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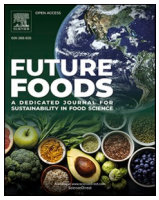

Consumer response to blended beef burgers and chicken nuggets is influenced by ingredient and nutrition claims - qualitative assessment

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ABSTRACT

Consumers and meat processors are receptive to blended/hybrid meat products, defined as products with partial meat replacement by plant-based ingredients. Blended meat products are a novel way to reduce meat consumption, however, a novel product's market success is determined by consumer expectations and acceptance. Therefore, this qualitative study investigated consumer expectations and opinions of blended meat products in different formats (beef burger, BB and chicken nugget, CN), with a range of blended ingredients, and nutrition claims. Twenty eight meat-eating consumers from Asian ($N = 16$) and non-Asian ($N = 12$) countries participated in the product mapping sessions. Both Asian and non-Asian consumers were willing to consume blended meat products for their health and environmental sustainability benefits, but commented that acceptable taste was required. Taste was the most important attribute driving Asian consumers' acceptance of new food products; it was less important for non-Asian consumers. Both groups liked the concept of blended BBs with added vegetables. Non-Asians favored blended with legumes and questioned the sustainability and high degree of processing associated with plant protein alternatives. The high nutritional value and health benefits of micro-algae was accepted by Asians and non-Asians, but it was not considered a desirable ingredient due to concerns about its expected undesirable taste. Most of the nutrition claims related to high protein and low fat in blended BBs were considered healthy and desirable for both groups. Blended BBs with "No GMO" and "No MSG" were classified as healthy and desirable by Asian groups while for non-Asians they were considered undesirable and not healthy. Labeling with "High in dietary fiber" led to consumers expecting an undesirable product texture in both groups. Blended CNs were especially undesirable for the non-Asians, as they were generally regarded as not healthy and undesirable as a snack. For Asian consumers, blended CNs had better healthiness than conventional CN, but were less desirable. Blended CN with "High in dietary fiber" claim was most liked followed by blended CN with "No trans-fat". Therefore, blended BBs show great opportunities for further product development for both non-Asian and Asian consumers. Findings from this preliminary study provide meat manufacturers and product developers with insight into how consumers from different cultures perceive BBs and CNs.

1. Introduction

Blended meat products (also known as hybrid meat products in some studies) are a recent product innovation that fill the gap between conventional meat products and plant based products (Neville et al., 2017; Asioli et al., 2023). They combine meat and various plant-based materials (Grasso and Jaworska, 2020) and are thought to deliver many benefits to the consumer including health, environmental sustainability and improved animal welfare (Profeta et al., 2021, 2020). Meat and meat products are significant components of a healthy diet as they provide various nutrients such as protein, vitamins, and minerals such as iron, zinc and vitamin B (Godfray et al., 2018). However, high consumption of red meat and processed meat can result in higher risk of cardiovascular disease, diabetes and some types of cancers (Marsh et al., 2017). Consequently, there is a trend for reduction in meat intake worldwide, especially for western consumers who have high rates of meat consumption. Blended meat products have potential for high rates of consumer acceptability and may help consumers reduce their meat consumption, without sacrificing the pleasure and indulgence of eating meat (Lang, 2020; Baugreet et al., 2016). Blended meat products that are manufactured into formats that are familiar to consumers (such as burgers and nuggets) have increased rates of consumer acceptance due

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to reduced rates of food neophobia (Macdiarmid et al., 2016; Profeta et al., 2021). If consumers of meat-based burgers and nuggets replace these products with blended meat analogues their meat consumption will reduce, and the perceived environmental and animal welfare impacts related to meat production would also reduce (Macdiarmid et al., 2016; Profeta et al., 2021). Blended meat products therefore deliver a range of benefits for the consumer wishing to reduce meat consumption and also those who have become flexitarian for sustainability and animal welfare reasons.

Despite all these perceived benefits, when blended meat products have been launched in the food retail market, the rate of success and long term viability of the products varies (Southey, 2021). Consumer acceptance and adoption of these products are key drivers of a products commercial success and longevity in the market, and in the case of a novel product is the result of consumer willingness to initially purchase an unfamiliar product (which is related to their attitudes, expectations and beliefs relating to that product) and their subsequent sensory experience of the product, which influences their repeat purchase decision (Linnemann et al., 2006; Guiné et al., 2020; Font-I-Furnols and Guerrero, 2014). Sogari et al. (2022) investigated the acceptance of blended beef burgers with mushroom among university students in North America. They reported that greater familiarity, sustainability and nutrition information contributed to purchase decisions and acceptance of blended burgers (Sogari et al., 2021, 2022). Furthermore, Asioli et al. (2023) found that providing European consumers with information on the benefits of hybrid meat products on food labels is important. Their willingness to pay increased when benefits such as "Reduced fat" and "Carbon Trust" labels were provided. Providing products with a higher plant protein content positively affects USA consumers' perception of sustainability, and thus promotes purchase intention (Smart and Pontes, 2023). Previous cross cultural studies have also demonstrated that a consumer's cultural background influences their beliefs and expectations relating to a product, which influences both their initial purchase decision and later decisions on repurchasing (Hastie et al., 2020; Khara et al., 2021). However, studies about blended meat products acceptance by Asian consumers, who are a large potential market for novel meat products, is lacking. Therefore, the purpose of this study was to investigate Asian and non-Asian consumers' preferences and expectations of novel blended meat products in terms of consumer perceived healthiness and desirability. For the product mapping exercise two blended product formats were considered: blended beef burgers (BBs) and blended chicken nuggets (CNs). Our experimental stimulus included a range of ingredient and nutrition claims associated with these products. Our hypotheses were two-fold: (i) Asian and non-Asian consumers use different product characteristics to determine if a product meets their needs and (ii) the two groups assess the quality of the product using different criteria, for example healthiness may be more important to non-Asian consumers while for Asian consumers, expected sensory experience may be more important.

2. Theory

Qualitative studies are generally conducted before designing quantitative consumer studies. The flexible semi-structured discussion of qualitative consumer sessions enables the researcher to test a wide range of product attributes with consumers and also captures underlying themes that may not have been considered previously before designing more in depth quantitative consumer studies. For the current investigation of consumer beliefs and attitudes towards blended meat products, the mapping methodology described by Lopetcharat and Beckley (2012) also known as 'napping', was selected due to the rapid provision of results, the capability to identify similarity between products, and the identification of market "gaps" for novel food development (Pagès, 2005). Mapping methods can enable consumers to distinguish groups of products based on consumer perceptions of the product qualities. Each product is mapped according to consumer perceived similarities and differences. Product mapping with a focus group can provide insight into consumer perceptions and attitudes towards products in an uncontrolled and natural environment, which helps researchers and the food industry identify possible opportunity areas for novel food product development or conversely identify product attributes that may act as a barrier for consumer adoption. It is particularly useful for comparing consumer groups in cross-cultural or demographic based studies (Lopetcharat and Beckley, 2012). In addition, product mapping has been used in many studies to investigate the different attitudes and behavior towards food products by consumers from various cultures (Bittner et al., 2017; Mena et al., 2020). Product mapping applied within a focus group is seen as a reliable technique, and it has been used on a range of food products; including cheese (Drake et al., 2009), meat (Hastie et al., 2020; Bittner et al., 2017), wine (Perrin et al., 2008) and yoghurt (Gupta et al., 2022). Product mapping methodologies work well with untrained consumers and can be used to generate a large amount of consumer insight in a short space of time (Hastie et al., 2020; Ramcharitar et al., 2005; Lawless and Heymann, 2010). Drake et al. (2009) revealed that the results of product mapping with a small sample size ($n = 12$) were similar to those obtained using more extensive quantitative mapping methodology ($n = 110$). Due to the breakout of Covid-19 pandemic, we ran our sessions online, as online group discussion has been found to be a good method to communicate among students and moderators (Rinekso and Muslim, 2020).

3. Materials and methods

The project was approved by the Human Research Ethics Committee of The University of Melbourne (HREC 1749295). All consumers provided their informed consent before participating in the product mapping sessions.

3.1. Discussion guide and general process overview

A flow diagram of the one-hour group interview process utilised in this study is shown in Fig. 1. A discussion guide was developed to ensure consistency between each interview session and full details can be found in Supplementary Table A. In brief, there was a 2 min introduction to the project and the researchers. Then 3 min was provided for general questions about demographic information and diet type to establish the baseline for consumer attitudes and expectations concerning blended meat products. Further details about their meat-eating habits were collected, such as choice of meat and a conversational discourse was established with participants for the remainder of the session. Next, consumers' familiarity and attitude towards blended meat products was assessed. The facilitator shared a PowerPoint slide defining the term "blended meat products", as "a novel meat product whereby a portion of meat is replaced with plant-based ingredients" (See Supplementary Fig. A). The slide also incorporated a picture of a blended beef burger (BB) as a visual reference for participants. To ensure participants are on the same level of knowledge about blended meat products, the same information/definition of blended meat products was given to all participants. Questions were then asked about their willingness to purchase and consume blended products, and their expectations of the products, etc., which took about 5 min. The mapping session then commenced (see Sections 3.3 and 3.4 for more details), which took approximately 40 min. During the 40 min mapping session the group was asked to map the stimuli set on 2 axes (x-axis was 'unhealthy' to 'healthy' and the y-axis was 'undesirable' to 'desirable' during this exercise the facilitator asked open ended questions to understand the product attributes and consumer perceptions of the product that were driving their mapping decisions particularly focussing on "why" and "how" questions. Once the mapping exercise was completed the participants discussed the ideal ratio of meat to plant-based material in a blended meat product and their price expectations, which took about 3 min. As a final question, the facilitator asked participants for any additional perspectives they may

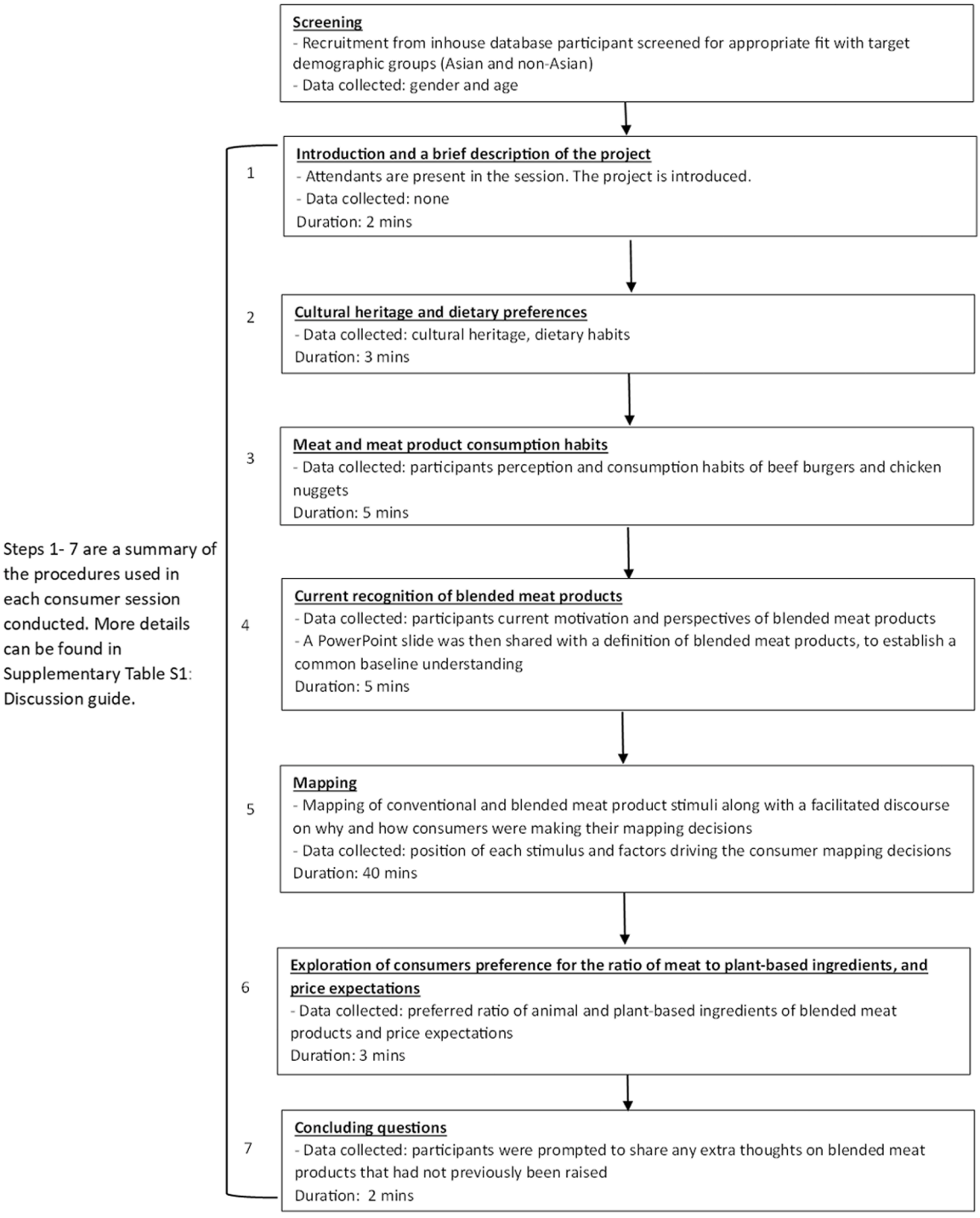

Fig. 1. A diagram showing the sequence of events and timing for the recruitment and selection and for the one-hour group interview for each session.

have regarding blended meat products that they had not provided in the preceding discussion.

3.2. Selection of stimuli and descriptive terms

The stimuli descriptive terms and rationale for their selection are summarised in Table 1. Two blended product formats were investigated: burgers and nuggets. The beef burger (BB) was chosen as it is representative of a readily available red meat product (both conventional and blended) and is often consumed as a meal while chicken nuggets (CNs) are a common snack found in fast food restaurants and frozen food aisles in supermarkets. For blended BBs, six terms related to ingredients were included “Vegetables, e.g. carrot, mushroom, sweet potato”, “Legumes, e.g. pea, chickpea, lentil, fava bean”, “Sustainable plant protein alternatives”, “Micro-algae”, “No Genetically Modified Organisms (GMO)”, "No Monosodium glutamate (MSG)”, and six terms related to nutrition claims on the package “High in dietary fiber”, “No trans-fat”, “Low in saturated fat”, “Low in cholesterol”, "Contain one serving of vegetables per burger" and “High in protein”. The beef mince and chicken breast stimuli were used as examples of relatively unprocessed meat products that can be used to make nuggets and burgers at home that are also readily available in both the Asian and non-Asian market.

Table 1
The descriptive terms and rationale (including references) used for the reference/control samples and the ingredient and nutrition claims for the conventional and blended stimuli.

Group	Descriptive term	Rationale
Reference / control samples		
Reference	Beef mince	A product that is familiar to both consumer groups and is used by the facilitator to demonstrate the mapping method.
Control	Conventional beef burger (BB)	The widely available conventional product against which blended products will be compared.
Reference	Chicken breast	Used in a similar manner to the beef mince; to establish a reference for chicken nugget product mapping.
Control	Conventional chicken nugget (CN)	The widely available conventional product against which the blended products will be compared.
Ingredient claims		
Blended BB	Vegetables e.g., carrot, mushroom, sweet potato	Common vegetables in non-Asian and Asian markets (Woolworths, 2022a; Woolworths, 2022b).
Blended BB	Legumes e.g., pea, chickpea, lentil, fava bean	Common legumes available in Asian and non Asian markets (Coles, 2022).
Blended BB and CN	Sustainable plant protein alternatives	A general term used to cover proteins from various sources, including legumes (i.e. pea, chickpea, lentil) and cereals (i.e. rice, wheat, barley) and their derivatives such as texturized protein (Woolworths, 2022c; van der Weele et al., 2019).
Blended BB and CN	Micro-algae	A nutritious and sustainable material, micro-algae are also considered a novel potential ingredient for food products, especially for meat products (Chacón-Lee and González-Mariño, 2010; Caporgno and Mathys, 2018; Fu et al., 2019; Weinrich and Elshiewy, 2019).
Blended BB	No Genetically Modified Organisms (GMO)	GM soy is potentially an ingredient for incorporation into blended products but the attitude towards GM as a food ingredient varies between Asia (Japan and China) and other countries such as Europe (France, Britain, Germany) and North America (USA and Canada) (Dannenberg, 2009). GMO food and its labeling and policy is controversial worldwide (Knight and Gao, 2009; Bongoni, 2016; Lefebvre et al., 2019; v2 food, 2022).
Blended BB	No Monosodium glutamate (MSG)	This label appears on the package in the supermarket for both conventional and plant based meat products and has been a substantial controversy for food producers and consumers (Radam et al., 2010; The Good Food Company, 2022; Ho, 2021).
Nutrition claims		
Blended BB and CN	High in dietary fiber	A common attribute on the label for 100% plant-based meat products and represents novelty relative to conventional meat products (v2 food, 2022; Omnifoods, 2021; Nextfoods, 2022).
Blended BB and CN	No trans-fat	Common in processed food products such as snacks, baked goods, animal products etc. due to the WHO's anti-trans-fat action (Dhaka et al., 2011; Parziale and Ooms, 2019). Interestingly, we observed that the plant-based meat products in China were labeled with No trans-fat but this was absent from the same products launched in Australia (Ho, 2020; Harvest Gourmet, 2022a; Nestle, 2020).
Blended BB	Low in saturated fat or cholesterol	Common labels in both fresh and processed meat products and the most frequent nutrition claim (Ansorena et al., 2019) (The Good Food Company, 2022; Beyond Meat, 2022; More Meat, 2020).
Blended BB	High in protein	Commonly used claim in conventional and plant based meat products (Ansorena et al., 2019). In this study, High in protein is chosen as an example of claims relevant to protein content (Omnifoods, 2021; Ingham's, 2022).
Blended BB	Contain one serving of vegetables per burger	Included to clarify the attitude towards the inclusion of vegetables in one serving and common for meat products. This label is currently on plant-based meat products on the supermarket shelves (Harvest Gourmet, 2022b).

The claims used in our stimulus set design were derived from commercially available products as referenced in Table 1, thus the claims are mostly positive. To avoid cultural bias, our stimuli set was selected to be representative of the product ingredients and claims for plant-based and blended meat products in non-Asian and Asian markets (Australia, USA, Canada, China, and Singapore). Nutrition claims and ingredients were selected for inclusion in the study on the basis that they would be familiar for all participants.

The study design focussed on four key conceptual themes understood to influence consumer perception of food products; sustainability, healthiness, naturalness, and novelty (detailed in Supplementary Table B1). These themes were selected based on previous studies regarding the consumer's focus when evaluating a food product as discussed below. Sustainability and healthiness are two significant reasons consumers choose to reduce meat intake and substitute blended meat products for meat (Profeta et al., 2020; Lang, 2020). Sustainability is related to reducing usage of the world's scarce resources and generation of pollutants during food production. Healthiness indicates how much the consumer perceives the food will benefit their health. In addition, according to the review of Roman et al. (2017), naturalness is a significant factor for consumer's liking of a food. Naturalness refers to the food origin, content/ingredient and processing of a food product (Evans et al., 2010). Novelty of food products is another factor to which food companies should pay attention. The consumer usually prefers familiar food products (Tuorila et al., 2001). When it comes to blended meat products, (a novel product) they may not have a high rate of consumer acceptance (Tuorila and Hartmann, 2020). Novel food products can be successful if the voice of consumers is considered in the product design (Guiné et al., 2020). It is therefore important during novel product development to determine whether adding familiar or novel ingredients or claims will increase or reduce consumer acceptance.

Stimuli images were sourced from the internet (Supplementary Table B2). In brief, it consisted of images of beef burger and chicken nuggets (controls), 12 blended BB and 4 blended CN products with descriptive terms, unpackaged beef mince and chicken breast. Unpackaged beef mince was selected as the initial reference sample which was mapped at the center of the map by the group facilitator to introduce participants to the mapping exercise; this product was selected to be familiar to all participants (based on previous work of Hastie et al. (2020) and confirmed by discussions with participants at the time of mapping). The same beef burger and chicken nugget images were used for the blended meat product stimuli to avoid any bias due to differences in stimulus visual appeal

3.3. Participants

A 'sample of convenience' approach was used for participant recruitment. The participants were recruited by a notice platform for student and staff of the Melbourne University. All participants were students or staff at The University of Melbourne aged between 19 and 45 years of age who had self-identified as meat eaters. Asian participants were selected according to the time they had been living in Australia. Asians who have not been to Australia (ie. were participating from an Asian country) or have not been living in Australia for more than one year were selected for the interview. Non-Asian participants were selected on the basis they had indicated no Asian cultural heritage. For all eligible participants, a plain language statement detailing the study and a consent form for the interview were sent before each session. A gift voucher of 15 AUD, which is of token value, was given to each participant as an incentive to encourage them to attend. There were two product mapping sessions run for each consumer group (2 product mapping sessions with Asian participants, 2 product mapping sessions with non-Asian participants). A saturation principle was used in determining the sample size (Glaser and Strauss, 2017) in that the second product mapping session for both consumer groups validated the findings of the initial session, and no additional data were found upon running the second product mapping sessions.

3.4. Product mapping procedure

Product mapping sessions were conducted via Zoom (Zoom Video Communications, Inc.) using a semi-structured focus group interview protocol. Each session was 1 h in duration, all participants had their cameras on and were visible to the research team and the zoom shared screen function used by the facilitator to share the prepared slides and diagram of the map. The facilitator led each session with a notetaker and observer present, and all sessions were video recorded for later data collation and analysis. The facilitator was responsible for asking questions according to the discussion guide direction and timings, for mapping the stimuli according to the participant consensus, and for initiating discussions with the group to reveal the product attributes and consumers perceptions driving their mapping choices. The notetaker wrote down all the participants' responses, including their answers and, where relevant, facial expressions. The observer's main job was to assist the facilitator in the session and to note any important findings from participants' responses. For the mapping exercise the facilitator shared a screen with the participants, which displayed a power point slide divided into 4 equal size quadrants, and the quadrants were marked using two axes. The x-axis had the words 'unhealthy' and 'healthy' at the extreme left and right of the axis respectively, and the y-axis was labeled 'undesirable' and 'desirable' on the bottom and top respectively. These axes were used by the participants to determine the location of each stimulus during the mapping exercise and were designed to allow the participants to differentiate between the stimuli and generate discussion on the product attributes driving their mapping decisions. At the start of each mapping session, the reference stimulus (a picture of unwrapped raw minced beef) was shown and placed in the middle of the map by the facilitator; this provided calibration for the session and allowed comparison between the sessions. All other stimuli were then mapped by the participants relative to this stimulus. During mapping, stimuli with descriptors were shown to participants and they were then asked to place them on the map. The stimuli were presented in a prescribed order to the consumers (shown in Supplementary Table B.2). In total, nineteen stimuli, were mapped, one at a time, according to participant discussion and consensus. Participants were encouraged to highlight when they were unfamiliar with a stimulus, and they were free to ask questions from the facilitator at any point. However, to avoid influencing the group responses the facilitator sought the opinion of other group members before providing definitions or examples.

3.5. Analysis of results

After each session, the research team reviewed recordings and written notes. The notes and the maps from each session were discussed and analyzed. Any themes and insights developed, were discussed, and validated with all research team members. The two axes of healthiness and desirability were allocated a score range of 0–10. In each case, the reference product "Beef mince" was placed in the center, hence its healthiness and desirability were allocated a score of 5. We measured the position of each stimulus on the x- and y- axis on the map and converted it to a score out of 10. The mean score, obtained by consensus across the discussion group, for both healthiness and desirability for the non-Asian and Asian groups was calculated for each stimulus. The effect of cultural heritage (non-Asian, Asian) and the trait claim (healthiness, desirability) for each stimulus was analyzed by ANOVA ($N = 4$) using Genstat (19th edition).

4. Results

4.1. Consumer meat consumption habits, motivations, and perspectives on blended meat products

Details of sessions including the number, gender, age, and cultural heritage of participants can be found in Table 2.

For non-Asian participants, all were meat eaters and several of them self-reported that they had reduced their intake of meat to decrease their environmental impact. Overall, most non-Asian consumers reported that burgers and nuggets were meat products they would make and cook at home, as well as purchase in the shop and purchase as a meal in a food service establishment. The blended meat products presented to the non-Asians were not familiar as they generally eat a meal with separate meat and vegetable portions. Non-Asian participants expressed interest in blended meat products from two primary perspectives: environment/sustainability and health, with the proviso that the good taste of traditional meat products must be maintained. As far as sustainability was concerned, the ingredients blended into meat were questioned heavily by the non-Asian participants. Some said they do not expect much from blended meat since they have tried plant-based meat burgers and perceived that they did not taste the same as 'real' meat.

All Asian participants self-reported as meat eaters who love meat, think meat is an important part of their diet, and did not have any intention to reduce their meat intake. Asian consumers reported that they buy burgers but prefer to make burgers themselves: buying

Table 2
Demographic information on non-Asian and Asian participants.

	Non-Asian participants ($N = 12$)			Asian participants ($N = 16$)		
Session	Gender	Age	Country/descent	Gender	Age	Country/descent
1	Male	29	Mexico	Female	23	China
1	Female	45	English and German descendent	Female	24	China
1	Male	33	Lebanon	Male	23	China
1	Male	38	Paraguay, Italian and Spanish descendent	Male	26	Indonesia
1	Male	23	Australia	Female	23	China
1	Male	21	Paraguay	Female	27	China
1				Female	24	China
2	Female	39	Australia	Male	19	Taiwan
2	Male	28	Brazil	Female	19	Thailand
2	Male	33	Honduras	Male	27	India
2	Female	24	Australia	Female	27	China
2	Female	29	Australia	Female	37	Indonesia
2	Male	23	South Africa	Female	25	Malaysia
2				Male	25	China
2				Male	20	Malaysia
2				Male	26	Malaysia

unprocessed meat and mincing it at home. Chicken nuggets were consumed mostly in fast food chains or bought from the supermarket rather than made at home. Most of the Asian participants had never tried commercially available blended meat products and reported they were interested in trying them when they become available. Similar to non-Asians, some Asian participants associated blended meat products with plant-based products such as the Impossible burger® and Beyond Meat®. Most of the Asian participants expect blended meat products to be healthier and cheaper, and a few mentioned expectations about sustainability and animal welfare. Asian consumers were concerned about the taste of the product. In general, Asians are familiar with blending vegetable and meat-based ingredients in their meal preparation. The Asian participants agreed that older people would likely have better digestion of blended meat products since the perception is that meat can be hard to digest, and plant-based ingredients are easier to digest. A few Asian consumers also brought up the issue of perceptions of higher levels of processing in plant-based meat alternatives.

4.2. Perceptual mapping

In Table 3, it is evident there are some differences in the ratings given between non-Asians and Asians and between the traits Healthy and Desirability. Non-Asians gave lower scores ($P < 0.05$) or tended to give lower scores ($P < 0.1$), for a few stimuli including blended BB with "Sustainable plant protein alternatives", "No GMO" and "No MSG" and also for blended CNs with "Micro-algae", "No trans-fat" and "High in dietary fiber", relative to Asians. Furthermore, the non-Asians scored each stimulus lower than beef mince ($P < 0.05$) whereas the Asians scored each stimulus higher than beef mince ($P < 0.05$). The score for healthiness was higher ($P < 0.05$) or tended to be higher ($P < 0.1$) than for desirability for the blended BBs with "Contain one serving of vegetables per burger", "High in dietary fiber" and "Micro-algae". Conversely, for the conventional chicken nugget, the desirability score was much higher than the healthiness score ($P = 0.003$).

Table 3
Scores (range = 0 to 10) for healthiness (Health) and desirability (Desire) for non-Asians and Asians, averaged across all groups, for each stimulus. The differences between the trait and the cultures for each stimulus are shown. The means and *P*-values with a trend for statistical difference ($P < 0.1$) or a statistical difference ($P < 0.05$) are in bold.

	Culture			Traits		
	Non-Asian	Asian	P-value	Health	Desire	P-value
Beef mince	5.0	5.0		5.0	5.0	
Conventional beef burger	4.5	4.7	0.921	3.8	5.4	0.136
Blended BB - Vegetables	7.8	7.7	0.759	8.0	7.5	0.116
Blended BB - Legumes	8.0	5.4	0.240	7.6	5.8	0.448
Blended BB - Sustainable plant protein alternatives	**4.6**	**6.7**	**0.055**	6.0	5.3	0.685
Blended BB - Micro-algae	5.8	6.0	0.899	**7.1**	**4.7**	**0.007**
Blended BB - No GMO	**4.2**	**6.6**	**0.054**	5.3	5.5	0.921
Blended BB - No MSG	**4.8**	**6.3**	**0.025**	5.7	5.4	0.843
Blended BB - High in dietary fiber	6.1	6.0	0.988	**8.1**	**4.0**	**0.006**
Blended BB - No trans-fat	6.3	7.0	0.457	7.1	6.2	0.301
Blended BB - Low in saturated fat	6.3	7.1	0.423	7.1	6.3	0.423
Blended BB - Low in cholesterol	6.5	6.9	0.544	6.4	6.9	0.430
Blended BB - High in protein	6.0	6.8	0.117	6.3	6.6	0.669
Blended BB - Contain one serving vegetables	6.4	7.1	0.718	**7.9**	**5.6**	**0.072**
Chicken breast	6.1	7.1	0.400	6.8	6.5	0.820
Conventional chicken nugget (CN)	4.9	4.5	0.942	**1.3**	**8.2**	**0.003**
Blended CN -Sustainable plant protein alternatives	2.5	3.9	0.363	2.7	3.7	0.504
Blended CN - Micro-algae	**2.2**	**5.1**	**0.094**	3.4	3.9	0.857
Blended CN - No trans-fat	**4.0**	**5.3**	**0.074**	4.3	4.9	0.623
Blended CN - High dietary fiber	**2.3**	**5.9**	**0.027**	3.6	4.4	0.784

The completed perceptual maps are provided in Figs. 2 and 3, for Non-Asian and Asian product mapping sessions respectively. The photos used as stimuli, with descriptive terms, explored the consumers' acceptance of meat products and their purchase intent. Therefore, a text version of the mapping diagrams is provided in Supplementary Table C and a summary of the responses of participants by themes is shown in Supplementary Table D. According to the mapping diagrams, both the Non-Asian and Asian groups placed conventional beef burger and chicken nuggets in the Desirable-Unhealthy quadrant. All placements of stimuli are shown in Figs. 2 and 3, Table 3 and supplementary material.

4.3. Insights regarding conventional and blended meat products

For non-Asian consumers, blended BBs were generally considered healthier than beef mince or conventional beef burger, except for the "No GMO" product. About half of the blended BB products were considered less desirable than beef mince including "Sustainable plant protein alternatives", "Micro-algae", "High in dietary fiber", "No GMO", "No MSG" and "Contain one serving of vegetables per burger". Blended BBs considered more desirable than beef mince included those with "Vegetables", "Legumes", "No trans-fat", "Low in saturated fat", "Low in cholesterol" and "High in protein". Hence ingredients considered healthy or natural were more desirable. A conventional beef burger was considered less healthy but more desirable compared to minced beef, with consumer comments on convenience likely driving the desirability. In addition, non-Asian consumers said they would like to make their own burgers with minced beef. When the blended BB with the label "Sustainable plant protein alternatives" was presented, participants asked for more information, such as the source of the protein and the credibility of sustainability claims. However, the claims above led them towards wondering whether blended meat is highly processed or uses deceptive marketing. Combining micro-algae into the concept meat burger caught the attention of consumers. Micro-algae have been marketed as a super food which is related to being healthy. However, the eating quality of the burger with micro-algae, including color, flavor, and taste, was questioned. A minority of the participants in the groups considered micro-algae disgusting and not acceptable in their diet. For the blended BB with a high fiber claim, it was considered healthy but undesirable, and participants mentioned that high fiber was liked, but the texture needs to be acceptable. The label "Contain one serving of vegetables per burger" was liked by consumers due to its perceived healthiness, but they reported that the type and content of the vegetables in the burger would influence their preference.

For the Asian consumers, all the blended BB products were considered healthier than beef mince and most were given higher desirability scores then beef mince, except for "Micro-algae", "High in dietary fiber" and "Legumes". The conventional beef burger was considered to be less healthy compared to beef mince due to the participants mistrust of added ingredients, e.g. higher fat content, and the reduced versatility as a meal ingredient. In contrast, beef mince can have ingredients added such as pork fat, salt, and spices. During interview regarding blended products, we found that Asian participants regularly questioned the appearance, flavor, and texture of the product stimuli provided. The blended BB with vegetables had the highest desirability score since it can be easily incorporated into the diet and was perceived to provide

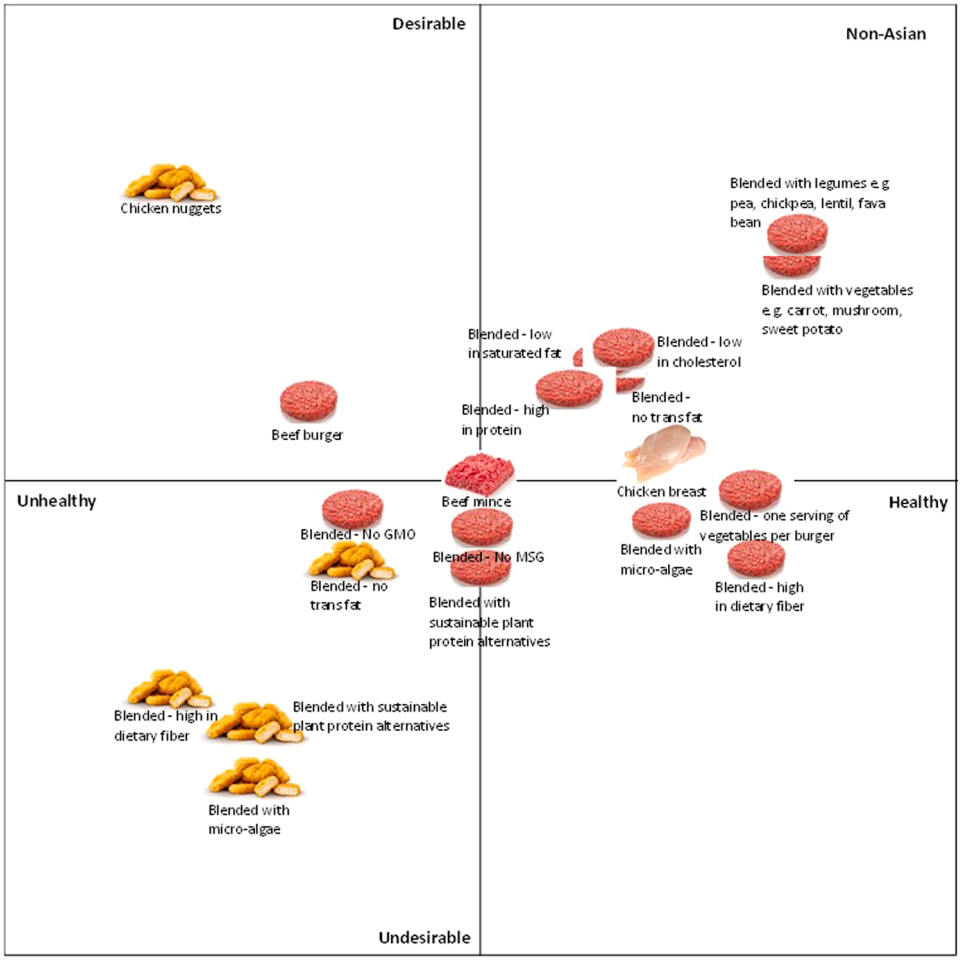

Fig. 2. Perceptual map resulting from the product mapping of conventional and blended meat products by the non-Asian groups.

nutrients not present in meat. Stimuli with "Low in cholesterol" and "High in protein" claims were also ranked high for desirability. Although adding legumes to beef was given a high healthiness score, it was considered undesirable; the comments were that although it can be easily incorporated into the diet it was not perceived to provide additional nutrients to those present in meat. Asian consumers perceived that blended BBs with plant proteins would have high levels of processing, but this was acceptable to them. In addition, blended BBs with plant protein were expected to be more sustainable as they contain less meat than conventional beef burgers. Some Asian participants were not familiar with micro-algae but once we explained that spirulina was an example of micro-algae, participants understood the meaning. Asian participants did not find blending micro-algae into a beef burger desirable due to the expected bad taste but thought it is a healthy ingredient for food. For the "No MSG" label, Asian participants could not imagine the taste of a blended burger without MSG; if it still tasted good without MSG they would be interested in the product. The "No GMO" label was also appealing to Asian consumers, with similar healthiness and desirability as the "No MSG" burger. A dietary fiber label on blended BB was not perceived as an ideal label for Asian consumers because of the concerns about an undesirable fibrous texture. Similar to the non-Asian group, Asian consumers had high desirability scores for low fat and high protein claims, but they required more information/knowledge about the claims. For instance, unfamiliarity with the terms saturated fat and trans-fat in Asian groups was observed since participants enquired what these substances are and said the labels are not common in their countries. Asian consumers are more familiar with low cholesterol claims, and these had greater desirability than claims of saturated fat and trans-fat. The stimulus claiming "Contain one serving of vegetables per burger" received the same level of healthiness as the blended vegetables burger but a lower desirability. This is because the type of vegetable significantly changes its acceptance and desirability, which was also observed in non-Asian groups.

Both Asians and non-Asians, gave very low healthiness scores, but very high desirability scores for conventional CN and they commented that CN was perceived as unhealthy because of the deep-frying process but desirable because of the convenience, taste, and indulgence aspects. Interestingly, both groups considered chicken breast to be more healthy and more desirable than beef mince. Overall, non-Asians gave low desirability and low healthiness scores to blended CNs, which were also lower than those for the control beef mince. The Asian consumers regarded blended CN as healthier products than conventional CN but showed less desirability for them. For non-Asian groups, chicken breast was perceived to be healthy but lacking in flavor. However, Asian group expressed greater desirability for chicken breast due to its high protein and low-fat features. Blended CNs with plant protein alternatives and micro-algae were not classified as healthy snack foods because deep frying remains a necessary step in cooking, which is considered unhealthy. For Asians, the labels "No trans-fat" and "High dietary fiber" added to blended CNs resulted in a rating of healthiness equal to or higher than beef mince and a higher desirability score then beef mince, especially for "High in dietary fiber".

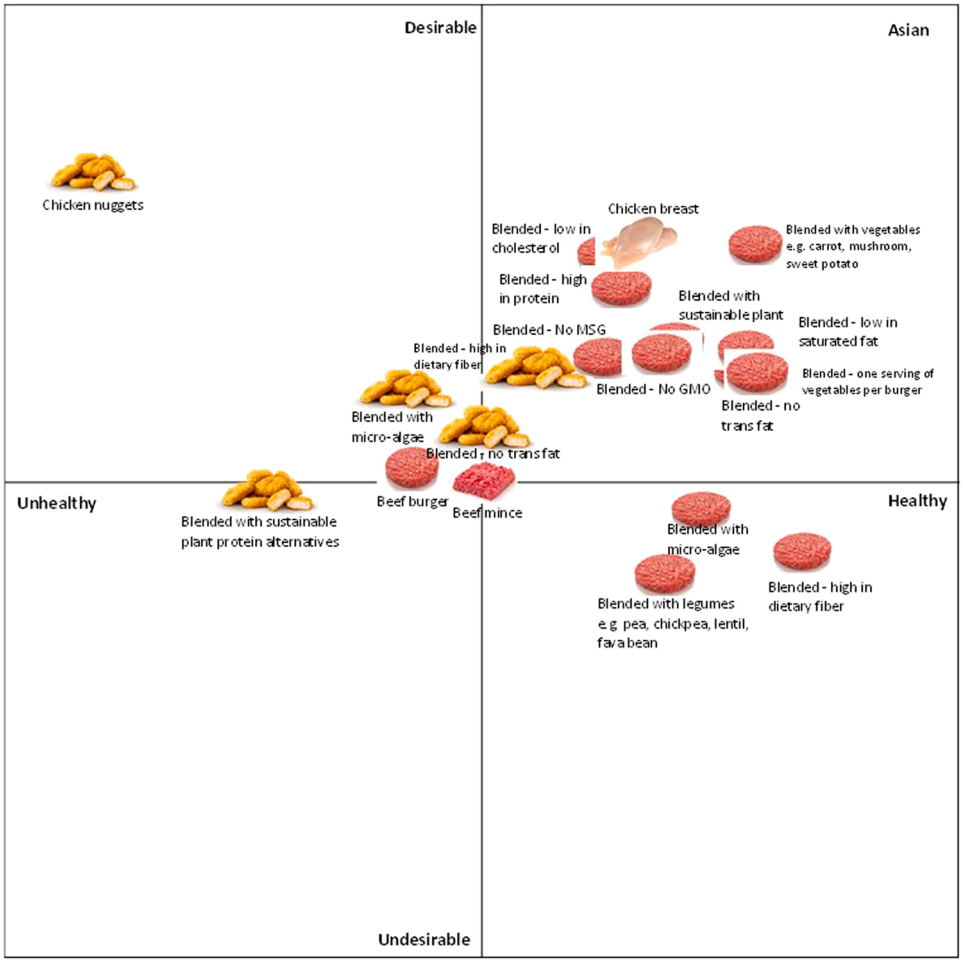

Fig. 3. Perceptual map resulting from the product mapping of conventional and blended meat products by the Asian groups.

4.4. Price and ratio of animal and plant-based ingredients of blended meat products

A surprising number of non-Asian consumers said they would be willing to pay more for blended meat products if the product is good quality and better than products they had already consumed; they defined quality in terms of flavor, texture, and healthiness. Non-Asians expressed their understanding, and concern, that the price of blended products will be higher compared to the price of conventional meat products due to the increase in manufacturing steps and cost of ingredients. In contrast, everyone in the Asian groups expected a lower price for blended products relative to meat, because plant material is perceived as less expensive than meat. in terms of the ratio of animal to plant ingredients, most non-Asian participants preferred meat as the main component which should be not less than 50% of the product. The acceptance of a blended meat product was dependent on the specific blended ingredients, and 50:50 was recommended as an appropriate ratio for all non-Asian consumers. Some participants said they would not mind having a burger with a high percentage of plant-based material if the taste is good and similar to meat. Asian participants opinions differed, as most preferred meat to be the main ingredient (60–80%). Depending on the occasion and mood, different ratios of meat and plant-based materials were considered.

5. Discussion

Desirability of blended meat products varied between the two consumer groups, with Asian consumers demonstrating a higher acceptance of blended products than non-Asian, for example in Figs. 2 and 3, only 4 blended products were mapped as undesirable by Asian consumers, while 10 were mapped as undesirable by the non-Asian consumer. While non-Asian consumers are not as accepting of blended meat products as Asian consumers, these products are attractive for the non-Asian consumers who intend to reduce their meat intake; which is in line with the findings of Profeta et al. (2020). It has been suggested the general lack of acceptance for blended meat products by non-Asian consumers is the result of perceived high levels of processed ingredients in these products which negatively impacts consumer acceptance (Collier et al., 2021; Barone et al., 2021). While Asian participants also expressed a dislike for processed products in our mapping sessions, we found they did not necessarily associate high degrees of processing with the same ingredients as the non-Asian groups. We propose that this is a result of non-Asian consumer's greater familiarity, knowledge and usage of processed foods and awareness of health risks associated with the consumption of processed meat products.

Many studies based in the USA, UK and Europe have demonstrated that consumers desire for blended meat products is driven by perceived health, sustainability and animal welfare benefits (Profeta et al., 2020; Apostolidis and McLeay, 2019; Profeta et al., 2021). In contrast, we found that expected sensory quality was the most important criteria for Asian consumers when assessing the desirability of blended meat products, and it was often the first criteria applied in their mapping decision process. For instance, while both Asian and non-Asian groups recognised that CNs are unhealthy, the Asian group rated them as more desirable than the non-Asian group because of expected pleasurable sensory experience (Figs. 2 and 3). This finding aligns with the study of

Nam et al. (2010) who reported that for Chinese consumers, the taste of food is valued over the food's nutritional and energy attributes. Therefore it is essential for the novel blended meat products destined for the Asian market to have acceptable sensory quality, to avoid market failure. In addition, sensory quality will be a key factor influencing repurchase decisions (Guiné et al., 2020; Banovic and Sveinsdóttir, 2021; Grasso and Jaworska, 2020). On the other hand, we observed that perceived healthiness was often driving the desirability of blended meat products for the non-Asian group. For both groups mapping decisions were based on a "what is in it for me" criteria rather than the perceived impact on the environment, humanity etc. These results are also likely a reflection of the differences in meat consumption intentions for the two groups, with many non-Asian participants focussed on reducing their meat consumption while Asian consumers were not.

Given sensory quality expectations were important to the Asian consumer, we also found ingredients were strongly influencing mapping choices for the Asian consumers based on their expectations in terms of the ingredients influence on taste. For instance beef blended with vegetables was a desired product for both consumer group participants, but the Asian group found beef blended with legumes was undesirable due to expected poor taste/flavor (Fig. 3). Unlike Asian consumers, non-Asian consumers liked legumes in blended BB due to the high protein content and perceived naturalness. Naturalness was a term used by non-Asian consumers to distinguish products and ingredients with little to no processing. Micro-algae are generally disliked by both groups due to expected poor taste and unfamiliarity, as has been reported previously by Weinrich and Elshiewy (2019), Lafarga et al. (2021). Furthermore, non-Asians and Asians had different preferences for "No GMO" and "No MSG" for blended BBs. Asians gave high desirability scores for blended BB labeled as "No GMO", but non-Asians considered this label as unhealthy and undesirable. Interestingly, from our background research, Beyond meat has "No GMOs" labeling in China but not in USA and Australia (Beyond Meat, 2022, 2020). In USA, a "No GMO" label obtained more attention than a "GMO" label (Kolodinsky et al., 2022), which implies that GMO-free products would be perceived as more natural, and consumers would value them more (Siegrist et al., 2016). Oselinsky et al. (2021) reported that USA college students' food choices were not affected by GMO- or GMO-free labels, even though they considered GM food dangerous. Chinese consumers who consider GM food unsafe prefer "No GMO" than "Contain GMO" labels (Zheng and Wang, 2021). Furthermore for Asian consumers, a "No MSG" label on blended BBs obtained higher desirability scores than for non-Asians. This finding aligns with the studies of Radam et al. (2010) and Bandara et al. (2016) who reported that there is a high and increasing demand for food products with "No added MSG" in Asian countries.

When looking at nutrition claims, Asian and non-Asian consumers preferred to have claims which made the blended BBs appear healthier than the conventional beef burger. Similar results have been reported for countries such as Europe and North America, where consumers also consider labeling meat products with information on ingredients, nutrition, and health claims as important (Van Wezemael et al., 2014; Rimal, 2005). In general, the Asian participants trusted the claims presented and indicated they would positively influence their product liking. This is similar to the finding of Hastie et al. (2020) who found that for beef products, providing an attractive product story increased the perception of "premiumness" for Asian consumers. Non-Asians critically analyzed the claims presented in the session and demonstrated a greater understanding of nutrition and food ingredients and health impacts. This is most likely to due to extensive and long-established health management labeling campaign such as "heart health" and traffic light systems employed in the non-Asian market (Thorndike et al., 2014; Sacks et al., 2011; Moreira et al., 2021). If similar health management strategies are to be employed in Asia using food labels and approved health claims, further education of Asian consumers on the health claims would be required. Both non-Asian and Asian respondents showed consistency in liking for No trans-fat, Low in saturated fat, and Low in cholesterol for blended BBs, which are all claims related to heart health, a major cause of non-Asian dietary related deaths (Clifton and Keogh, 2017). A study of consumers in the United Kingdom showed that labeling products with reduced or low-fat claims can positively influence consumer choice (Apostolidis and McLeay, 2019). Similarly, a low or reduced cholesterol claim leads to increased consumer's willingness to pay (Dolgopolova and Teuber, 2018). European consumers also show positive attitudes to plant-based ingredients that are fat reduced (Barone et al., 2021). High consumption of saturated fat and cholesterol is generally associated with cardiovascular disease in the majority of consumers' minds (Garretson and Burton, 2000). This is consistent with the Asian group mapping "Low in cholesterol" as the most desirable claim among the three claims related to fat. The high desirability for fat related nutrition claims of blended BB for non-Asians could be related to their high consumption of red meat (Micha et al., 2015), and their understanding of the health impacts associated with excessive animal fat consumption. Thus, nutrition claim labels related to reduced or low fat would stimulate more willingness to purchase for non-Asian, rather than Asian consumers.

High dietary fiber in blended BBs was favored by all consumers. Hence, it is suggested labeling products as high fiber would catch the consumer's attention and positivey influence their purchase behavior (Barrett et al., 2020; Gustafson and Rose, 2022). Moreover, "High in protein" for blended BB was desirable for all groups, especially for the Asian participants who associated this claim with satiation and the perceived weight loss benefits of high protein foods. Protein claims comprise 40% of weight loss and muscle building related claims which could explain why high protein claims are perceived to be linked to weight loss by the both groups (Hua et al., 2021). In terms of the "Sustainable plant protein alternatives", non-Asian consumers questioned the degree of sustainability of the claim and demonstrated some scepticism towards it. Sirieix et al. (2013) also found that consumers in United Kingdom were unfamiliar and sceptical about sustainable food labels and general sustainability claims. Asian consumers did not express the same level of scepticism and other researchers have reported that Asian consumers (Indian and Chinese) perceived greater sustainability of plant-based meat than USA consumers. In addition, the responses to "Contain one serving of vegetables per burger" in both consumer groups indicated that consumers would like to see specific details regarding the vegetable type. Higher acceptability is likely to occur if the description of the ingredients is more 'natural' and also considered to provide a good flavor or taste.

Regarding the ratio of plant-based to animal-based ingredients, there were varying opinions. Consumers mostly preferred meat as the major component and a 50:50 ratio was considered to be the upper limit for plant-based ingredient incorporation; these results agree with the study of Grasso et al. (2022) who reported consumer rankings for hybrid products decreased as their meat content decreased. The plant-based ingredient content also affects consumers' decision making as a higher plant content was perceived to have a positive influence on sustainability rating (Smart and Pontes, 2023). Among the newest successful market products, Maple Leaf Foods has the highest proportion of plant-based ingredients in their blended meat products at 50:50, which supports our findings (Shaffer, 2020).

In terms of price, it was found that non-Asian participants were willing to pay more for blended meat products if they met their quality expectations, whereas Asians want a cheaper price. Consumer studies in the USA, Germany, and Belgium demonstrate that less expensive hybrid meat products were preferred by consumers (Lang, 2020; Profeta et al., 2021). Likewise, European consumers were not willing to pay a premium for hybrid products (Asioli et al., 2023). However, the current situation is that in many countries, meat has a lower price than plant-based substitutes which is a barrier to reducing meat intake for consumers (Stoll-Kleemann and Schmidt, 2017). We propose that the difference in price expectations for the two consumer groups is an important consideration for product launch. Currently studies regarding

Asian consumers' attitudes towards blended meat products are lacking and there is an opportunity to undertake further research on this topic in target markets.

As expected, all four conceptual themes influenced consumer acceptance of blended meat products however, the relative importance of the theme/claim for the two groups varied. The qualitative nature of this study does not facilitate the quantification of the relative influence of these factors on consumer acceptance of blended meat products, but this area warrants further investigation. The authors acknowledge the study covers the opinions of a limited sample of young and middle-aged consumers, ranging from 19 to 45 years old, recruited from university who possibly have a more open mind to information and novel products (Asioli et al., 2023). Hence this preliminary study of cross-cultural differences of the importance of blended meat attributes to consumers requires validation with a larger sample size. It is recognised that the consumer categories used in our study, Asian and non-Asian, are broad and in fact both categories include a large range in cultures and cooking styles. Thus we acknowledge that a more stratified recruitment strategy would enable deeper insights into specific markets of interest. We deliberately limited the number of stimuli utilised in the sessions to cover a discrete range of topics that were selected to test a range of attributes that all consumers would be familiar with, and to avoid consumer fatigue. However, despite these methodology limitations, overall, we found many of the insights generated in the sessions align with previously reported findings, and that the interactive/flexible nature of the product mapping methodology revealed some themes that warrant further investigation. For example, we observed differences in the consumer groups perceptions of what constitutes a processed food product and how it influences their acceptance of blended meat products: had we used a more restrictive quantitative survey design we would not have captured this important theme. The insights gathered in this study will inform planned future work using a larger cohort of participants and quantitative data collection methods in market, which will enable further quantitation of the relative influences of the various themes / claims observed in this study. Additionally, exploration of local food formats, labeling requirements and allowable claims would facilitate the identification of the most effective attributes/claims for increasing consumer acceptance of blended meat products in target markets.

6. Summary and conclusions

This qualitative study demonstrates that consumers chose blended meat products primarily for health benefits with good taste as a priority. Both Asians and non-Asians preferred to avoid highly processed food in their diet. Non-Asians were more critical of high processing of ingredients than Asians who trusted the information provided. While micro-algae is nutrient-rich, it was not considered a desirable ingredient for blended meat products. However, there was also some evidence of cultural heritage similarities in product preferences, as a blended BB meal-based products was considered acceptable for both Asian and non-Asian consumers. In contrast, Asian consumers were more accepting of blended CN than non-Asians. Blended CNs, which are a snack-based product, were perceived as disappointing by non-Asian consumers, as nuggets are eaten for enjoyment not health benefits which likely is the cause of their emotional aversion to the product. Asian consumers, however, recognized the benefits of the product and had highest desirability scores for the blended CN with high dietary fiber. Vegetables were the most popular meat substitute in blended BB for both consumer groups, but non-Asian consumers were sceptical of claims of sustainable plant proteins. Legumes in blended BB were not desirable due to concerns of poor taste for Asians. For the nutrition based claims, both Asians and non-Asians had high desirability scores for claims of "High in protein", "Low in cholesterol", "Low in trans-fat", and "Low in saturated fat". Unlike the non-Asian groups, blended BBs with "No MSG" and "No GMO" were seen as healthy products for Asian consumers.

In conclusion, this qualitative study provides preliminary guidance/insights for the development of novel blended meat products in line with consumer preferences in Asian and non-Asian markets as well as a deeper understanding of how consumers assess the desirability and healthiness of these products. The results of this preliminary study also highlighted similarities and differences in consumer preferences for product formats and labeling and these findings will inform the design of future quantitative studies investigating the market opportunity for blended meat products in local and export markets.

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Ethical statement

This research involved human subjects and was carried out in accordance with the code of ethics for the world medical association. The project was approved by the Human Research Ethics Committee of The University of Melbourne (HREC 1749295). All consumers provided their informed consent before participating in the QMA sessions.

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.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.fufo.2023.100247.

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