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Consumer Acceptance of Grass Ingredients in Human Diets

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ABSTRACT

Grass has the potential to play a pivotal role in shaping sustainable diets as novel food technologies are exploring its use in human diets. By embracing unconventional yet nutritious sources like grass, we can mitigate the environmental impact of traditional agriculture while promoting healthy diets and supplying adequate nutrition. This research aims to explore the acceptance of grass in human diets through a quantitative analysis of consumer acceptance. 485 respondents were sampled for the study. The results suggest a positive response to grass-derived ingredients with a 3.58 mean score for their acceptance in human diets. Attitude, safety and preparedness, willingness, and readiness to try foods with grass-derived ingredients were significant factors influencing the acceptance of grass-derived ingredients in human diets. The positive results encourage the exploration of novel food sources to tackle emerging environmental issues and further suggest improving individual attitudes through strategic product design and marketing to encourage open-mindedness which drives consumer acceptance and willingness to include grass-derived ingredients in human diets.

Keywords: Grass, Sustainability, Consumer acceptance, Grass-based proteins, Human diets, Innovation

INTRODUCTION

The need to feed the growing population and the growing environmental concerns has exacerbated the global search for sustainable and alternative food supplies to meet the growing demand (OECD, 2004). As traditional agricultural practices face challenges related to resource depletion, climate change, and land use, researchers and nutritionists are exploring unconventional options to address these issues. One such unconventional but intriguing avenue is the utilization of grass as a food source. Grasslands make up a large portion of agricultural land in the UK, and the sole practice of rearing livestock on them has ignited discussions surrounding the industry's serious environmental impacts, especially the high carbon footprint (Barbour et al., 2022; Willett et al., 2019). Resulting in recommendations in the UK to reduce the consumption of beef, lamb, and dairy products by 20% to mitigate the negative environmental impacts of intensive animal husbandry

during meat production (Committee on Climate Change, 2020; (Gerber et al., 2013; Masson-Delmotte et al., 2021; Poore & Nemecek, 2018; Steinfeld, 2006). Proper utilization of grasslands can alleviate this issue. Additionally, producing food and feed locally from grassland sources has a lower carbon footprint than importing soymeal from outside (Kamp et al., 2019). Consequently, novel approaches to producing "green protein" a meat substitute for human nutrition by utilizing green biomass are also receiving attention.

Traditionally viewed as fodder for livestock, grasses have a long history of interaction with human societies, playing pivotal roles in both agricultural and cultural contexts. In recent years, there has been a growing interest in the potential of grass as a viable and sustainable component of human diets (HAU, 2022; University of Bath, 2022). In the field of novel food technologies, ryegrass especially perennial ryegrass is getting increasingly popular (Kaur et al., 2021; Ravindran et al., 2021). Although a member of the cereal crop family, the high fiber and phytochemical content in ryegrass limit how much of it can be directly consumed by humans (Lima et al., 2023). The ability to extract edible fractions from grass is a novel concept and is under development to gain consumer acceptance (HAU, 2022; University of Bath, 2022). Investigation of grass extracts, such as grass proteins from grass, is currently underway (Cervera, 2023; Southey, 2019). A recent study found that the protein extracts from perennial ryegrass had a balanced amino acid profile that was adequate to meet the FAO's requirements for essential amino acids (FAO, 2013; Pérez-Vila et al., 2024). In an experimental study, sprouted ryegrass flour in breakfast cereals of up to 8% can enhance the functionality of the food in terms of nutritional value and bioactive content (Lima et al., 2023). This finding suggests promising results using ryegrass in human diets. Subsequently, the use of grass-derived ingredients and their success will heavily rely on consumer acceptance of the ingredients in human diets as has been in the case of plant-based proteins whose success is heavily dependent on consumer acceptance (Lang & Lemmerer, 2019).

Based on evidence from other attempts to introduce novel foods and food technologies such as eating insects and alternative proteins from plants (Hartmann & Siegrist 2017; Lang & Lemmerer, 2019; Spencer et al., 2018; Hassoun et al., 2022), there is an indication that grass for human consumption may struggle to elicit positive reactions suggesting understanding consumer acceptance to aid the education and marketing tactic of these grass derived ingredients. Consequently, this paper aims to delve into the multifaceted aspects of grass as a food source, examining not only its historical and cultural significance but also its acceptance in human diets and influencing factors to better understand and measure consumers' acceptance of this novel technology. The paper navigates using both literature and quantitative methods of the acceptance of grass in human diets.

HISTORICAL AND NUTRITIONAL SIGNIFICANCE OF GRASS AS FOOD

Grasses have played integral roles in human societies throughout history, extending beyond their conventional use as fodder for livestock (Glémin &

Bataillon, 2009). Culturally, various civilizations have incorporated grasses into their diets, either directly or indirectly. For example, ancient grains like teff and millet have been staple foods in African and Asian cultures, highlighting the historical acceptance of grasses as a source of sustenance (Glémin & Bataillon, 2009). Understanding the nutritional content of grass is fundamental to evaluating its potential as a human food source. Different species of grass offer varying profiles of vitamins, minerals, and dietary fibers. While grasses are generally lower in calories compared to traditional grains, they may present unique nutritional benefits, including high fiber content and the presence of essential micronutrients (Lima et al., 2023).

ENVIRONMENTAL IMPACT OF GRASS CULTIVATION AND OPPORTUNITIES

Grass cultivation exhibits promising environmental characteristics, presenting an alternative to resource-intensive crops. Grasses often require less water, pesticides, and fertilizers, contributing to a reduced ecological footprint (Jørgensen & Lærke 2016). Additionally, certain grass species demonstrate resilience in diverse climates, potentially offering a sustainable solution for regions facing agricultural challenges (Jørgensen & Lærke 2016). While the exploration of grass as a food source presents exciting possibilities, it is crucial to address associated challenges (Lima et al., 2023). These may include taste acceptance, the need for agronomic research to optimize grass cultivation, and potential ecological implications. However, these challenges also represent opportunities for innovation, research, and collaboration to overcome barriers to widespread adoption. This study thus lays the groundwork for a paradigm shift in how we perceive and integrate unconventional food sources into our daily lives.

CONSUMER ACCEPTANCE OF NOVEL FOODS

Novel food technologies are critical to food sustainability, safety, and security. However, consumers often hesitate to accept them. Consumer acceptance of novel foods and technologies is a complex process (Rombach et al., 2022) that comprises an interplay of sensory experiences, cultural influences (Simões-Wüst et al., 2017), perceived benefits, trust in food safety, socioeconomic factors (Dean et al., 2022), marketing efforts, and societal norms (Siegrist & Hartmann 2020; Simões-Wüst et al., 2017). Understanding these factors and addressing consumer concerns through targeted strategies are essential for successfully introducing and mainstreaming novel foods in the market. Moreover, there is a need to account for these factors especially during the early stage of development and introduction to encourage higher acceptance of such foods (Siegrist & Hartmann, 2020).

METHODOLOGY

Data was collected in the UK in August 2023 through an online survey. This was done after approval from Harper Adams University Ethics Committee (0408-202305-STAFF). Two online access panels (Cint and TGM) were used

to recruit participants from the region and were responsible for recruitment compensation to the participants. An age limit of 18 years was set for participation with the participant's consent being requested before participation. 485 responses were used for the data analysis of the study.

Socio-demographic information collected included gender, age, education level and monthly average household income. Consumer allergies were also measured. The acceptance of grass-based ingredients was measured using 4 items using a 5-point Likert scale ranging from 1= strongly disagree to 5=strongly agree using the following statements: 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. Consumers were also asked to state their readiness, preparedness and acceptance using three statements Both Mean scores analysis and descriptive statistics were used to characterize the participants and offer detailed insights into their characteristics and behaviours.

RESULTS AND DISCUSSION

The socio-demographic characteristics of the groups are shown in Table 1 below. The descriptive statistics show that the majority of participants were male (54%), with the largest proportion of the population aged 65+ (32.4%). The majority of the population earned between £1,001-2,000: 25.2% with an income mean of 3.33. The mean education level of 2.94 suggests a moderate level of education on average. Indicating that the participants had diverse educational backgrounds, with a significant proportion having completed secondary or higher education. A relatively small percentage of participants (15.7%) reported having allergies, indicating that most of the surveyed population do not have allergic conditions.

Table 1. Descriptive statistics of the participants.

	Frequency	Percentage	*Mean	**Std. Deviation
Male	262	54		
Female	223	46		
Age groups			5.12	1.73
(1) 18–24	49	10.1		
(2) 25–34	60	12.4		
(3) 35–44	67	13.8		
(4) 45–54	75	15.5		
(5) 55–64	77	15.9		
(6) 65+	157	32.4		
Income groups (£)			3.33	1.72
(1) 1-1,000	71	14.6		
(2) 1,001-2,000	122	25.2		
(3) 2,001-3,000	101	20.8		
(4) 3,001-4,000	52	10.7		

(Continued)

Table 1. Continued

	Frequency	Percentage	*Mean	**Std. Deviation
(5) 4,001-5,000	44	9.1		
(6) 5,000+	95	19.6		
Education groups			2.94	0.88
(1) Primary	6	1.2		
(2) Secondary	183	37.7		
(3) Further Education	128	26.4		
(4) Higher Education	168	34.6		
Allergies				
Yes	76	15.7		
No	409	84.3		

Notes: *Mean scores values represent the categorical value of the representative group with 7, 6 and 4 groups for age, income and education respectively.

The results analyzing the consumer's readiness, preparedness and acceptance of grass-based foods are presented in Table 2. Despite grass-based ingredients being a new concept, the results indicate a positive response towards this novel technology with the mean score for readiness (M = 3.720) being the highest and that of acceptance (M = 3.530) being moderate. The high standard deviation on the acceptance to consume and include grass-derived ingredients in their foods suggests a variability among the response. The high median score for the variable readiness to include grass-derived ingredients suggest confirms the high standard deviation an indication that a majority of the population were ready to include grass-derived ingredients in their foods.

Table 2. Consumer acceptance/readiness and preparedness to consume grass-based ingredients.

	Mean	Std. Deviation	Median
I would be prepared to consume foods with grass-derived ingredients	3.640	0.851	3
I am ready to include foods with grass-derived ingredients in my diet	3.720	0.947	4
I will accept foods with grass-derived ingredients	3.530	1.009	3

To determine the acceptance of grass-based foods, four variables were used to measure this factor as shown in Table 3. The results of the consumer acceptance of grass-based foods show that the population surveyed was willing to consume grass-based foods. The mean score (3.59) suggests a moderate level of willingness among the participants. The standard deviation of (1.107) indicates some variability in responses, with a spread around the mean indicating that the responses were varied. For the participant's willingness to purchase new foods, the mean score (3.70) indicates a slightly higher willingness to buy compared to trying alone. The standard deviation (1.081) suggests variability in individual attitudes toward purchasing such products. The variable

reflecting the participants' willingness to pay a premium for foods containing grass-based ingredients had a high mean score (4.18) suggesting a generally strong willingness to invest more money in these products. The relatively low standard deviation (0.999) indicates that there is less variability in responses compared to the other variables. These variables measure participants' willingness to encourage others to consume or serve foods containing grass-based ingredients. The mean score of 4.02 indicates a positive attitude towards promoting such foods to others. The standard deviation (1.002) suggests some variability in the extent to which participants are willing to actively advocate for these products.

Table 3. Consumer acceptance of grass-based foods.

Variable	Mean	Std. Deviation
Eat/try foods containing grass-based ingredients	3.590	1.107
Buy foods containing grass-based ingredients	3.699	1.081
Pay more for foods that contain grass-based ingredients	4.177	0.999
Encourage others/serve food that contains grass-based ingredients	4.021	1.002

Notes: N = 485

As shown in Table 3, several variables influence the acceptance of grass-based ingredients in human diets. Socio-demographic factors and the characteristics of grass-based ingredients did not influence in the acceptance of grass-based ingredients, contrary to previous studies that have found that gender and age influence the acceptance of new foods (Wilks & Phillips, 2017; Verbeke, 2015). Preparedness to try grass-derived food ingredients ($p = 0.001$), readiness to try grass-derived food ingredients ($p = 0.001$), Willingness to try grass-derived food ingredients ($p = 0.001$) safety of the grass-based ingredients ($p = 0.042$) and attitudes (Eating grass is for cows and sheep, why even bother trying to make human food from it ($p = 0.012$), If it is good enough for a cow, it must be good enough for humans ($p = 0.010$), It would not be much different to eating spinach or lettuce ($p = 0.005$), Humans cannot digest grass ($p = 0.048$)) explained 71.6% of the variance in willingness to try grass-derived ingredients among meat avoiders ($F(16, 484) = 72.388$, $p < 0.001$, adj $R^2 = 0.716$).

Table 4. Regression analysis to predict acceptance of grass-based ingredients in diets.

		Std Error	t	Sig.
Socio-demographic Factors	Gender	0.052	0.196	0.845
	Age	0.018	−0.095	0.924
	Income	0.018	0.605	0.545
	Education	0.029	0.257	0.798

(Continued)

Table 4. Continued

		Std Error	t	Sig.
Preparedness	Preparedness to include grass-based ingredients	0.046	8.815	0.001
Readiness	Readiness to include grass-based ingredients	0.042	8.228	0.001
Willingness	Willingness to eat/try foods containing grass-based ingredients	0.033	4.163	0.001
Attitudes	Humans cannot digest grass	0.032	1.984	0.048
	If it is good enough for a cow, it must be good enough for humans	0.033	2.597	0.010
	It would not be much different to eating spinach or lettuce	0.03	2.796	0.005
	Eating grass is for cows and sheep, why even bother trying to make human food from it	0.03	−2.522	0.012
	It will improve the economic value/reduce food prices	0.032	1.596	0.111
Characteristics of grass-based ingredients	It is sustainable	0.033	−1.719	0.086
	Healthy	0.041	−1.138	0.256
	Safe to eat	0.046	−2.044	0.042
	Nutritious	0.041	−0.671	0.502

An individual's preparedness to include grass-based ingredients in their diets influences their acceptance of grass-based ingredients and suggests a positive inclination towards accepting such foods. This variable was a strong predictor indicating that individuals with higher preparedness are most likely to act towards incorporating these ingredients into their diets. Similarly, to preparedness, readiness was a robust predictor, indicating a high likelihood of acceptance and consumption of grass-based ingredients. readiness reflects an individual's inclination to include grass-based ingredients in their diets and may encompass factors such as familiarity with these ingredients, perceived benefits, or openness to trying new foods. The willingness to eat/try foods containing grass-based ingredients was also a strong predictor variable indicating that individuals who express a willingness to eat or try these foods are likely to accept and incorporate grass-based ingredients into their diets.

Attitude was measured using five statements of which four were significant predictors an indication that individuals' attitudes greatly impact the acceptance of new food ingredients. (i) Humans cannot digest grass: Despite being significant, the relationship between the significant variable of human inability to digest grass and the acceptance of ingredients derived from it may be more nuanced. Some people may find it difficult to accept the idea that grass is indigestible, especially if they have stomach problems or other health concerns. This misconception, meanwhile, might be invalidated with information or assurances regarding the safety and digestibility of processed ingredients derived from grass. (ii) If it is good enough for a cow, it must be good enough for humans: This variable represents the notion that food consumable by cows may be suitable for humans. This idea may have a positive

impact on the acceptance of grass-based ingredients in human diets by associating ingredients derived from grass with natural and wholesome attributes. An implication is that an individual with this attitude might be more receptive to including ingredients derived from grass in their diets as opposed to one who does not hold such beliefs. (iv) It would not be much different from eating spinach or lettuce: This variable measures people's perceived foods with grass ingredients as foods made from other plant-based foods like lettuce or spinach. An association between these well-known foods may prompt acceptance and positive responses towards grass-based ingredients or foods as they see them as acceptable and safe choices. (v) Eating grass is for cows and sheep, so why even bother trying to make human food from it: This variable explores the idea that grass is mainly meant for animal feed and raises doubts about the necessity or viability of using it in human diets. People who think this way might be less open to using ingredients made from grass because they think it goes against social or cultural norms. However, dispelling myths and emphasizing the environmental impacts of grass-based ingredients may help improve attitudes around this issue.

Safety concerns were also predictive indicators of the acceptance of grass-derived ingredients. However, the negative beta coefficient indicates that individuals who were mostly concerned with the safety of grass-based ingredients were less likely to accept these foods. An indication that safety assurances of these ingredients were critical to the acceptance of grass-derived ingredients. Suggesting that information on the safety measures put in place for this technology needs to be presented to consumers to promote acceptance of the novel foods.

In general, the participants were open to accepting grass-based ingredients foods in their diets. However, the study recommends investigation and further research, especially considering the potential influences of different variables (such as the socio-demographic variables) on consumer acceptance of novel foods which were not significant predictors. Further, for a more comprehensive perspective, these results could also be contrasted with outside standards or earlier research in the area of novel foods.

CONCLUSION

Overall, the participants demonstrated a moderate to high level of acceptance across all four dependent variables, suggesting a positive attitude toward grass-based ingredients. The variability in responses, as indicated by the standard deviations, suggests that there are diverse attitudes within the participant group. These findings provide valuable insights into consumer perceptions and attitudes towards grass-based ingredient products, which can be useful for businesses and marketers in shaping their strategies. Further, the use of grass as a food source contributes to the broader conversation on sustainable diets. Integrating grass into human nutrition has the potential to address health and environmental concerns, provided that challenges are met with innovative solutions. This study thus lays the groundwork for a paradigm shift in how we perceive and integrate unconventional food sources into our daily lives.

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