A multi-national comparison of meat eaters' attitudes and expectations for burgers containing beef, pea or algae protein

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A B S T R A C T

Within recent years, demand as well as supply of products to replace meat, so called meat alternatives, have increased. For future products, new plant-based protein sources are of high interest. Protein from pea and especially from algae provide huge potential for human nutrition as well as for the environment. To provide insight on consumers' opinions on the development of new meat alternatives, this study investigated consumers' opinions of pea and algae burgers compared to the traditional beef burger in terms of taste, health, and environmental friendliness. It has also explored the influence of factors such as meat commitment, food neophobia, and the attitude towards vegetarians and vegans; it has then compared the findings between three European countries with different culinary backgrounds. The online survey was conducted with meat-eating participants from Germany (N = 567), France (N = 605), and the United Kingdom (N = 562). Participants in all three countries expected pea and algae burgers to be less tasty, but healthier and more environmentally friendly compared to the beef burger. Expectations of taste, health, and environmental friendliness of pea and algae burgers were negatively influenced by higher levels of meat commitment, more negative attitudes towards vegetarian and vegan lifestyles, and higher food neophobia. Although the attitudes towards vegetarian lifestyles were generally negative, pea and algae emerged as promising protein sources because of their favorable health and environmental friendliness expectations. Nevertheless, negative taste expectations and attitudes towards meat-free diets remain a challenge for the adoption of more plant-based diets.

1. Introduction

The excessive consumption of meat is linked to various negative outcomes on the environment, animal welfare, and human health. Eating meat contributes to global warming through the emission of greenhouse gases, land use, and disrupting phosphorus as well as nitrogen cycles (Leip et al., 2015; Steinfeld et al., 2006; Vermeulen et al., 2012). The consumption of red and processed meat has been linked to numerous adverse health outcomes. The World Health Organization has therefore reviewed red meat to be probably cancerogenic and processed meat to cause colorectal cancer in humans (Bouvard et al., 2015; McGuire, 2016). A reduction of the current meat consumption would thus not only have beneficial effects on the environment and animal welfare, but also on human health (Westhoek et al., 2014).

Reasons for eating meat alternatives vary between different consumer groups (Apostolidis & McLeay, 2016; Circus & Robison, 2019; de Boer et al., 2017; Lang, 2020; Lemken et al., 2019). People who have already reduced their meat consumption have been found to be favorable of ethical motivations such as animal welfare and also being motivated to eat more environmentally friendly (Hoek et al., 2011; Malek et al., 2019; Sanchez-Sabate & Sabaté, 2019). Meat eaters, on the other hand, have been shown to choose meat alternatives out of curiosity; they are motivated by wanting more diversity in their diets, and sometimes they are looking for ways to make their meals healthier (Hoek et al., 2011; Lang, 2020; Sadler, 2004). Food neophobia, unfamiliarity, and low sensory attributes have been identified as major barriers preventing people from choosing meat alternatives (Hoek et al., 2011; Lea & Worsley, 2003).

The number of consumers in Western countries adopting a vegetarian or vegan diet is increasing (Ruby, 2012). Studies exploring attitudes towards vegetarians and vegans found that attitudes were mostly positive (Chin et al., 2002; Judge & Wilson, 2019) or generally neutral

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(Ruby et al., 2016). Findings of the later study further indicated that while females from America and Brazil have expressed admiration for vegetarians, French males and females exhibit negative attitudes towards vegetarians (Ruby et al., 2016). In general, attitudes towards vegetarians, compared to vegans, have been reported to be more positive (Judge & Wilson, 2019; MacInnis & Hodson, 2017). By examining the media coverage of newspapers in the United Kingdom during 2007, Cole and Morgan (2011) found that vegans were stereotyped as ascetics, sentimentalists, or even extremists and that the media further attempted to discredit the vegan diet by presenting it as temporary trend, ridiculing it, and describing it as impossible, or at least incredibly difficult to maintain in everyday life. MacInnis and Hodson (2017) propose that vegetarians and vegans are a target of bias because they represent a threat to the predominant cultural norm of eating meat. Thus, not eating meat is regarded as a symbolic threat that contributes to negative attitudes towards vegetarians and vegans (MacInnis & Hodson, 2017).

While females are generally more in favor of vegetarian diets than men (Judge & Wilson, 2019; Mullee et al., 2017; Ruby et al., 2016), male meat eaters have been found to express stronger commitment to meat than females (Dagevos & Voordouw, 2013; Graça et al., 2015; Malek et al., 2019; Piazza et al., 2015). Meat attachment has been shown to be negatively correlated with willingness and intention to reduce meat consumption and following a plant-based diet (Graça et al., 2015). Malek et al. (2019) showed that committed meat eaters were generally unwilling to reduce their protein consumption, were unlikely to be consumers of organic meat, and did not believe that livestock farming had an impact on climate change.

The variety of protein sources and respective protein contents of foods have received attention from consumers, which has led to a trend enriching many types of foods such as bread, yoghurt, and bars with protein (Banovic et al., 2018). While pulses present great potential to enrich people's diets with environmentally friendly proteins (Harwatt et al., 2017), their consumption is generally low (Melendrez-Ruiz et al., 2019). The incorporation of protein isolates from pulses such as pea or beans into meat alternatives represents a promising approach as such products (e.g., "planted.chicken," the "green mountain burger," or the pea based minced by "Naturli'") were launched recently in Switzerland. For future products, novel protein sources such as algae are also of high interest. Algae are largely unfamiliar to European consumers but have been part of the traditional cuisine in Asia for centuries. Their use in human nutrition offers immense potential because of their nutritional profile and their advantages in regard to land use compared to other plant-based protein sources (Becker, 2007). Though depending on the species, algae do not only contain a high fraction of all essential amino acids, but also produce long-chain polyunsaturated fatty acids which are beneficial for human health (Torres-Tiji et al., 2020).

As described in the context of algae, people's culinary backgrounds are likely to influence the appreciation of meat alternatives, as well as their attitude towards people following diets without meat. To explore consumers' expectations of meat alternatives as well as their attitude towards vegetarian lifestyles, a sample of consumers from Germany, France and the United Kingdom was studied. These three countries were chosen because of their different culinary background. Germany has a long tradition of sausage- and bread making and is renowed for brewing beer. France is well-known for wine and cheese, but also for dishes such as pot-au-feu or local delicacies like foie gras, frog, and escargot. And among well-known traditional British dishes are fish and chips, Sunday roast, shepherd's pie, and sausages and mash.

The aim of the current research is to investigate the taste, healthiness and environmental expectations of pea and algae as promising protein sources in meat alternatives and to examine factors such as food neophobia, meat commitment or the negative attitude towards vegetarian and vegan lifestyles influencing these expectations. The findings are intended to provide insights into consumer preferences for the development of new meat alternatives and to contribute to existing literature on consumers' perspectives on meat alternatives and attitudes towards

vegetarians.

2. Material and methods

2.1. Survey participants

Data for this study was collected by a commercial panel provider (Respondi AG, Cologne, Germany) in December 2019 in Germany, France and the United Kingdom. To ensure equal distribution of sex and age within each country sample, quotas were set (50% female, same number of people in five age groups from 20 to 69 years). Incomplete data sets and participants whose total survey duration was less than half of the median (N = 196) were excluded from data analysis. This procedure was suggested by the panel provider and has previously been implemented by Hartmann, Keller, and Siegrist (2016). Participants were provided with a short explanation of different diet styles and were asked to indicate which term (omnivore, pescetarian, flexitarian, vegetarian, or vegan) best describes their diet. Those participants who described their diets as pescetarian, vegetarian or vegan (N = 119), were removed from the data set, as non-meat eaters are not the target group of this research. The resulting data set included 567 meat-eating participants from Germany, 605 from France and 562 from the United Kingdom. An overview on the characteristics of the participants is presented in Table 1.

2.2. Survey procedure

The survey was distributed online using the survey software Qualtrics (Qualtrics, Provo, UT, USA). In the beginning of the questionnaire, participants were informed that the study was about their opinions on meat and meat alternatives. To manage the quotas of the age groups and sex, participants were first asked to indicate age and sex. It took participants around 12 min to complete the survey.

The consumption frequency of hamburgers was measured on a 6-point scale from "seldom or never" to "several times per day." Participants' expectations regarding burgers containing algae and pea as new source of protein and a burger containing beef as reference were assessed by asking how tasty, healthy, and environmentally friendly they expected these burgers to be. Participants were therefore randomly distributed into one of three burger groups (beef/ pea/ algae) and presented with the same picture of a generic burger (depicted in Fig. 1) in all three groups. Ratings of expected taste, healthiness and environmental friendliness were indicated using an adjustable slider on a scale ranging from 0, "not at all tasty/ healthy/ environmentally friendly," to 100, "very tasty/ healthy/ environmentally friendly."

To assess participants' attitudes towards vegetarian and vegan lifestyles, we developed eight statements about vegetarian or vegans based on previous findings (Chin et al., 2002; Cole & Morgan, 2011; Judge & Wilson, 2019; Ruby et al., 2016), personal experiences, and (social) media coverage. Participants were asked to indicate their levels of agreement for each of the statements on a 7-point scale from "1 strongly disagree" to "7 strongly agree."

In addition, participants' commitment to meat was measured using the seven-item meat commitment scale developed by Piazza et al. (2015). This scale asks about the level of agreement with items such as

Table 1
Participants' characteristics.

	Germany (%)	France (%)	United Kingdom (%)
N	567 (100)	605 (100)	562 (100)
Male	298 (52.6)	310 (51.2)	289 (51.4)
Female	269 (47.4)	295 (48.8)	273 (48.6)
Mean Age (years)	45.2	44.8	45.9
Omnivores	427 (75.3)	509 (84.1)	501 (89.1)
Flexitarians	140 (24.7)	96 (15.9)	61 (10.9)

In this picture, you see a burger containing algae as a source of protein.

How do you expect this burger to be?

Not tasty at all   Very tasty
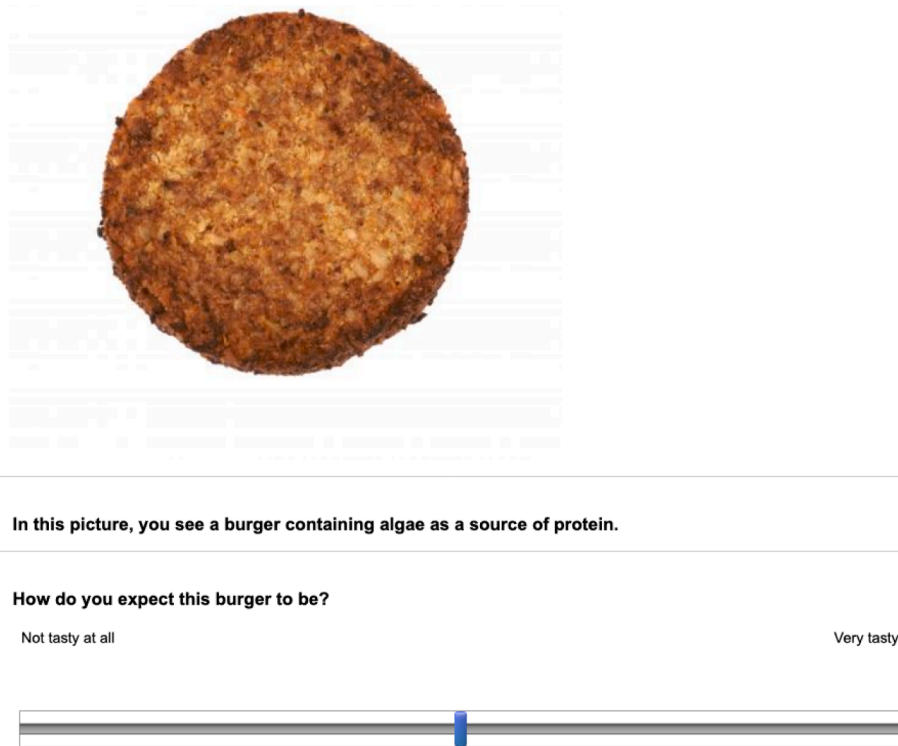
Fig. 1. Snapshot of the question how tasty participants expected the algae burger to be.

not wanting to eat meatless dishes, always choosing meat dishes, or the unwillingness to replace meat. To assess participants unwillingness to try of new foods, we used the 10-item food neophobia scale developed by Pliner and Hobden (1992) and translated by Siegrist, Hartmann, and Keller (2013).

2.3. Data analysis

To explore differences between Germany, France, and the United Kingdom, answers yielded from the evaluation of burgers containing different protein sources were analyzed with ANOVA (analysis of variance) tests and depicted graphically.

In order to use the attitude towards vegetarian and vegan lifestyles as predictor for the regression analyses, a scale was constructed based on the eight items included in the survey. The items "I will never give up eating meat" and "Meat alternatives are a good replacement for meat" were removed because they are thematically similar to the construct of meat commitment, which was measured separately using the seven-item meat commitment scale by Piazza et al. (2015). The item "A healthy diet is important to me" was excluded because of its low correlation to the rest of the items. We also excluded the item "No one should be allowed to tell me what to eat" because it is not specific to vegetarian and vegan diets but is valid in the general context. The Kaiser-Meyer-Olkin measure for the four remaining items was 0.77, and Bartlett's Test of Sphericity was significant ($p < .001$). The principal component analysis revealed that all four items loaded on one component which explained 68.21% of the total variance. Reliability analysis was performed showing a Cronbach's alpha of 0.84 for the four-item negative attitude to vegetarian and vegan lifestyles. The final four items of the scale are presented in Table 3. Answer options ranged from 1 "strongly disagree" to 7 "strongly agree."

Linear regression analyses were then conducted to estimate the influences of country, sex, age, meat commitment, food neophobia and the negative attitude to vegetarian and vegan lifestyle as predictors for the taste, healthiness, and environmental friendliness ratings of the pea and algae burgers. The countries were dummy coded using Germany as

reference. The significance level was set to $\alpha = 0.05$. All statistical analyses were performed using IBM SPSS statistics software version 26 (SPSS Inc. Chicago, IL, USA).

3. Results

3.1. Frequency of hamburger consumption

The number of burgers eaten by consumers was evaluated using a food frequency questionnaire. Based on Table 2, it is evident that 40% to 50% of the participants never or only rarely eat burgers. Among those who eat burgers, the majority does not eat burgers more than one to three times per month, which is roughly equivalent to one burger within two weeks.

3.2. Expectations for burgers containing pea or algae as protein source

Three two-way ANOVAs were conducted to explore the effects of country (Germany, France, United Kingdom) and burger type (beef, pea, algae) on expected taste, health and environmental friendliness ratings. For expected taste, there were statistically significant differences between countries ($F(2,1725) = 11.27, p < .001$) and type of burger ($F(2,1725) = 56.60, p < .001$). The interaction between country and type of burger was also significant ($F(4,1725) = 4.94, p = .001$). For expected healthiness, statistically significant differences were found between countries ($F(2,1725) = 5.12, p = .006$) and burger type ($F(2,1725) = 82.69, p < .001$). The relationship between country and type of burger was not significant ($F(2,1725) = 2.29, p = .058$). For expected environmental friendliness, the differences between countries were not significant ($F(2,1725) = 1.78, p = .17$). The differences between the types of burger were statistically significant ($F(2,1725) = 97.91, p < .001$) and the interaction between country and type of burger was again not significant ($F(2,1725) = 1.84, p = .12$).

The mean values of the expected tastiness, healthiness, and environmental friendliness for the burgers containing beef as reference and pea or algae as novel protein source are compared between the three

Table 2

Frequency of hamburger and meat alternatives (MA) consumption. Meat alternatives included vegetarian patties, soy, tofu etc. Number of individuals (Percentage).

	Germany (N = 567)		France (N = 605)		United Kingdom (N = 562)	
	Hamburger	MA	Hamburger	MA	Hamburger	MA
rarely or never	286 (50.4)	401 (70.7)	267 (44.1)	389 (64.3)	215 (38.3)	349 (62.1)
1–3 times per month	242 (42.7)	104 (18.3)	271 (44.8)	134 (22.1)	278 (49.5)	122 (21.7)
1–3 times per week	32 (5.6)	51 (9.0)	57 (9.4)	61 (10.1)	58 (10.3)	74 (13.2)
4–6 times per week	5 (0.9)	10 (1.8)	7 (1.2)	14 (2.3)	7 (1.2)	11 (2.0)
daily	2 (0.4)	1 (0.2)	3 (0.5)	6 (1.0)	4 (0.7)	5 (0.9)
several times per day	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)	0 (0.0)	1 (0.2)

Table 3

Item means for the negative attitude to vegetarian and vegan lifestyles scale. Mean (SD).

	Negative attitude to vegetarian and vegan lifestyles	Total (N = 1734)	Germany (N = 567)	France (N = 605)	United Kingdom (N = 562)
1	Vegetarianism is just a temporary fashion.	3.63 (1.93)	3.80 (1.98)	3.85 (1.84)	3.22 (1.90)
2	Vegans are extremists.	4.20 (2.00)	4.21 (2.00)	4.30 (1.96)	4.82 (2.03)
3	Meat alternatives are only for vegetarians and vegans.	3.30 (1.96)	3.30 (1.98)	3.50 (1.91)	3.10 (1.97)
4	Veganism is just a temporary fashion.	3.99 (2.04)	4.13 (2.04)	4.29 (1.99)	3.51 (2.01)

contains Cronbach's alpha, the mean values, and standard deviations across all participants and for each country individually.

In a subsequent step, the correlations between the negative attitude towards a vegetarian and vegan lifestyle and age, meat commitment, and food neophobia were examined. As can be seen from Table 5, the negative attitude towards vegetarian and vegan lifestyles are highly correlated with meat commitment and also significantly, but to a smaller extent, with age, and food neophobia. This indicates that participants who have a very negative attitude towards vegetarian and vegan lifestyles are also more committed to meat, are older, and have high food neophobia scores. Sex was dummy coded as 0 male and 1 female and was negatively correlated with the vegetarian lifestyle attitude, meaning that females scored lower on the negative vegetarian lifestyle attitude scale.

3.4. Factors influencing the expectations for burgers containing pea and algae protein

Results from the linear regression predicting taste, healthiness and environmental friendliness expectations of the pea and algae burgers are depicted in Table 6. All models were significant and explained between 16% and 26% of the variance for the taste, healthiness, and environmental friendliness expectation. Being from France, sex, age, meat commitment, food neophobia, and the negative attitude to vegetarian and vegan lifestyles emerged as significant predictors for the taste-, health-, and environmental friendliness ratings of the pea burger. Participants who were older, more neophobic, more committed to meat, and more negatively inclined towards vegetarian and vegan lifestyles thus gave lower ratings for taste-, health-, and environmental friendliness of the pea burger. In addition, the taste and health ratings of the pea burger were also negatively influenced by being from France compared to Germany. The environmental friendliness ratings for the pea burger were, in addition to age, meat commitment, food neophobia, and a negative attitude towards vegetarian lifestyles, also influenced by sex. This means that females rated the pea burger as more environmentally friendly compared to males.
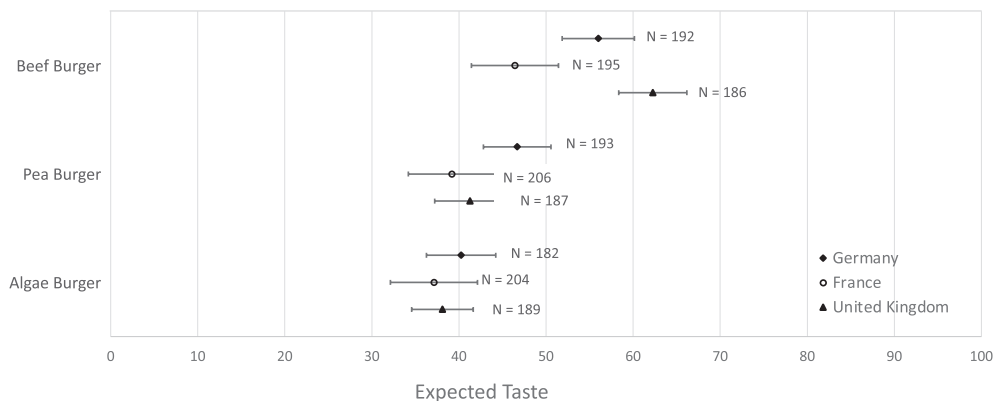
countries in Fig. 2 through Fig. 4, wherein non-overlapping 95% confidence intervals indicate significant differences. It can be observed that the pea and algae burgers were expected to be healthier and more environmentally friendly, but less tasty compared to the beef burger. The non-overlapping 95% confidence intervals in Fig. 3 suggest that the pea burger received higher healthiness ratings from Germany compared to France.

3.3. Negative attitude towards vegetarian lifestyles, food neophobia, and meat commitment

The attitude towards vegetarians and vegans was assessed using the negative attitude towards vegetarian and vegan lifestyle scale which was described in the survey procedure. The final items of the scale, as well as the mean and standard deviations are shown in Table 3. As the scale ranged from 1 "strongly disagree" to 7 "strongly agree," a higher score implies a more negative attitude towards vegetarian and vegan lifestyles.

Next to the negative attitude towards vegetarian and vegan lifestyles, food neophobia and meat commitment were also evaluated. Table 4

Fig. 2. Participants' tastiness expectation of the three burgers. Means and 95% CI shown for each country. 0 = not tasty at all, 100 = very tasty. Non-overlapping 95% confidence intervals represent significant differences between individual measures.
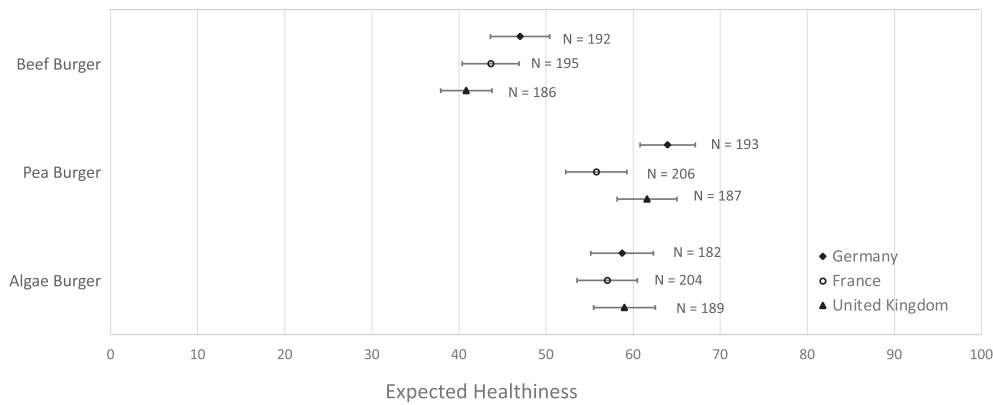
Fig. 3. Participants' healthiness expectation of the three burgers. Means and 95% CI shown for each country. 0 = not healthy at all, 100 = very healthy. Non-overlapping 95% confidence intervals represent significant differences between individual measures.
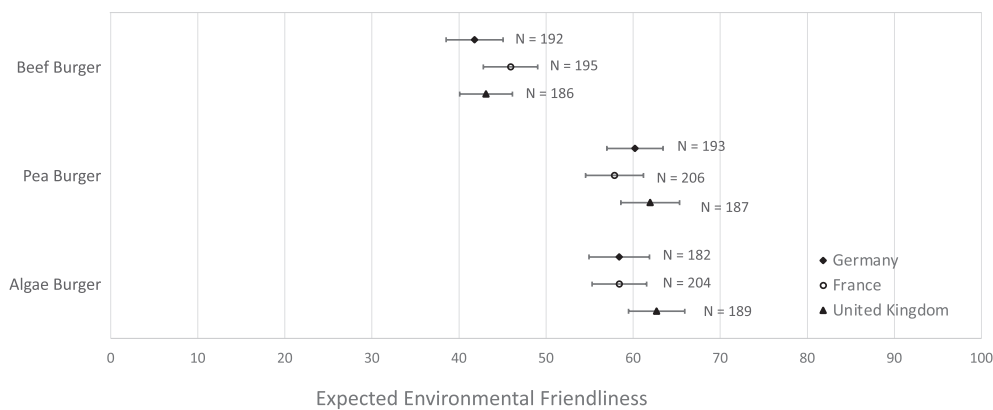

Fig. 4. Participants' environmental friendliness expectation of the three burgers. Means and 95% CI shown for each country. 0 = not environmentally friendly at all, 100 = very environmentally friendly. Non-overlapping 95% confidence intervals represent significant differences between individual measures.

Table 4
Cronbach's alpha, mean and standard deviations for food neophobia, meat commitment, and negative attitude towards vegan and vegetarian lifestyles. Mean [95% confidence interval].

Scale	Cronbach's alpha	Total (N = 1734)	Germany (N = 567)	France (N = 605)	United Kingdom (N = 562)
Food neophobia	0.84	3.21 [3.15, 3.26]	3.26 [3.17, 3.34]	3.13 [3.05, 3.21]	3.24 [3.13, 3.34]
Meat commitment	0.94	4.49 [4.41, 4.57]	4.40 [4.28, 4.53]	4.28 [4.15, 4.42]	4.80 [4.67, 4.94]
Negative vegetarian attitude	0.84	3.78 [3.70, 3.86]	3.86 [3.72, 4.00]	3.98 [3.86, 4.11]	3.48 [3.34, 3.62]

Table 5
Correlations between the negative attitude towards vegetarian and vegan lifestyles, age, meat commitment, and food neophobia.

	Age	Sex	Meat commitment	Food neophobia
Negative vegetarian lifestyle attitude	0.14**	−0.10**	0.52**	0.23**
Age		−0.01	0.09**	0.05
Sex			−0.22**	−0.04
Meat commitment				0.15**

Note: N = 1734, Sex: 0 = male, 1 = female, ** $p \leq .01$, * $p \leq .05$.

The ratings for the algae burger were significantly influenced by meat commitment, food neophobia, and the negative attitude towards vegetarian and vegan lifestyles. Participants with high food neophobia levels, a high degree of meat commitment, and a more negative attitude towards vegetarian and vegan lifestyles assessed the algae burger to be less tasty, less healthy, and less environmentally friendly.

4. Discussion

The present study has investigated factors which influence the ratings for burgers containing algae and pea as protein source with regard to expected taste, healthiness, and environmental friendliness. Furthermore, it has assessed participants' attitude towards vegetarian and vegan lifestyles, their degree of food neophobia and meat commitment, and examined consumers' consumption frequency of hamburgers.

Contrary to previous findings (Bryant, 2019; Chin et al., 2002; Judge & Wilson, 2019), the attitude of meat-eating consumers towards vegetarian and vegan lifestyles was found to be fairly negative in all three countries. Participants tended to see vegans as extremists, maybe because consumers do not like to be patronized with regard to dietary decisions. Participants with a more negative attitude towards vegetarian and vegan lifestyles rated the pea and algae burgers to be less tasty, less healthy, and less environmentally friendly. Although participants rather agreed that meat alternatives are not merely for vegetarians, the overall negative attitude towards vegetarians and vegans does not present fertile ground for the acceptance of meat alternatives; instead, it seems

Table 6

Regression table depicting unstandardized B, standardized β, t- and p-values for taste-, health-, and environmental friendliness expectations of pea and algae burger.

Predictor	Pea burger					Algae burger				
	B	95% CI	St. β	t	p	B	95% CI	St. β	t	p
Taste	$F_{(7,578)} = 30.55 p < .001.$ R^2 = 0.27, adj. R^2 = 0.26					$F_{(7,567)} = 27.55, p < .001.$ R^2 = 0.25, adj. R^2 = 0.24				
(Intercept)	101.65	[91.54, 111.76]		19.75	**<0.001**	88.81	[78.72, 98.9]		17.29	**<0.001**
France	−6.52	[−11.21, −1.83]	−0.11	−2.73	**0.01**	−3.10	[−7.69, 1.49]	−0.06	−1.33	0.19
UK	−0.91	[−5.82, 3.99]	−0.02	−0.37	0.71	−1.64	[−6.47, 3.19]	−0.03	−0.67	0.51
Sex	−0.44	[−4.41, 3.53]	−0.01	−0.22	0.83	−3.32	[−7.19, 0.54]	−0.06	−1.69	0.09
Age	−0.27	[−0.41, −0.13]	−0.14	−3.74	**<0.001**	−0.03	[−0.17, 0.10]	−0.02	−0.51	0.61
Meat commitment	−4.94	[−6.38, −3.50]	−0.30	−6.73	**<0.001**	−5.41	[−6.89, −3.93]	−0.33	−7.17	**<0.001**
Food neophobia	−2.43	[−4.33, −0.53]	−0.09	−2.51	**0.01**	−3.06	[−4.82, −1.30]	−0.13	−3.41	**0.001**
Negative vegetarian attitude	−3.72	[−5.19, −2.24]	−0.21	−4.94	**<0.001**	−3.20	[−4.69, −1.71]	−0.20	−4.23	**<0.001**
Healthiness	$F_{(7,578)} = 20.20, p < .001.$ R^2 = 0.20, adj. R^2 = 0.19					$F_{(7,567)} = 18.25, p < .001.$ R^2 = 0.18, adj. R^2 = 0.17				
(Intercept)	105.13	[95.85, 114.41]		22.26	**<0.001**	97.44	[87.46, 107.43]		19.17	**<0.001**
France	−7.58	[−11.88, −3.28]	−0.15	−3.46	**0.001**	−1.29	[−5.83, 3.25]	−0.03	−0.56	0.58
UK	−0.05	[−4.56, 4.45]	0.00	−0.02	0.98	−1.64	[−6.42, 3.14]	−0.03	−0.67	0.50
Sex	2.15	[−1.50, 5.79]	0.04	1.16	0.25	0.66	[−3.16, 4.49]	0.01	0.34	0.73
Age	−0.29	[−0.42, −0.16]	−0.17	−4.39	**<0.001**	−0.11	[−0.24, 0.02]	−0.07	−1.69	0.09
Meat commitment	−1.94	[−3.26, −0.62]	−0.13	−2.88	**0.004**	−2.06	[−3.53, −0.60]	−0.13	−2.76	**0.01**
Food neophobia	−2.62	[−4.36, −0.88]	−0.11	−2.95	**0.003**	−2.65	[−4.40, −0.91]	−0.12	−2.99	**0.003**
Negative vegetarian attitude	−3.36	[−4.72, −2.00]	−0.22	−4.87	**<0.001**	−4.31	[−5.78, −2.84]	−0.28	−5.76	**<0.001**
Environmental friendliness	$F_{(7,578)} = 17.41, p < .001.$ R^2 = 0.17, adj. R^2 = 0.16					$F_{(7,567)} = 20.46 p < .001.$ R^2 = 0.20, adj. R^2 = 0.19				
(Intercept)	95.02	[85.91, 104.14]		20.47	**<0.001**	95.69	[86.53, 104.86]		20.51	**<0.001**
France	−1.77	[−6.00, 2.46]	−0.04	−0.82	0.41	0.54	[−3.63, 4.71]	0.01	0.26	0.80
UK	4.10	[−0.32, 8.53]	0.08	1.82	0.07	2.13	[−2.26, 6.52]	0.04	0.95	0.34
Sex	4.20	[0.62, 7.78]	0.09	2.30	**0.02**	−1.07	[−4.58, 2.44]	−0.02	−0.60	0.55
Age	−0.21	[−0.34, −0.08]	−0.12	−3.23	**0.001**	−0.11	[−0.23, 0.01]	−0.07	−1.86	0.06
Meat commitment	−2.34	[−3.64, −1.03]	−0.17	−3.53	**<0.001**	−1.51	[−2.86, −0.17]	−0.11	−2.21	**0.03**
Food neophobia	−1.91	[−3.63, −0.20]	−0.09	−2.19	**0.03**	−2.29	[−3.89, −0.69]	−0.11	−2.81	**0.005**
Negative vegetarian attitude	−3.03	[−4.36, −1.70]	−0.21	−4.46	**<0.001**	−4.65	[−6.00, −3.30]	−0.33	−6.77	**<0.001**

Note: N = 1734, Sex: 0 = male, 1 = female. Country: Dummy coded with Germany as reference. Significant results ($p <= .05$) are marked in bold.

to indicate an unwillingness to change meat consumption, as reported in previous literature (Hartmann & Siegrist, 2017).

People like to eat meat, but at the same time also do not want to harm animals. Loving and not harming animals on one side and killing animals for meat on the other side are two values that contradict each other. Thus a discrepancy, the so called meat paradox (Loughnan et al., 2010) between the feelings or attitude towards animals in general and a particular behavior, namely eating meat, arises. This discrepancy is known as cognitive dissonance. To reduce cognitive dissonance, meat eaters prefer not to think about the moral implications of eating meat and employ various strategies to align their beliefs with their behavior (Buttlar & Walther, 2019; Rothgerber, 2014, 2020). As vegetarians and vegans resolved the meat paradox by adjusting their behavior and forgoing meat, having a negative attitude towards vegetarians and vegans might present another strategy which omnivores use to reduce their cognitive dissonance. This could explain why participants who were strongly inclined to meat had more negative attitudes towards vegetarian and vegan lifestyles and also gave lower taste, health, and environmental friendliness ratings for the pea and the algae burger. This possible explanation aligns with previous research showing that the more committed people are to meat, the less tasty, healthy, and environmentally friendly they expect meat alternatives to be (Graça et al., 2015; Hoek et al., 2011; Malek et al., 2019).

In all three surveyed countries, the pea and algae burger were expected to be healthier and more environmentally friendly, but also less tasty in comparison to the beef burger. As the beef burger is still the most common type of burger and since consumers might not be as familiar with burgers containing pea or algae, it was predicted that the expected taste of algae and pea burgers would be lower than for the beef burger. However, it is interesting that the expected tastiness of the pea and algae burger were not much lower compared to the beef burger. The lowest taste ratings of the beef burger, which were from French participants, were already close to the taste ratings for pea and algae burgers. One reason for the generally low taste expectation of the beef burger could be that the generic picture of the burger negatively influenced participants' assessment of its tastiness. Presentation of the burger on the picture

might have better matched consumers' expectation of meat alternatives than beef.

Nevertheless, as participants' expectations regarding the taste of pea and algae burgers are rather low, meeting, or exceeding these expectations presents a major challenge for the development and marketing of meat alternatives. In order for consumers to be enticed by the attractive sensory qualities of meat alternatives, it is not only necessary that meat alternatives provide these qualities, but also that consumers are willing to try the products in the first place. If consumers are not ready to try new products, it will not be possible to convince them of the environmental and health advantages of meat alternatives.

In the presented study, participants rated the pea and algae burger to be more environmentally friendly than the beef burger. Contrary to previous findings (Hartmann & Siegrist, 2017; Malek et al., 2019), this suggests that participants of our study were aware of the environmental consequences of meat consumption and thus rated plant-based meat alternatives as being more environmentally friendly. Furthermore, pea and algae burger were also rated as significantly healthier than the beef burger. This is interesting, as our sample mainly consisted of omnivores and this particular consumer group had been shown to eat meat because they see meat as an important part of a healthy diet (Hoek et al., 2011). However, reasons for meat eaters to adopt meat alternatives into their diet do not only include diversity seeking, but also the motivation to eat healthier (Lang, 2020; Sadler, 2004). Therefore, the findings that pea and algae burgers were rated as healthier and more environmentally friendly than the beef burger imply that positioning meat alternatives as healthy food with benefits for the environment could present a beneficial strategy to convince meat eaters to try plant-based alternatives.

The results from the linear regression illustrated that expectations for both, the pea and algae burgers were mainly influenced by consumers' degree of food neophobia, meat commitment, and the negative attitude towards vegetarian and vegan lifestyles. The more committed to meat, averse to vegetarians and vegans, and neophobic participants were, the lower ratings they gave for taste, healthiness, and environmental friendliness of both, the pea and the algae burger. In the case of food neophobia, it was previously shown that with increased food neophobia

scores, importance of environmental aspects of food choice decreased and importance of familiarity increased (Jaeger et al., 2021). Additionally, our findings also correspond to earlier research showing that food neophobia acts as a barrier towards the consumption of meat alternatives (Hoek et al., 2011; Lea & Worsley, 2003). Presenting meat alternatives in familiar shapes (such as burgers) might therefore be advantageous, as meat-eating consumers can use the meat alternative in the same manner as the meat product they are already familiar with.

Furthermore, age emerged as significant predictor for the attitude towards the pea, but not the algae burger. Being younger was associated with higher taste, healthiness, and environmental friendliness ratings for the pea burger. The finding might be attributed to young people being more open and interested in trying new food and thus being more likely to already consume meat alternatives (Hoek et al., 2011; Siegrist & Hartmann, 2019; Slade, 2018). As algae are considered a novel and unfamiliar food for participants of both sexes and every age in all three countries, it appears likely that consumers have not yet formed an opinion regarding algae products. Therefore, country, age, and sex did not have significant influence on the expectation for the algae burger. The view of algae as unfamiliar is further supported by food neophobia appearing as significant predictor.

The comparisons of the taste, healthiness and environmental friendliness ratings between the three countries showed only few differences in the expectations for the three protein sources, although the culinary backgrounds of these countries are quite different. Significant differences emerged only for the pea burger which was expected to be healthier by German participants compared to French participants.

5. Conclusion

Meat-eating consumers' attitudes towards vegetarian and vegan lifestyles across Germany, France, and the United Kingdom are negative. Nevertheless, the potential of pea and algae in terms of nutritional and environmental advantages over beef is reflected by consumers' high healthiness and environmental friendliness ratings of the pea and algae burger. The low taste expectation however, presents a major challenge for the market introduction of meat alternatives containing these protein sources. Ratings of the burgers are mainly influenced by consumers' level of meat commitment, their negative attitude towards vegetarians and vegans, and their degree of food neophobia. One of the major challenges for meat alternatives to successfully replace meat products lies in convincing consumers to try meat alternatives. As the consumption frequency of burgers appears to be low in all three countries, other shapes than burgers, which can be used for a variation of different dishes, are recommended. Finally, it is crucial that meat alternatives exceed consumers' currently low taste expectations in order to be appreciated as valid alternative to meat.

CRediT authorship contribution statement

Fabienne Michel: Conceptualization, Formal analysis, Writing - original draft, Visualization, Writing - review & editing. **Antti Knaapila:** Conceptualization, Writing - review & editing. **Christina Hartmann:** Conceptualization, Writing - review & editing. **Michael Siegrist:** Conceptualization, Writing - review & editing.

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