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Consumer Acceptance of Grass-Derived Ingredients in the UK: A Cross-Sectional Study

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Abstract: The development of sustainable food production requires reducing the strain from present production systems on the environment using novel/disruptive technologies, one of which is to use grass as an abundantly available raw material, either minimally processed grass or grass-derived ingredients. With grass supplies readily available and the potentially significant carbon footprint reduction that this technology offers, this is an opportunity for sustainable production of much-needed food ingredients for human consumption. This study investigates UK consumers' acceptance of grass-derived ingredients and examines the factors influencing their willingness to adopt these innovations as part of their diets. This study was conducted through a cross-sectional study in the UK, in which the participants were divided into three groups based on meat avoidance, i.e., meat reducers, meat avoiders, and meat consumers. The key findings emphasise the importance of education on grass-derived products to enhance consumer awareness and confidence. Other factors—such as age, meat attachment, grass-derived ingredients' characteristics, social norms, and attitudes—have influenced willingness to try (WTT)/accept grass-derived ingredients. The findings suggest that while grass-derived ingredients in human diets may struggle to gain positive perceptions, targeted product development and marketing strategies tailored to highlight grass-derived ingredients' nutritional benefits and safety are key to reshaping perceptions and fostering consumer readiness for novel food technologies in the UK.

Keywords: grass; novel food technology; sustainability; willingness to try; WTT; grass-derived ingredients; UK consumers' acceptance

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1. Introduction

Grasslands cover large land areas worldwide. In the United Kingdom (UK), 70% of all agricultural land is covered with substantial quantities of grass that is never fully utilised [1]. In the UK, using grasslands for agriculture and livestock farming has fueled debates surrounding livestock farming's significant environmental impacts, particularly its large carbon footprint [2,3]. This has resulted in recommendations to make 20% reductions in beef, lamb, and dairy consumption, which would equate to a 10% reduction in cattle and sheep if population growth is considered [4]. Intensive animal husbandry for meat production draws particularly heavily on the environment through the generation of unintentional emissions, surplus manure, and excessive use of energy, space, and raw materials [5–8]. Despite its abundance, utilisation of grass largely is limited due to its low economic value and limited use beyond its application as feed for animals [9]. Presently, the only way to produce food from grass is to feed it to animals, which convert it into meat or milk. This is a very inefficient process, as animals typically convert only 5% of the grass food fractions into meat and 10% into milk (total system efficiency) [10]. Thus, disruptive innovation in agriculture and food production is needed urgently to address the growing

demand for food and new products, as well as the negative effects caused by current meat production systems [11].

One such disruptive innovation is the concept of utilising abundant crops, such as grass, directly as food ingredients or to produce alternative oils and grass-derived proteins, herein referred to as grass-derived ingredients. While this might not be the most obvious suggestion, given the presence of highly nutritional fractions in grass, the notion is worthy of investigation [12,13]. The literature suggests that highly productive grasslands can yield more than two tonnes of dry-matter protein per hectare, which is 50% higher than peas, beans, or soy [9]. Furthermore, with the growing awareness of conventional animal agriculture's environmental impact, and the demand for health and sustainable alternatives, the exploration of grass-derived ingredients is gaining momentum [11]. The ability to utilise grass as human food, or extract edible fractions from grass, is a novel concept that is starting to receive some attention, and grass-fed proteins are leaner than meat- or milk-derived proteins, making them a healthier choice for consumers [14,15]. Furthermore, the higher omega-3 fatty acids derived from grasses also improve heart and brain functions, as well as reduce inflammation. Thus, the examination of grass in human diets is worthwhile, and the production of grass-derived ingredients can provide an opportunity to offer sustainable food sources that meet the quality demands of nutrition and climate sustainability.

The shift to and acceptance of environmentally friendly and sustainable foods has led to other novel foods, such as plant-based products [16–18] and myco-proteins [19–22]. Acceptance of these novel foods has been studied extensively by researching consumer attitudes and behaviours that dictate this shift [23]. Similarly, for grass-derived ingredients, understanding these patterns and shifts is critical, particularly during the early stages of exploration and product development. This shift can be represented on a continuum of diet change. The corresponding dietary preference groups can be classified as meat consumers, meat reducers (i.e., individuals who diminish, rather than abandon, meat eating), and meat avoiders (i.e., individuals who completely abandon meat eating) [23–27]. As such, this study strives to understand these three groups and their willingness to try (WTT) grass-derived foods, which are novel. Current discussions in the literature and the food industry mostly focus on consumers making changes towards plant-centric diets [28–33]. These findings suggest an initial low acceptance of such diets, as they are viewed as unappealing or unfamiliar, with disgust playing a role in their low acceptance [23,24,34,35]. These and other factors influence the acceptance of these diets, making it imperative to understand what other factors play a role in the acceptance of novel foods, such as grass-derived ingredients.

With the need to understand factors that influence the acceptance of novel foods and the emerging literature on the application of grass into human diets, this study pursued the following objectives: (1) investigate consumers' WTT grass-derived ingredients and their objections to the concept of grass as a food ingredient and (2) identify differences in consumers' WTT and acceptance of grass-derived ingredients among meat consumers, reducers, and avoiders and their influencing factors. By probing factors that influence the acceptance of grass-derived food ingredients, this study aims to add insights that can be used as guidance in the adoption of novel food technologies and contribute further to this scarce literature. Furthermore, including meat avoiders, who rarely are categorised separately, enables this study to form contrasting views among the groups. This is the first study, to the best of our knowledge, that aims to understand UK consumers' attitudes on the use of grass and grass-derived fractions in foods and their willingness to adopt them into their diets. Next, a succinct literature review is presented, followed by the methodology employed in our study, our findings, a discussion of our findings, and conclusions.

2. Literature Review

2.1. Grass and Novel Technologies Involving Grass

Novel technologies for human nutrition using green biomass are gaining attention with a push to produce 'green protein' as a meat alternative. According to Kamp et al., 2019 [36],

using local grassland sources for food and feed production creates a smaller carbon footprint than importing soymeal from overseas, thereby indicating a need to examine these novel technologies to mitigate these negative environmental consequences [35–38]. Extracts from grass, such as grass proteins, are currently in the research stage [39,40], and a recent study reported that protein extracts from perennial ryegrass comprise a balanced amino acid profile that is sufficient to cover essential amino acid requirements [6,12]. The most recent breakthrough in the use of grass in human diets includes the successful use of a biotechnological sprouting process with ryegrass to enhance its use as a cereal-based breakfast product, thereby demonstrating the use of ryegrass in food applications [4]. Ryegrass (*Lolium multiflorum* L.), particularly perennial ryegrass, belonging to the Poaceae family is gaining attention in the field of novel food technologies [4,37,38], as it is the most popular grass for animal feeding due to its morphological, agronomic, and nutritional characteristics, [2]. Although ryegrass belongs to the same family of cereal crops, its direct utilisation in the human diet is limited due to its high fibre and phytochemical content, and further research is underway to determine its use in human diets [4]. In the UK, grass-derived ingredients, such as hay, occasionally are used in artisan food products and luxury restaurant dishes but are not classed as a popular ingredient among UK consumers.

2.2. Consumer Perceptions and Acceptance

Consumer acceptance of novel foods is a complex process that is highly influenced by a multitude of factors [41,42]. Acceptance often is measured by WTT and eating and is informed by an array of consumers' perceptions regarding specific novel foods [41–43]. Consumer perceptions are key when introducing new food products to the market, particularly when novel/disruptive technologies are involved [44], because they can determine these innovations' success. Extant research has indicated that encouraging people to try a novel food product for the first time is one of the biggest challenges when introducing new, unfamiliar food technologies [45,46]. In Western countries in particular, introducing new foods—such as insects, which are consumed routinely in some African countries—has been proven to be challenging due to feelings of disgust [47,48]. This has led to the adoption of strategies, such as delicious and healthy food product development, to increase acceptance [48]. These findings suggest that grass for human consumption may struggle to gain positive perceptions. Therefore, examining this niche further—-including its influencing factors, application, education, and marketing techniques—-is an important aspect of this research. Being a novel product, it may be beneficial to market a product's tastiness to potential consumers to encourage them to try it for the first time, rather than for its health benefits [46,48].

2.3. Factors Influencing Willingness to Try Novel Foods

Previous research has examined factors that influence consumer acceptance of diverse, novel, and unfamiliar foods, such as in this study [12,13,17,49–51]. Food neophobia, defined as an aversion to trying unfamiliar foods [52,53], has been found to influence the acceptance of various novel foods greatly [54,55]. For example, [56,57] found that people with high food neophobia levels tend to be less accepting of novel meat substitutes. Cognitive factors, such as trust, also play crucial roles in consumers' willingness to buy cultured meat, as identified by [50,58]. Meat attachment also has been cited as a factor that determines behavioural patterns towards new products [59–61]. Wang and Scrimgeour [62] found that Chinese and New Zealand consumers' openness to alternative proteins correlated with four meat attachment factors derived from the meat attachment scale (MEA): affinity, entitlement, hedonism, and dependence. Consumer awareness and knowledge also have been found to influence WTT new foods. Hartmann and Siegrist [28] examined global awareness of meat's environmental impact. Awareness was low but increased when information about environmental, animal welfare, or health concerns proliferated. Harguess et al. [63] suggested combining knowledge with emotions to elicit effective dietary change. Sanchez-Sabate and Sabate [64] linked public awareness of environmental concerns to changing

behaviour. They indicated that as awareness of meat's impact on the planet proliferates, more people will alter their diets, and meat consumption per capita likely will decrease and boost demand for alternative proteins. Risk perception also has been found to influence people's eating behaviours [65–67]. Furthermore, social norms and attitudes have been found to influence human behaviours in trying new foods [68,69]. Gender also has been found to influence consumer acceptance of novel foods [58,70], with males being more open to accepting novel foods than females.

2.4. Study Framework and Hypotheses

Based on the literature review of previous studies regarding WTT novel foods [47,71–74], a framework was developed (Figure 1) that included organising various factors that influence WTT grass-derived ingredients. To achieve this study's objectives, a survey was used to assess these factors. Furthermore, the following research hypotheses were proposed: WTT foods with grass ingredients are influenced by knowledge (H1), food neophobia (H2), income (H3), social norms (H4), risk perception (H5), grass-derived ingredients' characteristics (H6), food preparation convenience (H7), meat attachment (H8), attitudes (H9), income (H10), education (H11), gender (H12), and environmental attitudes (H13).

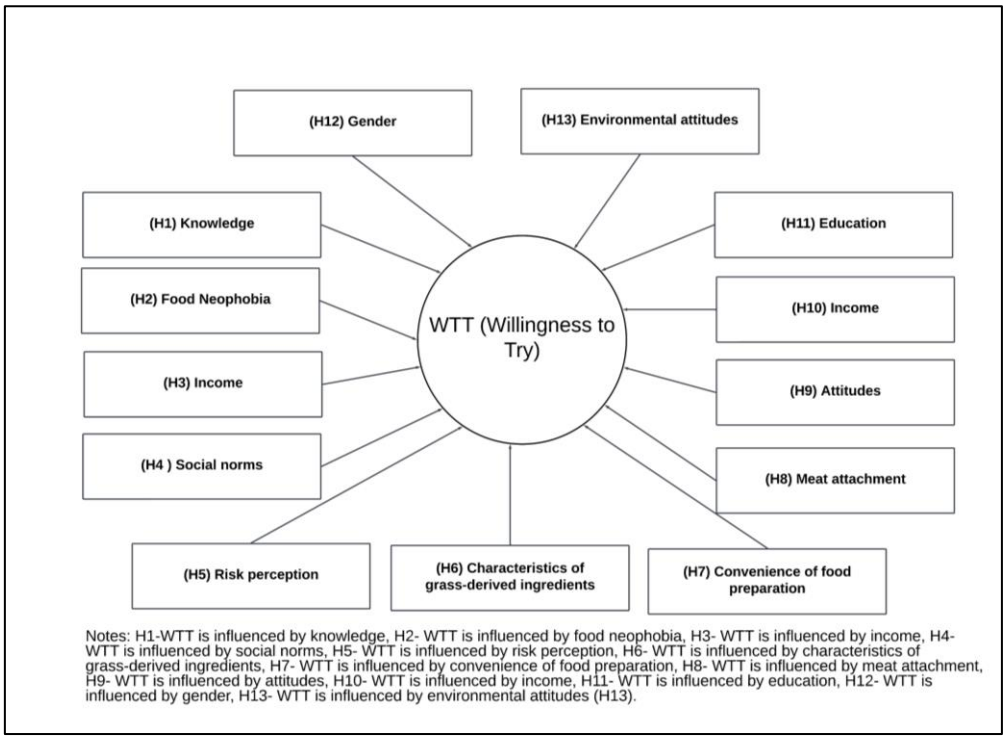

Figure 1. This study's hypotheses and framework.

3. Materials and Methods

3.1. Data Collection

Data were collected through a survey comprising distinct sets of questions and statements that aligned with this study's objectives and were developed from previous literature reviews and existing work on novel foods [43,49,72]. Following approval by the Harper Adams University Ethics Commission (0408-202305-STAFF), the survey was piloted prior to the external rollout. Data collection was conducted in the UK via an online survey during August 2023. UK participants were recruited through online access panels (Cint and TGM), which also were responsible for financial compensation for the participants. Quotas were set to reflect the most recent British census regarding gender split and 18+ age distribution. Participants received information that the survey concerned their perception(s) of novel foods prior to beginning the survey. The concept of grass-derived ingredients in food is

new, so to avoid any confusion or ambiguity about the term grass-derived ingredients, the following excerpt was provided to participants, explaining this novel food technology:

'One of the most abundant plant species in the UK is grass. Yes, the green, spriggy plants that grow on farms, along the roadside and on people's lawns. Through novel technologies, grass-derived ingredients, such as proteins, can be derived for human consumption. Furthermore, grass grows quickly and is much easier to manage, thereby providing a potentially sustainable solution. In this short section, we would like to hear from you about grass (fresh or dried [hay])-derived ingredients'.

Altogether, 1021 responses were collected, but 31 were rejected during an initial data screening due to either incomplete or duplicate data. Data quality also was inspected by running basic statistical analysis during the screening process to detect outliers before proceeding. The remaining responses were grouped as outlined in Figure 2, indicating the sample population and the dietary preference groups. The sample was an accurate representation of the general population, with meat consumers as the largest group and meat avoiders as the smallest group [20].

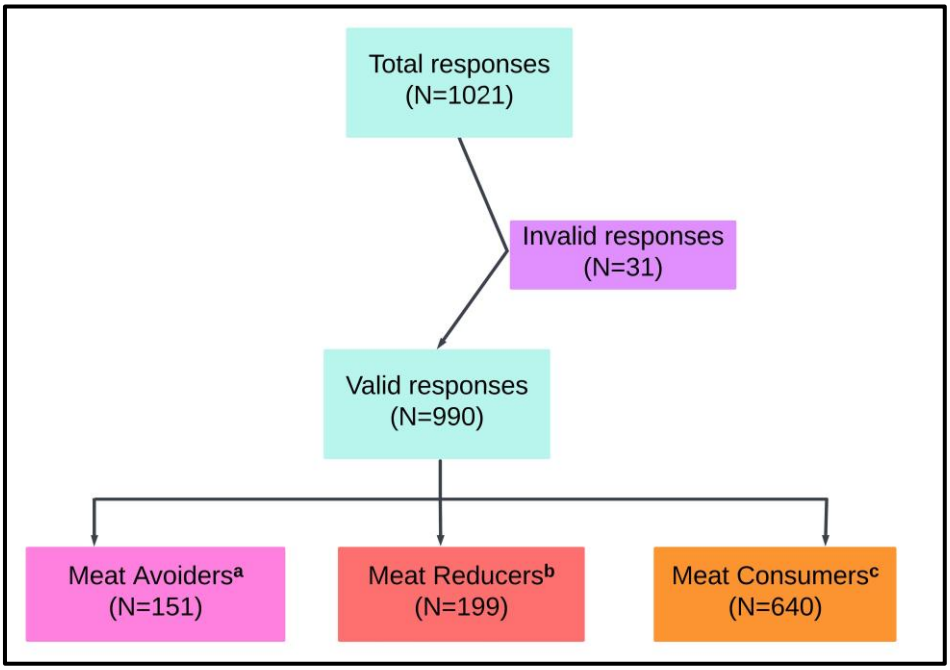

Figure 2. Sample population dietary preference groups. [a] Meat avoiders—individuals who actively avoid meat or other animal products. [b] Meat reducers—individuals who avoid meat or other animal products on some days, e.g., no-meat Mondays. [c] Meat consumers—individuals who do not actively avoid meat or other animal products.

3.2. Questionnaire Design and Variables Measured in This Study

Collected sociodemographic information included gender, age, education level, and monthly average household income. All the variables in this study were measured using a five-point Likert scale ranging from strongly disagree to strongly agree. WTT grass-derived ingredients, i.e., the dependent variable, was measured using a subscale comprising five items (α = 0.93): 'I would be prepared to consume foods with grass ingredients as a substitute for meat or my daily protein intake'; 'I would eat/try foods with grass ingredients'; 'I would buy foods with/that contain grass ingredients'; 'I would pay more for foods with/that contain grass ingredients'; and 'I would encourage others to serve foods with/that contain grass ingredients'.

This study included nine independent variables (Figure 1 and Table A1), namely, (i) the food convenience subscale, comprising two items (α = 0.77) [43]; (ii) meat attachment, i.e., the MEA subscale, comprising thirteen items (α = 0.90), modified from Kühn et al. [75];

(iii) the food neophobia subscale, comprising ten items (α = 0.82) [43,52]; (iv) attitudes towards grass as an ingredient subscale, comprising five items (α = 0.70) [76]; (v) the social norms subscale, comprising four items (α = 0.81) [67]; (vi) consumers' environmental attitudes and impact of their food choices, measured using the item 'When I buy foods, I try to consider how my use of them will affect the environment' (this item was based on Roberts [77]; (vii) knowledge—which measured any existing knowledge/awareness of the use of grass as a food ingredient ('I have heard of/I am aware of grass of as an alternative to proteins or starch in human food'); (viii) characteristics of grass-derived ingredients (CGDI) that measured expectations of grass-derived ingredients and their characteristics subscale, comprising four items (α = 0.87); and (ix) the risk factors subscale, comprising three items (α = 0.75) that were modified from literature sources [43,67]. Further detailed information on the subscales is presented in the Appendix A (Table A1). The items marked with an '(R)' for food neophobia and 'MEA' were recoded inversely [59].

3.3. Statistical Analysis

Statistical analyses were conducted using IBM SPSS v27. Mean scores and standard deviations were used to characterise the groups and offer detailed insights into their characteristics and behaviours. A chi-squared test for independence was computed between the sociodemographic characteristics and WTT grass-derived ingredients. The difference among independent variables for the three groups was investigated using Kruskal–Wallis one-way analyses of variance (ANOVAs). A one-way ANOVA with Bonferroni test post hoc comparisons of mean scores to test for significance differences in WTT grass-derived ingredients between meat consumers, avoiders, and reducers was employed. For all the subscales used in the data analysis, a reliability test to measure internal consistency was conducted, and Cronbach's alphas were reported. A cut-off (α = 0.5) was used for all scales with less than 10 items, and a cut-off (α = 0.7) for variables with more than 10 items was used [78,79]. The Kaiser–Meyer–Olkin (KMO) test and Bartlett's test were used to evaluate the strength of the relationship among the dependent variables before conducting the correlation analysis. A Pearson correlation analysis was conducted to identify the relationship and direction of the dependent variables, as well as determine their subscale use as one dependent variable. A normality test was conducted before the data were prepared for multiple linear regression. The skewness and kurtosis values obtained in the normality test fell between -2 and +2, thereby confirming that all the variables were distributed normally [80,81]. A multiple linear regression analysis with all the hypothesised determinants of WTT grass-derived ingredients was conducted, and the ENTER method of variable selection was adopted during the regression setup. The extracted variance of inflation (VIF) was employed to check for multicollinearity, with all VIF values below 5.0; thus, no collinearity issues were found within the models [82]. The results from the regression analysis were used to justify the group characteristics and provide potential justifications as to why particular predictor variables were prominent for each group.

4. Results and Discussion

4.1. Participants' Demographic Characteristics

The sample population comprised 50.2% males and 49.8% females. The population was divided into three groups based on meat avoidance, and their sociodemographic characteristics are reported in Table 1. As presented in Table 1, the sample size was a true representation of the population, i.e., most people consume meat compared with the other groups [83]. A chi-squared test for independence indicated that the relationship between these variables was only significant for meat reducers and meat consumers. Among meat reducers, age [χ^2 (100) = 125.300, p = 0.044] was significant, whereas income [χ^2 (100) = 144.783, p = 0.002] and age [χ^2 (100) = 133.783, p = 0.14] were both significant among meat consumers, as presented in Table 1. Among the three groups, meat consumers mostly were within the 45–54 (18.1%) age range, earned between GBP 1001 and GBP 2000 monthly (26.3%), and had a secondary education (37.2%). Meat reducers mostly were

female (59.3%), earned between GBP 1001 and GBP 2000 monthly (29.6%), and had a higher education (52.3%). However, meat avoiders mostly were male (52.3%) and had the highest scores for income, at GBP 2001–GBP 3000 monthly (28.5%), among the groups, as reported in Table 1.

Table 1. The respondents' descriptive statistics.

	Meat Consumers (N = 640 [64.6%])		**Meat Avoiders (N = 151 [15.3%])**		**Meat Reducers (N = 199 [20.1%])**		**Total (N = 990 [100%])**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Gender	(p = 0.570) [a]		(p = 0.683) [a]		(p = 0.910) [a]			
Male	337	52.7	79	52.3	81	40.7	497	50.2
Female	303	47.3	72	47.7	118	59.3	493	49.8
Age	(p = 0.02) [a]		(p = 0.044) [a]		(p = 0.276) [a]		-	
18–24	66	10.3	29	19.2	27	13.6	122	12.3
25–34	90	14.1	35	23.2	36	18.1	161	16.3
35–44	97	15.2	35	23.2	31	15.6	163	16.5
45–54	116	18.1	22	14.6	30	15.1	168	16.9
55–64	95	14.8	17	11.3	31	15.6	143	14.4
65+	176	27.5	13	8.6	44	22.1	233	23.5
Income	(p = 0.014) [a]		(p = 0.389) [a]		(p = 0.471) [a]		-	
1–1000	94	14.7	30	19.9	30	14.6	154	15.5
1001–2000	168	26.3	62	28.5	45	29.6	275	27.8
2001–3000	134	20.9	51	27.8	45	24.6	230	23.2
3001–4000	79	12.3	22	11.9	19	11.1	120	12.1
4001–5000	60	9.4	16	6.6	10	8.0	86	8.7
5000+	105	16.4	25	5.3	9	12.1	139	14.0
Education	(p = 0.566) [a]		(p = 0.112) [a]		(p = 0.307) [a]		-	
Primary	9	1.4	4	2.6	1	0.5	14	1.4
Secondary	238	37.2	40	26.5	42	21.1	320	32.3
Further Education	188	29.4	52	34.4	52	26.1	292	29.5
Higher Education	205	32	55	36.4	104	52.3	364	36.8

Notes: Income reported in GBP, [a] significance level in the chi-squared test for independence with WTT grass-derived ingredients.

4.2. Willingness to Try Grass-Derived Ingredients

As presented in Tables 2 and 3, the three groups (meat consumers, meat avoiders, and meat reducers) exhibited a somewhat high WTT grass-derived ingredients, indicating that the respondents had positive attitudes towards grass-derived ingredients despite them being novel and unfamiliar to the respondents. This finding contrasted with previous research that found unfamiliarity resulted in an increased dislike of a food product [44]. Thus, the conclusion was that UK consumers were open to trying new and unfamiliar foods and had an interest in including grass-derived ingredients in their diets. Among the groups, meat consumers demonstrated the highest willingness to include grass-derived ingredients in their diets compared with meat avoiders, who expressed the lowest willingness (Table 2)—a positive finding, as the majority of the sampled population comprised meat consumers.

Table 2. Comparisons of mean differences in willingness to try grass-derived ingredients among groups based on meat consumption/avoidance.

Group	N	Mean ± SD	Meat Consumers	Meat Avoiders	Meat Reducers
Meat consumers	640	3.60 ± 1.06	-	0.957 *	0.710 *
Meat avoiders	151	2.65 ± 1.06	−0.957 *	-	−0.247
Meat reducers	199	2.89 ± 0.98	0.710 *	0.247	-

Notes: Bonferroni F = 71.769, $p = 0.001$. * The mean difference is significant at the 0.05 level. A five-point Likert scale was used to measure WTT grass-derived ingredients, with a medium score of 3.

Table 3. Pearson's correlation of the dependent variable willingness to try grass-derived foods and ingredients.

Correlations of the Dependent Variable						
		1	2	3	4	5
1	Eat/try foods containing grass-derived ingredients	1				
2	Buy foods containing grass-derived ingredients	0.861 **	1			
3	Pay more for foods that contain grass-derived ingredients	0.631 **	0.710 **	1		
4	Encourage others/serve food that contains grass-derived ingredients	0.716 **	0.791 **	0.817 **	1	
5	I would be prepared to consume foods with grass-derived ingredients	0.734 **	0.748 **	0.613 **	0.687 **	1

** Correlation is significant at the 0.01 level (two tailed).

To determine differences in WTT grass-derived ingredients among the groups, a one-way ANOVA (Table 2) was conducted, yielding a statistically significant difference among the three groups (F [2, 987] = [71.769], $p = 0.001$). A Bonferroni post hoc test for multiple comparisons revealed a statistically significant difference between meat consumers and meat reducers amongst the groups ($p = 0.001$, 95% CI = [73.08, 118.33]) ($p = 0.001$, 95% CI = [50.70, 91.30]), indicating that the three groups had varying levels of intention to try grass-derived ingredients. No statistically significant difference was found between meat reducers and meat avoiders ($p = 0.085$).

The results from Pearson's correlation analysis (Table 3) revealed that the variables were correlated positively with one another. Bartlett's test of sphericity and the KMO measure of sampling adequacy analysis revealed strong correlations amongst the variables (KMO = 0.855, Bartlett's test of sphericity = 4365.120, df = 10, and $p = 0.001$). The sampling is deemed adequate if the KMO value is 0.6 or higher [84]. Therefore, these variables could be used to analyse WTT grass-derived ingredients and indicate a degree of intention to try these foods.

4.3. Independent Variables' Mean Scores across the Three Groups

For the independent variables among the groups, the results from the Kruskal–Wallis test with the significant values adjusted by the Bonferroni correction for multiple tests indicated no statistically significant differences for Hypothesis 7 (H7), i.e., food preparation convenience [$\chi 2$ (2, N = 990) = 4.007, $p < 0.135$]. The difference between the ranks totaled 490.24 (meat consumers), 473.33 (meat avoiders), and 529.24 (meat reducers). This was an indication that there were no differences in perceptions of convenience in meal preparation among the groups. All other variables were statistically significant, indicating that the three groups assessed these variables differently, potentially influencing their WTT, as presented in Table A2. The Kruskal–Wallis test results further supported the observed differences in WTT grass-derived ingredients among the groups, as presented in Table 2, i.e., meat reducers and avoiders demonstrated no major differences in their perceptions of various variables.

As presented in Table 4, meat consumers had a higher risk perception as it relates to food choices and were the most concerned about grass-derived ingredients' qual-

ity in the market, providing the highest mean scores for risk perceptions across the groups (Mean ± SD = 3.33 ± 0.77). They also had the highest mean scores for knowledge of grass-derived ingredients (Mean ± SD = 2.66 ± 0.62), a plausible indication that they were more knowledgeable about food-related topics. Furthermore, meat consumers expressed a higher level of concern over food choices' environmental impacts (Mean ± SD = 3.07 ± 1.08), a more positive attitude towards novel food technology (Mean ± SD = 3.07 ± 0.71), and a preference for characteristics associated with grass-derived ingredients (Mean ± SD = 3.04 ± 0.86). These high scores in this group further support their willingness and enthusiasm to try grass-derived ingredients, as indicated by the high scores in WTT grass-derived proteins. Furthermore, their concerns over their food choices' environmental impacts may be related to increased awareness of climate change and sustainability issues associated with meat production. This positive attitude towards novel food technology may stem from exposure to innovations, such as plant-based and lab-grown meats, which are marketed as more sustainable and technologically advanced options.

However, meat avoiders tend to be influenced the most by social norms regarding food choices (Mean ± SD = 3.33 ± 0.89) compared with the other groups. Their higher adherence to social norms regarding food choices could be driven by a desire to conform to societal expectations and avoid social discomfort, which would explain their high mean scores for meat attachment (Mean ± SD = 3.23 ± 1.00). Notably, the high standard deviation, indicating high variability in their responses for this variable, should not be ignored. They also had fewer environmental concerns (Mean ± SD = 2.47 ± 0.97), which could be associated with a lack of awareness, as they had the lowest scores on knowledge (Mean ± SD = 2.23 ± 0.76), or a belief that their personal dietary choices exert minimal influence on broader environmental issues. This group also had the lowest scores on attitudes towards novel technology (Mean ± SD = 2.60 ± 0.74). Meat avoiders seemed to bother with food preparation the least (Mean ± SD = 2.47 ± 0.93), which could be attributed to easier food choices, such as salads, which require less preparation and are less time consuming than meals with meat that require cooking, which could include butchering, cutting, and/or cleaning animals.

Meat reducers, on average, had the highest score on food preparation convenience (i.e., willingness to spend time preparing food) (Mean ± SD = 2.65 ± 0.95), although, across all three subgroups, they exhibited some variability in their responses on this attribute. This could indicate that whatever they substitute for the days when they do not consume meat must have certain characteristics for them to feel satisfied with their choices. The food preparation convenience score also might be plausible due to busy lifestyles and a desire for quick and easy meal options. Meat reducers demonstrated a comparatively high level of food neophobia (Mean ± SD = 3.43 ± 0.17) and a moderate level of attachment to meat (Mean ± SD = 2.91 ± 0.57), as explained by their reduction or avoidance of meat on some days. Similar to meat consumers, meat reducers demonstrated a positive attitude towards novel food technology (Mean ± SD = 2.70 ± 0.66), which could be due to exposure to plant-derived alternatives. These innovations often are promoted as healthier and more sustainable choices. They expressed a relatively positive attitude towards novel food technology. Their moderate knowledge levels could be attributed to high mean scores on higher educational levels exhibited by the group.

Table 4. Mean scores and standard deviations (SDs) of the independent meat consumption variables.

Factors	Meat Consumers (N = 640)	Normality Test			Meat Reducers (N = 199)	Normality Test			Meat Avoiders (N = 151)	Normality Test			Total (N = 990)
	Mean ± SD	Skewness	Kurtosis	*p*-Value *	Mean ± SD	Skewness	Kurtosis	*p*-Value *	Mean ± SD	Skewness	Kurtosis	*p*-Value *	Mean ± SD
Food neophobia	3.30 ± 0.65	−0.145	0.018	0.028	3.43 ± 0.62	−0.123	−0.113	0.058	3.17 ± 0.51	−0.115	0.163	0.122	3.31 ± 0.63
MEA [a]	2.28 ± 0.59	−0.077	−0.364	0.001	2.91 ± 0.57	−0.133	0.198	0.066	3.23 ± 1.00	0.298	−0.843	0.001	2.55 ± 0.77
Knowledge	2.66 ± 0.62	−1.621	1.392	0.001	2.34 ± 0.77	−0.664	−1.024	0.001	2.23 ± 0.76	−0.418	−1.161	0.001	2.53 ± 0.70
Risk levels	3.33 ± 0.77	0.123	0.508	0.001	3.14 ± 0.77	−0.555	0.743	0.001	3.12 ± 0.84	0.092	0.398	0.001	3.26 ± 0.78
Social norms	2.98 ± 0.82	−0.209	0.436	0.001	3.30 ± 0.70	−0.318	0.479	0.001	3.329 ± 0.89	−0.478	0.38	0.001	3.09 ± 0.82
CGDI [b]	3.04 ± 0.85	0.410	0.388	0.001	2.60 ± 0.76	0.555	1.205	0.001	2.49 ± 0.86	0.628	1.031	0.001	2.87 ± 0.87
Food preparation convenience	2.53 ± 0.94	0.297	−0.370	0.001	2.65 ± 0.95	0.037	−0.637	0.001	2.47 ± 0.93	0.347	−0.460	0.001	2.54 ± 0.94
Attitudes	3.07 ± 0.71	0.101	0.215	0.001	2.70 ± 0.66	0.179	0.558	0.030	2.60 ± 0.74	0.439	0.830	0.001	2.92 ± 0.73
Environmental impacts	3.07 ± 1.08	0.094	−0.656	0.001	2.46 ± 0.93	0.563	0.253	0.001	2.47 ± 0.97	0.571	0.037	0.001	2.54 ± 0.94

[a] Meat attachment; [b] CGDI—characteristics of grass-derived ingredients; * Shapiro–Wilk *p*-value reported.

4.4. Determinants of Willingness to Try Grass-Derived Ingredients

The multiple linear regression results (Table 5) indicated slight differences in the assessment of grass-derived ingredients among the groups. The results indicated that gender ($p = 0.018$), age ($p = 0.003$), knowledge ($p = 0.001$), meat attachment ($p = 0.001$), characteristics of grass-derived ingredients ($p = 0.001$), social norms ($p = 0.001$), attitudes ($p = 0.001$), risk ($p = 0.050$), food preparation convenience ($p = 0.049$), and food neophobia ($p = 0.016$) explained 69.3% of variance in WTT grass-derived ingredients (F [13, 626] = 108.768, $p < 0.001$, adj $R^2 = 0.687$) among meat consumers. However, age ($p = 0.033$), knowledge ($p = 0.001$), grass-derived ingredients' characteristics ($p = 0.001$), meat attachment ($p = 0.007$), and attitudes ($p = 0.001$) explained 72.9% of the variance in WTT grass-derived ingredients among meat avoiders (F [13, 137] = 32.068, $p < 0.001$, adj $R^2 = 0.729$). For meat reducers, 73.4% of the variance in WTT grass-derived proteins (F [13, 185] = 39.173, $p < 0.001$, adj $R^2 = 0.715$) was accounted for by age ($p = 0.039$), knowledge ($p = 0.001$), CDGI ($p = 0.001$), attitudes ($p = 0.001$), food neophobia ($p = 0.001$), environmental impacts ($p = 0.009$), social norms ($p = 0.012$), meat attachment ($p = 0.006$), and food preparation convenience ($p = 0.050$).

Table 5. Results from regression analyses of predictor variables for willingness to try grass-derived ingredients.

	Meat Consumers			**Meat Avoiders**			**Meat Reducers**		
	Std. Error	**Beta**	**VIF**	**Std. Error**	**Beta**	**VIF**	**Std. Error**	**Beta**	**VIF**
Gender	0.048	0.054 *	1.068	0.097	0.088	1.154	0.078	−0.004	1.063
Age	0.017	0.082 **	1.585	0.039	0.121 *	1.751	0.027	0.100 *	1.620
Income	0.017	0.008	1.477	0.042	−0.063	1.618	0.027	−0.010	1.317
Education	0.028	−0.036	1.043	0.056	−0.034	1.139	0.049	0.071	1.173
MEA [a]	0.044	−0.195 **	1.235	0.055	−0.142 *	1.497	0.069	−0.112 *	1.138
Knowledge	0.042	0.098 **	1.217	0.077	0.184 **	1.699	0.058	0.175 **	1.443
CGDI [b]	0.044	0.245 **	2.546	0.092	0.292 *	3.063	0.069	0.369 **	1.986
Social norms	0.036	−0.152 **	1.572	0.060	−0.121 *	1.364	0.065	−0.117 *	1.470
Food preparation convenience	0.026	−0.046 *	1.121	0.056	0.005	1.314	0.044	0.085 *	1.279
Attitudes	0.050	0.355 **	2.328	0.101	0.384 **	2.725	0.076	0.310 **	1.784
Food neophobia	0.038	−0.056 *	1.108	0.095	−0.067	1.142	0.068	−0.141 **	1.261
Environmental impacts	0.024	0.036	1.280	0.051	0.036	1.184	0.046	0.114 *	1.307
Risk	0.034	0.048 *	1.232	0.062	0.074	1.310	0.053	0.052	1.221
R^2		69.1%			74.8%			73.1%	
F		108.768			32.068			39.173	

* $p < 0.05$. ** $p < 0.01$. Std. Error = standard error, [a] meat attachment, [b] characteristics of grass-derived ingredients.

The three models' goodness of fit, i.e., pseudo R^2 values, indicated a strong fit between the model and data, implying that the included predictor variables exerted a substantial influence on their WTT grass-derived ingredients. These findings did not support Hypothesis 3 (income influences one's WTT grass-derived ingredients) and Hypothesis 11 (education influences one's WTT grass-derived ingredients), as these variables were not significant predictors of WTT in any of the groups, but confirmed all the other hypotheses proposed in this study (see Figure 1), i.e., among meat reducers, consumers, and avoiders, WTT grass-derived ingredients is influenced by knowledge (H1), food neophobia (H2), income (H3), social norms (H4), risk perception (H5), expectations of foods with grass-derived ingredients (H6), food preparation convenience (H7), meat attachment (H8), attitudes (H9), income (H10), education (H11), and gender (H12).

Although most of the variables exerted similar influences among the groups, notable differences were found in the factors that influenced WTT grass-derived ingredients among

the groups. The lack of major differences among the groups on influencing factors could be attributed to grass-derived ingredients' novelty, in which the groups did not necessarily have predetermined experiences or enough knowledge to make informed decisions or comparisons. This finding also suggests that when it comes to grass-derived ingredients, there may be similar ideologies and thinking. Notably, gender, food convenience, environmental impacts, and food neophobia exerted different influences on the groups.

Age was an important factor in predicting WTT grass-derived ingredients among all the groups with a positive beta coefficient, i.e., older people were more willing to accept grass-derived ingredients than the younger population. These results align with Dupont and Fiebelkorn [76], who found that older respondents demonstrated a greater willingness to consume foods made from insects and cultured meat. Another plausible explanation comes from Van der Weele and Driessen [83], who noted that when it came to alternative proteins, i.e., cultured meat, older individuals tended to frame their thoughts in the context of broader societal change, while younger individuals often approached the topic from a personal consumption perspective.

Knowledge was also a significant predictor in all three groups with a positive beta coefficient, i.e., those who had more knowledge about food-related topics were more inclined towards trying grass-derived ingredients. This finding highlights the role of information and awareness in shaping consumers' choices across different groups and the impact of the characteristics of the product being developed. This result aligns with Hartmann and Siegrist [35], who found that awareness and conscientiousness are higher when information on the topic was provided before asking relevant questions, leading to more acceptance of the topic.

Overall, safety, nutritional benefits, and grass-derived ingredients' healthiness, i.e., grass-derived ingredients' characteristics, were significant drivers of WTT grass-derived ingredients based on the significant values obtained. This finding aligns with that of Kamphuis et al. [85], who also found that health factors were influencing factors in food choices, particularly among older respondents, supporting the finding on the influence of age on WTT grass-derived ingredients. Similarly, these findings are consistent with those of Gómez-Luciano et al. [43], who made similar observations in the UK, Spain, and Brazil when assessing determinants of consumers' willingness to purchase three alternative proteins. Another deduction from this finding concerns preferences for characteristics associated with grass-derived ingredients, such as the novel products' taste or health benefits.

Attitudes towards grass-derived ingredients were a significant predictor in all three groups, emphasising the influence of a positive attitude on WTT grass-derived ingredients. Urala and Lähteenmäki [51] found a similar impact in their study of the use of new-category food products, in which they concluded that attitudes, more specifically perceived rewards, were predictors of WTT functional foods. This finding suggests that having a favourable view, one that includes rewards such as improved health or nutritional value of innovative food technology, plays a universal role in influencing consumers' WTT grass-derived ingredients. Therefore, efforts should be made to improve people's attitudes towards these products. Another important consideration from this study would be exploring options to help improve attitudes towards grass-derived ingredients and products, possibly through channels such as advertising, improving the product's flavor, and adding value to it by increasing health benefits associated with the product to cultivate more positive attitudes toward such products.

Meat attachment was an influencing factor among the three groups with a negative beta coefficient, indicating that individuals who were less attached to meat were more willing to try grass-derived ingredients. This finding was similar to [59,60,86], who found a negative association between willingness to reduce meat consumption and consumption of a plant-based diet. As Kühn et al. [75] found, individuals with higher MEAs often eat meat and have a more positive attitude towards meat. Social norms, or societal expectations regarding food choices, significantly influenced their WTT grass-derived ingredients;

however, the negative beta coefficient meant that individuals who cared more about what society expected from them were less likely to try grass-derived foods/ingredients. This indicates that their food choices may be influenced by what is socially accepted or expected.

Meat consumers and meat reducers had somewhat similar characteristics, as both groups were influenced by food preparation convenience and food neophobia when making decisions about grass-derived ingredients. Food neophobia with a negative beta coefficient was a significant predictor variable, i.e., people with lower food neophobia in the two groups were more averse to trying new foods. This finding aligns with that of Verbeke [70], who reported similar results from his study on consumers who were ready to adopt insects as meat substitutes. Food preparation convenience with a negative beta coefficient among meat consumers and positive beta coefficient among meat reducers was a significant predictor of WTT, i.e., among meat reducers, the less time and effort it took to prepare or use food with grass-derived ingredients, the more they were willing to try the products [70]. A plausible explanation for this observation could be that meat reducers prefer meals with short preparation times, particularly when they are avoiding meat products. However, meat consumers were willing to try products, even if it took more time and effort. A plausible explanation for this could be that meat consumers accept longer cooking times, as most meat products take longer to cook than vegetables or other foods.

Among meat consumers—similar to findings by [84,87–89], who found that females held more positive attitudes towards plant-based protein alternatives—gender was a significant determinant of WTT grass-derived ingredients in this group, i.e., female meat consumers were more willing to try grass-derived ingredients than males in this group. Although risk perception was a significant predictor of WTT, this group of respondents was less concerned about the risks associated with grass-derived ingredients based on the positive beta coefficient observed. This could be associated with possible trust in the technology and processes that would be undertaken before presenting the products in the market, as is the case with all novel technologies, which must be tested and approved as safe for human consumption before being released in the market.

Meat reducers were the only group who seemed to care more than the other two groups about the environment based on the significant predictor variable for environmental impacts, indicating that they considered environmental impacts when making food choices and were more likely to try grass-derived ingredients, suggesting that sustainability and environmental concerns play a key role in their decision-making process. The previous literature has found that consumer consciousness of environmental issues is growing, likely due to increased coverage of and exposure to this information [35]. Furthermore, consumers have expressed growing concern for the planet's ability to feed the growing population, which is driving consumers to be more conscious of their food choices and interested in sustainable options [64,90].

As mentioned earlier, age, knowledge, meat attachment, grass-derived ingredient characteristics, and social norms and attitudes exerted the greatest influence on WTT grass-derived ingredients. Contrary to our expectations, respondents were more open and possessed a level of awareness about grass-derived ingredients. To further develop the novel food sector or disruptive technologies, our findings suggest emphasising healthiness, safety, and nutritional characteristics, as these variables highly influence consumer acceptance of these foods [85]. However, caution should be taken regarding product design to ensure that these foods are convenient for cooking, as this plays a significant role in the use of these products. Furthermore, there should be an emphasis on promoting and strengthening positive attitudes towards grass-derived ingredients, particularly among the younger population. This can be achieved through unique marketing strategies, such as taste panels and curriculum modification in schools, to encourage openness among the younger population, who were not receptive to the novel foods in our case [61,76].

5. Limitations and Opportunities for Further Research

This study has some limitations. Firstly, this study focused solely on evaluating intention or WTT grass-derived ingredient products that were not yet readily available in the market. Therefore, consumers had no reference points, so the results from future research may differ when actual products are available. Thus, a follow-up study is recommended to make comparisons to reflect UK consumers' true opinions. Secondly, the intention to try grass-derived ingredients came from self-reported data, and these observations could change in a real-world setting, as the reported intention may not necessarily reflect actual consumption. Thirdly, although this study assessed a set of factors that influence WTT grass-derived ingredients, it was limited to the UK context and, thus, is not an exhaustive list. Further studies should be conducted to assess other factors, such as geographical location, i.e., rural or urban consumers and country contexts, which could come into play, particularly when consumers are presented with the actual product, and research is conducted in other country contexts. Fourthly, risks that may be associated with grass-derived ingredients—including pesticides, heavy mineral elements, or harmful microorganisms—make the purification process extensive and may require conducting toxicity tests to pass health checks. This may hinder such technologies from being adopted, as they may be costly. Therefore, further studies on the cost implications of using such novel technologies are required. Finally, an investigation into the integration of grass ingredients into people's diets, including flavor profiles and sensory factors desired by consumers, is needed to produce the most market-appropriate products with the best likelihood of being successful because flavor profiles may play a role in WTT grass-derived products. Furthermore, the pricing of the products needs to be examined and considered in future studies to determine whether it influences the acceptance of these products.

6. Conclusions

This study added insights into the acceptance of grass-derived ingredients among UK consumers and assessed the factors that influence their acceptance. This information is important for product development and for introducing new foods and food ingredients, both of which are driven by consumer acceptance. Knowledge was found to be a critical factor in determining WTT grass-derived ingredients. Given that the concept is relatively new, there was a considerable amount of know-how about the technology, underscoring this factor's importance. Increased knowledge of the products and novel technology leads to more acceptance and confidence in using the products being developed. Therefore, further education requirements should be explored as an avenue to increase this awareness, possibly through recipes and examples of the use of these products, thereby highlighting their health benefits. Furthermore, a life cycle assessment of the sustainability/environmental effects of consuming grass-derived products and dissemination of these results to the public could increase know-how and tip their acceptance scale to favor these products. This knowledge would encourage individuals who lead sustainable lifestyles to consume these products. Attitudes and social norms also were significant factors in determining acceptance of grass-derived ingredients, thereby emphasizing the need to change people's perceptions to increase WTT grass-derived ingredients. One positive observation from this study was overall openness to trying unfamiliar foods, which was found to be high among the participants, an indication that these products would be well received in the market. Therefore, key marketing strategies, such as product sampling, should be encouraged to increase WTT grass-derived ingredients. Grass-derived ingredients' characteristics are a significant factor influencing WTT grass-derived ingredients, thereby providing important insights into product design. Thus, product design and marketing of grass-derived ingredients should be geared towards emphasising these ingredients' healthiness, safety, and nutritional aspects, and efforts to communicate these products' benefits should be increased when marketing them.

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Institutional Review Board Statement: The study acquired approval to use human subjects, which was granted by the Harper Adams University Ethics Committee on 19/06/2023. Participation was voluntary, and all participants signed an informed consent statement to participate in the study.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study prior to their particiaption.

Data Availability Statement: Data will be made available upon request.

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Appendix A

Table A1. Subscales and the description of the items measured in this study.

Subscale	Items Measured Using a 5-Point Likert Scale	Cronbach's Alpha
Convenience food preparation	(a) The less I have to do to prepare a meal—the better (b) I love cooking and will spend a lot of time and effort to prepare foods daily	0.77
Expectations and perceptions of grass-derived ingredients and their characteristics	(a) is healthy (b) is safe to eat (c) is nutritious (d) Much cheaper than most other plant-based products.	0.87
Risk perception towards grass as food	(a) It may pose serious issues to human health, (b) It may cause allergic reactions in humans, and (c) It can introduce chemical residues into the food supply chain.	0.75
Meat attachment (MEA) scale	(a) I love meals with meat, (b) To eat meat is one of the pleasures in life, (c) To eat meat is disrespectful towards life and the environment (R), (d) A good steak is without comparison, (e) To eat meat is an unquestionable right of every person, (f) Meat reminds me of diseases (R), (g) According to our position in the food chain, we have the right to eat meat, (h) By eating meat I'm reminded of the death and suffering of animals, (i) I don't picture myself without eating meat regularly, (j) If I couldn't eat meat, I would feel weak, (k) I would feel fine with a meatless diet (R), (l) If I was forced to stop eating meat, I would feel sad, (m) Meat is irreplaceable in my diet.	0.90

Table A1. *Cont.*

Subscale	Items Measured Using a 5-Point Likert Scale	Cronbach's Alpha
Food neophobia scale	(a) I am constantly sampling new and different foods (R), (b) I do not trust new foods, (c) I like foods from different countries (R), (d) If I do not know what is in a food, I will not eat it, (e) At dinner parties I will try a new food (R), (f) Some foods look too weird to eat, (g) I am afraid to eat things I have never had before, (h) I am very particular about the foods I eat, (i) I will eat almost anything (R), (j) I like to try new foods from all over the world (R)	0.82
Attitudes towards grass as an ingredient	(a) I can see that some companies might be considering using grass as a food ingredient, (b) Humans cannot digest grass, (c) It is quite a smart concept, (d) If it is good enough for a cow, it must be good enough for humans, (e) It would not be much different to eating spinach or lettuce, (g) Eating grass is for cows and sheep, why even bother trying to make human food from it.	0.70
Social norms with regards to grass consumption	(a) It would help solve environmental issues, (b) I feel a personal obligation to contribute to the environment and sustainability matters, (c) The opinions of people who I value expect that I contribute towards sustainable environmental issues, (d) My friends and family would approve of me making such choices.	0.81

Notes: All statements are measured on a 5-point Likert scale.

Table A2. Kruskal–Wallis one-way analyses of variance for the independent variables among the groups.

Independent Variable Factors	Group	N	Rank	Meat Consumers	Meat Avoiders	Meat Reducers
					p-values	
Food neophobia scale	Meat consumers	640	496.66	-	0.016	0.001
	Meat avoiders	151	424.83	0.016	-	0.106
	Meat reducers	199	545.40	0.001	0.106	-
Kruskal–Wallis H χ^2 (2, N = 990) = 15.336, $p < 0.001$						
Meat attachment (MEA) scale	Meat consumers	640	396.93	-	0.001	0.001
	Meat avoiders	151	693.37	0.001	-	0.315
	Meat reducers	199	662.36	0.001	0.315	-
Kruskal–Wallis H χ^2 (2, N = 990) = 216.424, $p < 0.001$						
Convenience food preparation	Meat consumers	640	490.24	-	0.507	0.066
	Meat avoiders	151	473.33	0.507	-	0.088
	Meat reducers	199	529.24	0.066	0.088	-
Kruskal–Wallis H χ^2 (2, N = 990) = 4.007, $p < 0.135$						
Environmental factors	Meat consumers	640	551.28	-	0.001	0.001
	Meat avoiders	151	395.04	0.001	-	0.928
	Meat reducers	199	392.35	0.001	0.928	-

Table A2. *Cont.*

Independent Variable Factors	Group	N	Rank	Meat Consumers	Meat Avoiders	Meat Reducers
Kruskal–Wallis H χ^2 (2, N = 990) = 74.555, p < < 0.001						
Expectations and perceptions of grass-derived ingredients and their characteristics	Meat consumers	640	556.81	-	0.001	0.258
	Meat avoiders	151	363.71	0.001	-	0.001
	Meat reducers	199	398.33	0.258	0.001	-
Kruskal–Wallis H χ^2 (2, N = 990) = 86.013, p < < 0.001						
Knowledge	Meat consumers	640	541.64	-	0.312	0.001
	Meat avoiders	151	387.01	0.312	-	0.001
	Meat reducers	199	429.41	0.001	0.001	-
Kruskal–Wallis H χ^2 (2, N = 990) = 68.661, p < 0.001						
Attitudes towards grass as an ingredient	Meat consumers	640	554.03	-	0.39	0.001
	Meat avoiders	151	362.03	0.39	-	0.001
	Meat reducers	199	408.54	0.001	0.001	-
Kruskal–Wallis H χ^2 (2, N = 990) = 78.815, p < 0.001						
Social norms with regards to grass consumption	Meat consumers	640	451.63	-	0.001	0.001
	Meat avoiders	151	582.70	0.001	-	0.689
	Meat reducers	199	570.44	0.001	0.689	-
Kruskal–Wallis H χ^2 (2, N = 990) = 43.456, p < 0.001						
Risk perception towards grass as food	Meat consumers	640	516.56	-	0.357	0.003
	Meat avoiders	151	441.11	0.357	-	0.037
	Meat reducers	199	469.04	0.003	0.037	-
Kruskal–Wallis H χ^2 (2, N = 990) = 11.002, p < 0.001						

Notes: Items highlighted in bold indicate significant values for the pairwise Kruskal–Wallis test with the significance values adjusted by the Bonferroni correction for multiple tests.

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