frontiers | Frontiers in Animal Science

TYPE Original Research
PUBLISHED 07 June 2023
DOI 10.3389/fanim.2023.1129241

OPEN ACCESS

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RECEIVED 21 December 2022
ACCEPTED 09 May 2023
PUBLISHED 07 June 2023

CITATION
Lavranou G, Henchion M, McCarthy MB and O'Reilly SJ (2023) Valorizing meat by-products for human consumption: understanding consumer attitude formation processes.
Front. Anim. Sci. 4:1129241.
doi: 10.3389/fanim.2023.1129241

Valorizing meat by-products for human consumption: understanding consumer attitude formation processes

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Introduction: A considerable body of research has identified that meat by-products contain significant amounts of high-quality protein, which when properly extracted can lead to valuable opportunities for the food industry. However, the market success of food products containing protein extracted from meat byproducts is subject to consumer acceptance. This study explores Irish consumers' attitudes toward hypothetical food products containing protein derived from beef offal sources.

Methods: A nationally representative survey (n = 953) was undertaken to investigate what attitude processes, that is intuitive and/or deliberative, dominate attitude formation toward food products containing beef offal-derived protein, while accounting for the effects of product familiarity and information provision. Using a 2 x 3 between-subject design, study participants were randomly assigned to one of the 6 study conditions. Participants were exposed to Affect Misattribution Procedure (AMP) tasks which measured their intuitive evaluations, followed by a number of questions that measured deliberative evaluation, attitude ambivalence, attitudes and acceptability toward the food products containing protein extracted from beef offal.

Results: The study reveals that consumers' intuitive and deliberative evaluations worked in the same direction, predicting overall attitudes toward these products; however, deliberative evaluation was found to be a better predictor of consumers' attitudesthan intuitive evaluation. Moreover, intuitive evaluations do not influence deliberative evaluations, suggesting that information provision that prompts deliberative evaluations could lead to the formation of more considered and stable attitudes. Familiarity influences acceptance: these findings suggest that the potential impact of a lack of familiarity with the ingredient is offset by familiarity with the carrier products. Consumers who received benefit information about the health and environmental consequences of consuming food products containing protein extracted from beef offal expressed a more positive deliberative attitude toward these products. However, interestingly, the provision of benefit- and risk-orientated information

at the same time at the same time also had a positive effect on deliberative evaluations.

Discussion: The findings have implications for new product development, and more generally for strategies that seek to promote sustainable food production and consumption.

KEYWORDS

meat by-products, protein, information, consumer behavior, attitude formation, consumer, valorization, AMP

1 Introduction

The global population is predicted to grow to 9.7 billion by 2050, reflecting a growth of about one-third compared with the figure in 2015 (FAO, 2018). Alongside this are several factors that will influence the nature of the demand for food in the coming decades. These include global concerns regarding climate change and the availability of finite resources, particularly fossil fuel-based resources; the loss of natural ecosystems and declining biodiversity resulting from an expansion of land and fresh water used to produce food for a growing population (IPCC, 2019); health inequalities, such as obesity and malnutrition, which co-exist in many countries (FAO, 2018); and socioeconomic changes, such as urbanization and rapid income growth in some regions. Thus, the quantity of food required is expected to increase significantly, and the nature of food needed will change significantly too. This will place significant demands on the food production system, as evidenced by a recognition that the current means of food production and patterns of consumption are not sustainable (Steenson and Buttriss, 2020) and that fundamental changes to the food production system are required (FAO, 2018; Willett et al., 2019).

In this context, protein has attracted particular attention, with more sustainable and alternative protein sources being demanded by consumers, pursued by industry and researchers, and driven by policymakers at all levels (Clark and Lenaghan, 2020). Their approaches have targeted both existing and novel sources of protein. A review by Henchion et al. (2017) concluded that different factors influence the potential of these sources to sustainably satisfy protein demand. They found that the sustainability of existing protein sources, particularly animal-derived foods, is primarily limited by their negative environmental impacts and some concerns around health. However, high levels of consumer acceptance and social and economic benefits support their ongoing production. In contrast, proponents of novel proteins have to pay close attention to consumer acceptance, and related issues such as production costs and safety.

The global demand for animal-derived protein is expected to double by 2050 (Westhoek, 2011), thus necessitating particular attention. Novel protein production opportunities are available in this industry, with a focus on increasing the valorization of co-products in several sectors. There are several arguments in favor of this. First, raw materials are available in significant quantities—cattle slaughtering and processing generates by-products that account for 40%–50% of the total weight of the animal slaughtered (Cavaleiro et al., 2013). Second, they represent undervalorized sources of high-quality protein, and many other nutrients including essential amino acids, vitamins, minerals, antioxidants, and bioactive peptides (Florek et al., 2012; Jayathilakan et al., 2012; Mullen et al., 2017; Álvarez et al., 2018). Overall, there is growing scientific awareness that animal by-products contain significant amounts of nutritious and functional components when treated and processed correctly. Indeed, the development of techniques for the recovery and the utilization of protein from such sources has attracted considerable interest in recent years (Darine et al., 2010; Toldrá et al., 2012; Baiano, 2014; Lynch et al., 2017; Mullen et al., 2017). Last, their current use in many countries means that they are treated as waste, incurring costs for meat processors and representing a potential threat to the environment. Thus, from a sustainability perspective, making better use of by-products can help to reduce the environmental impact of meat production, and address the need to use animal proteins in a more responsible manner than is currently the case (Van Der Spiegel et al., 2013).

However, using animal by-products as a significant source of protein on a global basis is likely to elicit challenges relating to the fact that they areco-products and are animal derived. Martins et al. (1997) suggest that consumers tended to exhibit stronger neophobic responses in relation to animal products than to non-animal products, possibly as a result of the greater potential pathogenic threat posed by animal products. Thus, they are likely to be more wary of novel proteins from animal by-products than other sources. Moreover, if consumers are not familiar with potential innovations in this area, they may consider by-products as unhealthy and possibly not edible. Frewer and Gremmen (2007) argue that "unless consumers can agree that the benefits of by-products management are equivalent to sustainable, desirable, and acceptable food production practices, consumers are unlikely to recognize and realize many of the potential benefits of by-products management" (p. 32). This paper aims to explore Irish consumers' attitudes toward incorporating protein extracted from beef offal into food products. It builds on the methodology used in the study by De Beukelaar et al. (2019), adding theoretical concepts and applying it in a new context.

2 Theoretical framework

Consumers' food choices and behaviors are influenced by numerous sociocultural and sociopsychological factors, with most of these factors being internalized by individuals through the formation of attitudes. Attitudes are defined as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly and Chaiken, 1993, p. 1). Within food research, the important influence of the attitude construct on consumers' behavior is evident through its omnipresence in numerous analytical theories, models, and frameworks that examine food choices (e.g., Randall, 1981; Ajzen, 1991; Shepherd, 1999; Rozin, 2006).

2.1 Attitude formation processes

In some cases, people form attitudes effortlessly, without much conscious awareness of their formation, while in other cases, attitudes are consciously controlled and arise from the intentional and thoughtful consideration of attitude-relevant information (Marquardt and Hoeger, 2009; Kruglanski and Gigerenzer, 2011; Olson and Kendrick, 2011; Pachur and Spaar, 2015). The first process, referred to as "intuitive" within this paper, has been described as unintentional, immediate, stimulus based, and can involve emotion-based judgments based on quick intuitions such as "gut" feelings (Haidt, 2001; Duckworth et al., 2002; Pachur and Spaar, 2015). The second process described, referred to "deliberative" within this paper, is an analytic mode that requires individuals to think at complex levels and critically make evaluative judgments (Epstein, 2010). People can engage in both processes simultaneously, with each process exerting either independent or interdependent effects on evaluations (Moskowitz et al., 1995; Marquardt and Hoeger, 2009; Bohner et al., 2011).

Both processes may jointly influence people's evaluations in an additive, competitive, or sequential manner (Evans, 2008; Gawronski and Creighton, 2013). For example, when deliberative processing is incongruent with the judgment implied from intuition, deliberative evaluation can entirely set aside the intuitive process (Gawronski and Creighton, 2013). This might occur because the outcome implied by deliberate processing is likely to be seen as more reliable, and, therefore, the influence of intuition is reduced (Zuckerman and Chaiken, 1998). People use a common set of core values in their food choices, such as taste, cost, health, and convenience, and attach meanings to these values (Furst et al., 1996; Sobal and Bisogni, 2009). If all these values cannot be met at the same time, people develop ways of negotiating and balancing them (Sobal and Bisogni, 2009). Deliberative evaluation of a food product's health value may override an initial intuitive evaluation of disgust or a "gut" feeling for this product if consumers are health conscious. Thus, consumers' attitudes toward a food product can be the result of both intuitive and deliberate evaluations, with intuitive evaluations being formed first.

With the findings in the above literature and the study by De Beukelaar et al. (2019) in mind, it can be hypothesized that:

Hypothesis 1: the more positive consumers' intuitive and deliberative evaluations toward the food product containing offal-derived protein are, the more positive their overall attitude toward this product will be.

Hypothesis 2: the more positive consumers' intuitive evaluation toward the food product containing offal-derived protein is, the more positive their deliberate evaluation toward this product will be.

2.2 Ambivalence

Consumers' food choices and related behavior has been associated with ambivalence (Sparks et al., 2001). Ambivalence can be conceptualized as a state in which an individual "is inclined to give it [an attitude object] equivalently strong positive or negative evaluations" (Thompson et al., 1995, p. 367). For instance, a person may hold an ambivalent attitude toward meat consumption, deriving from strongly held positive and negative attitudes toward the associated benefits and risks. Attitudinal research has shown that individuals are motivated to reduce ambivalence and its associated negative feelings (Stone and Cooper, 2001; Zemborain and Johar, 2007; Sawicki et al., 2013). Empirical studies have shown that ambivalence is related to more effort and deliberation, as ambivalent attitude-holders experience an internal evaluative inconsistency, and, therefore, invest cognitive resources to come to a more unequivocal attitude (Van Harreveld and Van Der Pligt, 2004; Van Harreveld et al., 2004). Therefore, it is reasonable to assume that:

Hypothesis 3: the more ambivalent consumers' attitudes toward the food product concept containing protein extracted from beef offal, the greater the effect of deliberate evaluation on overall attitudes toward this product.

2.3 Familiarity with food product concept

Previous empirical research (e.g., Wansink, 2002; Fischer and Frewer, 2009; Gmuer et al., 2016) has shown that product familiarity plays an important role in introducing new foods to the market. Research on insects as food has repeatedly shown that insects are likely to be more acceptable when they are incorporated into familiar foods (Schösler et al., 2012; Tan et al., 2015; Gmuer et al., 2016; Tan et al., 2016). Some researchers have also suggested that incorporating insects and offal into convenience foods, such as burger patties and sausages, might be one of the most effective ways of encouraging consumer acceptance (Wansink, 2002; Schösler et al., 2012; Verbeke, 2015). Consumers' familiarity with a product concept they are required to evaluate might also affect the evaluation process that they use. In cases where individuals have limited knowledge and experience with the attitude object, it is more likely that they will access affective associations than construct cognitive associations (Van Giesen et al., 2015). Research on attitudes toward relatively unfamiliar food developments, such as genetically modified foods and nanotechnology applications, has indicated that affective/intuitive input is the main driver of attitude

formation (Lee et al., 2005; Van Giesen et al., 2015). Given the above literature it can be hypothesized that:

Hypothesis 4: consumers who are exposed to an image of a familiar product concept are more likely to have more positive intuitive evaluation toward the food product containing offal-derived protein than consumers who are exposed to unfamiliar product concepts.

2.4 Attitude formation and information processing

Attitude formation is highly related to information provision and processing (Crano and Prislin, 2006; Eagly and Chaiken, 2007), as attitudes can be formed (or altered) as a result of received information (McCarthy et al., 2003). Health-related information is increasingly used in the marketing of food products, and research has shown that it affects consumers' responses to foods in general, and to unfamiliar or novel foods in particular (Leathwood et al., 2007; Lampila et al., 2009; Lähteenmäki, 2013). Research on functional foods, for example, has shown that consumers are more willing to accept them if information on health benefits is provided (Siegrist et al., 2008; Lalor et al., 2011). In a study on consumer acceptance of unfamiliar acai berry-based fruit juices, Sabbe et al. (2009) demonstrated that health information leads to an increase in overall liking for these unfamiliar fruit juices. In addition or alongside the effect of health benefit information on consumer acceptance of new or unfamiliar foods, the effect of information on environmental benefits has also been studied. In a recent study, Barsics et al. (2017) showed that information on insect-based foods encompassing ecological, health, and gastronomic aspects could change consumers' attitudes and acceptance of novel insect-based food samples. In a similar vein, Verneau et al. (2016) investigated the effect of benefit communication on insect consumption and showed that providing information about the individual (i.e., health benefits) and social (i.e., environmental benefits) benefits of eating insects increased peoples' intention to eat insect-based food. Gorissen and Weijters (2016) investigated how consumers process information on the environmental impact of food products and how this information can be subject to biased processing. In one of their experiments, the authors found that people rated a hamburger together with an organic apple as having a lower environmental impact compared with the hamburger alone. The authors attributed this result to the biased effect of the "green product".

Consumers are often confronted with contradicting information regarding products' attributes and/or benefits. Insufficient or contradictory information leads to the ambivalence that characterizes public reactions to new foods (Grunert et al., 2001; Bäckström et al., 2003). According to the heuristic-systematic model (HSM) (Chaiken, 1980), in conditions where information is ambiguous, information can be interpreted in line with a heuristic cue and bias the results of deliberate processing (Gawronski and Creighton, 2013).

Hypothesis 5: individuals who are provided with either benefit or ambiguous information are more likely to have a more positive deliberate evaluation of product concepts containing protein extracted from beef offal than people who are provided with no information.

Hypothesis 6: for individuals who are exposed to ambiguous information, it is more likely that their deliberate evaluation will be determined by intuitive evaluation.

3 Materials and methods

3.1 Participants

Data were collected in January 2019 using an online survey. Participants were recruited by a field market research agency, from their consumer panel. Quota controls were applied in terms of age, gender, education, social class, and geographical area to ensure a representative sample of the Irish adult population. All responders had been living continuously in Ireland for the past 3 years and were consumers of burgers and sausages. A total of 1,027 consumers took part in the survey. From those, 74 respondents were excluded due to their not meeting the qualifying criteria[1], resulting in a final sample of 953 respondents.

3.2 Manipulations

3.2.1 Carrier product

Previous research on consumer attitudes toward new and novel foods, such as functional foods and insects, has stressed the important role of perceived fit of carrier–ingredient combination on acceptability (e.g., Bech-Larsen and Grunert, 2003; Van Kleef et al., 2005; Lyly et al., 2007; Verbeke et al., 2009; Krutulyte et al., 2011; Lu, 2015; Tan et al., 2015; Tan et al., 2017). In this study, the carrier effect was removed by choosing carrier products that conceptually represent an appropriate carrier–ingredient combination. In accordance with the study by De Beukelaar et al. (2019), we decided to include two different food product concepts to control for individual differences in liking for the specific food products and to serve as internal replications for the study. Sausages and burgers were chosen to fulfil these criteria. Given that these products are commonly produced with minced meat and/or red offal in a patty format, it was expected that it would be ideationally congruent to add ingredients extracted from offal to these products, as opposed to a product characterized by totally different properties (e.g., orange juice). This choice was also reinforced by a review of the meat science literature undertaken by the research team, which indicated that most recommendations concerning the applications of offal-extracted protein for the food industry were focused on processed meat products.

1 A total of 47 participants were excluded during the analysis due to self-reported missing observations for one or more of the explanatory variables of the analysis. Possible causes for failure to complete the section(s) could be limitations associated with the devices on which the survey was undertaken (e.g., small screen) in combination with the short duration for which some images were presented.

3.2.2 Familiarity

Familiarity with the product concepts was manipulated in terms of product concepts containing protein extracted from familiar compared with unfamiliar beef offal sources. Selection was based on the results of a pretest conducted with 26 Irish consumers, who reported their familiarity with burgers and sausages containing protein extracted from six different beef offal sources: heart, blood, liver, lung, bone, and skin. Familiarity with these product concepts was measured using a five-point scale according to Tuorila et al. (2001). Based on the reported differences in familiarity in this pretest, the following choices were made:

- familiar products consisted of "burger containing protein extracted from beef liver" and "sausages containing protein extracted from beef liver"
- unfamiliar products consisted of "burger containing protein extracted from beef lung" and "sausages containing protein extracted from beef lung".

3.2.3 Information provision

Manipulations in information provision within the survey consist of three levels: no information, benefit information, and ambiguous information. Participants in all conditions were informed that the presented food products contained protein extracted from beef liver or lung. In the "benefit information" condition, information was given to participants about the health and environmental benefits of protein extracted from beef liver or lung for human consumption. In the "ambiguous information" condition, a more extensive text was given to participants containing ambiguous arguments regarding the health and environmental benefits of protein extracted from beef liver or lung for human consumption. A pretest with 29 Irish third-level students confirmed that the two fictitious information texts differed significantly in terms of the strength and valence of their arguments.

Literature suggests that the impact of information provision on consumers' attitudes is strongly affected by the perceived credibility and trustworthiness of the information source (e.g., Frewer et al., 2003; Gray et al., 2005; Costa-Font et al., 2008; Cash et al., 2015; Henchion et al., 2016), and this is the case especially in situations where attitudes have not yet crystallized (Frewer et al., 1998). In this study, the source of the information was intentionally unspecified to minimize the potential effect of information source credibility on participants' expressed attitudes.

3.3 Experimental design

In line with De Beukelaar et al.'s (2019) study design, of a 2 × 3 between-subject design, participants were randomly assigned to one of six possible study conditions (see Table 1). The conditions differed according to the two factors: product concept familiarity (two levels: familiar or unfamiliar) and provision of information (three levels: no information provided, benefit information provided, or ambiguous information provided).

3.4 Measures

3.4.1 Intuitive evaluations

Intuitive evaluations of the product concepts containing protein extracted from beef offal were measured with an affect misattribution procedure (AMP), which was developed by Payne et al. (2005). The AMP has been used in food studies (e.g., Hofmann et al., 2009; Richard et al., 2017; Woodward et al., 2017) exhibiting relatively high levels of reliability (Lebel and Paunonen, 2011). Payne and Lundberg (2014) reported Cronbach's alpha coefficients ranging from 0.47 to 0.95 from 45 studies.

According to Payne et al. (2005), the AMP is an implicit measure, in the sense that participants do not directly report their attitudes, but their attitudes are inferred from the responses. This priming-based procedure measures automatically activated responses based on the principle that exposure to a visual positive or negative stimulus causes an affective state, which then automatically biases the evaluation of a subsequent neutral object (Payne and Lundberg, 2014). According to the AMP process, participants have to view pairs of pictures "flashed" rapidly one after the other; the visual prime, followed by a neutral Chinese character[2] (Payne et al., 2005, p. 280). Subsequently, they are asked to make evaluative judgments about the neutral target stimulus (i.e., the Chinese character) and are explicitly asked to ignore the photo prime. The stimulus (i.e., the Chinese character) tends to be judged more positively (*vs.* negatively) when it is preceded by a positive (*vs.* negative) prime (Payne et al., 2005).

During the survey, each participant was exposed to two AMP tasks containing images from one of the six conditions. Every AMP task began with briefly showing (1,200 ms) a photograph of the product (burger/sausages) containing protein extracted from beef offal (visual prime). After the prime, a Chinese character (see Figure 1) was shown for 1200 ms. Participants were asked to rate the Chinese character on a seven-point scale, ranging from "not very pleasant" to "very pleasant", plus the option to report "unable to see the image" (Figure 2). Before starting this part of the study, participants were explicitly instructed to ignore the photos prior to the Chinese characters. However, in accordance with AMP principles, it is expected that despite the given instruction, participants are more inclined to perceive the Chinese characters as (un)pleasant if they have formed a (un)favorable intuitive evaluation toward the visual primes, that is the food product concepts containing protein extracted from beef liver or lung.

3.4.2 Deliberative evaluation

Deliberate evaluation of the product concepts containing protein extracted from beef offal was assessed using three deliberate attitude items on a seven-point semantic differential scale from Bruner (2017).

2 The research team decided that it was appropriate to exclude individuals who speak Chinese, as their knowledge of the meanings of the Chinese characters could alter the results from the AMP tests.

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TABLE 1 The two stimuli in each of the six study conditions.

Factor: product familiarity		Familiar (protein extracted from beef liver)	Unfamiliar (protein extracted from beef lung)
Factor: information provision	Not provided	 *This burger contains protein extracted from beef liver*  *These sausages contain protein extracted from beef liver*	 *This burger contains protein extracted from beef lung*  *These sausages contain protein extracted from beef lung*
	Benefit information provided	 *This burger contains protein extracted from beef liver. Protein extracted from beef liver has a high health value and is environmentally friendly*  *These sausages contain protein extracted from beef liver. Protein extracted from beef liver has a high health value and is environmentally friendly*	 *This burger contains protein extracted from beef lung. Protein extracted from beef lung has a high health value and is environmentally friendly*  *These sausages contain protein extracted from beef lung. Protein extracted from beef lung has a high health value and is environmentally friendly*
	Ambiguous information provided	 *This burger contains protein extracted from beef liver. Protein extracted from beef liver has a high health value and is environmentally friendly. However, when improperly treated, protein extracted from beef liver does not supply any health value and can have a negative environmental impact*  *These sausages contain protein extracted from beef liver. Protein extracted from beef liver has a high health value and is environmentally friendly. However, when improperly treated, protein extracted from beef liver does not supply any health value and can have a negative environmental impact*	 *This burger contains protein extracted from beef lung. Protein extracted from beef lung has a high health value and is environmentally friendly. However, when improperly treated, protein extracted from the lung does not supply any health value and can have a negative environmental impact*  *These sausages contain protein extracted from beef lung. Protein extracted from beef lung has a high health value and is environmentally friendly. However, when improperly treated, protein extracted from beef lung does not supply any health value and can have a negative environmental impact*

3.4.3 Attitude ambivalence

Participants' "attitude ambivalence" toward the product concepts was measured using three items on a seven-point scale in accordance with Priester and Petty (1996). This scale has been used in numerous research papers (e.g., Nowlis et al., 2002; Nordgren et al., 2006; Clark et al., 2008). The scale is composed of three items that assess the extent to which a person reports having mixed feelings when making an evaluation.

3.4.4 Overall attitude

Overall attitude toward the food products containing protein extracted from beef offal was measured using three items on a seven-point bipolar continuum, in accordance with Pham and Avnet (2004) and Kempf and Laczniak (2001) (with reported Cronbach's alpha coefficients of 0.97 and 9.4, respectively).

3.4.5 Acceptability

In addition to the attitudinal measurements toward the food products containing protein extracted from beef offal, it was deemed useful to measure individuals' acceptance of these products. No specific hypotheses were made around acceptability; however, an explanatory analysis of the relationships between attitudinal constructs and acceptance will provide some additional insight. Acceptability was measured using three items on a seven-point scale based on that in the study by Tan et al. (2016).

3.5 Survey procedure

Participants were invited *via* email by the market research agency to take part in the survey. To avoid self-selection bias, specific project details were not included in the email invitation. Instead, individuals were invited to complete a survey and given the general survey details, that is, the survey theme and the length of survey. On clicking the survey link, participants were informed about the purpose of the study, that the information provided would be protected and anonymous, and asked to provide their consent to proceed with the survey.

FIGURE 1
Chinese characters used in the AMP (images retrieved from Payne et al. (2005). AMP, affect misattribution procedure.

The online survey consisted of four parts, which altogether took around 15 min to complete. In part 1, demographic and product consumption questions, and the exclusion criteria questions, were asked. If participants met the requirements to participate in the survey, they were randomly assigned to one of the six study conditions. In part 2, participants completed the AMP task. In part 3, participants rated their overall attitude, attitude ambivalence, and deliberate evaluation and acceptance of the food products containing protein extracted from beef offal. Finally, in part 4, participants rated their general attitudes toward eating burgers and sausages and their attitudes toward the Chinese characters. Piloting was undertaken with 56 participants to ensure the suitability and validity of the data collection instrument and of study manipulations. Age categories were defined *a priori* and were based on common age bands for adults. Social class categories were defined using a common market research classification, as follows: A—upper middle class; B—middle class; C1—lower middle class, C2—skilled working class; D—working class; E—non-working; and F—farmers.

3.6 Data analysis

Data analysis was performed using IBM SPSS 24. A critical *p*-value of 0.05 was selected. Prior to analysis, items denoted with (R) were reversed, so that higher-scale scores denote positive valence. For testing the hypotheses and the two scores for the individual products (burgers and sausages) were averaged to obtain a single aggregated score for each variable. Analyses consisted of reliability analysis of scales used (all scales had a Cronbach's alpha value > 0.70), descriptive statistics, Pearson's chi-squared correlations, and, finally, a regression analysis and analysis of variance (ANOVA) to test the hypotheses.

4 Results

The study sample is representative of the Irish adult population in terms of gender, age, education, and social class [according to the most recent census survey, conducted by the Central Statistics Office (CSO) in 2016]. Participants' general attitudes toward the two product carriers indicate that participants were equally positive about consuming burgers and sausages. In terms of consumption frequency, more than two-thirds of the participants (almost 73%) reported eating burgers "less than once per month" or "1–3 times per month", whereas almost two-thirds of the sample (64%) reported eating sausages "once a week" or "1–3 times per month". These reported frequencies indicate that more people consume sausages more frequently than burgers[3] (see Table 2 for further details).

Pearson's chi-squared coefficients show that participants were equally assigned across the six experimental conditions, with respect to sociodemographic characteristics. In addition, participants' general attitudes toward the two Chinese signs, which were used as the stimuli items in the "intuitive evaluation" section of the survey, in accordance with the AMP method, showed similar results (sign 1: mean = 3.65 SD = 1.12; sign 2: M = 3.70, SD = 1.07). A within-subjects repeated measures ANOVA showed that there were no significant differences between participants' attitudes toward the two Chinese signs [$(F(1,952) = 3.83$, $p = 0.05$, partial $\eta^2 = 0.004$], which suggests that the two Chinese signs were perceived as being equally attractive by participants. This

3 This sample represents burger and sausage consumers, as the consumption of these products was a qualifying criterion for participating in the survey.

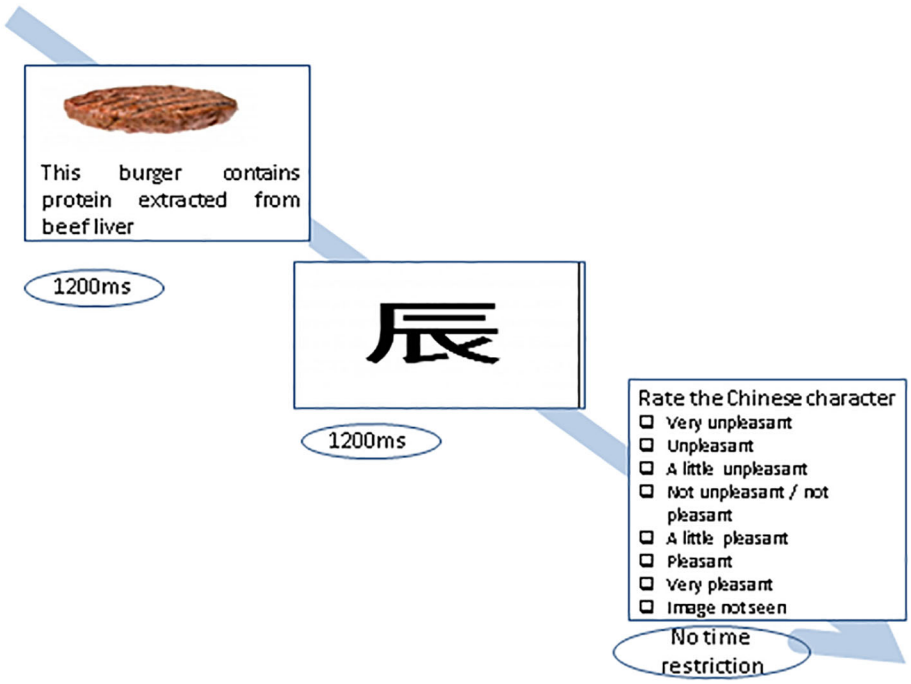

FIGURE 2
Example of steps for the AMP task. AMP, affect misattribution procedure.

indicates that any possible statistical difference in participants' intuitive evaluations was not due to differences in the perceived attractiveness of the Chinese signs.

4.1 Descriptive analysis

4.1.1 Main measured variables across conditions and products

An overview of the means and standard deviations for the main measured variables is provided in Table 3. For almost all variables, the highest values were noted when benefit information was provided and when protein was extracted from the liver (rather than the lung). In comparison, the lowest values were noted when no information was provided and when protein was extracted from the lung. Moreover, when comparing the variable scores acquired for the two product carriers, that is, burgers and sausages, there were no differences in the scores. This confirms that it is reasonable to average the measures coming for the two products to obtain an aggregated score for each variable.

4.2 Hypothesis testing

4.2.1 Predicting attitude formation

Intuitive evaluation had a significant effect on participants' *deliberate evaluation* of food products containing offal-derived protein, regardless of the experimental condition [$F(1,951)$ = 117.30, $p < 0.001$]. The direction of this effect was found to be positive ($\beta = 0.33$), meaning that participants with a more positive intuitive evaluation subsequently expressed a more positive deliberative evaluation.

The *overall attitudes* toward food products containing offal-derived protein were well predicted by data for the *deliberate* and the *intuitive* evaluations [$F(1,951) = 1429.99$, $p < 0.001$, $R^2 = 0.87$], with *deliberate evaluation* ($\beta = 0.85$) having a greater positive influence on *overall attitudes* than *intuitive evaluation* ($\beta = 0.03$). Therefore, results confirm hypothesis 1 and hypothesis 2.

The interaction effect of *deliberate evaluation* and *attitude ambivalence* was found to be insignificant [$F(1,951) = 719.75$, $p = 0.11$], indicating that participants' *deliberate evaluation* affected their overall attitude toward these products containing offal-derived protein regardless of experienced ambivalence. Thus, hypothesis 3 is not supported by the data.

4.2.2 Effect of familiarity and information manipulations on the main variables

We found that *familiarity* had no significant main effect on the *intuitive evaluation* of product concepts containing protein extracted from beef offal [$F(1,951) = 1.46$, $p = 0.23$]. Thus, hypothesis 4 is not supported by the data. Although not hypothesized, a significant main effect of *familiarity* on *deliberate evaluation* was detected [$F(1,951) = 9.52$, $p < 0.001$]. Specifically, participants' deliberate evaluation for familiar product concepts was significantly more positive than that for unfamiliar product concepts.

We found that *information provision* had a significant main effect on *deliberative evaluation* [$F(1,951) = 19.49$, $p < 0.01$] in the direction that providing information, either of benefit or ambiguous, led to a significantly more positive deliberate

TABLE 2 Participant demographics (n = 953) and Pearson's chi-squared test to ensure no sampling bias across the six study conditions.

	CSO[1],%	n (%) or M (SD)		Distribution across survey conditions
Gender				
Male	48.9	492	(51.6%)	$\chi^2(5) = 3.99$, $p = 0.55$
Female	51.1	461	(48.4%)	
Age category				
18–24 years	11.2	85	(8.9%)	$\chi^2(25) = 18.86$, $p = 0.84$
25–34 years	18.5	166	(17.4%)	
35–44 years	20.6	214	(22.5%)	
45–54 years	17.6	191	(20.0%)	
55–64 years	14.2	159	(16.7%)	
65+ years	17.9	138	(14.5%)	
Highest level of education completed				
Primary school	11.7	7	(0.7%)	$\chi^2(15) = 17.96$, $p = 0.26$
Secondary school	45.5	272	(28.5%)	
Third level (non-degree, i.e., diploma, certificate)	11.7	327	(34.3%)	
Third level (degree or higher, i.e., undergraduate, postgraduate, PhD, etc.)	30.9	347	(36.4%)	
Social Class				
AB	24.3	203	(21.3%)	$\chi^2(20) = 21.98$, $p = 0.34$
C1	17.1	304	(31.9%)	
C2	37.3	142	(14.9%)	
DE	14.8	292	(30.6%)	
F	6.6	12	(1.3%)	
Provnieco f resiedenc				
Dublin	22.8	280	(29.4%)	$\chi^2(20) = 23.49$, $p = 0.27$
Rest of Leinster	21.4	252	(26.4%)	
Munster	33.7	274	(28.8%)	
Connacht	14.5	100	(10.5%)	
Ulster (part of ROI)	7.6	47	(4.9%)	
Survey condition				
Familiar + no information		161	(16.9%)	
Familiar + benefit information		155	(16.3%)	
Familiar + ambiguous information		164	(17.2%)	
Unfamiliar + no information		158	(16.6%)	
Unfamiliar + benefit information		159	(16.7%)	
Unfamiliar + ambiguous information		156	(16.4%)	
Attitudes toward consuming product carriers[a]				
Burgers		4.65	(1.49)	
Sausages		4.85	(1.43)	
Frequency of burger consumption				
Less than once per month		341	(35.8%)	
1–3 times a month		351	(36.8%)	
Once a week		208	(21.8%)	
2–4 times per week		48	(5%)	
5–6 times per week		3	(0.3%)	
Daily		2	(0.2%)	
Frequency of sausage consumption				
Less than once per month		187	(19.6%)	
1–3 times a month		278	(29.2%)	
Once a week		334	(35%)	
2–4 times per week		124	(13%)	
5–6 times per week		22	(2.3%)	
Daily		8	(0.9%)	

[a]Evaluated by one item: "I am positive about eating…" on a seven-point scale (1 = strongly disagree, 7 = strongly agree).
[1]CSO, Central Statistics Office; M, mean; SD, standard deviation.

TABLE 3 Means (SDs) for intuitive evaluation, deliberate evaluation, overall attitude, and acceptance toward burgers tabulated by study conditions (measured on a seven-point scale) (n = 953).

		Protein extraction source	Intuitive evaluation	Deliberate evaluation	Overall attitude	Acceptance
Sausages	**No information**	Liver	3.84 (1.28)	3.70 (1.48)	3.57 (1.82)	3.81 (1.65)
		Lung	**3.72** (1.31)	**3.40** (1.56)	**3.12** (1.87)	**3.20** (1.76)
	Benefit information	Liver	3.82 (1.33)	**4.25** (1.54)	**4.30** (1.71)	**4.26** (1.53)
		Lung	3.77 (1.09)	4.15 (1.62)	4.25 (1.83)	4.17 (1.73)
	Ambiguous information	Liver	**4.00** (1.04)	4.12 (1.38)	4.17 (1.63)	4.17 (1.53)
		Lung	3.81 (1.29)	3.75 (1.58)	3.78 (1.87)	3.68 (1.74)
Burgers	**No information**	Liver	**3.57** (1.18)	3.74 (1.34)	3.92(1.70)	3.92 (1.59)
		Lung	3.58 (1.31)	**3.33** (1.48)	**3.19** (1.74)	**3.14** (1.68)
	Benefit information	Liver	**3.75** (1.36)	**4.39** (1.50)	**4.50** (1.78)	**4.37** (1.52)
		Lung	3.66 (1.10)	4.16 (1.62)	4.15 (1.67)	4.19 (1.62)
	Ambiguous information	Liver	3.70 (1.14)	4.16 (1.30)	4.24 (1.62)	4.20 (1.47)
		Lung	3.63 (1.17)	4.03 (1.56)	3.89 (1.90)	3.80 (1.68)

Red font denotes the highest value; blue font denotes the lowest value.
SD, standard deviation.

evaluation than when no information was provided [$t(950) = 6.03$, $p < 0.05$ (one-tailed)]. These results provide support for hypothesis 5, that is, receiving any kind of information significantly positively increased deliberative evaluation compared with not receiving any information.

The interaction effect for *intuitive evaluation* and *ambiguous information* on *deliberate evaluation* was not significant [$F(1,951) = 39.72$, $p = 0.38$]. These results do not confirm hypothesis 6 and indicate that participants' intuitive evaluation of products containing protein extracted from beef offal affected their deliberate evaluation of these products similarly, whether or not ambiguous information was provided to them.

5 Discussion

Although we found that attitude ambivalence did not impact on overall attitude, the nature of this attitude needs to be considered. It has been noted that attitude ambivalence is associated with weaker attitudes (Britt et al., 2011; Simons et al., 2019), more susceptibility to change (Bassili, 1996; Armitage and Conner, 2000), and less attitude–behavior consistency (Armitage and Conner, 2004). These three factors need consideration and indeed ambivalence, as it exists in our study, could lead to a significant attitude behavior gap. Furthermore, the behaviors of two individuals displaying the same overall attitudes could vary dramatically. Attitude instability because of ambivalence may result in an openness to new information, resulting in a shift toward either a more positive or negative attitude valence. The credibility, transparency, and relevance of the information provided (to addressing sources of ambivalence) is key to ensuring the emergence of more stable overall attitudes.

Using familiar carrier foods has been shown to increase the acceptance of novel foods (Wansink, 2002; Hartmann et al., 2015); however, exceptions occur when the combination of ingredients is perceived to be inappropriate (Stallberg-White and Pliner, 1999). To counter this risk, in the current study, we used two familiar carrier products. These were mince-based meats, to which the offal ingredient was added. Through this mechanism we were able to test the impact of familiarity of the ingredient on overall attitude. Our findings suggest that the potential impact of lack of familiarity with the ingredient is offset by familiarity with the carrier products. Building on the evidence base that incorporating novelingredients into familiar foods impacts on the acceptance of the former, importantly, this study suggests that the impact is equal across novel ingredients, irrespective of their level of novelty. The study findings also corroborate the conclusion put forward by Henchion et al. (2016), namely that "familiarity with the form of the carrier was significant in overcoming ideational influences". This is important because ideation could lead to a disgust response, which could manifest in intuitive evaluations. A disgust response results in foods being rejected "because of what they are, where they came from, or their social history" (Martins and Pliner, 2005 p. 215). The evidence here suggests that a disgust response is not dominating the evaluation of these novel foods but creating a "good gut feeling" about their consumption, which could in turn improve intuitive evaluations and indeed attenuate the effect of attitude ambivalence (Groenendyk, 2019).

With respect to attitude formation, this study found that consumers' intuitive and deliberate evaluations toward the

products with novel ingredients worked in the same direction, and predicted their overall attitudes toward these products. However, deliberate evaluation was found to be a better predictor of consumers' overall attitudes. This result can be related to the differential roles of intuitive and deliberate evaluation. Research has suggested a dissociation pattern, with intuitive evaluation influencing spontaneous choices and behaviors, and deliberate evaluations influencing conscious evaluations (Perugini, 2005; Richetin et al., 2007; König et al., 2016).

In addition, this analysis found that intuitive evaluations do not influence deliberate evaluations, suggesting that information provision that prompts deliberate evaluations could lead to the formation of more considered and stable attitudes. Although this study concurs with the argument of information studies in general and in related areas of application [e.g., Pelchat and Pliner, 1995, Verneau et al. (2016) in relation to insect-based products and Bekker et al. (2017) in relation to cultured meat] that providing information on product benefits results in more positive evaluations, it also found that the provision of information, be it benefit or benefit–risk orientated, has a positive effect on deliberate evaluations. This finding adds to the suggestion that explicitly referencing uncertainty, in this case the risk, can increase persuasion. Karmarkar and Tormala (2010) found that, in certain conditions, when an expert source expresses some level of uncertainty, deeper message processing can occur with a positive impact.

6 Practical implications

The current study demonstrates that consumers expressed relatively positive attitudes toward the food products containing protein extracted from beef offal, indicating that protein extracted from beef offal has a realistic potential of being incorporated into food products as an alternative protein source, and being accepted by consumers in Ireland. Specifically, familiar product concepts containing protein extracted from beef offal were more (deliberately) positively evaluated, than unfamiliar product concepts. Therefore, product developers should focus on incorporating protein extracted from familiar beef offal sources, such as the liver or heart rather than those that are more unfamiliar, such as lungs. Beyond the results of this study which was conducted with Irish consumers, it should be noted that familiarity and exposure to beef offal is culture dependent, and the social influence on individuals' choices to eat the meat of some animals and avoid that of others may vary among collectivistic and individualistic cultural contexts (Ruby and Heine, 2012).

Consumers' attitudes and acceptance of food products containing protein extracted from beef offal should be also considered at a societal level. Achieving acceptance on both personal and societal levels might support the emergence of stable attitudes, and, therefore, of decisions to consume these food products. Public acceptance of many new foods (e.g., sushi and avocado, in the European context) and associated technologies (e.g., GM) appears to be an evolutionary rather than a revolutionary process. Studies on foods that were initially perceived as novel and that gained widespread acceptance over time show that new foods initially gain popularity in one small social segment before diffusing further (House, 2016). Technologies that are more established also tend to be viewed more positively by some consumer segments (Food Standard Agency, 2020). Following on from work on the establishment of other new foods, it is recommended that early adopters, rather than general populations, receive greater attention, and familiar food technologies might positively contribute to public acceptance. In this way, the overall market acceptance of food products containing protein extracted from beef offal could be increased over time.

In addition to carefully designing products containing protein extracted from beef offal and ensuring the availability of these products, other elements of the marketing mix, particularly promotion, should be considered as a precondition for their success. Promotion of these products through social media, which allows businesses to be in direct contact with consumers, could be a promising channel of communication. Social networks and platforms enable people to communicate with each other, share information and content, and, in many cases, are used as a way to spread awareness and influence others. Communication of new things is often cognitive in nature, with a focus on explaining (Dudo, 2013). Indeed, the current study shows that providing information about the health and environmental benefits of consuming food products containing protein extracted from beef offal was (deliberately) positively evaluated. Therefore, any action that would favor deliberation is likely to increase the possibility that deliberate attitudes would drive consumers' attitudes and potentially their decisions in the marketplace. However, the present research also indicates that it is important to address affect when presenting these food products, as consumers' intuitive evaluations are also important. Therefore, communication campaigns for products containing protein extracted from beef offal should be carefully designed and incorporate both affective and cognitive elements.

Finally, it should be noted that in order to achieve successful inclusion of protein extracted from beef offal into humans' diet, collective action of a variety of stakeholders (e.g., nutrition experts, the food industry, policymakers, and food quality agencies) is necessary. Although marketing strategies at the product level (i.e., around the food product containing protein extracted from beef offal) are essential, broader communication which targets the consumer acceptance of products containing ingredients that have been extracted from co-processing streams more generally is also very important. This communication could be embedded in the context of drive toward a circular economy and the aim of transitioning toward a more sustainable food system. Moreover, this transdisciplinary approach facilitating engagement between different stakeholders supports learning and knowledge exchange across organizations and sectors. In this way, industry awareness will also be achieved, with manufacturers—across food and non-food sectors—having access to information regarding the opportunities to develop products containing ingredients from co-processing streams. Socializing the idea of valorizing meat by-products for human consumption, through different channels and with the use of consistently delivered, transparent, reliable, and

informative content could be an effective strategy to include beef offal extracted protein in diets. In essence, the end goal would be that food products containing protein extracted from beef offal could turn into habitual purchases for some consumer segments. In this process, consumers need to have the tools available to accommodate deliberative evaluation, and, when attitudes are positive, choices can turn into habits.

7 Limitations

As with any research, the scope of the present study is necessarily restricted. One limitation concerns the conceptualization of familiar and unfamiliar product concepts. Although the carrier products, that is, burgers and sausages, are well-established food products, familiarity with the product concepts was addressed through the incorporation of one more familiar (i.e., beef liver) and one more unfamiliar (i.e., beef lung) protein source into the product carriers. Future research should further identify what other product carrier–ingredient combinations are truly familiar or unfamiliar. Comparing attitudes toward unfamiliar food products from other cultures to familiar food products from one's own culture could be an interesting research direction.

A further limitation has to do with the experimental setup used in this study to investigate consumers' attitudes. Although a questionnaire-based survey is the most commonly used method, thanks to its relatively low cost and ease of administration, this method suffers from some limitations. The most salient of these are self-representation biases (e.g., responding in a way that reflects social desirability) and an inability to report actual cognitive contents and behaviors (Greenwald and Banaji, 2010; Glöckner and Herbold, 2011). The possible impact of the survey methodology on consumer responses also needs to be considered, as it is unlikely that consumers go through substantial elaboration in the process of attitude expression for most of their daily food decisions.

Finally, limitations arise for the measures used to depict intuitive evaluations such as the AMP used in this study. No intuitive measurement is process pure, as they are all based on a behavioral task that involves a controlled process (e.g., press a button, make a choice) besides the automatic evaluation (Conrey et al., 2005). Physiological measurements such as galvanic skin response, heart rate variability, fMRI (a technique that measures brain activity by detecting changes associated with blood flow), and eye tracking provide insights into underlying psychological processes, without constraining any of the involved processes (Glöckner and Witteman, 2010). Although it is practically impossible to apply these tools to a large study sample, it would be interesting to combine these experimental studies with large representative sample surveys to acquire a deeper understanding of the underlying processes in attitude formation toward the specific food products under investigation.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethics approval was not provided for this study on human participants because ethics approval was not required according to local legislation or lead research (Teagasc) institutional requirements. However, ethics and data protection guidelines as set down in the EC Ethics and data protection (2018) document were followed. Participants provided informed consent and were afforded the opportunity to withdraw from the study. In addition, all data were anonymized, and the data protection standards applied in all institutions were adhered to. The patients/participants provided their written informed consent to participate in this study.

Author contributions

GL: conceptualization, methodology, analysis, data curation, and writing—original draft. MH: conceptualization, methodology, supervision, writing—review and editing, and funding acquisition. MM: conceptualization, methodology, supervision, writing—review and editing, and funding acquisition. SO'R: conceptualization, methodology supervision, and writing—review and editing. All authors contributed to the article and approved the submitted version.

Funding

This research was funded through the Teagasc Walsh Fellowship Programme and forms part of the ReValueProtein Research Programme, which was supported by the Department of Agriculture, Food, and the Marine (DAFM) through the Food Institutional Research Measure (FIRM) (11/F/043).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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