer, J., Schösler, H., & Boersema, J. (2013). Motivational differences in food orientation
16 and the choice of snacks made from lentils, locusts, seaweed or “hybrid” meat. *Food Quality*
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

and Preference, 28(1), 32-35.

Duarte, C., Wu, J., Xiao, X., Bruhn, A., & Krause-Jensen, D. (2017). Can seaweed farming
play a role in climate change mitigation and adaptation? *Frontiers in Marine Science*, 4,
Article 100.

Elliot, C. (2014). Food as people: teenagers' perspectives on food personalities and
implications for healthy eating. *Social Science and Medicine*, 121, 85-90.

Fagerli, R. A., & Wandel, M. (1999). Gender differences in opinions and practices with
regard to a "healthy diet". *Appetite*, 32(2), 171-190.

Fernández-Martín F., López-López I., Cofrades, S., & Colmenero, F. J. (2009). Influence of
adding Sea Spaghetti seaweed and replacing the animal fat with olive oil or a konjac gel on
pork meat batter gelation. Potential protein/alginate association. *Meat Science*, 83(2), 209-
217.

Fleurence, J., Morançais, M., Dumay, J., Decottignies, P., Turpin, V., Munier, M., Jaouen, P.
(2012). What are the prospects for using seaweed in human nutrition and for marine animals
raised through aquaculture? *Trends in Food Science and Technology*, 27, 57-61.

1
2
3 Flight, I., Leppard, P., & Cox, D. N. (2003). Food neophobia and associations with cultural
4 diversity and socio-economic status amongst rural and urban Australian adolescents.
5
6 *Appetite*, 41, 51-59.
7
8
9

10 Food Standards Australia New Zealand (2011a). Wang Dried Seaweed – other (high levels of
11 naturally occurring iodine) – 28 June 2011. Retrieved from
12
13 <http://www.foodstandards.gov.au/industry/foodrecalls/recalls/Pages/wangdriedseaweedothe5>
14
15
16 203.aspx.
17
18

19 Food Standards Australia New Zealand (2011b). Dried Seaweed – other (high levels of
20 naturally occurring iodine) 8 November 2011. Retrieved from
21
22 <http://www.foodstandards.gov.au/industry/foodrecalls/recalls/Pages/driedseaweedotherhig53>
23
24
25 39.aspx.
26
27

28 Food Standards Australia New Zealand (2013). Monitoring of inorganic arsenic and iodine in
29 seaweed. Retrieved from
30
31 <http://www.foodstandards.gov.au/consumer/safety/arseniciodine/Pages/default.aspx>.
32
33
34

35 Food Standards Australia New Zealand (2016). Imported food risk statement: hijiki seaweed
36 and inorganic arsenic. Retrieved from
37
38 [https://www.foodstandards.gov.au/consumer/importedfoods/Documents/Hijiki%20seaweed%](https://www.foodstandards.gov.au/consumer/importedfoods/Documents/Hijiki%20seaweed%20and%20inorganic%20arsenic.pdf)
39
40
41
42
43 20and%20inorganic%20arsenic.pdf.
44
45

46 Food Standards Australia New Zealand (2018). The Whole Foodies Sea Vegetables Mixed
47 Seaweed. Retrieved from
48
49 [http://www.foodstandards.gov.au/industry/foodrecalls/recalls/Pages/The-Whole-Foodies-](http://www.foodstandards.gov.au/industry/foodrecalls/recalls/Pages/The-Whole-Foodies-SEA-VEGETABLES-Mixed-Seaweed.aspx)
50
51
52
53
54
55
56
57
58
59
60 SEA-VEGETABLES-Mixed-Seaweed.aspx.

1
2
3 Global Industry Analysts (2015). The global snack foods market. Retrieved from
4 [http://www.strategyr.com/MarketResearch/Snack_Foods_Salted_Baked_Frozen_Snacks_Mar](http://www.strategyr.com/MarketResearch/Snack_Foods_Salted_Baked_Frozen_Snacks_Market_Trends.asp)
5 [ket_Trends.asp](http://www.strategyr.com/MarketResearch/Snack_Foods_Salted_Baked_Frozen_Snacks_Market_Trends.asp).
6
7

8
9
10 Gould, S. J. (1988). Consumer attitudes toward health and health care: a differential
11 perspective. *Journal of Consumer Affairs*, 22(1), 96-118.
12
13

14
15 Gould, S. J. (1990). Health consciousness and health behavior: the application of a new
16 health consciousness scale. *American Journal of Preventive Medicine*, 6(4), 228-237.
17
18

19
20 Gresham, G., Hafer, J., & Markowski, E. (2006). Inter-functional market orientation between
21 marketing departments and technical departments in the management of the new product
22 development process. *Journal of Behavioral and Applied Management*, 8(1), 53-65.
23
24
25

26
27
28 Gupta, S., & Abu-Ghannam, N. (2011). Bioactive potential and possible health effects of
29 edible brown seaweeds. *Trends in Food Science and Technology*, 22, 315-326.
30
31

32
33 Hall, A. C., Fairclough, A. C., Mahadevan, K., & Paxman, J. R. (2012). Ascophyllum
34 nodosum enriched bread reduces subsequent energy intake with no effect on post-prandial
35 glucose and cholesterol in healthy, overweight males. A pilot study. *Appetite*, 58(1), 379-386.
36
37
38

39
40 Haynes-Maslow, L., Parsons, S. E., Wheeler, S. B., & Leone, L. A. (2013). A qualitative
41 study of perceived barriers to fruit and vegetable consumption among low-income
42 populations, North Carolina, 2011. *Preventing Chronic Disease*, 10, Article 120206.
43
44
45

46
47
48 Jain, K., & Srinivasan, N. (1990). An empirical assessment of multiple operationalizations of
49 involvement. In M. E. Goldberg, G. Gorn & R. W. Pollay (Eds.), *Advances in Consumer*
50 *Research* 17 (pp. 594-602). Provo, UT: Association for Consumer Research.
51
52
53

1
2
3 Jiménez-Colmenero, F., Cofrades, S., López-López, I., Ruiz-Capillas, C., Pintado, T., &
4 Solas, M. T. (2010). Technological and sensory characteristics of reduced/low-fat, low-salt
5 frankfurters as affected by the addition of konjac and seaweed. *Meat Science*, 84(3), 356-363.
6
7

8
9
10 Juhl, H., & Poulsen C. (2000). Antecedents and effects of consumer involvement in fish as a
11 product group. *Appetite*, 34, 261-267.
12
13

14
15 Köster, E. P. (2009). Diversity in the determinants of food choice: A psychological
16 perspective. *Food Quality and Preference*, 20, 70-82.
17
18

19
20 Kubberød, E., Ueland, Ø., Rødbotten, M., Westad, F., & Risvik, E. (2002). Gender specific
21 preferences and attitudes towards meat. *Food Quality and Preference*, 13, 285-294.
22
23

24
25 Laurent, G., & Kapferer, J.- N. (1985). Measuring consumer involvement profiles. *Journal of*
26 *Marketing Research*, 22, 41-53.
27
28

29
30 Lawton, R. J., Mata, L., de Nys, R., & Paul, N. A. (2013). Algal bioremediation of waste
31 waters from land-based aquaculture using ulva: selecting target species and strains. *PLoS*
32 *ONE*, 8(10), Article e77344.
33
34

35
36 Loewen, R., & Pliner, P. (2000). The food situations questionnaire: a measure of children's
37 willingness to try novel foods in stimulating and non-stimulating situations. *Appetite*, 35,
38 239-250.
39
40
41
42
43

44
45 Matthews, L. (2018). Should we eat more seaweed? *Friday Night Feast*. Retrieved from
46 <https://www.jamieoliver.com/news-and-features/features/should-we-eat-more-seaweed/>.
47
48
49

50
51 Meiselman, H. L., Mastroianni, G., Buller, M., & Edwards, J. (1999). Longitudinal
52 measurement of three eating behavior scales during a period of change. *Food Quality and*
53 *Preference*, 10, 1-8.
54
55
56

1
2
3 Mintel (2016). Seaweed-flavoured food and drink launches increased by 147% in Europe
4 between 2011 and 2015. *Mintel Press Office*. Retrieved from [http://www.mintel.com/press-](http://www.mintel.com/press-centre/food-and-drink/seaweed-flavoured-food-and-drink-launches-increased-by-147-in-europe-between-2011-and-2015)
5 [centre/food-and-drink/seaweed-flavoured-food-and-drink-launches-increased-by-147-in-](http://www.mintel.com/press-centre/food-and-drink/seaweed-flavoured-food-and-drink-launches-increased-by-147-in-europe-between-2011-and-2015)
6 [europe-between-2011-and-2015](http://www.mintel.com/press-centre/food-and-drink/seaweed-flavoured-food-and-drink-launches-increased-by-147-in-europe-between-2011-and-2015).
7
8
9

10
11
12 Moreau, C. P., Lehamann, D. R., & Markman, A.B. (2001). Entrenched knowledge structures
13 and consumer response to new products. *Journal of Marketing Research*, 38(1), 14-29.
14

15
16
17 Mouritsen, O. G., Johansen, M., & Mouritsen, J. D. (2013). *Seaweed: edible, available and*
18 *sustainable*. Chicago, IL: University of Chicago Press.
19

20
21
22 Nordin, S., Broman, D. A., Garvill, J., & Nyroos, M. (2004). Gender differences in factors
23 affecting rejection of food in healthy young Swedish adults. *Appetite*, 43(3), 295-301.
24

25
26
27 Papista, E., & Krystallis, A. (2013). Investigating the types of value and cost of green brands:
28 proposition of a conceptual framework. *Journal of Business Ethics*, 115(1), 75-92.
29

30
31
32 Perrea, T., Krystallis, A., Engelgreen, C., & Chrysochou, P. (2017). Much too new to eat it?
33 Customer value and its impact on consumer-product relationship in the context of novel food
34 products. *Journal of Product and Brand Management*, 26(6), 616-630.
35
36
37

38
39
40 Pieniak, Z., Verbeke, W., Scholderer, J., Brunsø, K., & Olsen, S. O. (2008). Impact of
41 consumers' health beliefs, health involvement and risk perception on fish consumption.
42 *British Food Journal*, 110(9), 898-915.
43
44

45
46
47 Pliner, P., & Hobden, K. (1992). Development of a scale to measure the trait of food
48 neophobia in humans. *Appetite*, 19(2), 105-120.
49

50
51
52 Potter, R., Stojceska, V., & Plunkett, A. (2013). The use of fruit powders in extruded snacks
53 suitable for children's diets. *LWT - Food Science and Technology*, 51(2), 537-544.
54
55
56

1
2
3 Prager, H. (2017). *What can be done to increase acceptance of seaweed into the western*
4 *diet?* Retrieved from

5
6 [https://www.ntnu.edu/documents/139799/1273574286/TPD4505.Henry.Prager.pdf/bcb465ea-](https://www.ntnu.edu/documents/139799/1273574286/TPD4505.Henry.Prager.pdf/bcb465ea-79e3-45c0-b1d2-1775b3d1852f)
7
8 [-79e3-45c0-b1d2-1775b3d1852f.](https://www.ntnu.edu/documents/139799/1273574286/TPD4505.Henry.Prager.pdf/bcb465ea-79e3-45c0-b1d2-1775b3d1852f)
9

10
11
12 Rathod, R., & Annapure, S. (2016). Effect of extrusion process on antinutritional factors and
13 protein and starch digestibility of lentil splits. *LWT - Food Science and Technology*, 66, 114-
14 123.
15
16

17
18
19 Raudenbush, B., & Frank, R. A. (1999). Assessing food neophobia: the role of stimulus
20 familiarity. *Appetite*, 32, 261-271.
21
22

23
24
25 Roohinejad, S., Koubaa, M., Barba F., Saljoughian, S., Amid, M., & Greiner, R. (2017).
26 Application of seaweeds to develop new food products with enhanced shelf-life, quality and
27 health-related beneficial properties. *Food Research International*, 99, 1066-1083.
28
29

30
31
32 Schösler, H., de Boer, J., & Boersema, J. J. (2012). Can we cut out the meat of the dish?
33 Constructing consumer-oriented pathways towards meat substitution. *Appetite*, 58(1), 39-47.
34
35

36
37
38 Tan, H. S. G., Fischer, A. R., van Trijp, H. C., & Stieger, M. (2016). Tasty but nasty?
39 Exploring the role of sensory-liking and food appropriateness in the willingness to eat
40 unusual novel foods like insects. *Food Quality and Preference*, 48, 293-302.
41
42

43
44
45 Tinellis, C. (2014). *Coastal chef: culinary art of seaweed and algae in the 21st century*,
46 Ulladulla, NSW, Australia: Harbour Publishing House.
47
48

49
50
51 Trondsen, T., Scholderer, J., Lund, E., & Eggen, A. E. (2003). Perceived barriers to
52 consumption of fish among Norwegian women. *Appetite*, 41(3), 301-314.
53
54

1
2
3 Tuorila, H., Lähteenmäki, L., Pohjalainen, L., & Lotti, L. (2001). Food neophobia among the
4 Finns and related responses to familiar and unfamiliar foods. *Food Quality and Preference*,
5 12, 29-37.
6
7

8
9
10 Tuorila, H., Meiselman, H. L., Bell, R., Cardello, A. V., & Johnson, W. (1994). Role of
11 sensory and cognitive information in the enhancement of certainty and liking for novel and
12 familiar foods. *Appetite*, 23(3), 231-246.
13
14

15
16
17 van der Spiegel, M., Noordam M. Y., & van Der Fels-Klerx, H. J. (2013). Safety of novel
18 protein sources (insects, microalgae, seaweed, duckweed, and rapeseed) and legislative
19 aspects for their application in food and feed production. *Comprehensive Reviews in Food*
20 *Science and Food Safety*, 12(6), 662-678.
21
22

23
24
25 Verbeke, W. (2005). Consumer acceptance of functional foods: socio-demographic, cognitive
26 and attitudinal determinants. *Food Quality and Preference*, 16(1), 45-57.
27
28

29
30
31 Verbeke, W. (2015). Profiling consumers who are ready to adopt insects as a meat substitute
32 in a Western society. *Food Quality and Preference*, 39, 147-155.
33
34

35
36
37 Verbeke, W., Sans, P., & van Loo, E. J. (2015). Challenges and prospects for consumer
38 acceptance of cultured meat. *Journal of Integrative Agriculture*, 14(2), 285-294.
39
40

41
42
43 Verbeke, W., Scholderer, J., & Lähteenmäki, L. (2009). Consumer appeal of nutrition and
44 health claims in three existing product concepts. *Appetite*, 52(3), 684-692.
45
46

47
48 Warwicker, M., & Taylor, A. L. (2012). Seaweed: should people eat more of it? *BBC News*.
49 Retrieved from <http://www.bbc.com/news/magazine-17870743>.
50
51

1
2
3 Wong, J. (2010). Food recall: dried seaweed with unusually high levels of iodine. *Australian*
4 *Food News*. Retrieved from [http://www.ausfoodnews.com.au/2010/03/17/food-recall-dried-](http://www.ausfoodnews.com.au/2010/03/17/food-recall-dried-seaweed-with-unusually-high-levels-of-iodine.html)
5 [seaweed-with-unusually-high-levels-of-iodine.html](http://www.ausfoodnews.com.au/2010/03/17/food-recall-dried-seaweed-with-unusually-high-levels-of-iodine.html).
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For Peer Review Only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

APPENDIX 1: Willingness to eat seaweed products

INSERT Appendix 1 Table

APPENDIX 2: Psychological influences on seaweed consumption – measurement scales and factor loadings

INSERT Appendix 2 Table

For Peer Review Only

Who eats seaweed? A Australian perspective

List of tables included in this document:

Table 1: Respondent profile.

Table 2: Demographic differences associated with seaweed consumption.

Table 3: Seaweed products consumed.

Table 4: Dietary choices and seaweed consumption.

Table 5: Dietary preferences and seaweed consumption.

Table 6: Psychological influences on seaweed consumption.

Table 7: Relevant reasons (drivers) for eating seaweed. Mean scores and standard deviations presented.

Table 8: Relevant reasons (barriers) for not eating seaweed. Mean scores and standard deviations presented.

APPENDIX 1: Willingness to eat seaweed products

APPENDIX 2: Psychological influences on seaweed consumption – measurement scales and factor loadings

Table 1: Respondent profile.

Demographics	Total	
	<i>n</i>	<i>%</i>
Gender		
Male	202	38.8
Female	315	60.5
Prefer not to say	4	0.8
Highest educational level attained		
Primary school	2	0.4
Secondary school	157	30.1
Trade or technical certificate	171	32.8
Undergraduate degree	126	24.2
Postgraduate degree	65	12.5
Annual HOUSEHOLD income after tax (AUD)		
Under AUD40,000	166	31.9
AUD40,000 - 59,999	84	16.1
AUD60,000 - 99,999	133	25.5
AUD100,000 or over	138	26.5
Age category (years)		
18 - 35	177	34.4
35 - 44	100	19.5
45 - 59	135	26.3
60+	102	19.8

Table 2: Demographic differences associated with seaweed consumption.

Demographics	Ever eaten seaweed	Eaten >once a month in the past 12 months	Likely to eat in the next 12 months
Sample	74% (n=370)	37% (n=195)	62% (n=272)
Gender			
Males	70%	32%	63%
Females	76%	41%	61%
	$\chi^2=2.55$ (p=.11)	$\chi^2=4.52$ (p=.03)	$\chi^2=.175$ (p=.68)
Purchasing role			
Main shopper	76%	38%	64%
Joint shopper	66%	34%	55%
	$\chi^2=4.08$ (p=.04)	$\chi^2=0.61$ (p=.43)	$\chi^2=2.26$ (p=.13)
Education			
Secondary	65%	25%	52%
Trade/tech	75%	35%	46%
Undergraduate	78%	46%	57%
Postgraduate	83%	57%	82%
	$\chi^2=9.84$ (p=.02)	$\chi^2=25.57$ (p=.00)	$\chi^2=21.90$ (p=.00)
Household income			
AUD <40k	64%	30%	55%
AUD 40k - 60k	68%	30%	55%
AUD 60k - 100k	76%	38%	64%
AUD >100k	86%	51%	72%
	$\chi^2=19.07$ (p=.00)	$\chi^2=17.01$ (p=.00)	$\chi^2=9.24$ (p=.03)
Age (years)			
<35	82%	49%	65%
35 - 44	73%	35%	62%
45 - 59	72%	36%	62%
+60	63%	23%	56%
	$\chi^2=12.09$ (p=.01)	$\chi^2=20.62$ (p=.00)	$\chi^2=1.76$ (p=.62)

Table 3: Seaweed products consumed.

Seaweed product	Total	
	<i>n</i>	%
Sushi rolls wrapped in seaweed	368	70.6
Seaweed flavoured crackers	253	48.6
Seaweed in a soup (e.g. Miso)	184	35.3
Seaweed flavoured snacks	118	22.6
Fresh seaweed in a salad	98	18.8
Seaweed flakes or sprinkles	71	13.6
Seaweed supplement	30	5.8
Seaweed in a drink (e.g. tea, smoothie)	20	3.8
Seaweed jelly or lollies	15	2.9
I have not eaten any of these	105	20.2

Table 4: Dietary choices and seaweed consumption.

I eat....	Eaten:		Frequency:		Intention:	
	<i>No</i>	<i>Yes</i>	<i><once a month</i>	<i>>once a month</i>	<i>Unlikely</i>	<i>Likely</i>
red meat:	4.7	4.8 ^{ns}	4.8	4.8 ^{ns}	4.7	4.8 ^{ns}
lollies, cake, desserts, chocolate:	4.5	4.6 ^{ns}	4.5	4.6 ^{ns}	4.5	4.7 ^{ns}
or drink dairy products:	5.4	5.7 ^{ns}	5.6	5.6 ^{ns}	5.5	5.6 ^{ns}
chicken:	4.8	5.0 ^{ns}	4.9	4.9 ^{ns}	4.7	5.1 ^{**}
fish and seafood:	3.8	4.3 ^{**}	3.9	4.6 ^{***}	3.6	4.6 ^{***}
vegetables:	5.5	6.0 ^{***}	5.8	6.1 ^{**}	5.6	6.1 ^{***}
salads:	4.7	5.2 ^{***}	4.9	5.3 ^{**}	4.9	5.4 ^{***}
lentils and pulses:	2.4	3.8 ^{***}	2.9	3.7 ^{***}	2.7	3.5 ^{***}
quinoa and couscous:	2.1	3.1 ^{***}	2.4	3.5 ^{***}	2.4	3.2 ^{***}

ns: no significant; **p < 0.01; ***p < 0.001.

Table 5: Dietary preferences and seaweed consumption.

Dietary preference	Eaten seaweed:	Eaten >once a month:	Likely to eat:
I prefer to eat fish but I will eat other animal proteins such as red meat, pork or chicken	83%	44%	71%
I eat red meat, fish/seafood, eggs and dairy	76%	41%	70%
I am vegetarian/vegan/pescatarian	73%	47%	50%
I prefer to eat red meat, pork and or chicken rather than fish or seafood	63%	22%	42%
	$\chi^2 = 9.56$ (p =.02)	$\chi^2 = 16.59$ (p=.01)	$\chi^2 = 29.28$ (p=.00)

Table 6: Psychological influences on seaweed consumption.

Psychological influence	Ever eaten		Frequency in past 12 months		Intention in next 12 months	
	<i>No</i>	<i>Yes</i>	<i>< once a month</i>	<i>> once a month</i>	<i>Unlikely</i>	<i>Likely</i>
Neophobic	4.1	3.3***	3.8	3.2***	4.0	3.2***
Responsibility/food safety	4.6	5.0**	4.8	5.1**	4.5	5.1***
Symbolic value	3.8	4.3***	4.0	4.5***	3.7	4.5***
Health-consciousness	4.5	4.9**	4.7	5.0**	4.4	5.0***
Snacking behaviour	3.6	3.8 ^{ns}	3.6	4.0**	3.5	3.9**

ns: no significant; **p < 0.01; ***p < 0.001.

Table 7: Relevant reasons (drivers) for eating seaweed. Mean scores and standard deviations presented.

Reasons for eating seaweed	Mean	SD	% Relevant
It is healthy	3.60	1.25	64
It is nutritious	3.52	1.26	61
It is a natural source of omega 3	3.47	1.27	59
It is tasty	3.46	1.35	60
It is natural	3.45	1.24	60
I like it	3.43	1.35	59
It is safe	3.41	1.26	57
It is fresh	3.40	1.23	57
It is a source of protein	3.35	1.25	54
It is low in calories	3.31	1.29	52
It is sustainable	3.31	1.26	53
It is environmentally friendly	3.31	1.25	53
It is a good source of iodine	3.30	1.24	52
It is pleasant	3.29	1.32	53
It adds variety to my diet	3.27	1.29	51
It is versatile - can be used in different ways	3.27	1.26	51
It is good value for money	3.22	1.24	48
It is convenient	3.22	1.25	47
It is organic	3.16	1.27	48
I like the texture	3.13	1.28	45
It is a natural source of salt	3.12	1.23	43
It would support the seafood industry	2.99	1.23	37
It would support the development of new businesses	2.95	1.20	35
I like the way it looks	2.88	1.22	30
I like the smell	2.81	1.23	29
It is a vegetarian option	2.81	1.31	33
It is a vegan option	2.65	1.29	27
It is novel	2.63	1.24	21

Table 8: Relevant reasons (barriers) for not eating seaweed. Mean scores and standard deviations presented.

Reasons for not eating seaweed	Mean	SD	% Relevant
I do not know how to prepare it	3.12	1.30	45
I do not know of any recipes for it	3.02	1.29	41
It is expensive	3.02	1.26	37
I do not know how long you can keep it	3.00	1.27	41
I do not know what to serve it with	2.98	1.30	38
I dislike the smell	2.95	1.31	39
I do not know how to store it	2.93	1.26	38
I dislike the taste	2.93	1.39	37
I do not know where to buy it	2.93	1.28	36
I'm concerned about chemical contamination	2.92	1.34	37
I'm concerned about bacterial contamination	2.91	1.29	36
I do not like it	2.88	1.41	34
I dislike the texture	2.85	1.30	33
It is unpleasant	2.82	1.36	33
I'm concerned about how safe it is to eat	2.78	1.29	32
I dislike the way it looks	2.73	1.28	29
It is weird	2.63	1.30	25
I'm concerned it may not be good for my health	2.53	1.28	25
I might be allergic to it	2.51	1.29	23

APPENDIX 1: Willingness to eat seaweed products

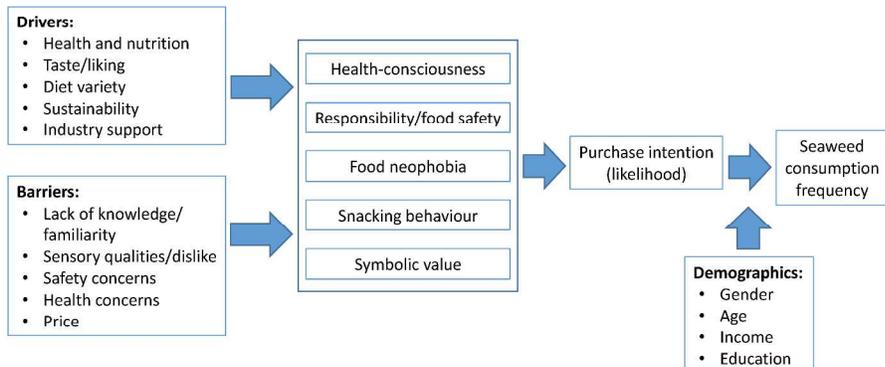
Seaweed Product	Mean (SD)	% Willing
Sushi rolls wrapped in seaweed	3.58 (1.51)	62.4%
Seaweed flavoured crackers	3.46 (1.39)	59.5%
Seaweed flavoured snacks	3.31 (1.39)	53.7%
Seaweed in a soup (e.g. Miso)	3.30 (1.44)	52.4%
Seaweed flakes or sprinkles	3.16 (1.35)	47.0%
Fresh seaweed in a salad	3.12 (1.38)	47.6%
Seaweed supplement	2.86 (1.27)	33.4%
Seaweed in a drink (e.g. tea, smoothie)	2.63 (1.27)	28.0%
Seaweed jelly or lollies	2.55 (1.25)	25.0%

(Scale: 7 point with 1 = Not at all willing to 7 = Highly willing)

**APPENDIX 2: Psychological influences on seaweed consumption – measurement scales
and factor loadings**

	F1:	F2:	F3:	F4:	F5:
Responsibility/food safety (Alpha: 0.88):					
I am concerned about the conditions under which the food I buy is produced	.836				
I try to choose food that is produced in a sustainable way	.791				
I'm concerned about the amount of artificial additives and preservatives in food	.780				
It is important to understand the environmental impact of our eating habits	.741				
The quality and safety of food nowadays concerns me	.697				
Neophobic (Alpha: 0.85):					
I only eat foods which are familiar to me		.823			
I don't trust new foods		.817			
I am afraid to eat things I have never had before		.803			
Food from other cultures looks too weird to eat		.776			
Health consciousness (Alpha: 0.85):					
I'm usually aware of my health			.770		
I reflect about my health a lot			.765		
I'm very self-conscious about my health			.723		
I'm aware of the state of my health as I go through the day			.685		
Symbolic value (Alpha: 0.88):					
What and where someone eats, says something about who they are as a person				.866	
The food you eat is an expression of your personality				.838	
You can tell a lot about a person, by what they eat				.836	
Snacking behaviour (Alpha: 0.85):					
I eat a lot of snacks rather than having set meal times					.856
I tend to snack during the day, which often means I am not hungry at mealtimes					.851
I eat a lot of small meals rather than keeping to fixed mealtimes					.834

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



297x210mm (300 x 300 DPI)

View Only