



## Comparing motivations and barriers to reduce meat and adopt protein alternatives amongst meat-eaters in Australia, China and the UK

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### ABSTRACT

Motivations are central in determining consumer food choices and provide insights regarding barriers to change. Given the global need to transition towards more sustainable protein consumption patterns, understanding cross-cultural motivations is important. The present research aimed to address this knowledge gap by reviewing motivations to reduce meat and to adopt meat substitutes, edible insects and cultured meat amongst meat-eating consumers in Australia, China and the UK ( $n = 1,777$ ). An online survey captured the importance of key motivations via closed-ended statements, with barriers to change collected via open-ended questions for extremely unwilling consumers. Results found food safety and environmental benefits to be the most important motives for meat reduction and protein alternatives adoption. Chinese and UK consumers were more motivated by these factors compared to Australian consumers who had the greatest proportion of consumers unwilling to reduce based on the belief meat consumption is necessary for health reasons. Relative differences in motivational importance were also apparent by protein alternative type. In general, the greatest proportion of unwilling responses amongst Australians ( $n = 245$ ) related to the use of meat substitutes, whilst for Chinese ( $n = 160$ ) and UK consumers ( $n = 97$ ) it related to edible insects. Six key themes were identified amongst extremely unwilling consumers, with the protein alternatives being perceived as; Unhealthy, Unnecessary, Unsustainable, Unsafe, Unnatural and Unappealing. The prominence of themes differed between countries and across protein categories, but the perception that alternatives were unnecessary was a communal theme. Overall, the findings provide interesting insights and recommendations to support country-specific protein transitions.

### 1. Introduction

Total global food demand is expected to increase by up to 56 % by 2050 (Van Dijk et al., 2021). Predominantly this is driven by growing populations alongside economic development and urbanisation. Subsequently, it is expected that there will be a greater demand on animal proteins causing further environmental pressures with regards to deforestation, water pollution and Green House Gas (GHG) emissions (Steinfeld et al., 2006). Increasing food production whilst minimising environmental damage, ensuring food security and addressing public health issues therefore present some of the biggest global challenges moving forward.

Mitigative solutions relate to a reduction in meat consumption and

including a wider variety of non-animal protein sources (Clark & Tilman, 2017; Willett et al., 2019). Additionally, there is a need to consume meat from more sustainable sources such as Carbon Neutral Beef which is produced using regenerative agricultural techniques. In summary, this farming practice is an alternative method for producing food that has the potential to reduce and or provide a net positive environmental and social impact (Newton et al., 2020). Through mimicking the earth's natural cycles, this form of agriculture has numerous benefits (e.g., improved soil health, greater carbon sequestration, reduced GHG emissions).

Additionally, the inclusion of a wide range of protein alternatives are needed to meet differing consumer needs. For example, this could be in relation to affordability, availability, nutritional needs, varying cuisines

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and palates. Potential protein alternatives include plant-based meat substitutes, edible insects and cultured meat which eliminate or reduce the need to breed, raise and slaughter animals and therefore alleviate the environmental pressures associated with traditional animal agricultural practices (Kim et al., 2020; Parodi et al., 2018). Examples of protein alternatives include plant-based meat substitutes which often incorporate a variety of ingredients (e.g., pea or soy protein, mycoprotein, seitan, tempeh) and are frequently processed into products that mimic the appearance, taste and texture of meat (Tso et al., 2020). Currently, the plant-based meat market has seen huge global growth which is projected to rise 24.9 % between 2023 and 2030 from USD \$4.4 billion in 2022 (Grand view Research, 2023). However, this forecast is not always supported by current news which has observed a continued decline in plant-based sales since 2021 with nearly a 21 % decrease in volume sales over a 52-week period (Wilson, 2023).

Alternatively, a potential novel source of protein are edible insects. Although edible insects are consumed by several hundreds of millions of people (Van Huis et al., 2022), they are less prevalent within western societies (van Huis, 2013). However, the past decade has seen increased attention focused on the promotion of insects as human food (Van Der Weele et al., 2019). This is partially due to their similar nutritional value and health benefits to meat, but much lower environmental impact than meat (Van Huis & Rumpold, 2023). For example, although the nutritional composition of insects varies greatly between species (Payne et al., 2016a) some do have favourable nutrient profiles when compared with meat (Payne et al., 2016b). Furthermore, insects emit less greenhouse gas emissions and require less land, especially in the case of mealworms compared to beef (Kim et al., 2020; Oonincx & De Boer, 2012).

By comparison, cultured meat, which utilises future food technology to grow animal cells *in vitro*, is also gaining traction as a future protein alternative. The rapid development of technologies means that products are likely to become available to the public soon (Lee et al., 2020). However, before cultured meat becomes available on the market, there are still many challenges to overcome such as technological difficulties and high costs associated with scalability (Deliza et al., 2023; Treich, 2021). Overall, it is thought the substitution of meat with protein alternatives will play a contributing role in achieving sustainable global food production goals (Kozicka et al., 2023; Moruzzo et al., 2021; Nobre, 2022). However, the success of this dietary transition depends on consumers changing their consumption habits.

### 1.1. Consumer motivations and barriers to reduce meat and adopt protein alternatives

Motivations are central in determining consumer food choices and provide insights with regards to prominent barriers to change. Key food related motivations include; price, food safety, sensory appeal, convenience, animal welfare, environmental and health benefits (Lindeman & Väänänen, 2000; Steptoe et al., 1995). In general, the top motivations for reducing meat consumption are reported to be health benefits, animal welfare and environmental/ sustainability concerns (Cheah et al., 2020; Graça et al., 2019). Conversely, the barriers can relate to a belief that meat is indispensable in a balanced diet (Font-i-Furnols & Guerrero, 2022). Meat-eaters can also demonstrate meat-related cognitive dissonance associated with animal welfare issues (Rothgerber, 2020) and have lower environmental concerns around meat reduction (De Boer and Aiking, 2022). Additional barriers towards meat reduction include a general attachment to meat (Ford et al., 2023a; Graça et al., 2015a) which is often linked to the justifications that eating meat is natural, normal, necessary and nice (Piazza et al., 2015).

For plant-based meat substitutes, motivations can relate to moral and ethical factors as well as the convenience and ease of cooking as a replacement to meat (Graça et al., 2019; Onwezen et al., 2021). Sensory appeal is also a prominent motive, but the processes involved in creating products that mimic meat can create negative consumer perceptions

around unnaturalness and subsequent concerns related to health and safety (Ford et al., 2023a; Varela et al., 2022). In addition, although meat substitutes are often marketed under the pretence of being beneficial for the environment and health, partially due to the role they play in replacing meat in the diet, it is not guaranteed that consumers will agree with this (Hartmann et al., 2022).

For edible insects and cultured meat, similar motivations and barriers are apparent with potential environmental and health benefits being key drivers for acceptance, whilst food neophobia and concerns around food safety reduce acceptance (Onwezen et al., 2021). Additionally, for edible insects, disgust remains a prominent psychological barrier preventing consumers from eating insects (Russell & Knott, 2021; White et al., 2023). In contrast, negative perceptions around naturalness and concerns around affordability are additional barriers for cultured meat (Bryant & Barnett, 2020; Pakseresht et al., 2022; Siddiqui et al., 2023).

Overall, there is a baseline level of understanding of the motivations and barriers towards meat reduction and protein alternatives. Considering a recent *meta*-review found motivation to be an important domain for driving and supporting the protein transition (Onwezen & Dagevos, 2023), it continues to be an important area to explore especially as food trends and consumer needs evolve. However, the relative importance placed on food choice motives are known to vary across cultures (Markovina et al., 2015; Torán-Pereg et al., 2023) and by protein alternative category (Hartmann & Siegrist, 2017; Onwezen et al., 2021; Tso et al., 2020). Predominantly this is due to cultural differences in meat consumption and variations in the familiarity with protein alternatives (Font-i-Furnols, 2023). Currently, there is little understanding as to how the magnitude of motivations differs across protein alternative categories and by cultural backgrounds. As this is of considerable importance when developing strategies to encourage protein transitions it highlights gaps in future research.

### 1.2. Research gaps, strategy and study aims

It is known that meat consumption varies by country (Font-i-Furnols, 2023). For example, currently, China is the world's largest consumer of pork, with rapid economic development leading to a general increase in other types of meat (Wang, 2022). Conversely, Australia has one of the highest per capita meat intakes in the world, increasing red meat consumption by 12Kg between 2020 compared to 2019 (Font-i-Furnols, 2023). By contrast, UK consumption is lower, but the Committee on Climate Change has made it a priority to encourage a 20 % reduction in meat consumption by 2030 in order to meet carbon reduction targets (CCC, 2021).

The present study follows on from previous research (Ford et al., 2023b) reviewing meat-eaters willingness to reduce meat and to adopt protein alternatives amongst consumers in Australia, China and the UK. Findings reflected cultural variations in meat consumption rates, willingness to reduce different types of meat and willingness to use/adopt protein alternatives. Specifically, Australians were predicted to be less willing to reduce meat and to use/adopt meat substitutes and cultured meat and more willing to try edible insects. In contrast, consumers from the UK and China were more willing to reduce meat and to use/adopt meat substitutes and cultured meat but less willing to try edible insects (Ford et al., 2023b). Therefore, as future protein transitions are likely to be culturally specific it is important to understand the motivations and barriers behind these results.

Although an increasing number of papers have reviewed consumer acceptance towards meat reduction and plant-based meat substitutes (Graça et al., 2019; Onwezen et al., 2021), edible insects (Florença et al., 2022; Van Huis & Rumpold, 2023) and cultured meat (Pakseresht et al., 2022; Siddiqui et al., 2022), there is still a lack of cross-cultural studies comparing product related motivations including comparisons across protein alternatives. As consumer responses can vary considerably dependent on the protein alternative type (plant vs insect vs cultured

proteins), it is important to understand such differences (Onwezen & Dagevos, 2023). Furthermore, the majority of research has focused on willing consumers, yet it is equally important to study the extremely unwilling consumers to understand barriers. In understanding the barriers, we can develop evidence-based actions for supporting the protein transition (e.g., informing, framing, nudging, (dis)incentivising) (Onwezen & Dagevos, 2023). Findings can inform social marketing campaigns aiming to promote sustainable protein consumption.

Open-ended questions have been used widely in surveys and allow consumers to be open and free in their opinions. Previously, this data collection method has been applied to food-related consumer studies (Ares et al., 2014; Jaeger et al., 2023; Spinelli et al., 2017; Vidal et al., 2022), including consumers' perceived representation, impact and rationales around meat consumption (Graça et al., 2015b). It has also been applied in a cross-cultural context (Aguirre et al., 2019). It is therefore a popular tool to collect a range of in-depth, unprompted consumer opinions within the field of sensory and consumer research.

Considering the variation in consumption patterns between the three countries in this study, it was hypothesised that the countries will not be homogenous in their motivations to reduce meat consumption and to adopt alternatives. Therefore, findings provided interesting insights between two western countries with differing meat consumption habits and a non-western country. Specifically, the present study aimed to extend current findings and contribute to new knowledge by addressing the following study objectives:

- 1) To understand and compare the most important motivations across countries in relation to; reducing meat consumption and adopting meat substitutes, edible insects and cultured meat.
- 2) To explore the underlying reasons across countries for being extremely unwilling to reduce meat and to try/ adopt meat substitutes, edible insects and cultured meat.

## 2. Materials and methods

An online consumer survey was designed and administered through Jisc online surveys, certified to ISO/IEC 27,001 standard (JISC®, 2022). Details pertaining to the development of the questionnaire, participant recruitment and sample demographics have previously been published (Ford et al., 2023b). The UK and China surveys were approved by the University of Nottingham's Faculty of Medicine and Health Sciences Ethics Committee (UK Ref. number: 89-0820; China Ref. number: 154-0121), and the Australian survey was approved by the Human Research Ethics Committee at the University of Adelaide (Ref. number: H-2021-022). Before answering any questions, consumers were asked to give their consent to take part in this research. Data was collected between October 2020 – June 2022 throughout Australia (n = 503) the UK (n = 489) and just within the city of Shanghai in China (n = 785). The surveys were circulated in each country separately to allow the recruitment, advertisement and participant information sheet to specifically require participants to currently reside in either the UK or Australia. Participants also had to give consent of their residency before completing the survey. For the Chinese survey, a market research agency (Credamo, China) was utilised to ensure only consumers from the city of Shanghai were recruited. A back translation process from English to Chinese and back into English was applied by two native Chinese speakers (authors YZ & QY).

### 2.1. Questionnaire design

This questionnaire formed part of a larger survey which collected data in relation to a variety of topics (e.g., consumers' perceptions of sustainable diets, current meat intake, willingness to reduce meat, personality traits, meat attachment). For the current paper, general motivations to reduce meat consumption and to adopt protein alternatives are evaluated. Additionally, open-ended responses from consumers who

scored 'extremely unwilling' in response to meat reduction and the adoption of protein alternatives are reviewed. Findings therefore follow on from a previously published paper by the authors reviewing consumer willingness (Ford et al., 2023b). Key demographic characteristics were collected and are presented in the Appendix (Table S1).

#### 2.1.1. Willingness to reduce meat and adopt protein alternatives

Consumers were asked about their willingness to reduce meat and their willingness to use meat substitutes<sup>1</sup> in the next year. Consumers were then asked about their willingness to try and/ or adopt edible insects and cultured meat in future diets. The questions were presented using a 7-point scale with the anchors 'extremely unwilling (1)' to 'extremely willing (7)' (Ford et al., 2023b). Consumers who scored 'extremely unwilling' in response to reducing meat and adopting the three protein alternatives were not asked about their motivations on the premise that they were not motivated to reduce meat and adopt alternatives and could skew the results. Therefore, motivational data was not available to analyse for consumers who scored extremely unwilling (score 1).

#### 2.1.2. Motivations

The remaining participants who scored 2 – 7 on the willingness scale were asked about their motivations to reduce meat consumption and eat and or try protein alternatives. Therefore, the total number of participants (n = 1,777) who completed the motivational data for each question were as follows; To reduce meat consumption Aus: = 286, China = 759, UK = 435; To use meat substitutes: Aus = 258, China = 752, UK = 427; To adopt edible insects: Aus = 376, China = 625, UK = 392; To adopt cultured meat: Aus = 311, China = 752, UK = 435.

Motivations were captured throughout the questionnaire with the anchors 'extremely unimportant (1)' to 'extremely important (7)'. Participants were provided with a list of seven motives (health benefits, convenience, sensory appeal, price, animal welfare, food safety, environmental benefits) adapted from the Food Choice Questionnaire (Steptoe et al., 1995) and Ethical Concern Subscale (Lindeman & Väänänen, 2000). Consumers were asked, "How important are the following factors in your decision to reduce your overall meat consumption?". Using the same set of motives, consumers were then asked, "How important are the following factors in motivating you to eat and or try meat substitutes?". The questions were repeated for edible insects and cultured meat.

#### 2.1.3. Reasons behind extremely unwilling

For those who scored 'extremely unwilling', these participants were asked to 'please provide a reason as to why you are extremely unwilling to; reduce your meat consumption in the next year for sustainability or environmental reasons; to consider using meat substitutes as a replacement to meat in the next year; to consider adopting edible insects/ cultured meat into your future diet'. The number of participants who scored 'extremely unwilling' to each individual open-ended question are presented in Table 1.

## 2.2. Data analysis

### 2.2.1. Motivations to reduce meat and adopt protein alternatives

Regression tree analysis with the CHAID algorithm was applied to

<sup>1</sup> **Meat substitutes** were defined as: 'products that are protein-containing foods that are primarily vegetable based and are frequently used to replace the function of meat as a meal component. Meat substitutes are often made up of pea protein, soya (tofu), mycoprotein (Quorn), jackfruit or animal-like proteins produced by yeast extract and are often designed to imitate meat in taste, texture, and appearance. They can therefore take the form of burgers, sausages, chicken strips, ham slices etc. They are predominantly used in hot meals and can make up components of ready-made meals'.

**Table 1**  
Cross tabulation between extremely unwilling responses and country.

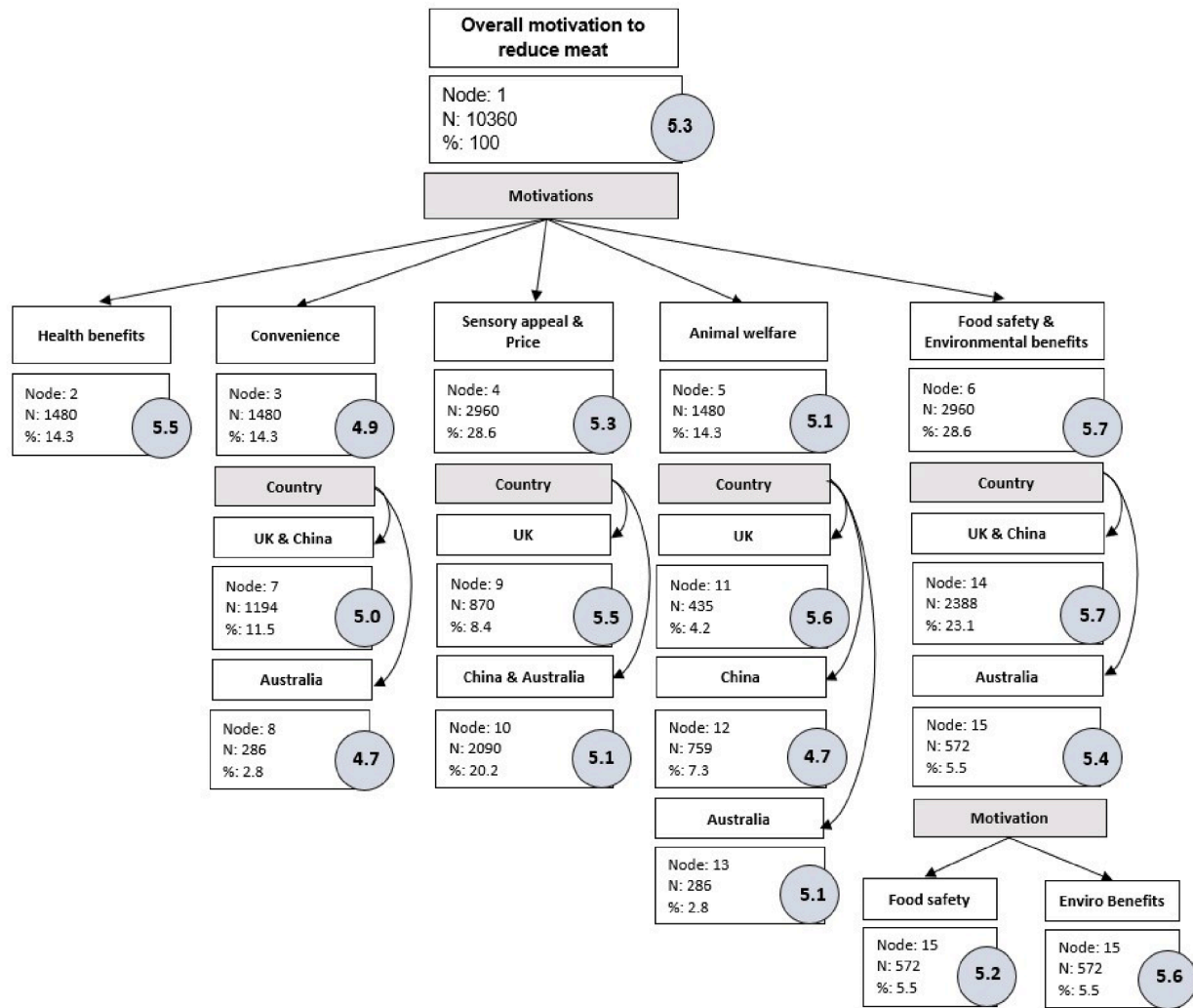
| Extremely unwilling        | Total<br>(n = 1,777) | Australia<br>(n = 504) |      | China<br>(n = 785) |      | UK<br>(n = 489)  |      |
|----------------------------|----------------------|------------------------|------|--------------------|------|------------------|------|
|                            | n                    | n                      | %    | n                  | %    | n                | %    |
| To reduce meat consumption | 297                  | <b>217 (&gt;)</b>      | 73.1 | <b>26 (&lt;)</b>   | 8.8  | 54 (<)           | 18.2 |
| To use meat substitutes    | 340                  | <b>245 (&gt;)</b>      | 72.1 | <b>33 (&lt;)</b>   | 9.7  | 62 (<)           | 18.2 |
| To adopt edible insects    | 384                  | <b>127 (&lt;)</b>      | 33.1 | <b>160 (&gt;)</b>  | 41.7 | <b>97 (&gt;)</b> | 25.3 |
| To adopt cultured meat     | 279                  | <b>192 (&gt;)</b>      | 68.8 | <b>33 (&lt;)</b>   | 11.8 | 54 (<)           | 19.4 |

**Note:** Bold values are significantly different according to Fisher’s test for significance (0.05) (i.e., if the actual value is lower (<) or higher (>) than the theoretical value for each cell). Please note: the number of responses is representative of consumers who scored ‘1’ on the willingness scale (e.g., in total 297 consumers out of 1,777 were extremely unwilling to reduce meat consumption, the majority (n = 217) were from Australia).

explore the associations between country and motivations with; meat reduction and protein alternative adoption. The data was analysed using XLSTAT version 2022.2.1 (Addinsoft, Paris, France). The dependent variable related to the motivation scores for reducing meat intake and adopting protein alternatives, whilst the independent variables related to country, motivation category and protein alternative type. To interpret the data, the predicted mean value scores are based on the original 7-point scales, with N = number of pooled participant responses and % = sample population. For this analysis, consumers who scored extremely unwilling were excluded.

2.2.2. Reasons for being extremely unwilling

The responses to the four open-ended questions were collected and analysed using the qualitative analysis software Nvivo, 20. The Chinese responses were translated into English by the author YZ. Thematic analysis (TA) following an inductive coding process was then applied using the guidelines of Braun & Clarke. (2022). After the familiarisation and coding stage, an initial framework matrix of themes was generated by the author, HF which was reviewed and developed by the rest of the authors. The open-ended responses could be assigned to more than one theme. In close alignment with the principles of quantitative content



**Fig. 1.** Regression tree generated for motivations to reduce meat consumption with country and the seven motivation categories as independent variables. Please note: N = number of pooled participant responses, % = sample population. The predicted mean value scores are based on the original scale: 1 = Extremely unimportant, 2 = Moderately unimportant, 3 = Slightly unimportant, 4 = Neutral, 5 = Slightly important, 6 = Moderately important, 7 = Extremely important. Consumers who scored extremely unwilling to reduce meat were excluded leaving; Aus = 286, China = 759, UK = 435.

analysis (Krippendorff, 2018), the frequency of themes was calculated based on the number of times each consumer provided a response within a theme. Similar approaches have been presented in previous research (Aguirre et al., 2019; Jaeger et al., 2023). Verbatim responses were used to clarify and support the chosen themes.

### 3. Results

#### 3.1. Motivations to reduce meat intake

For the strength of motivations to reduce meat, the different motivational categories were more influential compared to country differences, as identified by the first split (Fig.1). Factors were grouped together when there was a significant result and therefore a significant relationship between variables based on the Pearson’s chi-squared test of independence. Overall, food safety and environmental benefits were grouped together as the most important factors (M = 5.7) followed by health benefits (M = 5.5), sensory appeal and price (M = 5.3), animal welfare (M = 5.1) and convenience (M = 4.9). Therefore, all of the factors are somewhat important to consumers, scoring between ‘slightly’ and ‘moderately’ important. Additional splits found country differences to be apparent for all the motivational factors excluding health benefits. For food safety and the environmental benefits, consumers in the UK and China (Shanghai) found these factors significantly more important (M = 5.7) compared to consumers in Australia (M = 5.4). Australian consumers additionally found environmental benefits to be more important (M = 5.6) than food safety (M = 5.2). For sensory appeal and price, consumers in the UK scored higher (M = 5.5) compared to Australian and Chinese consumers (M = 5.1). For animal welfare, UK consumers found this to be more important (M = 5.6) compared to Australian consumers (M = 5.1) who also scored higher than Chinese consumers (M = 4.7). Lastly, for convenience, this factor was more important for

consumers in China and the UK (M = 5.0) compared to Australian consumers (M = 4.7).

#### 3.2. Motivations to use and or adopt protein alternatives

For the strength of motivations to use and /or adopt protein alternatives, the motivational categories were the most influential factor, followed by country and protein alternatives. Overall, food safety and the environmental benefits which were grouped together were the most important factors (M = 5.7) followed by sensory appeal (M = 5.6), health benefits (M = 5.4), price (M = 5.3), convenience (M = 5.0) and animal/ insect welfare (M = 4.9) (Fig. 2). All motivational categories identified significant country differences.

For the environmental benefits, UK and Chinese consumers found this to be more important (M = 5.8, M = 5.9) respectively compared to Australian consumers (M = 5.4). Similar importance was placed on the environmental benefits of each protein alternative for UK consumers, with Australian consumers finding no significant difference. However, Chinese consumers found the environmental benefits to be more important for cultured meat (M = 6.0) compared to edible insects and meat substitutes (M = 5.6).

A similar trend was observed for convenience, with Chinese and UK consumers scoring this as significantly more important (China: M = 5.2, UK: M = 5.1) compared to Australian (M = 4.6) consumers. Overall, Australians were the only consumers to show a reasonably large mean difference between the protein alternatives. Specifically, convenience was more important for cultured meat and meat substitutes (M = 5.8) compared to edible insects (M = 4.4).

For food safety, Chinese consumers found this to be a more important factor (M = 5.9) compared to UK (M = 5.6) and Australian consumers (M = 5.4). In particular, Chinese consumers felt it was more important for edible insects and meat substitutes (M = 6.1) compared to cultured

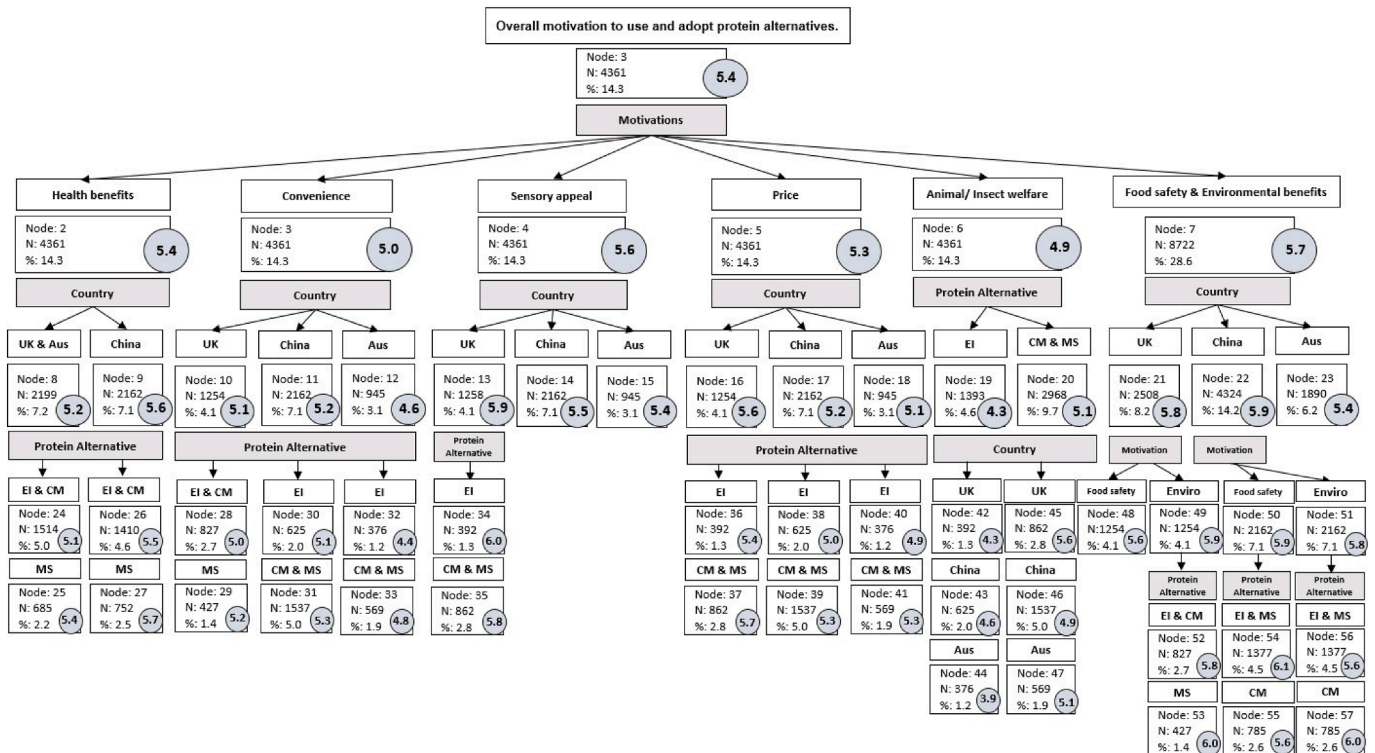


Fig. 2. Regression tree generated for motivations to use/adopt meat substitutes, edible insects and cultured meat with country, the seven motivations and protein alternative categories as independent variables. Please note: N = number of pooled participant responses, % = sample population. The predicted mean value scores are based on the original scale: 1 = Extremely unimportant, 2 = Moderately unimportant, 3 = Slightly unimportant, 4 = Neutral, 5 = Slightly important, 6 = Moderately important, 7 = Extremely important. Consumers who scored extremely unwilling to adopt were excluded leaving the final totals; MS (Meat substitutes): Aus = 258, China = 752, UK = 427; EI (Edible insects): Aus = 376, China = 625, UK = 392; CM (Cultured meat): Aus = 311, China = 752, UK = 435.

meat (M = 5.6). By comparison, Australian and UK consumers found food safety to be equally important across protein alternatives. Chinese consumers also scored the health benefits significantly higher (M = 5.6) compared to Australian and UK consumers (M = 5.2). However, all groups found small mean differences between protein alternative type.

In terms of sensory appeal, UK consumers found this to be more important (M = 5.9) compared to Chinese and Australian consumers (M = 5.5, M = 5.4) respectively. However, all countries found the importance of sensory appeal to be similar or equal across protein alternative types. In addition, UK consumers also found price to be significantly more important (M = 5.6), compared to Chinese (M = 5.2) and Australian (M = 5.1) consumers. However, all three countries found it to be more motivational in relation to cultured meat and meat substitutes, compared to edible insects with the biggest mean difference observed amongst Australian consumers (0.4).

Lastly, for animal/ insect welfare, this factor was the least important overall but had the biggest mean difference between protein alternative types. Overall, it was more motivating for cultured meat and meat substitutes (M = 5.1) compared to edible insects (M = 4.3). For cultured meat and meat substitutes, UK consumers scored welfare higher (M = 5.6) compared to Australian (M = 5.1) and Chinese (M = 4.9) consumers. Whereas for edible insects, Chinese consumers rated welfare higher (M = 4.6) compared to UK (M = 4.3) and Australian (M = 3.9) consumers.

### 3.3. Barriers towards meat reduction and adoption of protein alternatives

In total, 1,300 open-ended responses were collected for the meat reduction and protein alternative questions, with all extremely unwilling consumers leaving a comment. The Pearson chi-square statistic found a significant ( $p < 0.0001$ ) difference in the proportion of extremely unwilling consumer responses across countries and by category (i.e. meat reduction, meat substitutes, edible insects, cultured meat) (Table 1).

Overall, Australian participants had the greatest proportion of consumers supplying unwilling responses compared to Chinese and UK consumers. Australians were most unwilling to adopt meat substitutes (n = 245, 72 %), reduce their meat consumption (n = 217, 73 %) or adopt cultured meat (n = 192, 69 %) with the lowest proportion of unwilling responses relating to edible insects (n = 127, 33 %). By comparison, the greatest proportion of unwilling responses for Chinese and UK consumers related to adopting edible insects (n = 160, 42 %; n = 97, 25 %) and the lowest responses related to reducing meat consumption (n = 26, 9 %; n = 54, 18 %), respectively. It should be noted that the Chinese participant responses were considerably shorter which highlights potential cross-cultural differences in responding to open-ended questions.

#### 3.3.1. Extremely unwilling to reduce meat consumption

Applying thematic analysis revealed six themes: Meat consumption is necessary for health reasons; Meat consumption is not environmentally damaging, other factors are; Meat is normal, nice and better than alternatives and Meat can be produced and consumed sustainably (Table 2). In addition, two themes were created grouping together the comments from consumers who disagreed with the information and who gave an emotional response.

The most frequently mentioned theme for being extremely unwilling to reduce meat intake related to meat being necessary for health reasons (Aus: 59.4 %; China: 26.9 %; UK: 13 %).

Australian consumers mentioned this more frequently compared to Chinese and UK consumers. Consumers found meat to be *the healthiest*

**Table 2**

Extremely unwilling consumers (%) who mentioned the different themes in relation to meat reduction.

| Theme  | Topics   | Total | Aus  | China | UK   |
|--|--|-------|------|-------|------|
| <b>Meat consumption is necessary for health reasons</b>                    | Meat improves health and wellbeing, is a complete source of nutrients, essential for dietary needs.                                | 35.4  | 43.3 | 19.2  | 11.1 |
|  | Protein alternatives provide insufficient nutrition and can lead to negative health consequences.                                  | 12.8  | 16.1 | 7.7   | 1.9  |
| <b>Meat consumption is not environmentally damaging, other factors are</b> | Current meat production and consumption is sustainable, meat is not the problem.   | 14.1  | 14.7 | 11.5  | 13.0 |
|  | Other factors are also an issue; food waste, food miles, packaging, burning fossil fuels, international travel, plant-based foods. | 15.8  | 20.3 | 7.7   | 1.9  |
|  | Others   | 5.7   | 3.7  | 11.5  | 11.1 |
| <b>Meat consumption is normal, nice and better than alternatives</b>       | responsibility, up to the producers not the consumers, individual change won't make a difference.                                  | 10.8  | 12.0 | 0.0   | 11.1 |
|  | It is natural and normal; humans have evolved to eat meat.   | 13.1  | 6.5  | 42.3  | 25.9 |
|  | Enjoy, like eating meat, meat tastes good.   | 9.4   | 10.6 | 11.5  | 3.7  |
| <b>Meat can be produced and consumed sustainably</b>                       | Don't like vegetables or processed alternatives.   | 17.8  | 23.0 | 0.0   | 5.6  |
|  | Regenerative agriculture is the way forward. Eating locally produced, high welfare sustainable meat in moderation is the solution. | 12.5  | 11.5 | 3.8   | 20.4 |
| <b>Disagree with information</b>   | Disagree, biased view presented.   | 20.2  | 24.0 | 0.0   | 14.8 |
|  | Climate change is not real.  | 3.7   | 4.1  | 0.0   | 3.7  |
| <b>Emotional response</b>  | Defensive or angry: my diet, my choice.  | 10.8  | 9.7  | 7.7   | 16.7 |
|  | Others are behind the need to change: vegans, vegetarians, big food companies, politics, the privileged, people of power.          | 7.7   | 7.8  | 0.0   | 11.1 |

**Please note:** Australia, n = 217, (73 %); China, n = 26, (9 %); UK, n = 54, (18 %); Total, n = 297 (100 %). The % values in the table reflect the proportion of consumers who mentioned that theme within each country (e.g., for Australia, out of the 73 % (n = 217) of extremely unwilling consumers, 43.3 % mentioned meat consumption was necessary for health reasons).

human food on the planet' and therefore an essential nutritional source. In comparison, protein alternatives were found to be nutritionally inadequate and likely to cause negative health consequences. Subsequently, consumers mentioned the inclusion of meat in their diet as being vital in helping address various physical and mental health issues (obesity, pre-diabetes, depression), as well as autoimmune and dietary deficiencies (digestive issues, anaemia). Example responses from each country are shown below:

"Meat is vital to health. I have reversed several health conditions by embracing animal products."  
(Australia, Female, 25–34)

"To ensure nutritional intake."  
(China, Male, 25–34)

"I want to stay healthy by consuming readily digestible amino acids, bioavailable vitamins and minerals provided by meat, which are not available from plants."  
(UK, Male, 65 + )

The second most frequently mentioned theme related to the perception that meat consumption is not environmentally damaging but other factors are (Aus:38.7 %; China: 30.7 %; UK: 26 %). Consumers in all three countries felt meat reduction was unnecessary when current production and consumption is and can be sustainable. Therefore, meat was perceived to not be a problem. In particular, Australian consumers felt that the production of plant-based foods is more cause for concern referencing the environmental damage and pressure caused through mono-crop agriculture. Subsequently, a larger proportion of Australians mention other factors (20.3 %) compared to Chinese (7.7 %) and UK (1.9 %) consumers. Other factors mentioned included the burning of fossil fuels and the emissions associated with cars and flights, whilst Chinese consumers mentioned the impact of food waste and excessive packaging. The belief that others were more accountable, whether that be the food producers or people around the world who are increasing their meat intake was mentioned more frequently by UK and Chinese consumers (~11 %) compared to Australian consumers (3.7 %).

"I would like to see people reduce their impact on the environment by flying less, using their cars less and consider their impact on the environment."  
(Australia, Female, 55–65)

"The environmental impact of food waste and excessive packaging may be far greater than the impact of meat production."  
(China, 18–24, Female)

"I do not believe that I as one person can change anything – the pressure to make the industry more sustainable should be on producers not on consumers."  
(UK, Female, 18–24)

Another frequently mentioned theme related to meat consumption being normal, nice and better than alternatives (Aus: 29.1 %; China: 53.8 %; UK: 40.7 %). Interestingly, a higher proportion of Chinese (42.3 %) and UK (25.9 %) consumers mentioned this compared to Australian consumers (6.5 %). Instead, for Australians the emphasis was more on meat being natural and normal and linked to our ancestral needs. This theme was also mentioned by some UK consumers but was not stated by Chinese consumers. A dislike of vegetables and processed meat-free alternatives was also mentioned more frequently by Australian (10.6 %) and Chinese consumers (11.5 %) compared to UK consumers (3.7 %).

"We have come from cave man, our brains grew, we evolved eating meat and fat."  
(Aus, Female, 35–54)

"I have money, love to eat meat".  
(China, Female, 18–24)

"I both like meat and believe humans are designed to eat meat".  
(UK, Male, 55–65)

The final key theme related to the perception that meat can be produced and consumed sustainably (Aus: 34.5 %; China: 3.8 %; UK: 26 %). The premise that meat can be produced sustainably was predominantly mentioned by consumers in Australia (23 %) and a few in the UK (5.6 %) but was not mentioned by Chinese consumers. The main topic related to regenerative farming practices which were perceived to be a better solution compared to meat reduction and were thought to underpin a sustainable diet. Consumers described the process of regenerative farming, highlighting how animal agriculture typically utilises non-arable land, sequesters carbon, replenishes soil. Examples of how to consume meat sustainably were more frequently mentioned amongst UK consumers (20.4 %) compared to Australian (11.5 %) and Chinese (3.8 %) consumers. Factors related to eating meat in moderation, from local butchers, produced ethically, from regenerative farm practices, with minimal food waste (e.g., eating nose to tail).

"Regenerative farming to provide a sustainable diet requires ruminants not monocropping. A majority of the land for ruminants cannot be cropped and cannot feed the world with a plant-based diet."  
(Australia, Male, 45–54)

"I have not caused waste in my meat consumption."  
(China, Female, 18–24)

"Eating more, but higher welfare and more locally produced meat, helps to support local farmers and drive down the price compared to less sustainable products."  
(Female, UK, 45–54)

In total, 20.2 % of consumers stated that they disagreed with the statement that accompanied the question (Appendix I – Statement A). The majority of consumers were Australian (24 %) and from the UK (14.8 %) whilst no Chinese consumers explicitly disagreed. Overall, only a few were climate change deniers (3.7 %). It was very apparent when reviewing the responses that a proportion of consumers across all three countries were also defensive and or angry (10.8 %) towards the suggestion of reducing meat consumption. For some consumers, there was a sense of 'it's my diet, my choice', and subsequently a feeling of being constrained, controlled, and told what to do. For some Australian (7.8 %) and UK (11.1 %) consumers there was a perception that others are behind the need to reduce meat intake, notably non-meat-eaters such as vegans and vegetarians. It was also believed that big pharmaceutical and food companies, political agendas, the privileged and people of power would likely benefit from the transition.

"Absolute rubbish being perpetuated on society by vested groups and vegans."  
(Australia, Female, 55–65)

"This vegan push is best culturally insensitive, really racist and at worse genocide through malnutrition."  
(Australia, Male, 45–54)

"Let me ask you, have you reduced it yourself?"  
(China, Male, 25–34)

"Like to eat meat, unwilling to be constrained."  
(China, Male, 25–34).

"All you bloody tofu eaters need to leave meat eaters alone."  
(UK, Male, 45–54)

"I believe in freedom of choice, and I like meat".  
(UK, Male, 55–65)

#### 3.4. Extremely unwilling to eat and or try protein alternatives

Overall, five key themes were identified; Unhealthy, Unnecessary,

Unsustainable, Unsafe and Unappealing. For meat substitutes and cultured meat, an additional theme relating to Unnaturalness was also identified. The most frequently mentioned themes differed across countries and by protein alternative.

3.4.1. Meat substitutes

The most frequently mentioned themes amongst Australian consumers related to meat substitutes being unhealthy and unnatural (~35.5 %). Whilst the perception that meat substitutes are unnecessary was the most mentioned theme amongst Chinese (39.4 %) and UK (40.4 %) consumers (Table 3).

**Unhealthy:** A larger proportion of Australians (36.7 %) mentioned meat substitutes were unhealthy compared to Chinese (18.2 %) and UK (11.3 %) consumers. Meat substitutes were especially perceived as being nutritionally inadequate and in some cases, detrimental to health compared to conventional meat which was believed to contribute to good health. This was partially related to the processed nature of products, with some concerns around the different chemical ingredients included and the low bioavailability of nutrients in products. The quantity of substitutes that need to be consumed in order to match the

**Table 3**  
Extremely unwilling consumers (%) who mentioned the different themes in relation to being extremely unwilling to use meat substitutes.

| Theme                        | Topics  | Total | Aus  | China | UK   |
|------------------------------|---|-------|------|-------|------|
| Unhealthy                    | Unhealthy, nutritionally inadequate, toxic, meat is essential.  | 30.3  | 36.7 | 18.2  | 11.3 |
|                              | Unnatural & highly processed, fake food, artificial, full of additives/chemicals.   | 26.8  | 34.3 | 6.1   | 8.1  |
| Unnecessary                  | Enjoy and prefer real meat, whole foods, meat consumption is necessary and normal.  | 20.6  | 18.0 | 36.4  | 22.6 |
|                              | There are sustainable options for eating meat, regenerative farming, self-sufficiency, meat is not the culprit.                               | 4.7   | 3.3  | 3.0   | 11.3 |
|                              | Other ways to be meat-free, vegetables, grains, tofu, beans.  | 4.1   | 4.1  | 0.0   | 6.5  |
| Unsustainable                | Environmentally damaging, worse for the environment compared to livestock farming, large carbon footprint, food miles, supports monocropping. | 15.0  | 16.7 | 0.0   | 14.5 |
| Unsafe                       | Unsafe, not fit for human consumption, too many chemicals, toxic.   | 4.7   | 4.1  | 15.2  | 1.6  |
| Unappealing                  | Unappealing, don't like them, don't want them.  | 2.9   | 0.4  | 3.0   | 12.9 |
|                              | Negative sensory appeal; taste is not good, bland, boring, unable to replicate real meat.   | 5.3   | 1.2  | 24.2  | 11.3 |
| Disagree with information    | Disagree, biased view presented.  | 15.3  | 17.1 | 0.0   | 16.1 |
| Others are behind the change | Gives power/ control to big food companies to make profit, people of power, vegetarians and vegans.   | 4.7   | 4.5  | 3.0   | 6.5  |

**Please note:** Australia, n = 245, (72 %); China, n = 33, (10 %); UK, n = 62, (18 %); Total, n = 340 (100 %). The % values in the table reflect the proportion of consumers who mentioned that theme within each country (e.g., for Australia, out of the 72 %, (n = 245) of extremely unwilling consumers, 36.7 % mentioned meat substitutes were unhealthy).

nutritional value of meat was also questioned. The negative effects of meat substitutes were associated with an increased risk of developing diabetes, high blood sugar levels, obesity, anaemia as well as being triggering for conditions such as fibromyalgia, IBS, Chron's disease, hives and allergy problems (soy).

"Because it's unhealthy, full of oestrogen mimicking soy and highly inflammatory seed oils."

(Australia, Female, 35–44)

"Moderate meat intake contributes to good health."

(China, Male, 25–34)

"As an athlete, I don't feel the nutritional content is as good as consuming meat."

(UK, Female, 18–24)

**Unnatural:** A larger proportion of consumers in Australia (34.3 %) compared to the UK (8.1 %) and China (6.1 %) commented on meat substitutes being highly processed and unnatural labelling them as 'fake' and 'full of harmful additives / awful chemicals / unnatural ingredients'. References to being high in salt / preservatives, containing pro-inflammatory ingredients and high oestrogen concentrations were also made.

**Unnecessary:** Meat substitutes were perceived to be unnecessary when there is 'real' meat available. Many therefore questioned why there is a need to replace meat with 'fake' foods that mimic meat. The enjoyment gained from meat was frequently mentioned by Chinese (36.4 %) and UK consumers (22.6 %), more than Australian consumers (18 %). However, only Australians gave the reasoning that meat consumption is 'normal' and part of our evolution and ancestral needs. Subsequently, instead of consuming meat substitutes, alternative options were mentioned such as 'less but better meat' (local, high welfare, regeneratively farmed). These options were more apparent to consumers in the UK (11.3 %) compared to Australian and Chinese (~3%) consumers. Some from the UK and Australia also commented on alternative whole food ingredients which can be utilised instead of meat substitutes when going meat-free (grains, vegetables, legumes).

"I don't understand why when there are legumes etc. we would need to eat a meat substitute."

(Australia, Female, 65 + )

"Can't find a substitute as the meat tastes fantastic."

(China, Female, 18–24)

"The solution is to source sustainable meat in small quantities, local, fed with local food. Less meat but better meat both for the environment and animal welfare."

(UK, Female, 18–24)

The themes unappealing, unsafe and unsustainable were less frequently mentioned but the responses were closely linked to the themes previously mentioned. A summary of the output with corresponding quotes can be found in the Appendix.

3.4.2. Edible insects

Overall, the most frequently mentioned theme by all consumers related to the unappealing nature of edible insects (Table 4).

**Unappealing:** For many, the thought of consuming edible insects was disgusting, fear inducing and made some feel queasy. The unappealing nature was most frequently mentioned by Chinese consumers (92.5 %) followed by UK (79.4 %) and Australian (53.5 %) consumers. The psychological discomfort towards insects was partly based on the unpleasant appearance and negative taste/texture experiences or perceptions. Subsequently, a few also stated that edible insects should not be considered as food.

"I can't stand them living let alone as a meal."

(Australia, Male, 65 + )



**Table 4**  
Extremely unwilling consumers (%) who mentioned the different themes in relation to being extremely unwilling to adopt edible insects.

| Theme                     | Topics   | Total | Aus  | China | UK   |
|---------------------------|--|-------|------|-------|------|
| Unappealing               | Unappealing, unacceptable, not interested, don't like, psychological barrier, food neophobia, apprehension, aversion, creepy, disgusting, disturbing, gross, scary, queasy, revolting. | 76.3  | 53.5 | 92.5  | 79.4 |
|                           | Negative sensory appeal, unpleasant appearance, aesthetically unappealing, taste revolting, unpalatable, boring, fishy, crunchy, bitty residue.  | 10.2  | 6.3  | 11.9  | 12.4 |
|                           | Not a food source, eat real food, not their place in the food chain, don't want to eat my foods food.  | 3.9   | 3.9  | 4.4   | 3.1  |
|                           | We have plentiful sources of meat/ protein to meet future population needs, would not be able to replace meat, happy with current diet, no need to eat insects.                        | 7.3   | 15.7 | 1.3   | 6.2  |
| Unnecessary               | There are better alternatives, real meat, sustainable meat produced through regenerative agriculture, vegetarian and vegan food.   | 7.8   | 13.4 | 0.6   | 12.4 |
|                           | Insects are more plausible as animal and fish food.  | 1.0   | 1.6  | 0.0   | 2.1  |
| Unsafe                    | Dirty, unhygienic, pesticides, vermin, not sanitary, dirty unknown health effects, vectors for disease.  | 3.9   | 4.7  | 2.5   | 5.2  |
| Unhealthy                 | Nutritionally inadequate especially compared to meat, insufficient fat levels, not a complete protein.   | 1.8   | 3.9  | 0.6   | 1.0  |
|                           | Allergic to shellfish, medical condition.  | 1.0   | 2.4  | 0.0   | 1.0  |
| Unsustainable             | Insects are important to the environment, pollinators, ecology, would create an unbalance, regenerative agriculture is more sustainable.   | 1.3   | 2.4  | 0.6   | 1.0  |
|                           | Welfare, insects have feelings too, sentient beings, killing the same but on a larger scale.   | 2.3   | 0.8  | 1.3   | 6.2  |
| Disagree with information | Disagree, imaginary problem, biased statement.   | 1.0   | 1.6  | 0.0   | 2.1  |
| Agenda pushed by others   | Gives power to others, green lobby, political/ alternative agenda, politicized narrative, fascist plan, elite fraudsters.  | 1.8   | 3.1  | 0.0   | 3.1  |

**Please note:** Australia, n = 127, (33 %); China, n = 160, (42 %); UK, n = 97, (25 %); Total, n = 384 (100 %). The % values in the table reflect the proportion of consumers who mentioned that theme within each country (e.g., for Australia, out of the 33 %, (n = 127) of extremely unwilling consumers, 53.5 % mentioned edible insects were unappealing).

"I'm scared of bugs, even if it's not made to look like a bug, but if it says it's a bug, it's still unpalatable."  
(China, Female, 18–24)

"No sensory appeal. The time I tried a bar with cricket flour in it tasted horribly fishy."  
(UK, Female, 35–44)

**Unnecessary:** A larger proportion of Australians mentioned edible insects were unnecessary (15.7 %) compared to UK (6.2 %) and Chinese consumers (1.3 %). In general, consumers felt there was no need for edible insects when there are plentiful sources of meat which can be produced sustainably through regenerative agriculture. Others were satisfied with their current diet and felt no real need to add edible insects. In particular, UK consumers mentioned they would rather stick to plant-based sources of protein.

"I eat the natural Human diet. Meat, and meat-based food. Insects eat insects."  
(Australia, Male, 45–54)

"It's not primitive. There's no need to eat insects."  
(China, Male, 55–65)

"There is no need, we can produce adequate volumes of protein to meet the needs of the future population."  
(UK, Male, 65 +)

The remaining themes, unsafe, unhealthy and unsustainable were less frequently mentioned and the output is summarised in the Appendix. Compared to the other alternatives, few consumers disagreed with the statement presented in the Appendix (statement C).

### 3.4.3. Cultured meat

The top theme identified amongst UK and Australian consumers related to the perception that cultured meat is unnatural (42.6 %, 33.9 %), whilst for Chinese consumers the top theme related to the unappealing nature (i.e. scared, uncomfortable with the thought) of cultured meat (33.3 %) (Table 5).

**Unnatural:** Cultured meat was perceived as unnatural and processed with some labelling it as 'Frankenstein food' especially amongst UK (42.6 %) and Australian (33.9 %) consumers compared to Chinese consumers (12.1 %). In particular, the thought of food produced in a lab acted as a psychological barrier.

"Feel sick psychologically."  
(China, Female, 55–65)

"I won't eat anything unnatural. The concept is absolutely revolting to me."  
(Australia, Female, 45–54).

"Nothing made in a laboratory should ever grace a plate of food."  
(UK, Male, 45–54)

**Unappealing:** The unnatural perception of cultured meat was closely associated with unappealing, which was mentioned more amongst consumers in China (33.3 %) compared to the UK (11.1 %) and Australia (10.9 %). In addition, a greater proportion of Chinese consumers (15.2 %) mentioned negative sensory perceptions compared to Australians (2.9 %), with UK consumers not mentioning this topic. Specifically, there was a concern that cultured meat would taste and look different and lack the subtle flavours induced by food sources.

"It can only be made palatable by adding unhealthy food."  
(Australia, Male, 55–65)

"Haven't tried it, but I think artificial meat is similar to cheating your senses."  
(China, Female, 18–24)

**Table 5**  
Extremely unwilling consumers (%) who mentioned the different themes in relation to being extremely unwilling to adopt cultured meat.

| Theme                            | Topics   | Total | Aus  | China | UK   |
|----------------------------------|--|-------|------|-------|------|
| <b>Unnatural</b>                 | Unnatural and processed, fake foods, Frankenstein food.  | 33.0  | 33.9 | 12.1  | 42.6 |
| <b>Unappealing</b>               | Unappealing, don't like the thought, food neophobia; disgusting, weird, repulsive, revolting, wrong, unacceptable, dangerous, won't eat it.  | 13.6  | 10.9 | 33.3  | 11.1 |
| <b>Unnecessary</b>               | Negative sensory appeal.   | 2.9   | 1.6  | 15.2  | 0.0  |
|                                  | Nothing wrong with current meat consumption, too old to change, won't be available for a while.  | 3.9   | 5.2  | 0.0   | 1.9  |
|                                  | Humans have always eaten meat; we have evolved to eat meat.  | 2.2   | 3.1  | 0.0   | 0.0  |
| <b>Unsustainable</b>             | There are better alternatives, unprocessed foods, real meat, reduced meat, sustainable meat produced through regenerative agriculture.   | 21.5  | 20.8 | 18.2  | 25.9 |
|                                  | Environmentally damaging, high carbon emissions, does not allow for regenerative agriculture, energy intensive, process requires huge resources; plastic, water, land, electricity, storage, transportation, less efficient, high dependence on monocrops to feed the cells. | 14.7  | 20.8 | 9.0   | 1.9  |
|                                  | Unethical, does not support/ will destroy the farming community, does not address animal welfare issues/ animals still being used.   | 5.4   | 4.2  | 9.0   | 13.0 |
|                                  | Unaffordable, inaccessible.  | 3.2   | 2.1  | 12.1  | 1.9  |
| <b>Unsafe</b>                    | Unsafe, harmful, still experimental, unknown side effects, untested, will make us sick, food safety, hygiene.  | 8.6   | 8.3  | 12.1  | 7.4  |
| <b>Unhealthy</b>                 | Unhealthy, cannot match conventional meat for nutrition.   | 8.6   | 11.5 | 6.1   | 0.0  |
| <b>Disagree with information</b> | Disagree, biased view presented.   | 9.3   | 9.9  | 0.0   | 13.0 |
| <b>Gives power to others</b>     | Gives power/ control/ profit to others, pharmaceutical companies, big food industries, the wealthy, privileged, corporate controlled society.  | 7.9   | 7.8  | 0.0   | 13.0 |

**Please note:** Australia, n = 192, (69 %); China, n = 33, (12 %); UK, n = 54, (19 %); Total, n = 279 (100 %). The % values in the table reflect the proportion of consumers who mentioned that theme within each country (e.g., for Australia, out of the 69 %, (n = 192) of extremely unwilling consumers, 33.9 % mentioned cultured meat was unnatural).

“Artificial items destroy the qualities of the meat itself and will not have the characteristics of natural meat.”  
(China, Male, 25–34)

**Unnecessary:** Similar to the comments made around meat substitutes, consumers felt that cultured meat is not needed when there are better alternatives available. Specifically, consumers mentioned the

consumption and enjoyment of consuming real, authentic meat and whole food alternatives most frequently amongst consumers in the UK (25.9 %) followed by Australia (20.8 %) and China (18.2 %). UK consumers also mentioned another option would be the reduction or complete removal of meat rather than consuming cultured meat. In contrast, Australian consumers mentioned the role of regenerative agriculture in producing meat sustainably which was perceived as a more viable route compared to making meat in a lab using ‘*mad science*’. Australians were also the only group of consumers (3.1 %) to mention the notion that humans have always eaten meat and it is therefore an evolutionary need.

“I don't see the point in creating Frankenstein meat when we could concentrate on healthy and sustainable animal farms and stop destroying so much land by planting million-acre mono-crops to grow food that leads to obesity and increased risk such as CVD.”  
(Australia, Female, 45–54)

“I prefer to eat real natural meat.”  
(China, Male, 18–24).

“I think I'd rather just be a vegetarian than eat meat that was cultured / developed in a laboratory.”  
(UK, Female, 35–44).

The remaining themes, unsustainable, unsafe and unhealthy are reported in the Appendix. Included are the responses from those who disagreed with the information and who felt the concept of cultured meat gives power to big food industries, pharmaceutical companies and wealthy individuals.

#### 4. Discussion

The discussion firstly reviews country differences in relation to the extremely unwilling responses and the key reasons behind the consumer responses. Key differences in motives across the protein alternatives for each country are then discussed and recommendations in relation to practical implications provided. It is worth noting that the current findings cannot be generalized to UK, Australian and Chinese (Shanghai) consumers. Future research should recruit a more nationally representative data set and should require consumers to affirm the duration of their residency in a given country. In addition, the comparatively brief responses to the open-ended questions from Chinese consumers could suggest the findings are less data rich compared to Australian and UK consumers. One suggestion could be to encourage participants to “write as much as you can” (Jaeger & Cardello, 2022).

##### 4.1. Extremely unwilling responses country differences

The higher proportion of extremely unwilling responses from Australian consumers, highlights a greater resistance towards meat reduction and protein alternative adoption compared to Chinese and UK consumers as observed previously (Ford et al., 2023b). Specifically, Australians were extremely unwilling to adopt plant-based meat substitutes more than the other alternatives. This contradicts previous research which suggests overall, that plant-based meat tends to be favoured more than cultured meat and edible insects (Circus & Robison, 2019; Gómez-Luciano et al., 2019; Grasso et al., 2019; Heijnk et al., 2023; Motoki et al., 2022). By comparison, the higher proportion of extremely unwilling responses for edible insects compared to the other alternatives for Chinese and UK consumers aligns with these findings. One reason for the greater resistance amongst Australians could be due to a larger preference for whole grains and legumes compared to more processed forms of plant-based meat substitutes (Estell et al., 2021). The barriers discussed below provide further insights into the main reasons driving this response.

**Table 6**

Top 3 themes mentioned by extremely unwilling consumers for each protein type across countries.

| Barriers                | Australia  | China  | UK   |
|-------------------------|--|--|--|
| To reduce meat          | 1. Necessary for health reasons<br>2. Meat is not environmentally damaging<br>3. Meat can be produced and consumed sustainably | 1. Meat consumption is normal, nice & better than alternatives<br>2. Meat is not environmentally damaging<br>3. Necessary for health reasons | 1. Meat consumption is normal, nice & better than alternatives<br>2. Meat is not environmentally damaging<br>3. Necessary for health reasons |
| To use meat substitutes | 1. Unhealthy<br>2. Unnatural<br>3. Unnecessary   | 1. Unnecessary<br>2. Unappealing<br>3. Unhealthy   | 1. Unnecessary<br>2. Unappealing<br>3. Unsustainable   |
| To adopt edible Insects | 1. Unappealing<br>2. Unnecessary<br>3. Unhealthy   | 1. Unappealing<br>2. Unsafe<br>3. Unnecessary & Unsustainable  | 1. Unappealing<br>2. Unnecessary<br>3. Unsustainable   |
| To adopt cultured meat  | 1. Unnatural<br>2. Unnecessary<br>3. Unsustainable   | 1. Unappealing<br>2. Unsustainable<br>3. Unnecessary   | 1. Unnatural<br>2. Unnecessary<br>3. Unsustainable   |

#### 4.2. Barriers to reduce meat intake and adopt protein alternatives

The top three themes given by extremely unwilling consumers to not reduce meat and adopt protein alternatives are provided in Table 6. These key barriers are used as guidance for the structure of the discussion.

##### 4.2.1. Meat consumption is not environmentally damaging, other factors are

The notion that other factors (i.e., food waste, food miles, packaging, burning of fossil fuels, international travel) are more environmentally damaging compared to meat consumption supports findings amongst a nationally representative Australian sample (Rattenbury & Ruby, 2023). These authors reported that despite an increase in awareness, consumers may still view meat as less environmentally damaging compared to other factors (e.g., public transport, renewable resources, recycling). However, previous research has claimed that meat and dairy production contributes a similar level of emissions compared to the transport sector despite many consumers perceiving the transport industry to be a bigger contributor (Bailey, 2014). In general, it is thought that what we choose to eat has far greater impact on the environment compared to food miles and packaging based on estimates that more emissions are produced during the production of meat and subsequent changes in land (i.e. deforestation required for animal feed) (Poore & Nemecek, 2018; Ritchie, 2020). However, this also simplifies the complexity of the topic, with environmental emissions varying by numerous factors (e.g., meat type, production method). Either way, the importance of what people choose to eat supports the sentiment many of the unwilling to reduce meat consumers felt. Specifically, the consumer focus should be on how meat is produced not a reduction of meat. In other words, 'it's not the cow, it's the how' (Rodgers & Wolf, 2020).

##### 4.2.2. Meat can be produced and consumed sustainably

Following on from the above points, some consumers felt the current depiction of meat being environmentally damaging, ignores the potential benefits of regenerative agriculture. Regenerative agriculture formed the basis of the reasoning behind the belief that 'meat can be produced and consumed sustainably'. Australian consumers were especially knowledgeable on this topic mentioning it more frequently compared to Chinese and UK consumers. This could be in response to the bushfires in Australia, in which farmers were directly impacted which subsequently made the need for supportive and sustainable farming practices more pertinent. The higher awareness amongst consumers for this practice is likely due to Australia having one of the biggest communities of advocates promoting the natural role of ruminant animals in protecting the farming environment (Cusworth et al., 2022). Overall,

these findings bring into question whether a greater level of resistance to meat reduction would also be present in other countries like China and the UK if awareness of these sustainable farming practices were more apparent and / or products produced through this method were more available.

Although regenerative agriculture offers a sustainable prospect for producing and consuming meat, which is recognised in the recent Intergovernmental Panel on Climate Change report (IPCC, 2019), it is thought to only make up a small proportion (less than 1 %) of the total meat market (Friedrich, 2021). It also faces barriers towards adoption, such as it is an expensive process for farmers to transition towards (e.g., upfront costs, lack of resources) which comes with its own social stigma and fear around change (Kenny & Castilla-Rho, 2022). Subsequently, for consumer demand to increase, it will require consumers to be willing to pay more for 'clean and green' meat or for alternative cost reducing strategies to be put in place with support from government, food distributors, supermarkets and wider communities (Kenny & Castilla-Rho, 2022). In addition, regenerative farming practices vary by location, for example, a comparable strategy called 'Agriculture Green Food Development' is applied in China. Similarly, products labelled as 'green' or 'organic' are thought to be associated with higher costs but also greater levels of mistrust due to food safety scandals (Xu et al., 2020). Consequently, a middle ground between the environmental benefits of reducing meat intake and producing affordable, efficient and safe meat from sustainable practices is required. Ultimately, if consumers are motivated by the environmental benefits, whether that be associated with meat intake, reduction or consuming only sustainably grown meat, a certain level of disruption to meat production and consumption practices are required.

##### 4.2.3. Protein alternatives are unsustainable & unnecessary

The unnecessary nature of all protein alternatives was a commonality between countries amongst extremely unwilling consumers. This theme links closely with the stance that meat can be produced and consumed sustainably, and protein alternatives are comparatively unsustainable. Consumers were less concerned about the potential unsustainable nature of edible insects compared to plant-based meat substitutes and cultured meat. Of the few consumers concerned, references related to changing the balance of the environment and ecology. Indeed, the challenges associated with the sustainable production of edible insects have been highlighted (Lange & Nakamura, 2023). As there is a risk that collecting edible insects can threaten essential ecosystems (i.e., pollination, composting, pest control) (Losey & Vaughan, 2006). Alternatively, insect farming can prevent the risks of collecting insects outside of their regenerative capacity (van Huis, 2013). In addition, a few extremely unwilling consumers commented on the sentient nature of edible insects, especially

amongst UK consumers. This could be related to the UK government formally recognising animals as “sentient beings”, although this does still not include edible insects (DEFRA, 2022). In general, there are a lack of welfare regulations in place for insect farming despite falling under the category of “farmed animals” within EU regulations (Delvendahl et al., 2022). New research reviewing consumer awareness and perceptions of welfare issues related to edible insects, especially in comparison to welfare and meat are required.

A stance frequently mentioned by Australian and UK extremely unwilling consumers was that meat substitutes and cultured meat are not a sustainable alternative to conventional meat. Meat substitutes were associated with the negative effects of mono-cropping, which were perceived as being harmful to soil and detrimental to long-term food security. However, it is argued, that despite a few exceptions (e.g., nuts, poultry), on the basis of protein content, growing crops for human feed is more efficient and environmentally friendly (e.g., less GHG emissions, reduced land use and lower eutrophication) than growing crops for livestock feed (Breewood & Garnett., 2023; Poore & Nemecek, 2018). Therefore, a counterview is that a reduction in meat production and subsequent consumption would reduce demand for pasture and arable land (Breewood & Garnett., 2023). Nevertheless, it seems consumers with greater awareness of monocropping are more resistant to change their behaviour.

In relation to cultured meat, the environmental benefits are largely determined by how the released land from livestock production is used (Treich, 2021). Unwilling consumers mentioned the resources required to set up factories and distribution networks would likely result in high land use and emissions. However, it has been suggested that cellular agriculture production sites could be set up closer to populated areas, reducing the need for transport (Post et al., 2023). Overall, a conclusion often provided to address conflicting views relates to a reduction in animal sourced foods, alongside mixed sustainable farming practices (grass-fed livestock, regenerative agriculture). This way the same land can potentially be maximized to accommodate for crops, grazing and fallow periods (Breewood & Garnett., 2023).

#### 4.2.4. *Meat consumption is necessary for health reasons and protein alternatives are unhealthy*

Health appeared to be a substantial barrier for meat reduction and adoption of meat substitutes and cultured meat. Consumers were extremely unwilling to reduce meat based on it being a nutritional necessity in the diet; a known rationalisation for meat consumption (Piazza et al., 2015). This perception was closely associated with the belief that plant-based alternatives provide insufficient nutrition. Meat is one of the most nutritious sources of food on the planet; rich in iron, zinc and Vitamin B12 (Godfray et al., 2018). It is therefore justifiable that extremely unwilling consumers object to changing their current meat diets which are, in their view, perfectly healthy. However, it is also believed that these nutrients can be obtained from a wider range of foods, although this is more feasible in high income countries (Godfray et al., 2018).

By comparison, the unhealthy perception of protein alternatives was a barrier, especially for meat substitutes which was mentioned the most by Australian consumers. In reality, processed plant-based meat substitutes are often high in sodium, saturated fats and possess inadequate sources of protein compared to conventional meat (Nezlek & Forestell, 2022; Santo et al., 2020). Subsequently, it has been observed that Australians tend to have high expectations for plant-based meat alternatives, demanding similar levels of iron and B12 to conventional meat (Estell et al., 2021). However, the reported health benefits of meat substitutes are both complex and inconclusive (Gastaldello et al., 2022) and at best speculative for cultured meat (Santo et al., 2020). Reported concerns include questions around cultured meats’ nutritional quality (i.e. iron absorption, micronutrient benefits) (Chriki & Hocquette, 2020; Deliza et al., 2023). Nonetheless, these concerns may be counterbalanced by the potential to control and adjust cultured meat’s fat

composition allowing for healthier sources to be promoted (Chriki & Hocquette, 2020). Encouragingly, research has found edible insects to have a host of health benefits, namely prebiotic properties, improved gut health and prevention of cardiovascular disease, diabetes, cancer and high blood pressure (Van Huis & Rumpold, 2023). Although further research is required to establish these claims, health benefits may be an attribute for which edible insects can gain superiority over other protein alternatives.

#### 4.2.5. *Meat consumption is normal & nice, alternatives are unnatural & unappealing*

The belief that meat is normal and nice is a well known justification applied by meat eaters (Piazza et al., 2015). The enjoyment gained from eating meat and the inadequate taste of vegetarian diets have been previously observed as a major barrier to change (Kemper, 2020; Rosenfeld & Tomiyama, 2020). In particular, meat eaters are more likely to select that they liked the taste of meat compared to meat reducers (Kemper et al., 2023). Interestingly, the narrative that meat consumption is ‘normal’ and part of our ancestral needs was more embedded amongst Australian and UK consumers compared to Chinese consumers. This suggests cultural backgrounds impact consumers’ relationship and rationalisation around meat, which are strongly linked with meat traditions (Leroy & Praet, 2015).

By comparison, the unappealing nature of edible insects has been widely cited and is closely linked with food neophobia and expected negative sensory perceptions (Onwezen & Dagevos, 2023; Van Huis & Rumpold, 2023). Conversely, unnaturalness was closely associated with the perception of highly processed foods, which were full of additives and chemicals in the case of meat substitutes and fake, ‘Frankenstein’ foods for cultured meat. Indeed, previous research found the biggest barrier against the possible consumption of processed meat substitutes to be unnaturalness which was intertwined with lack of trust (Varela et al., 2022). In addition, the unnatural perception of cultured meat is commonly observed (Bryant & Barnett, 2020; Pakseresht et al., 2022) and thought to be higher amongst consumers high in mistrust and fear (Wilks et al., 2021). To overcome this barrier, focusing on the unnatural nature of other conventional food has increased acceptance of cultured meat (Bryant et al., 2019).

#### 4.2.6. *Defensive and emotional responses*

The belief that others, in particular non-meat eaters are behind the need to change is a common defensive mechanism observed based on the perception that this consumer group can appeal self-righteous and a threat to moral identities (Piazza et al., 2015). Extremely unwilling consumers may therefore feel more inclined than meat reducers to protect their meat-eating identity. For example, more resistant meat-eaters anticipate more vegetarian stigma (Rosenfeld & Tomiyama, 2020). Overall, the defensive and emotionally charged responses, especially for meat reduction, suggest extremely unwilling consumers can be hard to engage with. It also highlights the sensitive nature of this topic which is taken into consideration when recommending strategies to support a protein transition.

#### 4.3. *Motivations to reduce meat intake and adopt protein alternatives*

The relative importance of the food choice motives varied across countries and by protein alternative type. Considering the multiple variables involved (country, motive, protein type), the top three most important motives in each country (Table 7) and mean score differences  $\geq 0.4$  in the regression trees (Fig. 1, 2) are discussed. Specifically, these relate to environment, health, food safety, animal welfare, sensory appeal and price. For Chinese consumers, the top three motives were the same across categories (environmental benefits, food safety, health benefits). However, for UK and Australian consumers, the motivations differed, with the exception of the environmental benefits which were consistently in the top three across categories.

**Table 7**  
Top 3 motives mentioned by consumers for each protein type across countries.

| Motives                 | Australia   | China   | UK   |
|-------------------------|---|---|--|
| To reduce meat          | 1. Environmental benefits<br>2. Health benefits<br>3. Food Safety         | 1, 2. Environmental benefits & food safety<br>3. Health benefits  | 1, 2. Environmental benefits & food safety<br>3. Animal welfare benefits |
| To use meat substitutes | 1. Food safety, environmental benefits, sensory appeal & health benefits. | 1. Food safety<br>2. Health benefits<br>3. Environmental benefits | 1. Environmental benefits<br>2. Sensory appeal<br>3. Price               |
| To adopt edible Insects | 1. Food safety, environmental benefits & sensory appeal                   | 1. Food safety<br>2. Environmental benefits<br>3. Health benefits | 1. Sensory appeal<br>2. Environmental benefits<br>3. Food safety         |
| To adopt cultured meat  | 1, 2, 3. Food safety, environmental benefits & sensory appeal             | 1. Environmental benefits<br>2. Food safety<br>3. Health benefits | 1, 2. Environmental benefits & Sensory appeal<br>3. Price                |

**Please note:** 1,2,3 means no difference between the top three motives.

#### 4.3.1. Environmental benefits

Despite the environmental benefits being rated as one of the most important factors, previous research has found it to have a weak influence on meat consumption attitudes (Hartmann & Siegrist, 2017; Sanchez-Sabate & Sabaté, 2019). In particular, the lack of environmental concern associated with meat consumption has been observed amongst consumers in Australia (Hoek et al., 2017; Lea & Worsley, 2008), China (Happer & Wellesley, 2019) and the UK (Macdiarmid et al., 2016). However, in recent years this trend is starting to change amongst consumers in all three countries supporting current findings (Cheah et al., 2020; Ford et al., 2023b; Malek et al., 2019a; Wang, 2022). This is partially in response to increased attention around the meat-climate relationship often accessed through online news articles or conversations (Bryant et al., 2023). Lived experiences associated with climate change (e.g., poor air quality in China, Bushfires in Australia, Flooding in the UK) are also likely to bring greater attention towards environmental changes.

Previous research has also recognised the environmental benefits to be a prominent motive with regards to the adoption of protein alternatives (Nguyen et al., 2022; Onwezen et al., 2021). Yet, when making comparisons across alternatives, it is interesting to find this factor was of equal or similar importance amongst consumers in Australia and the UK, respectively. This perception is somewhat valid considering preliminary estimates show cultured meat to have similar GHG emissions when compared with plant-based processed products (Tuomisto, 2019). However, it is likely that consumers have a low awareness of the differing environmental impacts of food. For example, consumers are thought to have a lack of knowledge for estimating the environmental impact of meat compared to other foods (Hartmann et al., 2022; Siegrist & Hartmann, 2019).

By comparison, Chinese consumers found the environmental benefits to be more important in the context of cultured meat. Findings support a previous study amongst consumers from Shanghai which found that environmental concerns are a strong driver for the adoption of cultured meat (Wang & Scrimgeour, 2022). However, results suggest there may be more pressure on cultured meat to prove its environmentally friendly status compared to other alternatives amongst Chinese consumers (Wang & Scrimgeour, 2022). A review of the prospects of cultured meat in China predicted a reduction in its environmental impacts including lowered GHG emissions and land use if substituted for conventional meat (Sun et al., 2015). However, it also noted that the energy usage would be higher compared to current Chinese pork production with large scale production posing a risk to biodiversity through a reduced need for grassland (Sun et al., 2015). Seemingly, further research on the overall environmental benefits of cultured meat when products are scaled up and how this impacts consumer acceptance is required.

#### 4.3.2. Food safety

The importance of food safety in China has been frequently observed as a prominent motive partly due to various food safety scandals (Wang, 2022). As a result, Chinese consumers are willing to pay more for products with food safety attributes, especially pork (Yang & Fang, 2021). However, in the UK and Australia, the high scores may be a response to the pandemic which was ongoing at the time of data collection. Subsequently, consumer views on the safety of the food chain are likely to be heightened, including fear around zoonotic viruses (Krishnamoorthy et al., 2023). Findings therefore signify a shift in motivations amongst western consumers. By contrast, consumers who were unwilling to reduce meat did not show any concerns around the food safety of meat which suggests a level of trust in the meat they consume.

Regarding protein alternative type, food safety was of equal importance amongst Australian and UK participants despite each type of alternative having distinct food safety challenges associated with anti-nutrients, microbial risks and allergens (Banach et al., 2022). Conversely, Chinese consumers rated food safety attributes as the most important motive for edible insects which has previously been observed as a key concern (Liu et al., 2019). Interestingly, Chinese consumers found food safety to be less important for cultured meat compared to the other alternatives. This may relate to the sterile conditions used for cultured meat production implying a lower level of predicted contamination (Lee et al., 2020; Zhang et al., 2020a). However, as production systems become upscaled challenges associated with contamination are likely to arise (Deliza et al., 2023). Furthermore, the extent to which the more ethical 'immortalized' animal cells express oncogenes, which are known to have tumorigenicity, is a current gap in knowledge (Soice & Johnston, 2021).

#### 4.3.3. Health benefits

Health benefits were equally important across countries for meat reduction, scoring in the top three for Chinese and Australian consumers. However, for the protein alternatives, they were more important to Chinese consumers. To some extent differences between countries are expected, as healthy food choices are influenced by variations in cultural exposures related partly to socio-economic status and upbringings (Enriquez & Archila-Godinez, 2022). Yet, when comparing across protein alternative type, little differences were observed within each country suggesting health is of equal importance. This could be due to the scarce number of studies reviewing the effect of long-term substitution of meat with plant-based meat substitutes, edible insects and cultured meat (Tso et al., 2020).

Health concerns have previously been considered important for meat reduction amongst Australian (Bogueva et al., 2017; Malek et al., 2019a; North et al., 2021), Chinese (Taufik, 2018; Wang, 2022) and UK

consumers (Clonan et al., 2015; Eating Better, 2022; Mylan, 2018). This is likely due to positive perceptions that a reduction of excessive meat intake is beneficial in preventing and/or addressing various diseases (e.g. cancer, heart disease, Crohn's disease, nutritional deficiencies) (Cheah et al., 2020). Similarly, the importance of health benefits for motivating protein alternatives is likely due to the supportive role they play in meat substitution. For example, substituting a high meat diet with plant-based meat substitutes is thought to provide health benefits namely a lower risk of cardiovascular disease (Guasch-Ferré et al., 2019). However, estimates are based on high-quality plant protein sources (e.g., legumes, soy, nuts).

#### 4.3.4. Sensory appeal

This factor was predominantly important for Australian and UK consumers across all protein types. Indeed, numerous studies support this finding and highlight its importance for repeat consumption (Onwezen & Dagevos, 2023). In particular, positive taste expectations are important for plant-based meat substitutes (Ford et al., 2023a), especially when products can be perceived as inferior in taste compared to a conventional meat (Michel et al., 2021). However, of all the alternatives, cultured meat is thought to replicate the sensory characteristics of meat the most (Post et al., 2023). However, for edible insects and cultured meat, due to the lack of commercially available products, taste is often based on predicted perceptions. In some instances, this raises expectations. For cultured meat this may be achievable as a study found consumers considered the taste of a burger labelled as 'cultured' to be slightly better, despite it being the same as the conventional burger product (Rolland et al., 2020). However, outside of a tasting context, cultured meat is thought to be less tasty compared to conventional meat (Mancini and Antonioli, 2019) with general low sensory expectations (Bryant and Barnett, 2020).

By comparison, for edible insects, one sensory study on a commercially available edible insect burger found consumer acceptance to be low, especially when compared to a beef burger (Schouteten et al., 2016). However, another study found liking for a pizza with mealworms to increase compared to perceived expectations (Ventanas et al., 2022). Indeed, familiarity is thought to increase acceptance of insects as food (Onwezen et al., 2021; Van Huis & Rumpold, 2023). Therefore, it is important that consumers have a positive first sensory experience, and in some cases, if products are indistinguishable from their conventional counterpart.

#### 4.3.5. Price

Only UK consumers rated price within the top three important motives in relation to meat substitutes and cultured meat. Previous research has noted the importance of cost as a barrier for UK consumers wanting to consume sustainable food (FSA, 2021; Whittall et al., 2023). A brief overview of products from one UK retailer concludes that despite some meat being cheap, it is estimated that comparatively, meat substitutes are never the cheapest option (Ritchie, 2023). For cultured meat, price as a motive is understandable as one of the biggest challenges facing the cellular agricultural industry, is scaling at an affordable cost (Post et al., 2023). Although price was important to Australian and Chinese consumers, when traded-off against other attributes (e.g., health benefits and food safety) price is not as significant. Findings suggest consumers may be willing to pay a higher price if products are healthy and safe to consume. Indeed, research amongst Australians has indicated a higher willingness to pay a price premium for certain plant-based products (Estell et al., 2021).

#### 4.3.6. Animal/Insect welfare

Although Animal / insect welfare had a lower level of overall motivation for meat reduction and protein alternative adoption compared to the prior factors discussed, it is worth noting that it had the biggest difference in mean scores between countries and protein alternative categories. Findings therefore suggest this is an important motive to

consider when tailoring protein transition strategies. For meat reduction, UK consumers found animal welfare notably more important in comparison to Australian and Chinese consumers. The observed cultural differences are understandable based on differing country related animal welfare standards and practices. For example, pre-slaughter stunning, a humane animal welfare practice, is conducted by law in Australia and the UK, but is not routinely applied and mandated in China (Sinclair et al., 2023). Additionally, Chinese consumers stated they felt more comfortable watching the slaughtering processes compared to Australian and UK consumers (Sinclair et al., 2023).

The reduction or complete removal of animal involvement for meat substitutes and cultured meat is of more importance compared to the welfare of insects, especially for Australian and UK consumers. This suggests that the welfare principles may differ across vertebrates and invertebrates, and is thought to relate to phylogenetic distance, which is greater between humans and insects compared to humans and animals. The greater the phylogenetic distance, the less humans are thought to apply anthropomorphism (i.e. project humanlike characteristics to non-human agents) (Delvendahl et al., 2022; Wang & Basso, 2019).

#### 4.4. Practical implications and future research

A meta-analysis by Onwezen & Dagevos. (2023) highlighted the need to explore across alternatives and include cross-cultural comparisons, including consumers outside of western high-income countries. Our research has contributed to addressing this knowledge gap with findings reinforcing the need for country specific protein transitions as previously stated (Ford et al., 2023b). In particular, key recommendations are provided for food producers/ marketers and policy makers to complement the growing body of reviews suggesting strategies to reduce meat consumption (Harguess et al., 2020; Onwezen, 2022) and encourage the sustainable consumption of plant-based meat substitutes, edible insects and cultured meat (Onwezen et al., 2021; Pakseresht et al., 2022; Van Huis & Rumpold, 2023).

Previous motives in relation to meat reduction and protein alternative adoption mention the importance of health, sustainability and animal ethics (Onwezen & Dagevos, 2023). However, our study also highlights the importance of food safety as a motive for change, which is likely heightened since the pandemic. Therefore, intervention strategies that inform consumers of the safety of products could positively influence consumer acceptance towards cultured meat, edible insects and meat substitutes (Bryant & Barnett, 2020; Tso, Lim, & Forde, 2020; Van Huis & Rumpold, 2023). Moreover, as food safety is a personal benefit, it is likely to be more persuasive (Onwezen & Dagevos, 2023). Overall, as awareness around food safety, environmental and health benefits increases, there is a need to map changes to consumer acceptance over time which is currently lacking (Tso et al., 2020).

The environmental benefits were equally motivating across countries for the different protein categories. Therefore, despite observed differences across countries for willingness to reduce meat/ adopt alternatives (Ford et al., 2023b), the main underlying motive towards changing behaviour is similar. Informing consumers of the environmental benefits of protein alternatives can positively influence acceptance (Weinrich, 2019), including through more informative packaging (e.g., lower carbon footprint) (Holenweger et al., 2023). Currently, there is a need for intervention strategies to increase awareness on the environmental impact of food, especially for enhanced protein alternative acceptance (Onwezen & Dagevos, 2023).

Conversely, the extremely unwilling responses bring into question whether the behaviours of these consumers could ever be shifted. Nevertheless, some general suggestions across countries include; challenging the narrative that meat is a necessity in the diet by promoting the health benefits of plant-based foods, being transparent about the sustainable nature of the land being farmed for plant-based foods (i.e., the extent of monocropping) to reduce scepticism; promoting the sentiment that 'every change makes a difference' in instances where

consumer feel other sectors are more damaging. For the protein alternatives, the perception that they were unnecessary was a communal belief across countries. One solution to tackling this negative perception is to provide an alternative frame. For example, a counter narrative could be the unnecessary pain and suffering animals currently endure which could be alleviated by protein alternatives (Katz-Rosene et al., 2023). Replacing animal sourced protein with a variety of alternative protein sources will be necessary to reduce GHG emissions, mitigate the climate crisis and to maintain global food security (Katz-Rosene et al., 2023; Willett et al., 2019).

#### 4.5. Strategies to implement on the country level

##### 4.5.1. Australia

Of the three countries, Australians had the greatest proportion of extremely unwilling consumers, especially towards meat reduction and meat substitute acceptance. Findings therefore suggest a greater resistant to changing behaviour likely due to meat consumption being deeply embedded within Australian cultural norms (Sievert et al., 2022). Although meat reduction may not be imminent, there is potential for Australian consumers to transition towards consuming meat only from sustainable sources. In particular, the interest extremely unwilling consumers revealed in supporting regenerative agriculture should be taken advantage of. Future research should better understand whether this is a viable option for the average consumer and the possible barriers consuming only regeneratively farmed meat poses for the individual (e.g., higher cost, limited availability). Considerations should also be given towards the wider implications of promoting regeneratively farmed meat on the meat industry and environmental, public health goals. Currently, it's thought that meat reducers are more likely to report changes towards purchasing more sustainable meat products (e.g., Australian produced, Certified Humane, Organic) compared to committed meat eaters (Malek et al., 2019b).

For Australians who are to some extent willing to change, the health benefits of meat reduction and meat substitutes needs to be promoted. Arguably, for plant-based meat substitutes to be a success, they need to be healthy and or nutritionally comparable to conventional meat. In addition, sensory appeal was particularly applicable to Australian consumers across the alternatives. For plant-based meat substitutes, exploring which composition and recipe is most preferred could highlight the best avenues to proceed with. For example, a study amongst French consumers found Mycoprotein to be the most preferred, mostly due to texture (Cordelle et al., 2022). Likewise, for edible insects, understanding which sensory attributes drive consumer acceptance will be key. Especially considering consumers are more willing to adopt edible insects, compared to meat substitutes and cultured meat (Ford et al., 2023b). Therefore, this indicates a great potential in Australia to promote edible insects as suitable protein alternatives. However, a number of factors influence the sensory profile of insects (e.g., product type, processing, species, packaging, storage) which need to be better understood (Mishyna et al., 2020; Wendin & Nyberg, 2021). Currently, it is thought Australians are more likely to consume insects when hidden and unrecognisable within a product or mixed into a dish (Wilkinson et al., 2018).

##### 4.5.2. China

For Chinese (Shanghai) consumers, food safety continues to be an important motive, especially for protein alternatives, such as edible insects. A study by Liu et al. (2019) recommended implementing effective government policy to ensure the production of edible insects follows strict safety guidelines. In addition, trust in the government's food safety regulations is also relevant for cultured meat (Zhang et al., 2020b). In the context of meat substitutes, safety in the ingredients used is likely to be imperative. China has a long history of consuming a variety of meat substitutes e.g., tofu, therefore the greater familiarity is likely to enhance consumer trust, with consumers thought to be more open to

products, which could be further promoted (Wang, 2022).

Overall, messaging campaigns that positively promote the hygienic conditions edible insects are farmed under and the sterile conditions cultured meat is produced in could re-assure consumers and increase acceptance. Additionally, further highlighting the food safety risks associated with intensive farming practices provides a counter narrative that could accelerate behavioural change. Lastly, the high proportion of extremely unwilling consumers perceiving edible insects as unappealing should be explored. In particular, more research reviewing strategies to counter food neophobia towards insects is required (Onwezen & Dagevos, 2023). Some solutions include culinary education programmes, collaborative and innovative marketing strategies from policy makers and private business (Liu et al., 2019).

##### 4.5.3. UK

For UK consumers, the importance of price as a motive for meat substitute and cultured meat acceptance should be explored. Most likely this is reflective of the ongoing cost of living crisis. However, understanding consumers' willingness to pay towards alternatives could help understand expectations and consumer acceptance. Currently it is thought that UK consumers are willing to purchase plant-based meat substitutes the most (approx. 58 % of consumers) and cultured meat the least (approx. 20 %) (Gómez-Luciano et al., 2019). Yet, when compared to hybrid and beef burgers, UK consumers were least willing to purchase plant-based burgers (Grasso et al., 2022). However, it is thought that in promoting the perceived benefits of cultured meat, consumers may be willing to pay a price premium (Rolland et al., 2020). Furthermore, price incentives such as subsidies have been successful in increasing the adoption of alternatives, but greater research is needed (Onwezen & Dagevos, 2023; Taufik et al., 2019). Ultimately, protein alternatives will need to not just be price competitive, but ideally cheaper than conventional meat.

In addition, sensory appeal was also important to UK consumers across the alternatives. As mentioned for the Australian consumers, future research should better explore which sensory attributes consumers seek and or prefer within each of the protein alternative categories. Despite technological advancements in replicating the taste and texture profiles of meat products, challenges still remain (Tso et al., 2020). However, it is recommended that companies focus on taste and texture as the main attributes influencing liking (Sogari et al., 2023). It may be that food developers need to create different recipes and blends to meet a variety of consumer needs.

## 5. Conclusion

Overall, our findings add to the existing knowledge regarding the importance of product related motivations in driving change towards a protein transition. Importantly, this study has compared motives for meat reduction alongside a range of protein alternatives within a cross-sectional context. The most important motivations for meat reduction and protein alternative adoption, irrespective of cultural backgrounds, relates to environmental benefits and food safety. This is reflective of current concern around climate change and our post-pandemic status. It also signifies the inclusion of these factors alongside health benefits which has been a long-standing motive. However, these motivational factors are equally contested as barriers to change, especially in terms of being negative to health and the environment.

Findings also provide a novel insight into extremely unwilling consumers mindsets, which are currently an under-explored consumer group. The emotional and sometimes angry and defensive responses given towards the concept of reducing meat consumption and being willing to adopt protein alternatives indicates the sensitive nature of this topic. It also highlights that perhaps many of the unwilling consumers overlooked the sentiment of the question which was focused on meat reduction and not a complete removal of meat. Therefore, it is important to communicate the need to take a balanced approach and the

supportive role of alternatives when encouraging protein transitions. In particular, the type of protein alternative needs to be considered on a country basis (Ford et al., 2023b), and the appropriate motivations leveraged to increase acceptance.

### CRedit authorship contribution statement

**Hannah Ford:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Yuchen Zhang:** Investigation, Data curation. **Joanne Gould:** Writing – review & editing, Supervision. **Lukas Danner:** Writing – review & editing, Supervision. **Susan E.P. Bastian:** Writing – review & editing, Supervision. **Qian Yang:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

### Declaration of competing interest

The 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.

### Data availability

Data will be made available on request.

### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.foodqual.2024.105208>.

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