Impact of front-of-pack labels with nutrition and Grass-Fed claims on consumer perceptions and expected sensory and nutritional characteristics of Cheddar cheese – A comparative study of Irish and US consumers

Food Quality and Preference

McGuinness, Lauren; McCabe, Mairead; Kiernan, Celine; McCrickerd, Keri; Forde, Ciaran G. et al

https://doi.org/10.1016/j.foodqual.2022.104649

Food Quality and Preference 101 (2022) 104649

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

Impact of front-of-pack labels with nutrition and Grass-Fed claims on consumer perceptions and expected sensory and nutritional characteristics of Cheddar cheese – A comparative study of Irish and US consumers

Lauren McGuinness [a], Mairead McCabe [a], Celine Kiernan [a], Keri McCrickerd [b], Ciaran G. Forde [c], E. Dolores O'Riordan [a], Emma L. Feeney [a,*]

[a] Food for Health Ireland (FHI), University College Dublin, Belfield, Dublin 4, Ireland
[b] Singapore Institute for Clinical Sciences (SICS), A*STAR Research Entities and National University Health System, Singapore 117609, Singapore
[c] Sensory Science and Eating Behavior Group, Division of Human Nutrition and Heath, Wageningen University and Research, the Netherlands

ARTICLE INFO

Keywords:
Grass-Fed
Front-of-pack labels
Nutrition
Cheese
Labelling

ABSTRACT

Consumer interest in Grass-Fed dairy products is increasing with some consumer groups willing to pay a premium for dairy labelled as Grass-Fed. The aim of this study was to examine the effect of the term Grass-Fed on a label in combination with claims on fat content, on consumer perceptions of Cheddar cheese in Irish and US participants. Consumers from Ireland (n = 345) and the United States (n = 432) completed an anonymous online survey and were presented with one of two sets of cheese label images, either Regular-Fat and Regular-Fat-Grass-Fed or Lighter-Fat and Lighter-Fat-Grass-Fed. Participants were asked to rate expected sensory characteristics and perceived healthiness and naturalness, based on each label. Participants then selected a portion of each cheese that they would be likely to consume on a slice of toast for lunch, from 100 portion size images ranging from 1.2 g to 120 g. Inclusion of a Grass-Fed claim on a cheese label did not influence sensory expectations of cheese, but perceived healthiness and naturalness were higher, in both cohorts. The Lighter-Fat claim had a negative influence on sensory expectations, with consumers in both cohorts reporting a lower expected liking and flavour intensity. In the Irish cohort, a Lighter-Fat claim enhanced perceived healthiness. The front-of-pack claim had no impact on portion selection in US consumers. Irish consumers, however, chose a larger portion for the Lighter-Fat cheese compared to the Regular-Fat-Grass-Fed cheese. Inclusion of Grass-Fed on the label alongside information on Regular-Fat or Lighter-Fat may enhance consumers' perceptions of healthiness and naturalness, without compromising sensory expectations. Products with Lighter labels may be chosen in larger portions, with potential implications for consumers who choose them as part of a weight-control strategy.

1. Introduction

There is increasing consumer demand for pasture-fed dairy products, due to the perception that they are healthier, more natural and have added value (Cheng et al., 2020). Consumers also consider pasture feeding as more environmentally and animal welfare friendly (Moscovici Joubran et al., 2021). Bord Bia has conducted extensive research with consumers on the perception and understanding of Grass-Fed. As well as being considered more natural, Grass-Fed is perceived as more nutritious and more sustainable – all of which are key consumer trends (McCarthy, 2020). Alongside consumer demand, and the cost effectiveness of pasture-feeding, dairy manufacturers are keen to understand if the inclusion of a Grass-Fed claim on a front-of-pack (FoP) label will affect consumer expectations of dairy products, and if this perception differs based on the consumers' geographical location.

Pasture feeding is typical of temperate climates e.g., Ireland and New Zealand, while indoor feeding systems using a total mixed ration (TMR) diet (ie. forage, grains, protein feeds, minerals, vitamins, feed additives, and by-products) is more common in other climates including the United States (Alothman et al., 2019). Milk derived from a Grass-Fed diet has a higher fat and protein content with improved nutrient content (higher concentrations of vaccenic acid, CLA, ß-carotene, and α-linolenic acid)

* Corresponding author.
E-mail addresses: lauren.mc-guinness@ucdconnect.ie (L. McGuinness), mairead.mccabe@ucdconnect.ie (M. McCabe), celine.kiernan@ucdconnect.ie (C. Kiernan), ciaran.forde@wur.nl (C.G. Forde), dolores.oriordan@ucd.ie (E. Dolores O'Riordan), emma.feeney@ucd.ie (E.L. Feeney).

https://doi.org/10.1016/j.foodqual.2022.104649
Received 22 January 2022; Received in revised form 3 May 2022; Accepted 29 May 2022
Available online 2 June 2022

than TMR derived milk (Martin *et al.*, 2004; Alothman et al., 2019). Differences in feed type lead to differences in milk composition which influences the sensory properties of milk and dairy products (Bendall, 2001; Elgersma et al., 2004; Couvreur et al., 2006; Benbrook et al., 2013; Alothman et al., 2019). Croissant et al. (2007) found that pasture-based milk had higher intensities of grassy and cowy/barny flavours compared with TMR derived milk. There was also distinct flavour and compositional differences between TMR and pasture-fed milks, but the differences were such that they did not affect consumer acceptance (Croissant et al., 2007). The β-Carotene content of milks derived from grass or grass/clover diets was reported as higher than that of TMR diets and appeared to have directly influenced colour perception (Faulkner et al., 2018). P-cresol concentration was also higher in milk from grass and grass/clover diets than TMR diets and appears to be responsible for the barnyard aroma of milk (Faulkner et al., 2018). Irish sensory assessors preferred pasteurized milk produced from grass-fed cows, with least preference from milk produced from total mixed ration diets (Faulkner et al., 2018).

There is also evidence that consumers differ in their perceptions of Grass-Fed dairy products depending on the feed type common in their geographical region. Cheng et al. (2020), conducted a study in Ireland, China and the US on skim milk powder (SMP) produced from different feed types and found that sensory perception and volatile profiles of SMP were influenced by diet and that sensory differences existed between cohorts based on their familiarity with dairy products. Garvey et al. (2020) found cross-cultural preferences and sensory differences for butters produced from different feed types among US, German and Irish consumers and concluded that these differences are likely influenced by familiarity. Drake et al. (2005), found that when evaluated by trained panels, Cheddar cheeses from Ireland, New Zealand and the US displayed distinctive flavours characteristic of each country of origin.

Consumers want evidence that the food they consume is produced in a 'sustainable' manner (McCarthy, 2020). To provide verifiable proof of grass-based production systems in Ireland, Bord Bia has introduced a Grass-Fed standard, whereby an individual herd must be fed a minimum of 90% grass or grass forage on a fresh weight basis, cows must spend an average of 240 days per year at pasture and milk pooled for processing from these farms must achieve a minimum Grass-Fed figure of 95% (Bord-Bia, 2021). A similar strategy is used in the US with dairy products labelled as pasture-fed or pasture-raised, however, according to the US Department of Agriculture (2000), organic dairy farming standards only require cows to spend a minimum of 120 days per year at pasture. An investigation of the drivers of choice for milk compared to plant-based alternatives in the US showed that Grass-Fed milk with a lower carbon footprint than conventional milk was more appealing to those who only consume non-dairy alternatives, but only if the flavour was also appealing (McCarthy et al., 2017). Peira et al. (2020) found that consumers in Italy were willing to pay more for Grass-Fed milk than conventional milk. They concluded that Grass-Fed milk is a higher value product meeting the need for more sustainable production than conventional milk (Peira et al., 2020). Harwood and Drake (2020) identified consumer segments in the US with preferences for nonconventional milk types and found that these groups were primarily motivated by the belief that organic, local, or pasture-raised milks were superior in sensory quality. A review on consumer perceptions, preferences, and behaviour regarding pasture-raised livestock products found that a variety of consumer groups are willing to pay a premium for a pasture-raised attribute, even on top of an organic price premium (Stampa et al., 2020). Although consumer perceptions of fluid milk with Grass-Fed has been well studied (McCarthy et al., 2017; Peira et al., 2020; Harwood and Drake, 2020; Stampa et al., 2020), there is a lack of published work on the effect of a FoP Grass-Fed claim on consumers perceptions of Cheddar cheese.

Recent evidence suggests dairy products do not adversely affect the risk of cardiovascular disease (CVD) (Soedamah-Muthu et al., 2011; Fontecha et al., 2019; Chen et al., 2021) and that consumption may lower risk of mortality, CVD and stroke (Qin et al., 2015; Dehghan et al., 2018). However, some consumers have negative health perceptions of milk fat (Vargas-Bello-Pérez et al., 2020) or concerns regarding weight control, and as a result, nutrition claims such as lighter and fat free are frequently displayed on the FoP labels of dairy products. A cross-cultural study across Denmark, Norway, and California (Johansen et al. (2011), observed that perceptions of low in fat, healthier, and good taste were the most important motives for purchasing calorie-reduced yoghurt and cheese, in all three countries. This indicates that fat reduced, and calorie reduced dairy products are perceived as being healthier by consumers. Therefore, including Lighter-Fat on a FoP label could be beneficial, as a Reduced Fat product is a positive factor in driving purchase decisions (Johansen et al., 2011). Although there has been work published in relation to consumers' perceptions of Lighter-Fat claims in dairy products, no studies have investigated the combination of a Lighter-Fat with a Grass-Fed claim on a FoP label.

It is important for dairy manufacturers to consider how consumer perceptions generated by FoP claims might impact subsequent portion selections and intake. McCann et al. (2013), found that in a laboratory setting, a low fat/energy claim on a lunch meal significantly increased the food and energy consumed when compared to a baseline and or high fat/energy claim. This suggests that including a low fat or low-calorie claim may license consumers to select and consume larger food portions. In a systematic review, Brown et al. (2018) found that nutrition and health information on food labels has varying effects on portion size consumption. Some labels have a positive effect (decreased consumption of energy-dense, nutrient-poor foods or increased consumption of nutrient-dense foods), some had a negative effect (increased consumption of energy-dense, nutrient-poor foods), and some had no effect and due to these mixed results, portion size consumption is not determined by energy density alone. McCrickerd et al. (2020) found that FoP health and nutrient labels can bias consumer judgements, but portion selection may be based more on the sensory experience of eating, suggesting that a product's sensory attributes could be more influential at shaping portion decisions than labelled health messages. Therefore, if a Grass-Fed claim affected sensory expectations, it follows that portion size could also be affected.

This study aimed to examine the impact of Lighter-Fat, and/or Grass-Fed claim on (1) the expected characteristics of Cheddar cheese (2) the hypothetical portion size selected for Cheddar cheese based on validated methods and (3) to determine if these expected characteristics and portion selection of Lighter-Fat and Grass-Fed claims differ between Irish and US consumers.

2. Methods

2.1. Ethics statement and consent

This anonymous online survey was approved as a Low-Risk study by the UCD HREC, reference number LS-E-20–43-McGuinness-Feeney. All participants gave informed consent at the beginning of the survey for their data to be used and analysed. Anyone who did not consent to participate in the survey was brought to an end page and did not complete the survey.

2.2. Participant recruitment

Irish and US participants were recruited online through an anonymous survey link via email and social media. 124 US participants and 112 Irish participants were recruited using a Qualtrics' recruitment panel. Inclusion criteria included being a cheese eater, a resident of the island of Ireland or the US and aged 18 years or older.

A total of 345 Irish participants (n = 123 male, n = 222 female, and 2 preferred not to say) and 432 US participants (n = 162 male, n = 260 female, and 10 preferred not to say) completed the online survey.

2.3. Online survey

The online survey was conducted using the Qualtrics survey platform (Seattle, USA) which is a web-based software that allows users to build, distribute and analyse surveys.

2.4. Survey overview

2.4.1. General questionnaire procedure

The questionnaire was split into 10 blocks. The first block was an introduction to the survey and asked participants to provide consent. The second block asked participants if they eat cheese. If participants answered no in block 1 or 2, the survey was ended. Blocks 3, 4 and 5 made up demographic questions, eating behaviour questions and a shortened version of the Three Factor Eating Questionnaire (all described below). Blocks 6, 7, 8 and 9 presented a cheese label Regular-Fat (RF), Lighter-Fat (LF), Regular-Fat-Grass-Fed (RFGF), and Lighter-Fat-Grass-Fed (LFGF) (see section 2.5 for label development) with accompanied questions about these labels. These blocks were randomised by sex with participants seeing either the RF and RFGF label (blocks 6 and 8) or the LF and LFGF label (blocks 7 and 9). The final block was optional and involved questions about height and weight.

The online survey took an average of 12 min and 12 s to complete.

2.4.2. Demographic questions

Demographic questions included: sex, age, county or state of residence, education, exercise, interest in health and wellbeing (100-point Visual Analogue Scale (VAS)), cheese consumption and purchase decisions.

2.4.3. Dietary restraint using TFEQ R-18

Questions comprising the cognitive restraint section of the TFEQ R-18 (Karlsson et al., 2000) which is a shortened version of the three factor eating questionnaire of Stunkard and Messick (1985) were used in this survey to probe the level of restraint of our participants.

2.4.4. Presentation of labels

Participants were presented with two of the four cheese labels. Participants were randomly assigned either the RF and RFGF label or the LF and LFGF label. These labels were distributed among sexes (Irish: 65.7% female for Regular-Fat labels, 63.8% for Lighter-Fat labels, US: 62% female for Regular-Fat labels, 61.2% female for Lighter-Fat labels).

2.4.5. Expected characteristics and portion selection

Participants rated their expected liking of taste/flavour, expected flavour intensity, and expected aftertaste using a 100-point VAS. They were also asked to rate their perceived healthiness and naturalness of the cheese based on the label, also using a 100-point VAS.

To assess portion selection, participants were shown a picture of the labels again along with a slice of toast and were asked to choose a portion of cheese they would eat on the slice of toast for lunch. Details of the portion images and calorie ranges are reported in section 2.6.

Ratings were made individually for either the RF and RFGF or the LF and LFGF labels, depending on the group participants were assigned too. Participants were randomly assigned to the RF labels or the LF labels.

2.4.6. Height and weight

At the end of the questionnaire, participants were given the option to provide their height (in feet and inches or metres) and weight (in stones and pounds or in kilograms). BMI was calculated for participants who self-reported their weight and height.

2.5. Front-of-Pack (FoP) labels

The FoP labels were developed using a cheese product packaging image obtained from istock.ie and were designed on Office PowerPoint (Redmond, Washington, USA). Four cheese packaging labels were developed in a 2 × 2 design as shown in Fig. 1, one with a Regular-Fat claim (RF), one with a nutritional claim, Lighter (LF), one with a Regular-Fat and a Grass-Fed claim (RFGF) and one with a nutritional and a Grass-Fed claim (LFGF). The Regular-Fat cheeses were presented as being Full Fat on the labels. The Lighter-Fat labels included a lighter claim, and that they contained 33% less fat. (Under EU regulations, reduced fat and light claims follow the same conditions i.e., 33% less fat in this case). A darker blue was used for the Regular-Fat cheese packaging and pale blue was used for the Lighter-Fat cheese packaging as pale packaging is often used to portray a Reduced Fat product (Mai et al., 2016).

2.6. Portion size images

100 portion size images of cheese ranging from 1.2 g to 120 g were taken using an Olympus E-PL9 camera (Olympus Corporation, Tokyo) held by a tripod (Amazon, UK) in a Heorryn 16 × 16 × 16 in. LED Lightbox to ensure uniform colour and lighting in all pictures. The camera was controlled using the mobile phone application Olympus Image Share to ensure there was no movement of the camera during shooting. An overview of the images presented is shown in Table 1.

2.7. Data analysis

A series of independent t-tests were used to compare participant characteristics between males and females and Irish and US participants. Three-way Analysis of Variance (AVOVA) was used to compare expected sensory characteristics (liking, aftertaste, and flavour intensity), healthiness and naturalness perceptions and portion selection. ANOVA was conducted with the following independent variables: Fat label (Regular vs Lighter-Fat, measured between groups), Grass-Fed label (no Grass-Fed claim vs Grass-Fed, repeated measures) and location (Irish vs US, between groups).

A General Linear Model was used to assess the effect of FoP claim (within-subjects) and location (between-subjects) on the outcomes of interest: expected sensory characteristics, healthiness and natural

Fig. 1. Four cheese labels presented to the participants: Regular-Fat (RF), Regular-Fat-Grass-Fed (RFGF), Lighter-Fat (LF) and Lighter-Fat-Grass-Fed (LFGF).

Table 1
Grammes, and kilocalorie (Kcal) content of the cheese portions associated with a photo number.

Photo Number	Weight (g)	Energy content (kcal) (Regular-Fat)	Kcal content (Lighter-Fat)
1	1.2	5	3.6
25	30	125	90
50	60	250	180
75	90	375	270
100	120	500	360

perceptions and portion selection. There was a positive Pearson correlation between tendency to buy reduced calorie foods and tendency to pay attention to nutrition labels, r (3106) = 0.565, $p < 0.001$ and therefore tendency to buy reduced calorie foods was removed from the final statistical model. Interest in health and well-being, tendency to pay attention to nutrition labels and gender influenced the main outcomes and were included in the final statistical models. Exercise, cheese consumption, eating restraint and BMI had no influence on main outcomes and were not included in the final statistical model. All analyses were performed in SPSS version 24 for Windows (SPSS Inc., Chicago, IL) and the alpha level was set at $p < 0.05$.

3. Results

3.1. Participant characteristics

In the Irish cohort, there was no significant difference between male and females for BMI, dietary restraint, amount of exercise per week, interest in health and wellbeing, tendency to pay attention to nutrition labels and tendency to buy reduced calorie foods.

In the US cohort, males and females differed in several characteristics with males having higher scores for dietary restraint, exercise, interest in health and wellbeing, tendency to pay attention to nutrition labels, and tendency to buy reduced calorie foods.

Participant characteristics for both studies are presented in Table 2. US participants had lower interest in health and wellbeing, tendency to pay attention to nutrition labels, and tendency to buy reduced calorie foods than the Irish cohort.

Table 2
Characteristics of Irish and US participants.

	Irish			US			*p*-value
	N	Mean	± S.D	N	Mean	± S.D	
BMI	246	28.6	28.6	328	28.9	13.7	0.868
Dietary restraint	345	43.9	19.5	432	44.2	21.8	0.842
Amount of exercise (times per week)	345	3.4	2.1	432	3.2	2.2	0.199
Interest in health and wellbeing (0–100) [+]	345	80.5	17.7	432	76.0	18.8	0.001*
Tendency to pay attention to nutrition labels (0–100) [++]	345	53.3	29.0	432	43.0	32.1	0.0001*
Tendency to buy reduced calorie foods (0–100) [+++]	345	45.7	30.5	432	33.8	31.2	0.0001*

* Significant differences between male and females.
[+] Where 0 is not at all interested and 100 is extremely interested.
[++] How much participants agreed with the following statement: 'I usually pay attention to nutrition labels when I'm choosing my cheese' Where 0 is strongly disagree and 100 is strongly agree.
[+++] How much the participants agreed with the following statement: 'I usually buy reduced calorie foods' where 0 is strongly disagree and 100 is strongly agree.

As shown in Table 3, the majority of respondents in both cohorts consumed Full Fat or regular cheese and a very small proportion consumed reduced salt cheese with no female participants selecting this category. In the Irish cohort, there was no significant differences between male and females for cheese consumption per week. In the US cohort, females consumed more cheese per week than males. US participants had higher cheese consumption than the Irish cohort.

3.2. Expected sensory characteristics

Results from the ANOVAs for expected sensory characteristics are shown in Table 4.

3.2.1. Expected Liking, Flavour Intensity and Aftertast

3.2.1.1. Expected liking. The linear model showed a significant main effect of LF claim on the expected liking of the cheese (F (1, 1536) = 113.095, p <.001) with participants expecting a lower expected liking from a LF claim. There was also significant main effect of the GF claim (F (1, 1536) = 5.628, p =.18) with participants expecting a higher expected liking from a GF claim. US participants expected to like Lighter-Fat cheese less than Irish participants (p <.05). There was no main effect of country on the expected liking in this model (F (1, 1536) = 1.048, p =.306).

3.2.1.2. Expected flavour intensity. There was a significant main effect of LF claim on the expected Flavour Intensity of the cheese (F (1, 1536) = 123.331, p <.001) with participants expecting a lower expected flavour intensity from a LF claim in both cohorts. US participants expected a lower flavour intensity than Irish participants (p <.05). There was no main effect of the GF claim (F (1, 1536) = 2.732, p =.099) or country on the expected flavour intensity in this model (F (1, 1536) = 0.350, p =.554).

3.2.1.3. Expected aftertaste. There was a significant main effect of LF claim on the expected aftertaste of the cheese (F (1, 1536) = 26.242, p <.001) with participants expecting a lower expected aftertaste from a LF claim. US participants found no difference in expected aftertaste between the cheeses (p >.05). US participants expected a stronger aftertaste for LF cheese than Irish participants (p <.05). There was no main effect of the GF claim (F (1, 1536) = 1.597, p =.207) or country on the expected aftertaste in this model (F (1, 1536) = 2.059, p =.151).

3.3. Perceived healthiness and naturalness

Results from the ANOVAs for healthiness and naturalness

Table 3
Types of Cheddar cheese normally consumed by participants.

	Irish		US	
	Male (%)	Female (%)	Male (%)	Female (%)
Full Fat or regular cheese	74.4	76.1	73.5	94.2
Reduced Fat cheese	22.3	23.4	24.1	5.8
Reduced salt cheese	3.3	0.5	2.5	0

	Irish			**US**			***p*-value**
	N	**Mean**	**± S.D**	**N**	**Mean**	**± S.D**	
Cheese consumption (per week)	345	4.1	1.9	432	5	2.4	0.0001*

* Significant differences between male and females.

Table 4
Mean (±SD) expected sensory characteristics for Irish participants (n = 170 RF and RFGF, n = 175 LF and LFGF) and US participants (n = 217 RF and RFGF, n = 215 LF and LFGF) measured on a 100-point VAS.

	Expected liking					Expected flavour intensity					Expected aftertaste				
	Irish		US			Irish		US			Irish		US		
	Mean	*S.D*	*Mean*	*S.D*	*p*-value	*Mean*	*S.D*	*Mean*	*S.D*	*p*-value	*Mean*	*S.D*	*Mean*	*S.D*	*p*-value
	66.5	24.5	68	23.5	0.544	68.3	21.3	68.1	21.1	0.934	62.3	23.6	58.4	22.5	0.101
	56.4	23.9	47.8	26	0.001*	55.9	24.1	50.9	27.6	0.06	50.5	22.7	55.7	25.5	0.038*
	68.8	20.5	68.9	20.6	0.97	69.1	17.9	68.8	18.4	0.876	62.8	20.2	58.9	22.5	0.072
	60.2	21.3	51.9	23.3	0.0003*	59	21.4	54.5	23.1	0.048*	54.4	21.2	58.1	23.4	0.111

*p-values represent significant differences between Irish and US participants from ANOVA.

perceptions are shown in Table 5.

3.3.1. Perceived healthiness

Results showed a significant main effect of GF claim on the perceived healthiness of the cheese (F (1, 1536) = 25.574, p <.001.) with participants expecting a higher perceived healthiness from a GF claim. For the Irish cohort the LF, LFGF and RFGF cheese were perceived as being healthier than the RF cheese (p <.05). The US cohort found the RFGF cheese had a greater perceived healthiness than the LF and the RF cheese (p <.05). The US participants perceived the LF and LFGF cheeses as less healthy than Irish participants (p >.05) (Table 5). There was no main effect of the LF claim (F (1, 1536) = 2.640, p =.104.) or country on the perceived healthiness in this model (F (1, 1536) = 0.039, p =.843).

3.3.2. Perceived naturalness

There was a significant main effect of LF claim on the perceived naturalness of the cheese (F (1, 1536) = 109.229, p =.000) with participants expecting a lower perceived naturalness from a LF claim. There was also a significant main effect of the GF claim (F (1, 1536) = 41.512, p =.000) with participants expecting a higher perceived naturalness from a GF claim. Overall, the US participants perceived the RFGF cheese as being more natural than Irish participants. There was no main effect of country on the perceived naturalness in this model (F (1, 1536) = 2.283, p =.131).

3.4. Portion selection

Results from the ANOVAs for Portion Selection are shown in Table 6.

A significant main effect was observed for LF claim on the portion selection of the cheese (F (1, 1536) = 10.963, p =.001) with participants choosing a higher portion size from a LF claim. There was also a significant main effect of location (F (1, 1536) = 4.682, p =.031) with US participants selecting a higher portion size than Irish participants. There was no main effect of GF claim on the portion selection in this model (F (1, 1536) = 0.913, p =.339).

4. Discussion

This study aimed to examine Irish and US consumer perceptions, expected sensory characteristics and portion selection of cheese labelled as Regular-Fat or Lighter-Fat, with or without Grass-Fed claims, it also determined if the expectations of Grass-Fed and Lighter-Fat claims differ between Irish and US consumers.

The Grass-Fed claim did not affect the perceived sensory characteristics of the cheese in either cohort. This finding agrees with Garvey et al. (2020), who concluded that different feed systems affected Irish and US consumers perception of butter, they also suggested that familiarity of products from specific feeds systems is a factor, but butter acceptance in terms of overall liking was not impacted. However, this finding differs from that of Harwood and Drake (2020) who found that consumer segments in the US with preferences for nonconventional milk types, were primarily motivated by the belief that pasture-raised milks were superior in sensory quality. US and Irish participants expected a greater liking and flavour intensity for the Regular-Fat cheeses than the Lighter-Fat cheeses. This indicates that including a Lighter-Fat claim on a cheese may reduce the expected liking of the cheese. This finding agrees with Childs and Drake (2009), who found that liking of Cheddar cheese reduces as the fat content reduces. Furthermore, US participants expected a lower liking and flavour intensity from the Lighter-Fat cheese compared to Irish participants. Investigating the texture of Low Fat Iranian cheese, Rahimi et al. (2007) found that the reduction in fat content significantly affected the texture, appearance, flavour, and overall acceptability of Iranian White cheese by a consumer panel. Childs and Drake, (2009) hypothesised that this general dissatisfaction

Table 5
Mean (±SD) perceived healthiness and naturalness for Irish (n = 170 RF and RFGF, n = 175 LF and LFGF) and US participants (n = 217 RF and RFGF, n = 215 LF and LFGF) measured on a 100-point VAS.

	Perceived Healthiness					Perceived Naturalness				
	Irish		US			Irish		US		
	Mean	*S.D*	*Mean*	*S.D*	*p*-value	*Mean*	*S.D*	*Mean*	*S.D*	*p*-value
	44.3	21.4	46.1	21.6	44.3	55.8	24.8	59.7	24.2	0.127
	50.1	19.4	45.5	22.4	50.1	46.4	24.5	41.4	26.0	0.052
	53.4	19.3	51.6	20.2	53.4	63.9	22.7	69.6	21.3	0.013*
	52.9	18.9	48.8	21.4	52.9	53.7	22.6	50.0	26.1	0.141

*p-values represent significant differences between Irish and US participants from ANOVA.

with Lighter-Fat products, particularly in the US, has persisted since the 1990′s, when cheese technology was not as advanced as modern technology and thus consumers had to sacrifice cheese flavour for a low-fat product. An online survey with consumers of pre-packaged Cheddar cheese shreds showed that consumers consistently wanted shreds with full fat and regular sodium content, suggesting that flavour expectations outweigh potential health benefits from reduced fat or sodium cheese (Speight et al., 2019).

The Grass-Fed cheese was perceived as being healthier and more natural in Irish and US cohorts and therefore adding a Grass-Fed claim can increase the perceived healthiness and naturalness of Cheddar cheese without influencing the expected sensory characteristics. US participants perceived the Lighter-Fat products as being less healthy than Regular-Fat products. The view that Lighter-Fat products are more processed and are therefore less healthy may also originate back to poor technology in the 1990′s that meant Lighter-Fat products required a greater number of additives (Childs and Drake, 2009). However, the Lighter-Fat cheese was perceived as being healthier than the Regular-Fat cheese by the Irish cohort. This was in agreement with research by Johansen, Næs *et al.* (2011), who found that consumers in Denmark, Norway, and California perceived Lighter-Fat and calorie-reduced dairy products as being healthier than Regular-Fat products. This may be linked to consumers understanding of saturated fat and its role in the diet as according to consumers have negative health perceptions of milk fat (Vargas-Bello-Pérez et al., 2020).

Participants chose a higher portion for the LF cheese. This finding is in agreement with McCann et al. (2013), who found that including a low fat or low calorie claim may contribute to the consumption of large food portions. However, Roberto et al. (2012) and Brown et al. (2018) found that nutrition and health information on food labels have varying effects on portion size consumption. McCrickerd et al. (2020) observed that sensory characteristics affect portion selection more so than labelled health messages in a laboratory study, the results presented here suggest that while the combined labels of Regular-Fat and Grass-Fed resulted in higher sensory expectations, the fat content alone had a greater impact on the portion selection. A limitation of the present online study was that the portion selection task was hypothetical, and there may have been differences in the actual portion consumed in a real-life scenario. Nonetheless, the results presented here do suggest that the inclusion of a Grass-Fed claim on a FoP label has potential enhance sensory expectations. On the other hand, labels which highlight a Lighter-Fat content have the potential to increase consumption. From a food retailer perspective, this may be a benefit, however from a consumer perspective, it may inadvertently increase intake, and negate some of the benefit of a lower energy–density food choice.

Finally, it is worth noting that our label manipulations may have influenced consumer perceptions in ways not captured in the current study. For example, although the labels were labelled consistently, the specific label design – including the choice of blue colours and fonts – may have evoked different meaning for different participants that could affect judgements. Semiotics considers the thoughts, emotions, impressions and associations that are consciously and unconsciously interpreted from product labels, and potentially influence how they are evaluated by different consumer groups (Ares et al., 2011). It has been reported that, although the main messages conveyed by model yoghurt labels were well understood by consumers in Uruguay and Spain, there were cultural differences in the label meaning (Ares et al., 2011). Uruguayan consumers used hedonic terms whilst Spanish consumers referred more to commercial brands when discussing the yoghurt products. Similarly, Piqueras-Fiszman et al. (2011), found age related semiotic differences in relation to model yoghurt labels. Participants under 35 years gave product specific responses, whilst those aged over

Table 6
Mean (±SD) portion size selected by Irish and US participants for the various cheese types.

	Portion size selected (grams)						
	Irish			US			
	N	*Mean*	*S.D*	*N*	*Mean*	*S.D*	*p*-value
	170	14.2	8.6	217	16.6	18.0	0.099
	175	17.4	16.6	215	18.4	20.4	0.594
	170	13.6	10.9	217	15.8	16.5	0.142
	175	16.8	14.3	215	18.2	20.5	0.445

*p-values represent significant differences between Irish and US participants from ANOVA.

60 used more hedonic terms. In the current study, a darker blue label was used for the Full Fat cheese packaging whilst pale blue was used for the Reduced Fat cheese packaging. We believe this was justified as pale packaging is often used to portray a Reduced Fat product (Mai et al., 2016). However, it is possible that the colour chosen may have influenced consumer perceptions of the Cheese. The assessment of the wider semiotic influence of these label characteristics, in terms of emotions or product value, were not captured in this study, but would be an important dimension to consider in follow-up work, particularly when comparing consumer groups across countries.

5. Conclusion

The inclusion of a Lighter-Fat claim on a FoP label may negatively affect the sensory expectations of cheese. However, a Lighter-Fat claim may enhance perceived healthiness in an Irish population yet have a negative effect on this attribute for US consumers. A Grass-Fed claim on a FoP label did not influence sensory perceptions, but increased the perceived healthiness and naturalness of the cheese in both US and Irish cohorts. The findings in this study may have implications for cheese manufacturers and for future research. Regarding practical implications for the industry, it is important to note that consumers had a positive perception of Grass-Fed Cheddar cheese without compromised sensory expectations. On the other hand, consumers may choose larger portions of lighter-labelled products, potentially reducing the effectiveness of these foods for weight-control strategies, which has implications for public health messaging.

CRediT authorship contribution statement

Lauren McGuinness: Formal analysis, Investigation, Methodology, Project administration, Resources, Visualization, Writing – original draft, Writing – review & editing. **Mairead McCabe:** Investigation, Methodology, Project administration, Resources. **Celine Kiernan:** Investigation, Methodology, Project administration, Resources. **Keri McCrickerd:** Conceptualization, Methodology, Software, Writing – review & editing. **Ciaran G. Forde:** Conceptualization, Methodology, Software, Writing – review & editing. **E. Dolores O'Riordan:** Funding acquisition, Supervision, Visualization, Writing – review & editing. **Emma L. Feeney:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Supervision, Visualization, Writing – review & editing.

Declaration of Competing Interest

E.D.O'R and E.L.F have received research funding through the Food for Health Ireland project, funded by Enterprise Ireland and industry partners, grant number TC20180025. L.MG is supported by the Food for Health Ireland project, funded by Enterprise Ireland and industry, grant number TC20180025. ELF has previously received travel expenses and / or speaking honoraria from the National Dairy Council and the European Milk Forum. The funders had no role in the analyses or interpretation of data in the writing of the manuscript, or in the decision to publish the findings. The other authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This work is funded by Food for Health Ireland (FHI). The FHI-3 project is funded by Enterprise Ireland and industry [TC201800025].

References

Alothman, M., Hogan, S. A., Hennessy, D., Dillon, P., Kilcawley, K. N., O'Donovan, M., . . . O'Callaghan, T. F. (2019). The "Grass-Fed" Milk Story: Understanding the Impact of Pasture Feeding on the Composition and Quality of Bovine Milk. *Foods (Basel, Switzerland)*(8). 10.3390/foods8080350.

Ares, G., Piqueras-Fiszman, B., Varela, P., Marco, R. M., López, A. M., & Fiszman, S. (2011). Food labels: Do consumers perceive what semiotics want to convey? *Food Quality and Preference, 22*(7), 689–698. https://doi.org/10.1016/j.foodqual.2011.05.006

Benbrook, C. M., Butler, G., Latif, M. A., Leifert, C., & Davis, D. R. (2013). Organic Production Enhances Milk Nutritional Quality by Shifting Fatty Acid Composition: A United States-Wide, 18-Month Study. *PLoS One, 8*.

Bendall, J. G. (2001). Aroma Compounds of Fresh Milk from New Zealand Cows Fed Different Diets. *Journal of Agricultural and Food Chemistry, 49*(10), 4825–4832.

Brown, H. M., Rollo, M. E., de Vlieger, N. M., Collins, C. E., & Bucher, T. (2018). Influence of the nutrition and health information presented on food labels on portion size consumed: A systematic review. *Nutrition Reviews, 76*(9), 655–677. https://doi.org/10.1093/nutrit/nuy019

Chen, Z., Ahmed, M., Ha, V., Jefferson, K., Malik, V., Ribeiro, P. A. B., … Drouin-Chartier, J. (2021). Dairy product consumption and cardiovascular health: A systematic review and meta-analysis of prospective cohort studies. In *Advances in nutrition (Bethesda, Md.)*. https://doi.org/10.1093/advances/nmab118

Cheng, Z., O'Sullivan, M. G., Kerry, J. P., Drake, M. A., Miao, S., Kaibo, D., & Kilcawley, K. N. (2020). A cross-cultural sensory analysis of skim powdered milk produced from pasture and non-pasture diets. *Food Research International, 138*, 109749. https://doi.org/10.1016/j.foodres.2020.109749

Childs, J. L., & Drake, M. (2009). Consumer Perception of Fat Reduction in Cheese. *Journal of Sensory Studies, 24*, 902–921.

Couvreur, S., Hurtaud, C., Lopez, C., Delaby, L., & Peyraud, J. L. (2006). The Linear Relationship Between the Proportion of Fresh Grass in the Cow Diet, Milk Fatty Acid Composition, and Butter Properties. *Journal of Dairy Science, 89*(6), 1956–1969.

Croissant, A. E., Washburn, S. P., Dean, L. L., & Drake, M. A. (2007). Chemical properties and consumer perception of fluid milk from conventional and pasture-based production systems. *Journal of Dairy Science, 90*(11), 4942–4953. https://doi.org/10.3168/jds.2007-0456

Dehghan, M., Mente, A., Rangarajan, S., Sheridan, P., Mohan, V., Iqbal, R., … Yusuf, S. (2018). Association of dairy intake with cardiovascular disease and mortality in 21 countries from five continents (PURE): A prospective cohort study. *The Lancet (British edition), 392*(10161), 2288–2297. https://doi.org/10.1016/S0140-6736(18)31812-9

Drake, M. A., Yates, M. D., Gerard, P. D., Delahunty, C. M., Sheehan, E. M., Turnbull, R. P., & Dodds, T. M. (2005). Comparison of differences between lexicons for descriptive analysis of Cheddar cheese flavour in Ireland, New Zealand, and the United States of America. *International Dairy Journal, 15*(5), 473–483.

Elgersma, A., Ellen, G., van der Horst, H., Boer, H., Dekker, P. R., & Tamminga, S. (2004). Quick changes in milk fat composition from cows after transition from fresh grass to a silage diet. *Animal Feed Science and Technology, 117*(1), 13–27.

Faulkner, H., O'Callaghan, T. F., McAuliffe, S., Hennessy, D., Stanton, C., O'Sullivan, M. G., … Kilcawley, K. N. (2018). Effect of different forage types on the volatile and sensory properties of bovine milk. *Journal of Dairy Science, 101*(2), 1034–1047.

Fontecha, J., Calvo, M. V., Juarez, M., Gil, A., & Martínez-Vizcaino, V. (2019). Milk and Dairy Product Consumption and Cardiovascular Diseases: An Overview of Systematic Reviews and Meta-Analyses. *Advances in nutrition (Bethesda, Md.), 10*(suppl_2). https://doi.org/10.1093/advances/nmy099. S164–S189.

Garvey, E. C., Sander, T., O'Callaghan, T., Drake, M., Fox, S., O'Sullivan, M. G., … Kilcawley, K. N. (2020). A Cross-Cultural Evaluation of Liking and Perception of Salted Butter Produced from Different Feed Systems. *FOODS, 9*(12), 1767. https://doi.org/10.3390/foods9121767

Harwood, W. S., & Drake, M. A. (2020). Validation of fluid milk consumer segments using qualitative multivariate analysis. *Journal of Dairy Science, 103*(11), 10036–10047. https://doi.org/10.3168/jds.2019-17797

Johansen, S. B., Næs, T., & Hersleth, M. (2011). Motivation for choice and healthiness perception of calorie-reduced dairy products. A cross-cultural study. *Appetite* (vol. 56 (no. 1),, 15–24. https://doi.org/10.1016/j.appet.2010.11.137

Karlsson, J., Persson, L., Sjöström, L., & Sullivan, M. (2000). Psychometric properties and factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and women. Results from the Swedish Obese Subjects (SOS) study. *International Journal of Obesity, 24*(12), 1715–1725. https://doi.org/10.1038/sj.ijo.0801442

Mai, R., Symmank, C., & Seeberg-Elverfeldt, B. (2016). Light and Pale Colors in Food Packaging: When Does This Package Cue Signal Superior Healthiness or Inferior Tastiness? *Journal of Retailing, 92*(4), 426–444.

McCann, M. T., Wallace, J. M. W., Robson, P. J., Rennie, K. L., McCaffrey, T. A., Welch, R. W., & Livingstone, M. B. E. (2013). Influence of nutrition labelling on food portion size consumption. *Appetite, 65*, 153–158. https://doi.org/10.1016/j.appet.2013.02.013

McCarthy, K. S., Parker, M., Ameerally, A., Drake, S. L., & Drake, M. A. (2017). Drivers of choice for fluid milk versus plant-based alternatives: What are consumer perceptions of fluid milk? *Journal of Dairy Science, 100*(8), 6125–6138. https://doi.org/10.3168/jds.2016-12519

McCarthy, T. (2020). Utilising our grass-fed advantage. *Bord Bia Farmer Newsletter* (Winter 2020).

McCrickerd, K., Tang, C. S., & Forde, C. G. (2020). The independent and combined impact of front-of-pack labelling and sensory quality on calorie estimations and portion selection of commercial food products. *Food Quality and Preference, 79*. https://doi.org/10.1016/j.foodqual.2019.103766

Moscovici Joubran, A., Pierce, K. M., Garvey, N., Shalloo, L., & O'Callaghan, T. F. (2021). Invited review: A 2020 perspective on pasture-based dairy systems and products. *Journal of Dairy Science, 104*(7), 7364–7382. https://doi.org/10.3168/jds.2020-19776

Peira, G., Cortese, D., Lombardi, G., & Bollani, L. (2020). Grass-fed milk perception: Profiling italian consumer. *Sustainability (Basel, Switzerland), 12*(24), 1–13. https://doi.org/10.3390/su122410348

Piqueras-Fiszman, B., Ares, G., & Varela, P. (2011). Semiotics and perception: Do labels convey the same messages to older and younger consumers? *Journal of Sensory Studies, 26*(197–208). https://doi.org/10.1111/j.1745-459X.2011.00336.x

Qin, L., Xu, J., Han, S., Zhang, Z., Zhao, Y., & & Szeto, I. M. (2015). Dairy Consumption and Risk of Cardiovascular Disease: An Updated Meta-Analysis of Prospective Cohort Studies. *Asia Pacific journal of clinical nutrition, vol. 24*(no. 1), pp. 90-100. 10.6133/apjcn.2015.24.1.09.

Rahimi, J., Khosrowshahi, A., Madadlou, A., & Aziznia, S. (2007). Texture of low-fat iranian white cheese as influenced by gum tragacanth as a fat replacer. *Journal of Dairy Science, 90*(9), 4058–4070. https://doi.org/10.3168/jds.2007-0121

Roberto, C. A., Shivaram, M., Martinez, O., Boles, C., Harris, J. L., & Brownell, K. D. (2012). The Smart Choices front-of-package nutrition label. Influence on perceptions and intake of cereal. *Appetite, 58*(2), 651–657. https://doi.org/10.1016/j.appet.2012.01.003

Soedamah-Muthu, S. S., Ding, E. L., Al-Delaimy, W. K., Hu, F. B., Engberink, M. F., Willett, W. C., & Geleijnse, J. M. (2011). Milk and dairy consumption and incidence of cardiovascular diseases and all-cause mortality: Dose-response meta-analysis of prospective cohort studies. *The American Journal of Clinical Nutrition, 93*(1), 158–171. https://doi.org/10.3945/ajcn.2010.29866

Speight, K. C., Schiano, A. N., Harwood, W. S., & Drake, M. A. (2019). Consumer insights on prepackaged Cheddar cheese shreds using focus groups, conjoint analysis, and qualitative multivariate analysis. *Journal of Dairy Science, 102*(8), 6971–6986.

Stampa, E., Schipmann-Schwarze, C., & Hamm, U. (2020). Consumer perceptions, preferences, and behavior regarding pasture-raised livestock products: A review. *Food Quality and Preference, 82*, Article 103872.

Stunkard, A. J., & Messick, S. (1985). The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *Journal of Psychosomatic Research, 29*, 71–83.

Vargas-Bello-Pérez, E., Faber, I., Osorio, J. S., & Stergiadis, S. (2020). Consumer knowledge and perceptions of milk fat in Denmark, the United Kingdom, and the United States. *Journal of Dairy Science, 103*(5), 4151–4163.