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Young consumers' perceptions of and preferences for alternative meats: an empirical study in Japan and China

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Introduction: Alternative meats have the potential to shape a sustainable food system. This study examined young consumers' perceptions of and preferences for plant-based and cultured meats. Since comparative studies on consumer preferences for alternative meats in different key Asian markets remain insufficient, this study was conducted in Japan and China, both of whom have promising alternative meat markets in Asia.

Methods: We conducted a discrete choice experiment and co-occurrence networks among 2006 ($n = 887$ in Japan and $n = 1{,}119$ in China) young consumers. This study adopted a treatment-control design where respondents in the treatment groups received health information on the use of antibiotics in meat production.

Results: Respondents in both countries perceived meat alternatives to be substitutes to conventional meat and associated them with plant-based proteins, processed products, and health benefits. In general, Japanese and Chinese respondents differed in their preferences for burger patties but had similar preferences for other attributes. Respondents in both countries were willing to pay a premium for "antibiotic-free," "traceable," and low carbon footprint labeling. This study reveals the heterogeneity of consumer preferences and the complexity of the impact of information interventions on consumer preferences.

Discussion: Plant-based meat is already available on the market in both countries, whereas cultured meat is still in the research and development stage. Hence, young consumers were more familiar with plant-based meat than cultured meat. It is worth noting that young Japanese consumers preferred cultured meat to conventional meat. This is attributed to the concerns about food security and food animal welfare. Furthermore, this study found that information intervention can induce and direct respondents' attention to an aspect of alternative meats that is negatively perceived. Based on the findings, this study has three implications for promoting alternative meat products: marketing messaging, food labeling, and product development.

KEYWORDS

alternative meat, co-occurrence network, cultured meat, discrete choice experiment, perception, plant-based meat, preference, young consumer

1. Introduction

Currently, the steady increase in global meat demand is shaping an unsustainable food system. From 2001 to 2021, global meat production increased from 237.0 million to 357.4 million tonnes (FAO, 2023). According to OECD/FAO (2022), global meat consumption is projected to increase by 15% before 2031 with the growth of the world's population. Climate change will be exacerbated by the expansion of the livestock sector (Grossi et al., 2019; Rehman et al., 2021), which emits approximately 14.5% of all human-derived greenhouse gas (GHG) emissions (Gerber et al., 2013). Further, livestock farming consumes extensive natural resources, such as water and land (Herrero et al., 2009; Thornton, 2010), and biodiversity is threatened by the loss of natural habitats (Batchelor et al., 2015; Machovina et al., 2015). In addition to environmental hazards, animal welfare (Gallo and Huertas, 2016; Sinclair et al., 2019), food security (Hibino et al., 2023), and the diseases caused by meat consumption (De Smet and Vossen, 2016; De Oliveira Mota et al., 2019; Espinosa et al., 2020) are rapidly becoming topics of grave concern.

Plant-based and cultured meat products are expected to meet the growing demand for meat while contributing to sustainability (Lee et al., 2020). Plant-based meat is manufactured by extracting proteins from protein-rich plants, such as soybeans, wheat, and peas (Wang Y. et al., 2023). Plant proteins have long been used as meat substitutes (Lee et al., 2020). In recent decades, vegetarians became interested in traditional plant-based meat products, such as veggie burgers (Broad, 2020). To better imitate the characteristics of real meat, novel plant-based meat products undergo improvements in nutritive value and sensory experiences, including taste and texture (Rubio et al., 2020). Cultured meat is another type of alternative meat that is produced by the extraction of stem cells from animals and use of *in vitro* cell culture and tissue engineering (Post, 2012). It enhances the flavor of meat and adjust fatty acid composition using technical methods such as controlling the medium's composition (Bhat and Hina, 2011). Producers can add desired nutrients or compound cells to the medium to enhance nutrition (Van Eelen, 2007).

The shift in consumption from conventional to alternative meats is viewed as a step toward sustainable development. From the environmental perspective, plant-based meat is more sustainable than animal meat in terms of natural resource consumption, carbon emission, and energy use (Hadi and Brightwell, 2021). As cultured meat is still not produced on a large scale, it is still unclear whether it is conducive to environmental sustainability, requiring a future life cycle assessment of its production system (Lynch and Pierrehumbert, 2019). Additionally, an increasing number of studies are focusing on animal welfare issues in the livestock industry (Gallo and Huertas, 2016; Sinclair et al., 2019). Although cultured meat production requires stem cells from animals, alternative meat production eliminates the need for livestock slaughter. Furthermore, with the rising demand for meat, plant-based and cultured meats can address sustainability challenges related to food security (Li, 2020; Hibino et al., 2023). In terms of health, plant-based and cultured meats can reduce the diseases associated with meat consumption. According to epidemiological studies, there is a positive association between red meat consumption and the occurrence of cardiovascular disease and colorectal cancer (Aykan, 2015; Zhong et al., 2020). Moreover, Intensive livestock production may contribute to the transmission of zoonotic diseases from animal hosts to human beings (Zinsstag et al., 2007).

Marketers and the media currently promote alternative meat products to realize the aforementioned benefits (Santo et al., 2020). Although plant proteins have a long consumption history, new plant-based meat products are being developed today using new technologies (Lee et al., 2020). Cultured meat is an emerging high-technology product with no history of consumption. As of June 2023, only Singapore and the United States allow the commercial sale of cultured meat (Food Frontier, 2023). To promote these products, researchers are focusing on tailoring novel plant-based products to consumer expectations and introducing consumers to the novel concept of cultured meat.

With a view to making alternative meats appealing to consumers, many studies examine consumer preferences regarding plant-based and cultured meats (Van Loo et al., 2020; Ortega et al., 2022; Washio et al., 2023). Factors affecting the acceptance of alternative meats include familiarity (Hoek et al., 2011; Mancini and Antonioli, 2019), health concerns (Food Frontier, 2023), taste and texture (Michel et al., 2021), unnaturalness (Weinrich et al., 2020), food security (Hibino et al., 2023), and animal welfare (Valente et al., 2019). Earlier studies investigated the role of food labeling, such as nutritional labels (Apostolidis and McLeay, 2016; Profeta et al., 2020; Wang et al., 2022), environmental labels (Apostolidis and McLeay, 2016; Profeta et al., 2020; Ortega et al., 2022), animal welfare labels (Ortega et al., 2022), origin labels (Apostolidis and McLeay, 2016; Profeta et al., 2020), and brand labels (Apostolidis and McLeay, 2016; Van Loo et al., 2020), in determining consumers' meat and alternative meat choices. In addition, researchers examined the effects of information interventions, including health information (Wang et al., 2022; Bazoche et al., 2023), environmental information (Van Loo et al., 2020; Wang et al., 2022; Bazoche et al., 2023), and technological information (Van Loo et al., 2020), on consumer preferences.

Although earlier studies provide valuable insights into consumer preferences for alternative meats, we identified two important research gaps in these studies. First, young consumers' perceptions of and preferences for alternative meats have not been sufficiently examined. Although some studies have reported that younger consumers are more likely to purchase alternative meats (Slade, 2018; Van Loo et al., 2020), only a few of them have delved into the underlying reasons driving these preferences or examined their specific perceptions of alternative meats. Young consumers, especially Generation Z, are often associated with sustainable consumption (e.g., Dabija et al., 2020; Dragolea et al., 2023). As they are poised to become a dominant force in the consumer market, exploring their perceptions and preferences is crucial for the development of the alternative meat market. Second, comparative studies on consumer preferences between different Asian countries are limited. A report on alternative proteins emphasized the importance of the Asian market and indicated variations in alternative meat markets in different Asian countries (Food Frontier, 2023). However, there is a lack of research comparing consumers' perceptions of and preferences for alternative meats in Asian countries. To overcome these research gaps, this study answers the following questions:

> RQ1. How do young consumers' perceptions of alternative meat products vary by country?

> RQ2. How do the preferences of young consumers for the different attributes of conventional and alternative meat products differ by country?
>
> RQ3. How can alternative meat products be promoted among young consumers in these countries?

This study was conducted in Japan and China, both of which have promising potential for alternative meat markets in Asia. In 2022, China had the largest meat substitutes market revenue in the world at 2.0 billion United States dollars, while Japan ranked second in Asia with 285 million United States dollars, following China (Statista Research Department, 2023). While plant-based meat is widely available in both the countries (Food Frontier, 2023), cultured meat is not yet allowed for sale in either country but its research and development efforts are in effect. Notably, China incorporated cultured meat in its 14th Five-Year Plan (Sheldon, 2022), and a Japanese cultured meat research consortium aims to demonstrate its manufacturing equipment at the Expo Osaka 2025 to promote public awareness of cultured meat (Anzo, 2023). There are some differences in the consumption of alternative meats between Japanese and Chinese consumers. For example, Chinese consumers (60.1%) have more experience consuming plant-based meat than Japanese consumers (23.9%) (Cross Marketing, 2021; Wang G. et al., 2023). In addition, the most important aspect considered by Japanese consumers when purchasing plant-based meat is flavor, whereas the aspect examined by Chinese consumers is health attributes (Food Frontier, 2023). Therefore, young Japanese and Chinese consumers are likely to have significant differences in their perceptions of and preferences for alternative meats.

The remainder of this paper is organized as follows: Section 2 explains the research methodology, whereas Section 3 presents the study's results. Further, Section 4 addresses the research questions based on our results, and Section 5 summarizes the findings and limitations of the study.

2. Materials and methods

To answer the research questions, online surveys were conducted among young Japanese and Chinese consumers. This study adopted a discrete choice experiment (DCE) and co-occurrence networks.

2.1. Experimental design materials and methods

DCEs are attribute-based experimental techniques that are applied in various fields to examine individuals' preferences for goods or services (Dinh et al., 2021; Phillips et al., 2021; Lizin et al., 2022). In particular, DCEs are widely used to explore consumers' preferences for meat products (Apostolidis and McLeay, 2016; Profeta et al., 2020; Van Loo et al., 2020; Ortega et al., 2022; Wang et al., 2022). DCEs form choice sets, and respondents select the most preferred option from two or more alternatives based on their evaluation of the attributes (Aizaki et al., 2014). In unlabeled DCEs, choice sets comprise multiple hypothetical profiles (i.e., alternatives) with fixed attributes and variable levels (Van Dijk et al., 2016). Compared to labeled DCE, unlabeled DCE is more appropriate for use in situations where consumers are unfamiliar with products, since it enables a better exploration of consumer trade-offs between different decision-making attributes (De Bekker-Grob et al., 2010).

Based on the DCE, we adopted a treatment-control design to test how information intervention affects consumer preferences (Grilli and Curtis, 2021). Information interventions were included in earlier studies on consumer preferences for alternative meat products (e.g., Van Loo et al., 2020; Wang et al., 2022; Bazoche et al., 2023), as well. In our study, respondents assigned to the treatment group received health information before answering DCE questions. To ensure that the respondents completely understood the information, they were asked to take a comprehension test. The respondents who answered incorrectly the first time were asked to repeat the reading, and those who answered incorrectly again were excluded from the study.

Prior to the formal survey, two focus groups (FGs) were conducted to gain a preliminary understanding of young consumers' perceptions of alternative meat products and examine which attributes and levels should be used in the DCE (Louviere et al., 2000). FGs typically consist of six to eight members (Finch and Lewis, 2003). We recruited six Japanese and eight Chinese participants who were 18 to 25 years of age. The Chinese and Japanese FGs were conducted on December 23, 2022, and January 6, 2023, respectively. Both the FGs were implemented online using Zoom, an online meeting software. The FGs were recorded using Zoom, and the informed consent of participants was obtained in advance.

2.1.1. Unlabeled DCE design

The first step in designing a choice experiment is identifying the product. To examine the meat preferences of young consumers in Japan and China, product selection criteria was two-fold: the product should (1) be popular among young consumers and (2) have minimal differences in terms of cooking style across the countries. Thus, burgers were considered the ideal product for this study. Although not indigenous to Japan or China, burgers are popular among young consumers in both countries (GlobalData Consumer, 2023; Mori, 2023). Additionally, we found that some FG participants exhibited greater familiarity with burger prices compared to raw meat prices.

The next step was to determine attributes and levels. Table 1 depicts the five finalized attributes and their corresponding levels, all of which were same for both countries, except the price levels. The selection of attributes prioritized the ones that are demand-related, measurable, and policy-relevant (Blamey et al., 2002). Attributes and levels were selected based on earlier studies and finalized based on the feedback provided in FGs; FG participants confirmed whether these attributes reflected their interest in selecting burgers and whether the levels were reasonable. Based on FG discussions, we made some adjustments to the attributes. For example, we excluded the calorie attribute because participants indicated that calorie information barely affected their purchase decisions regarding burger products.

Finally, five attributes and their corresponding levels were determined. First, burger patties were selected to examine young consumers' preferences for meat alternatives. We included plant-based and cultured meats, since plant-based patties are now widely available and cultured meat will likely be served in the coming years (Van Loo et al., 2020). The second attribute was price, which was

considered the most important factor affecting consumers' choice of meat products (Merlino et al., 2018; Xu et al., 2019). All price levels were obtained by analyzing market prices, and their reasonableness was confirmed by FGs. The antibiotic claim was selected as the third attribute. Antibiotics are commonly used in the livestock industry for economic benefits; however, the abuse of antibiotics can pose a huge threat to public health (Ghimpețeanu et al., 2022). The "no claim" level indicates that the product does not specify antibiotic use. In an earlier study, the public in Germany, Italy, and the United States revealed a negative attitude toward the use of antibiotics in the livestock industry (Busch et al., 2020). The fourth attribute was the traceability of the burger patty. Traceability systems ensure food safety, and consumers are usually willing to pay a premium for "traceable" labeling (Ortega et al., 2011; Zhou et al., 2022). The last attribute was carbon footprint. According to the Parliamentary Office of Science and Technology (2006), the carbon footprint of a product refers to the total greenhouse gasses released throughout its production life cycle. Based on the data provided by earlier studies (Berners-Lee, 2011; Poore and Nemecek, 2018), we roughly estimated the carbon footprint of a burger and set the values to 1-, 4-, 7-, and 10-kg CO_2eq. FG participants understood that the difference between the lowest (1 kg) and highest (10 kg) values was significant.

2.1.2. Questionnaire design

The questionnaire for treatment groups comprised eight components: (1) sociodemographic characteristics, (2) dietary preferences, (3) consumption experience and intention to consume alternative meat products, (4) perceptions of meat alternatives, (5) knowledge tests on plant-based and cultured meat, (6) information intervention for the treatment groups, (7) comprehension test, (8) DCE choice sets, and (9) two psychological scales (i.e., green consumption value (GCV) and food neophobia scale (FNS)). The questionnaire for the control groups included all the eight components, except 6 and 7. A sample questionnaire is included in Supplementary material S1.

TABLE 1 Depiction of attributes and levels.

Attribute	Level		Information sources
	Japan	China	
Burger patty	Conventional meat Plant-based meat Cultured meat		Lee et al. (2020), Slade (2018), and Van Loo et al. (2020)
Price (JPY/CNY)	500 550 625 750	20 22 25 30	Analysis of available products FGs
Antibiotic claim	No claim Antibiotic-free		Busch et al. (2020) and Yang and Renwick (2019)
Traceability of the burger patty	Not traceable Traceable		Ortega et al. (2011) and Zhou et al. (2022)
Carbon footprint (CO_2eq)	1 kg 4 kg 7 kg 10 kg		Berners-Lee (2011) and Poore and Nemecek (2018) FGs

1 JPY = 0.007 USD (August 8, 2023); 1 CNY = 0.139 USD (August 8, 2023). CNY, Chinese Yuan; JPY, Japanese Yen; FG, focus group; USD, US dollar.

The components 1–5 and 9 were designed to obtain deep insights into consumer preferences. Alternative meat products are often considered environmentally friendly (Hadi and Brightwell, 2021); hence, we used the GCV created by Paço et al. (2019) to examine any correlation between GCVs and meat preferences. We also adopted the FNS designed by Pliner and Hobden (1992) to investigate whether food neophobia could be a predictor of young consumers' preference for alternative meat products. Both GCV and FNS used a 7-point Likert-type scale.

To clarify how young consumers perceive alternatives to meat, we designed an open-ended question asking respondents to create free associations about meat alternatives and input them in the form of single words or sentences (4). Free association is an effective technique to examine consumers' perceptions of things, since the associations made by people with cue words (i.e., meat alternatives) depend on their experience (Nelson et al., 2004).

To examine young consumers' knowledge of alternative meats, we designed True or False questions on the production of plant-based and cultured meats (5). Respondents were asked to read two statements and select their responses among "True," "False," and "I do not know." These statements were based on earlier studies (Van Loo et al., 2020; Wang Y. et al., 2023).

For DCE choice sets (8), we adopted an orthogonal main effect design to reduce the number of choice sets to 32 from 192 (= $3 \times 4 \times 2 \times 2 \times 4$) potential choice sets (Lorenzen and Anderson, 1993). Since too many DCE questions can be psychologically stressful for respondents (Aizaki et al., 2014), the 32 choice sets were divided into two blocks, and participants were randomly assigned to one of the blocks. Before answering the DCE questions, respondents were instructed to imagine purchasing a burger at a fast-food restaurant. This was based on a market analysis of burger prices in fast-food restaurants, which was further confirmed by FGs. According to Ortega et al. (2022), consumption location does not affect consumer preferences for alternative meat products. To ensure that respondents could accurately understand the attributes, we explained the meaning of the antibiotic claim and provided the definitions of traceability and carbon footprint. Once they understood this information, respondents were asked to answer eight DCE questions. Figure 1 depicts a sample of the DCE questions used in the survey.

Prior to asking DCE questions, we provided health information on the use of antibiotics in meat production (Figure 2) to the treatment groups (6). We provided the following explanatory text along with Figure 2, as well:

Intensive livestock production can lead to the transmission of zoonotic diseases, such as the mad cow disease, from animal hosts to human beings (Zinsstag et al., 2007). Plant-based and cultured meats can reduce the risk of contracting the diseases associated with the consumption of conventional meat. Moreover, they can be produced without the use of hormones or antibiotics (Wang et al., 2022).

2.2. Data collection

In this study, we recruited 2,154 respondents aged 18–25 years who were registered with survey companies ($n = 1{,}000$ for Japan; $n = 1{,}154$ for China). The Japanese survey was conducted by Freeasy

Which of the following burgers do you prefer to buy?

	Burger 1	Burger 2
Burger patty	Conventional meat	Plant-based meat
Price	550 Yen	750 Yen
Antibiotic claim	No claim	Antibiotic-free
Traceability of the meat patty	Not traceable	Traceable
Carbon footprint (CO2eq)	10 kg	4 kg

○ Prefer to buy burger 1
○ Prefer to buy burger 2
○ Neither of them

FIGURE 1
Example of a discrete choice experiment question.

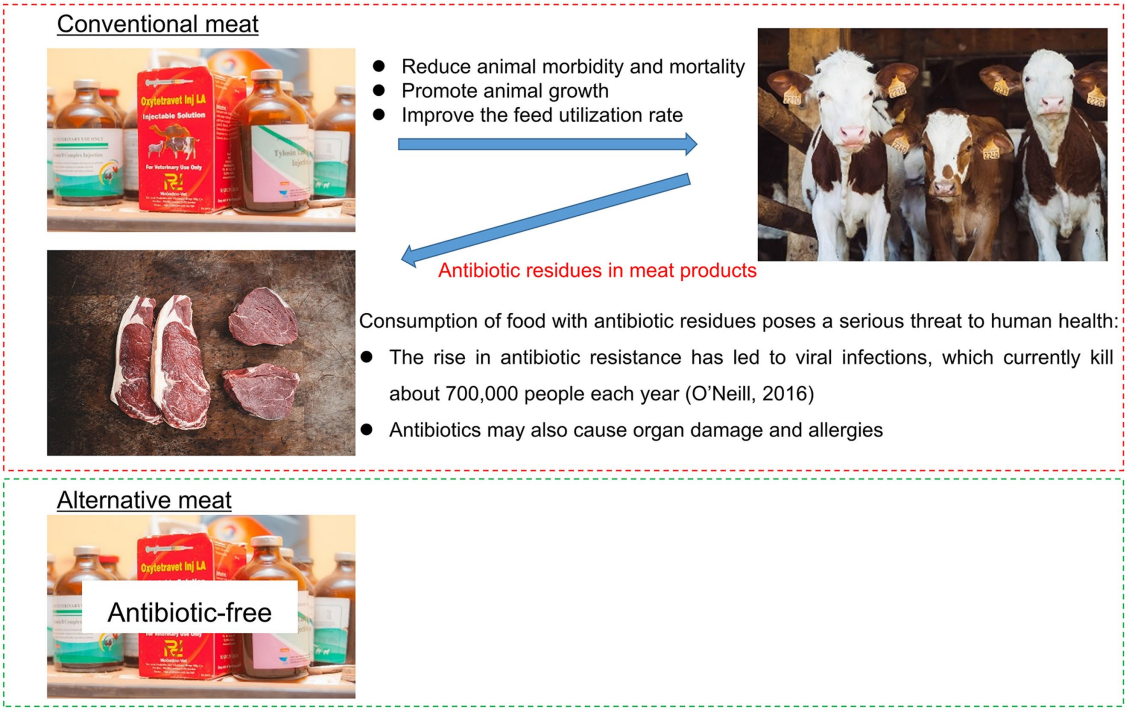

FIGURE 2
Health information for the treatment groups. (Adapted from Ghimpețeanu et al. (2022), Haiping et al. (2021), Hendrickson et al. (2020), and O'Neill, 2016. Photo courtesy: Unsplash).

(2023) from March 10 to March 11, 2023, and the Chinese survey was conducted by Wenjuanxing (2023) from April 8 to 12, 2023. These are professional online survey companies based in Japan and China. In each country, respondents were randomly assigned to one of four questionnaires (i.e., two blocks of choice design × control and treatment groups). After excluding the respondents who failed to pass

TABLE 2 Sociodemographic characteristics of the sample.

	Japan (n = 887)		China (n = 1,119)	
Gender	Male	49.9%	Male	45.2%
	Female	50.1%	Female	54.8%
Disposable income (JPY/CNY)	Below 20,000	43.0%	Below 1,000	11.6%
	20,000 to below 50,000	40.0%	1,000 to below 2,000	56.7%
	50,000 to below 100,000	13.9%	2,000 to below 5,000	26.1%
	Above 100,000	3.2%	Above 5,000	5.6%

CNY, Chinese Yuan; JPY, Japanese Yen.

the comprehension test, a valid sample of 2006 was collected (n = 887 in Japan and n = 1,119 in China).

2.3. Data analysis

2.3.1. Discrete choice experiment analysis

We applied mixed logit models to the DCE analysis. The mixed logit model is a prominent discrete choice model because it can approximate any random utility model (McFadden and Train, 2000). Because of its high degree of flexibility, the model is widely used in various fields of research (Arteaga et al., 2022). The mixed logit model includes random parameters and enables researchers to identify heterogeneity in choice preferences (Greene and Hensher, 2007).

In the random utility framework, the utility function can be expressed as follows:

$$U_{nsj} = V_{nsj} + \varepsilon_{nsj}, \quad (1)$$

where U_{nsj} denotes the utility obtained by consumer n by selecting alternative j in choice situation s, which can be separated into an observed component (V_{nsj}) and a residual unobserved component (ε_{nsj}) (Hensher et al., 2015). In the mixed logit model, the observed component (V_{nsj}) can be specified as follows:

$$\begin{aligned} V_{nsj} = {} & ASC + \alpha Price + \beta_{1,n} Burger\ patty \\ & + \beta_{2,n} Antibiotic\ claim + \beta_{3,n} Traceability \\ & + \beta_{4,n} Carbon\ footprint, \end{aligned} \quad (2)$$

where ASC refers to the alternative-specific constant; α is the mean coefficient of price, which is fixed; and other coefficients (i.e., $\beta_{1,n}$ to $\beta_{4,n}$) represent random parameters that are assumed to be normally distributed. To capture the interaction effects of consumer characteristics and choice preferences, we added the following interaction terms to the model:

$$\begin{aligned} V_{nsj} = {} & ASC + \alpha Price + \beta_{1,n} Burger\ patty \\ & + \beta_{2,n} Antibiotic\ claim + \beta_{3,n} Traceability \\ & + \beta_{4,n} Carbon\ footprint + \beta_{5,n}\left(Burger\ patty \times GCV\right) \\ & + \beta_{6,n}\left(Burger\ patty \times FNS\right), \end{aligned} \quad (3)$$

where the interaction terms between *Burger patty* and *GCV* and between *Burger patty* and *FNS* are included. We adopted effects coding instead of dummy coding for nominal variables (i.e., *Burger patty*, *Antibiotic claim*, and *Traceability*) to avoid confusion among base-level variables and *ASC* (Hensher et al., 2015). The base levels were "conventional meat," "no claim," and "not traceable." To make the results more intuitive, we reversed the carbon footprint codes during data analysis, for example, the carbon footprint of 4 kg was coded as "-4" in the actual analysis.

Based on the mixed logit model, we computed consumers' willingness to pay (WTP) by dividing the estimated parameters of non-price attributes by the price parameter (Croissant, 2020). The original utility function (Equation 1) can be rewritten as follows:

$$U_{nsj} = ASC + \alpha Price + \beta'_{,n} Non\text{-}price\ attribute + \varepsilon_{nsj}, \quad (4)$$

where $\beta'_{,n}$ refers to the set of random parameters of non-price attributes. V_{nsj} was divided into two parts, price (i.e., $\alpha Price$) and non-price attributes (i.e., ASC, $\beta'_{,n}$ *Non-price attributes*). In this setting, a non-price attribute's WTP can be expressed as follows:

$$WTP_{Non\text{-}price\ attribute} = -\frac{\beta_{,n}}{\alpha}. \quad (5)$$

We adopted Krinsky and Robb's method to calculate 95% confidence intervals and test for significant differences in the distribution of WTP between control and treatment groups (Aizaki et al., 2014). The entire DCE analysis was conducted by statistical software R, version 4.2.2.[1]

2.3.2. Co-occurrence networks

Co-occurrence networks were used to analyze respondents' free associations with meat alternatives. The co-occurrence networks present the words that often appear together and reveals different themes by grouping them (Higuchi, 2016a). We used KH Coder 3. Beta.07b,[2] which is a free software that performs quantitative analyses of texts. We used a Japanese lexical analysis engine (ChaSen) and a Chinese lexical analysis engine (Stanford POS Tagger) to extract words from the original text. We cleaned the data before creating the co-occurrence network by removing meaningless words (Yano et al., 2018). All operations were performed according to the KH Coder 3 manual (Higuchi, 2016b).

3. Results

3.1. Respondents' characteristics

In this study, a total of 2006 (n = 887 in Japan and n = 1,119 China) valid samples were collected. Table 2 depicts respondents' sociodemographic characteristics. The gender ratio of men to women of 20–24 years is 1.05 in Japan (Ministry of Internal Affairs and

1 https://www.r-project.org/

2 https://khcoder.net/en/

Communications, 2023) and 1.13 in China (Office of the Leading Group of the State Council for the Seventh National Population Census, 2022). The sample differed slightly from the national gender ratio, since the percentage of female respondents exceeded that of male respondents (1.00 in Japan and 0.83 in China). Further, national statistical data on the distribution of disposable income among young people were unavailable.

Table 3 depicts the dietary preferences of the sample. Most of the respondents in both countries were omnivores. The respondents adopted a diet without meat or fish (i.e., a vegetarian or vegan diet) were limited in both countries but significantly higher in Japan than China (5.9% of the Japanese sample compared to 1.6% of the Chinese sample) [t (1282) = 4.8653, $p < 0.001$].

The Cronbach's alpha values for GCV and FNS were 0.86 and 0.76, respectively, for Japan and 0.81 and 0.74, respectively, for China. All values of Cronbach's α were greater than 0.70, which indicated the internal consistencies of the two scales used in this study (Taber, 2018). The mean GCV of Japanese respondents was 4.03, whereas that of the Chinese was 5.05 [t (1820.7) = −23.264, $p < 0.001$]. The mean FNS scores were 4.15 for Japan and 3.64 for China, which indicated that Japanese respondents were more resistant to unfamiliar foods than Chinese respondents [t (1801.5) = 14.594, $p < 0.001$].

3.2. Respondents' knowledge and perceptions of alternative meat products

Figure 3 depicts respondents' consumption experiences regarding alternative meat products. Among Japanese respondents, 32.24% had eaten alternative meat products; the corresponding proportion of Chinese respondents was relatively high, 64.97% [(1) + (2)] [t (2004) = −15.388, $p < 0.001$]. In terms of consumption intention, 53.89% of Japanese respondents compared to 79.09% of Chinese respondents were willing to try alternative meat products in future [(1) + (3)] [t (1693.7) = −12.175, $p < 0.001$].

TABLE 3 Dietary preferences of the sample.

	Japan (n = 887)	China (n = 1,119)
Omnivore	87.1%	88.2%
Flexitarian	4.5%	9.4%
Pescetarian	2.5%	0.8%
Vegetarian	4.1%	1.5%
Vegan	1.8%	0.1%

Table 4 depicts respondents' knowledge of plant-based and cultured meats. Among Japanese respondents, 56.71% knew the raw materials of plant-based meat, and 18.15% of them were aware of how cultured meat is produced. In contrast, 78.02 and 27.44% of Chinese respondents answered the knowledge tests correctly, respectively.

The co-occurrence networks (Figures 4, 5) illustrate words with high co-occurrence in the respondents' free associations with meat alternatives. Eleven and eight subgraphs were identified in the Japanese and Chinese samples, respectively. The words in each subgraph are more closely associated with each other than with the words in the remainder of the network (Higuchi, 2016b). The size of the circle reflects the frequency of a word. To better interpret the results, we labeled each subgraph using a theme.

Similarities between the two samples were identified. First, respondents from both countries described the characteristics of meat alternatives and recognized them as substitutes to conventional meat (Subgraphs 1, 4, and 8 in Figure 4; Subgraph 1 in Figure 5). Second, the respondents perceived meat alternatives as products containing plant proteins (Subgraphs 10 and 11 in Figure 4; Subgraphs 4 and 8 in Figure 5). Third, meat alternatives were often associated with processed foods (Subgraph 6 in Figure 4; Subgraph 5 in Figure 5). Fourth, respondents expressed their concerns regarding health (Subgraph 7 in Figure 4; Subgraph 2 in Figure 5). Fifth, both samples included product experience (Subgraph 3 in Figure 4; Subgraph 3 in Figure 5).

However, there were differences between the two samples, as well. For example, Subgraph 9 in Figure 4 reveals that Japanese respondents perceived insects as a meat alternative. Although Chinese respondents mentioned some high-protein foods (Subgraph 6 in Figure 5), the terms in the subgraph do not include insects. In addition, Subgraph 7 in Figure 5 presents Chinese respondents' perceptions of the benefits of meat alternatives; here, the terms "environmental protection" and "health" co-occurred, whereas the term "environment" in the Japanese sample appeared in the subgraph depicting the characteristics of meat alternatives (Subgraph 1 in Figure 4).

3.3. Discrete choice experiment model estimates

Table 5 depicts the results of the mixed logit model estimates for cases without (model type 1) and with (model type 2) interaction

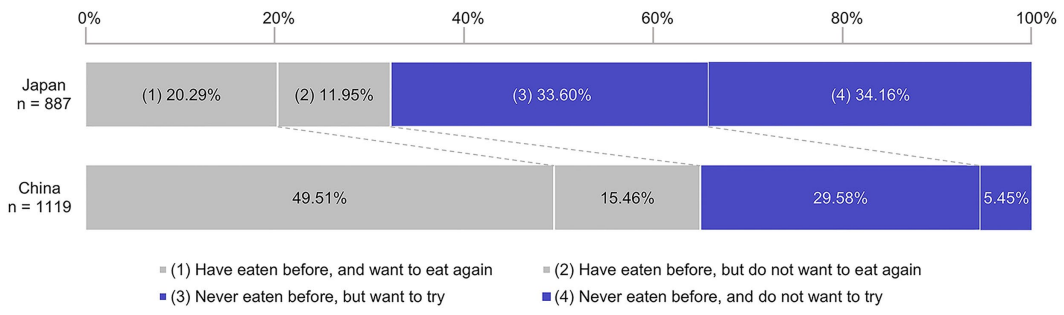

FIGURE 3
Alternative meat product consumption experience and consumption intention of respondents.

TABLE 4 Knowledge tests on plant-based and cultured meats.

Statement	Japan (n = 887)			China (n = 1,119)		
	True	False	I do not know	True	False	I do not know
1. Currently, the main raw materials of plant-based meat are soybeans, wheat, and peas.	**56.71%**	6.20%	37.09%	**78.02%**	3.84%	18.14%
2. Cultured meat, a type of alternative meat product, is produced by extracting stem cells from animals.	**18.15%**	11.39%	70.46%	**27.44%**	15.73%	56.84%

The correct answers are bolded.

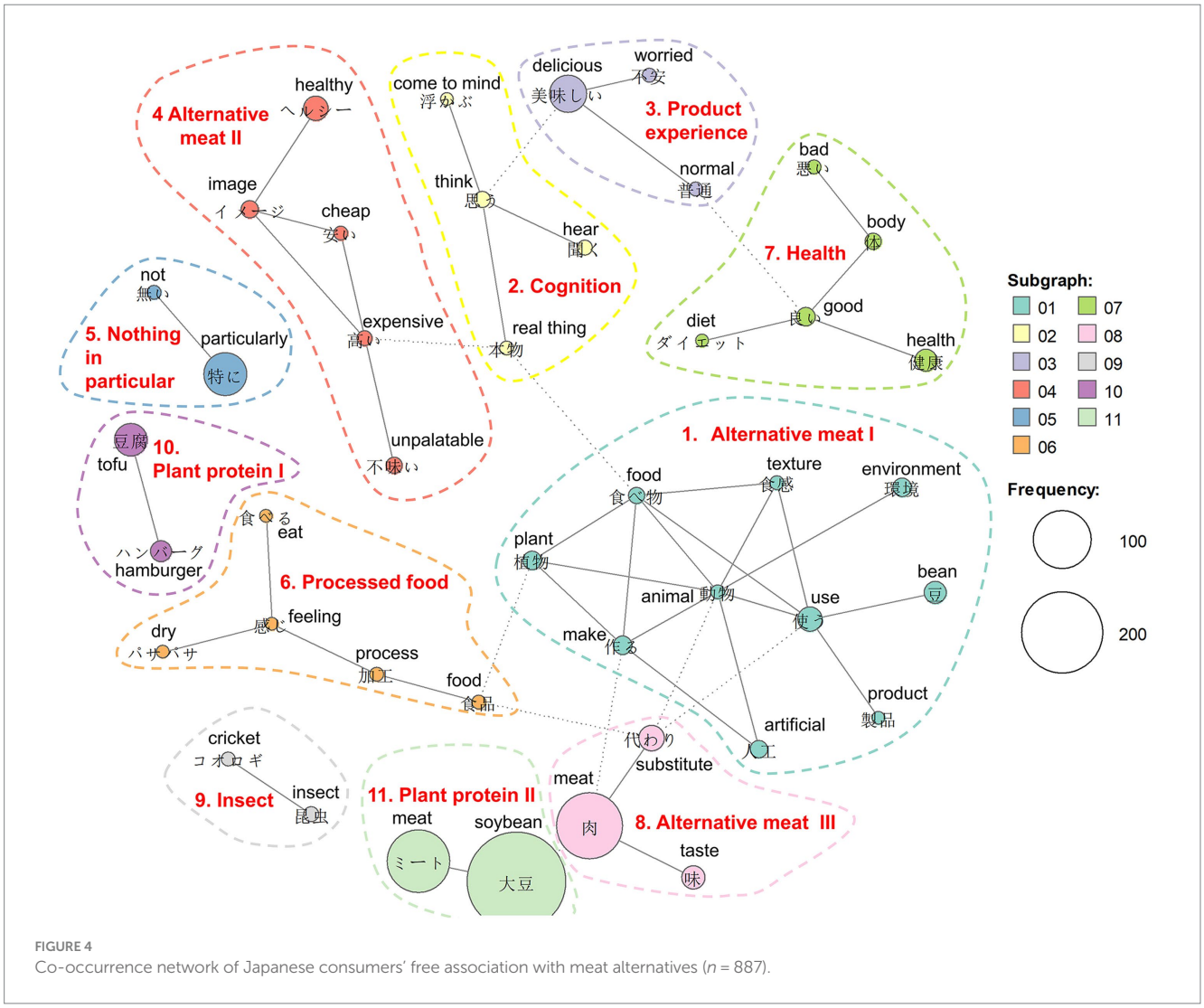

FIGURE 4
Co-occurrence network of Japanese consumers' free association with meat alternatives (n = 887).

terms. All the mean coefficients of the attributes in model type 1 were statistically significant. After including interaction terms, the signs and statistical significances of mean coefficients were identical to those in model type 1, except for "Plant-based meat" and "Cultured meat." When comparing models, the model with a lower Akaike information criterion (AIC) was considered better that the other (Mohammed et al., 2015), that is, model type 2 was the better estimate for all combinations in terms of AIC than model type 1. Therefore, hereafter, we focus on model type 2 alone. Our results found some interaction terms with statistical significance, such as the interaction between plant-based meat and GCV in the treatment groups of both countries. This indicates that respondents with a high GCV in the treatment group significantly preferred plant-based meat over conventional meat. The negative signs of the price coefficients were in line with the expectation that consumers' relative utility would decrease with the increase in price (Louviere et al., 2000). All standard deviations of random parameters, except "Traceability" in Japanese control and treatment groups, were significant in both models, which implies heterogeneity in consumer preferences.

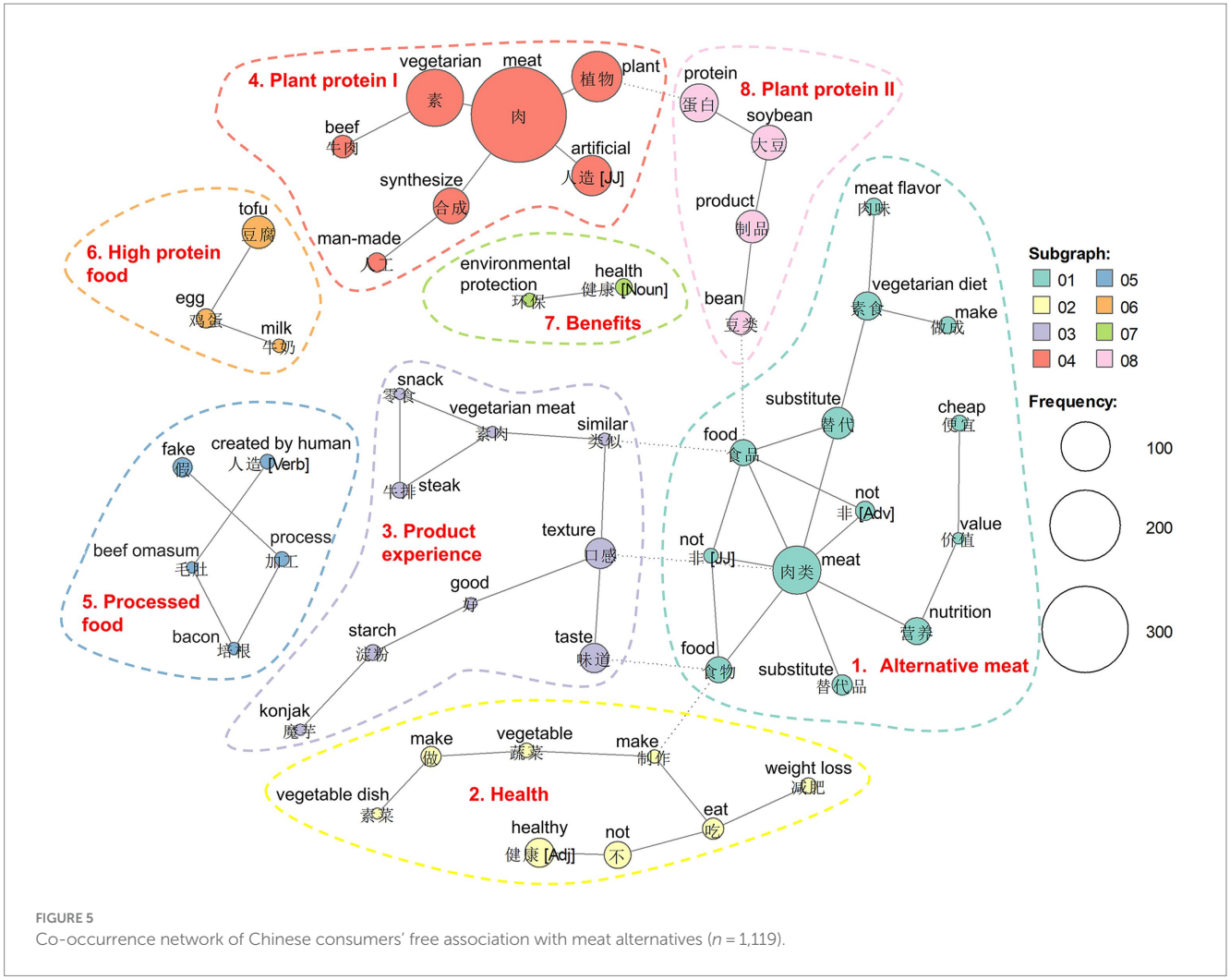

FIGURE 5
Co-occurrence network of Chinese consumers' free association with meat alternatives (n = 1,119).

Based on model type 2, the mean WTP was calculated for the items having statistical significance (Table 6). In general, Japanese and Chinese respondents differed in their preferences for burger patties but had similar preferences for other attributes. Without information intervention, Japanese respondents preferred cultured meat over conventional meat but had no significant difference in preference for conventional and plant-based meats, whereas Chinese respondents showed no significant preference for any type of meat. Moreover, respondents in the control and treatment groups from both countries preferred products with "antibiotic-free," "traceable," and low carbon footprint labeling.

Many dissimilarities and similarities were observed between control and treatment groups. The treatment groups of both countries preferred plant-based meat over conventional meat but had no clear preference between conventional and cultured meats. The significance levels indicated by asterisks in Table 6 demonstrate whether there was a significant difference in WTP between the groups. Compared with the control group, Chinese respondents in the treatment group had a significantly higher WTP for antibiotic claims; however, Japanese respondents' WTP for antibiotic claims did not differ significantly between the two groups. The WTP for low carbon footprint in the treatment group of Japanese respondents was significantly lower than that in the control group.

4. Discussion

4.1. Familiarity with and perceptions of meat alternatives [RQ1]

Our study revealed that Japanese respondents had less experience in consuming meat alternatives than Chinese respondents (see Figure 3). Among the Japanese respondents, 32.24% had consumed meat alternatives; this figure is higher compared to the survey finding that 23.9% of Japanese respondents between the ages of 20 and 69 had consumed meat alternatives (Cross Marketing, 2021). This may be because young consumers are more willing to consume meat alternatives (Van Loo et al., 2020). In comparison, 64.97% of Chinese respondents had consumed meat alternatives, which is consistent with the findings of Chung et al. (2023) that 60.1% of Chinese respondents had consumed plant-based meat. A study conducted in four major Chinese cities found that 85% of respondents had consumed plant-based meat (Wang G. et al., 2023), which may reflect the situation in first-tier cities, whereas our data align more closely with the national average. In addition, we found that the Japanese respondents had less positive consumption intentions than their Chinese counterparts (see Figure 3). This is explained by earlier findings, which indicate that individuals' familiarity with alternative

TABLE 5 Mixed logit model estimates.

	Japan $n = 887$				China $n = 1,119$			
	Control		Treatment		Control		Treatment	
	Model type 1	Model type 2	Model type 1	Model type 2	Model type 1	Model type 2	Model type 1	Model type 2
Mean coefficient								
ASC	3.494*** (0.235)	3.508*** (0.234)	4.271*** (0.231)	4.273*** (0.232)	4.691*** (0.217)	4.693*** (0.218)	4.343*** (0.216)	4.349*** (0.216)
Plant-based meat	−0.248*** (0.049)	0.249 (0.320)	−0.165*** (0.047)	−0.637* (0.319)	−0.113** (0.042)	−0.177 (0.315)	−0.129** (0.043)	−0.689* (0.319)
Cultured meat	−0.326*** (0.046)	0.701* (0.315)	−0.347*** (0.045)	−0.232 (0.303)	−0.570*** (0.043)	−0.349 (0.318)	−0.365*** (0.041)	−0.208 (0.297)
Antibiotic claim	0.259*** (0.036)	0.256*** (0.036)	0.326*** (0.035)	0.325*** (0.035)	0.502*** (0.034)	0.505*** (0.034)	0.652*** (0.038)	0.653*** (0.038)
Traceability	0.237*** (0.038)	0.238*** (0.038)	0.284*** (0.038)	0.283*** (0.039)	0.587*** (0.039)	0.590*** (0.039)	0.594*** (0.040)	0.595*** (0.040)
Carbon footprint	0.138*** (0.014)	0.142*** (0.014)	0.113*** (0.012)	0.114*** (0.012)	0.045*** (0.009)	0.045*** (0.009)	0.043*** (0.009)	0.044*** (0.009)
Price	−0.004*** (0.000)	−0.004*** (0.000)	−0.005*** (0.000)	−0.005*** (0.000)	−0.112*** (0.008)	−0.112*** (0.008)	−0.104*** (0.008)	−0.104*** (0.008)
Plant-based meat: GCV		0.051 (0.048)		0.142** (0.047)		0.063 (0.044)		0.109* (0.047)
Cultured meat: GCV		−0.058 (0.046)		−0.012 (0.044)		0.030 (0.043)		0.051 (0.045)
Plant-based meat: FNS		−0.171** (0.059)		−0.025 (0.057)		−0.068 (0.057)		0.003 (0.059)
Cultured meat: FNS		−0.193** (0.060)		−0.016 (0.055)		−0.103 (0.056)		−0.114* (0.054)
Standard deviations of the random parameters								
sd.Plant-based meat	0.675*** (0.073)	0.647*** (0.073)	0.580*** (0.069)	0.562*** (0.069)	0.525*** (0.065)	0.521*** (0.065)	0.584*** (0.068)	0.575*** (0.068)
sd.Cultured meat	0.555*** (0.082)	0.540*** (0.082)	−0.439*** (0.085)	−0.441*** (0.085)	0.660*** (0.065)	0.652*** (0.065)	0.519*** (0.069)	0.510*** (0.070)
sd.Antibiotic	−0.54*** (0.064)	−0.547*** (0.064)	−0.546*** (0.064)	−0.549*** (0.064)	0.447*** (0.062)	0.448*** (0.061)	0.549*** (0.060)	0.548*** (0.060)
sd.Traceability	0.057 (0.142)	0.013 (0.149)	0.028 (0.177)	0.038 (0.170)	0.249** (0.093)	0.252** (0.093)	0.336*** (0.081)	0.339*** (0.081)
sd.Carbon footprint	0.443*** (0.024)	0.450*** (0.024)	0.342*** (0.019)	0.344*** (0.020)	0.168*** (0.012)	0.168*** (0.012)	0.177*** (0.012)	0.178*** (0.012)
AIC	6343.85	6326.38	6195.80	6194.52	7269.59	7268.04	7107.07	7101.14
Log-likelihood	−3159.9	−3147.2	−3085.9	−3081.3	−3622.8	−3618.0	−3541.5	−3534.6
Number.obs	10,800	10,800	10,488	10,488	13,800	13,800	13,056	13,056

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$. Standard errors are depicted within parentheses. ASC, alternative specific constant; GCV, green consumption value; FNS, food neophobia scale; AIC, Akaike information criterion.

meat products affects their acceptance (Hoek et al., 2011; Mancini and Antonioli, 2019).

The knowledge tests (Table 4) corroborated the findings of earlier studies that consumers are more familiar with plant-based meat than cultured meat (Wang, 2022; Takeda et al., 2023). Plant-based meat is already on the market in both countries, whereas cultured meat is still in the research and development stage and remains unavailable for sale (Food Frontier, 2023). In Japan, food chains, such as Mos Burger and Freshness Burger, have already introduced plant-based burgers with soy patties (Anzo, 2021). Marukome Co., Ltd., a top miso company in Japan, sells a range of alternative meat products made from soybeans (Marukome, 2023). Plant-based meat products, such as vegetarian chickens, have a long history in China, as well. In recent years, food brands such as Starbucks and KFC launched plant-based

TABLE 6 Comparison of WTP estimates for control and treatment groups by country.

	Japan (JPY)			China (CNY)		
	Control	Treatment	Significance level	Control	Treatment	Significance level
Burger patty						
Plant-based meat (compared to conventional meat)		−128.31 [−265.41, −7.60]			−6.63 [−12.77, −0.64]	
Cultured meat (compared to conventional meat)	159.27 [17.05, 301.84]					
Antibiotic claim						
Antibiotic-free (compared to "no claim")	58.10 [41.97, 75.78]	65.44 [50.99, 81.42]		4.51 [3.83, 5.33]	6.28 [5.38, 7.41]	**
Traceability						
Traceable (compared to "not traceable")	54.04 [35.35, 74.82]	57.04 [40.02, 75.04]		5.27 [4.43, 6.31]	5.73 [4.69, 6.94]	
Carbon footprint						
	32.28 [25.96, 40.32]	22.89 [17.89, 28.54]	*	0.40 [0.25, 0.57]	0.42 [0.26, 0.62]	

WTP was computed only for statistically significant variables in model type 2. The figures in brackets represent 95% confidence intervals. Asterisks indicate the statistically significant difference between control and treatment groups (calculated according to the method by Krinsky and Robb). ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

meat products in China, and internationally renowned plant-based meat brands, such as Beyond Meat, entered the Chinese market (Ye, 2023). These alternative meat products that are already on the market have increased consumers' awareness of plant-based meat. We also found Chinese respondents to be more knowledgeable of alternative meats than Japanese respondents (see Table 4). This is expected since the Chinese have had more consumption experience (see Figure 3).

Co-occurrence networks (Figures 4, 5) revealed young consumers' perceptions of meat alternatives in detail. Five similarities were identified between the two samples. First, young consumers perceived meat alternatives as substitutions to conventional meat with specific characteristics, rather than supplements. Second, they associated meat alternatives with plant protein, which is consistent with the findings of Michel et al. (2021). This can be attributed to the plant-based products that are already available in the market. A Chinese study noted that "vegetarian chicken" and "Buddha duck" were made from plant-based ingredients; this has caused consumers to associate plant protein with meat (Wang, 2022). Third, meat alternatives are considered processed products. This is not surprising, because alternative meat products undergo several processing procedures to mimic the taste, texture, and appearance of real meat. Fourth, the health theme appeared in both samples. An earlier study found food safety to be an important factor influencing the food purchasing behavior of Japanese consumers (Sasaki et al., 2022). For example, after the first case of Bovine Spongiform Encephalopathy infection was reported in Japan in 2001, Japanese consumers' demand for beef decreased significantly (Godo, 2015). Similarly, Chinese consumers became highly concerned about the safety of meat products after the reporting of several food safety scandals (Wang, 2022). The final similarity between the two samples is that the respondents mentioned product experience, which probably influenced their consumption preferences.

We observed two differences in the co-occurrence networks, as well. First, Japanese respondents associated meat alternatives with insects, whereas Chinese respondents did not. Since edible insect products are widely available in both countries, we attributed this difference to young Chinese consumers' tendency to perceive insects as protein supplements, rather than meat substitutes. The second difference is that environmental benefits appeared in different themes in the two samples. The co-occurrence of "environmental protection" and "health" in the Chinese sample implies that respondents perceived a strong link between these two benefits. However, in the Japanese sample, "environment" did not co-occur with "health" to form a separate subgraph; rather, they appeared in the subgraph depicting the characteristics of alternative meat. This implies that Japanese respondents perceived environmental benefits as a characteristic of alternative meat but did not associate them with health. This may cause young Japanese consumers to make a trade-off between environmental benefits and health in their preferences, which is explained in Section 4.2.

4.2. Consumer preferences for conventional and alternative meat products [RQ2]

Model types 1 and 2 presented different consumer preferences for burger patties. The results of model type 1 were straightforward, with all signs of alternative meats being negative and statistically significant. These results were consistent with the findings of earlier studies on meat alternatives (Van Loo et al., 2020; Washio et al., 2023). However, by including GCV and FNS, model type 2 demonstrates the complexity of consumer preferences. Since model type 2 had a better AIC for all cases, the model without interaction terms (model type 1)

might be a misleading aspect in this study. Therefore, we focused on the results obtained using model type 2.

4.2.1. Plant-based meat

Our results revealed similar preferences for plant-based meat between young Japanese and Chinese consumers. The control groups did not show significant preferences between plant-based and conventional meats; however, the treatment groups showed a negative WTP for plant-based meat compared to conventional meat (Table 6). The negative effect of food health information on consumer preferences for plant-based meat was not recorded by earlier studies (e.g., Ortega et al., 2022; Wang et al., 2022). A possible explanation is that our health information was not sufficiently convincing, and consumer attention was directed toward the health benefits of alternative meat. In FGs, we found negative perceptions of the health benefits of plant-based meat. One Japanese participant believed that plant-based meat could not provide the same amount of protein as conventional meat. Further, Chinese FG participants stated that "plant-based meat may contain a large number of food additives" and that "plant-based dishes may be cooked with high levels of oil and salt." In co-occurrence networks, respondents associated meat alternatives with processed foods (Figures 4, 5). It is noted that ultra-processed plant-based meat products have harmful health consequences (Flint et al., 2023). A high sodium content is another concern for consumers (Bohrer, 2019). Therefore, treatment groups may have been influenced by such negative health perceptions due to which they showed a preference for conventional meat over plant-based meat.

While the treatment groups showed a negative preference for plant-based meat, in general, respondents with a high GCV in the treatment groups preferred plant-based meat to conventional meat (Table 5). There are two possible explanations for this observation. First, consumers with a high GCV were aware of the negative effects of antibiotic use on the environment. For example, antibiotics can cause water and soil pollution and alter environmental microbiota (Martinez, 2009). Second, consumers with a high GCV were highly concerned about their health and were easily convinced by the provided health information. Although no studies have directly proved this causal relationship, consumers' environmental attitudes are significantly influenced by their health attitudes (Ritter et al., 2015). However, this preference was not observed in the control groups. This can be attributed to a lack of awareness of the negative environmental impact of conventional meat production (Hartmann and Siegrist, 2017).

Japanese respondents with a high FNS in the control group preferred conventional meat to plant-based meat, whereas Chinese respondents with a high FNS showed no preference (Table 5). Food neophobia is often considered a barrier to the acceptance of alternative meats (e.g., Hoek et al., 2011; Siegrist and Hartmann, 2020). The difference in preferences between the two countries is probably because the Japanese respondents were less familiar with plant-based meat than their Chinese counterparts (see Figure 3; Table 4). In the treatment group, Japanese respondents with a high FNS showed no preference between conventional and plant-based meats. For consumers with a high FNS, familiarity is a prominent consideration in making food choices; they consider familiarity more important than health concerns (Karaağaç and Bellikci-Koyu, 2022). While the information intervention directed respondents' attention to health, Japanese respondents with a high FNS cared more about the knowledge provided by the information intervention, which increased their familiarity with plant-based meat.

4.2.2. Cultured meat

Our results revealed that the Japanese control group preferred cultured meat to conventional meat, whereas the Chinese control group had no preference. This contradicts the findings of earlier studies indicating that cultured meat is less preferred than conventional meat (e.g., Van Loo et al., 2020; Ortega et al., 2022). There are two possible explanations for the positive preference toward cultured meat in the Japanese control group. First, the role of cultured meat in ameliorating world hunger significantly increases its consumer acceptance (Hibino et al., 2023). According to a Japanese survey, 55% of respondents agreed that cultured meat is a possible solution to global famine (Nissin Foods Group, and Hirosaki University, 2019). Moreover, Japanese domestic news and online articles often associate cultured meat with food security (Ishikawa, 2021; JBpress, 2021; NHK, 2023), which probably reinforces young consumers' awareness. Second, animal welfare can be one of the main reasons why consumers prefer cultured meat to conventional meat (Valente et al., 2019; Specht et al., 2020; Weinrich et al., 2020). Although the current production of cultured meat relies on real animals to obtain stem cells, it ensures a reduction in the number of animals slaughtered and reduces intensive animal husbandry (Rubio et al., 2020). A Brazilian study found that more than 80% of the respondents had limited knowledge of cultured meat; however, 63.6% said they would eat cultured meat, mostly out of concern for animal welfare (Valente et al., 2019). It is also considered one of the strongest positive drivers of the acceptance of cultured meat in Germany (Weinrich et al., 2020). A Japanese study found that 59.4% of respondents advocated the reduction of livestock suffering (Iwamoto and Kubota, 2022). Another study revealed that most Japanese respondents have a positive WTP for animal welfare (Sonoda et al., 2018).

The negative impact of information intervention was reflected in Japanese respondents' preference for cultured meat, as well. In contrast to the control group, the Japanese treatment group no longer preferred cultured meat over conventional meat but tended to treat them equally. Their attention can be directed toward the health benefits of alternative meats by providing health information, and there was a negative perception of the health benefits of cultured meat (e.g., Tucker, 2014; Hocquette et al., 2015). This likely undermines Japanese respondents' preference for cultured meat to a certain extent.

Interestingly, we found different effects of the information intervention on the preference for cultured meat of respondents with a high FNS in the two countries. Our health information positively influenced the Japanese respondents' preferences for cultured meat. Japanese respondents with a high FNS in the control group preferred conventional meat to cultured meat, which was not surprising because the respondents were not familiar with cultured meat (see Table 4). In the treatment group, Japanese respondents with a high FNS showed no preference between conventional and cultured meat, which implies that our health information could increase the trust in cultured meat of Japanese respondents with a high FNS. However, the information intervention had a negative impact on Chinese respondents' preference for cultured meat. One possible explanation is that our health information made Chinese respondents with a high FNS realize that they lacked knowledge of the health benefits of cultured meat. Most of them did not know how cultured meat was produced (see Table 4).

Respondents with a high GCV in the treatment groups of both countries preferred plant-based meat to conventional meat; however, they did not show any preference between cultured and conventional meats. This is attributed to the perceived unnaturalness of cultured meat (e.g., Tucker, 2014; Weinrich et al., 2020). An earlier study found that the consumers who were ready to pay a premium for environmentally friendly products were among those who were the most concerned about the naturalness of food (Lockie et al., 2004). Therefore, the perceived unnaturalness of cultured meat can be a barrier to its acceptance by consumers with a high GCV.

4.2.3. Antibiotic claim

Respondents in both countries preferred "antibiotic-free" over "no claim" labeling, which indicates that young consumers had a negative attitude toward antibiotic use in meat production. A meta-analysis by Yang and Renwick (2019) found a similar result that consumers were willing to pay a high premium for hormone- or antibiotic-free livestock products. The abuse of antibiotics may lead to the human consumption of food contaminated with antibiotic residues, and antibiotic resistance poses a serious threat to human health (Ghimpețeanu et al., 2022). Due to the perceived health benefits of such food products, young consumers were willing to pay a premium for "antibiotic-free" labeling. However, this may also indicate that young consumers are unaware of the benefits of antibiotic use in the livestock industry. Proper antibiotic use can improve animal welfare and enhance food safety, which are often overlooked by consumers (Busch et al., 2020).

With information intervention, Chinese respondents showed significantly stronger preference for "antibiotic-free" labeling, whereas Japanese respondents did not. This could be because the information intervention reminded the Chinese respondents of the food safety scandals associated with antibiotic residues that came to light. For example, in 2012, when China's KFC chicken supplier used antibiotics and hormones to accelerate the growth of poultry, excessive levels of antibiotics were detected in the chickens (Hornby Lucy, 2013). Another possible reason is that the information intervention stimulated Chinese respondents' awareness of the experiment's implementation. Given that the information intervention centered on antibiotics, Chinese respondents in the treatment group may have felt that they were expected to favor "antibiotic-free" labeling. However, in a real-life consumption scenario, consumers may not place a higher premium on "antibiotic-free" labeling when presented with marketing messages about antibiotics.

4.2.4. Traceability

Our study found that respondents in both countries were willing to pay a premium for "traceable" labeling; this result aligns with the findings of several earlier studies (e.g., Ortega et al., 2011; Wu et al., 2015; Zhou et al., 2022). This indicates the positive attitude of young consumers in both countries toward the establishment of traceability systems for alternative meats. The information intervention did not have a significant impact on the preference for "traceable" labeling, which is reasonable since our health information did not include traceability.

Japanese respondents showed homogeneity in their preferences, whereas Chinese respondents showed heterogeneity. In the Japanese sample, the standard deviations of the random parameter (sd. Traceability) were not statistically significant; this indicates the homogeneity of Japanese respondents' preferences. Currently, Japan has mandatory traceability systems for beef and rice and encourages food business operators to establish traceability systems for other food products (Jin and Zhou, 2014). The homogeneous preferences of Japanese respondents regarding traceable products may be the result of their awareness of the benefits of traceability systems. In comparison, Chinese respondents showed heterogeneity in their preferences for traceability. An earlier study using an extended theory of planned behavior model found that factors such as face consciousness, trust, and policy support affected Chinese consumers' purchase intentions for traceable products (Ding et al., 2022). Household income and education level were also identified as two factors contributing to the heterogeneity in Chinese consumers' preferences for traceability (Wu et al., 2015).

4.2.5. Carbon footprint

The respondents in both countries preferred low carbon footprint labeling, which is consistent with the findings of earlier studies (e.g., Apostolidis and McLeay, 2016; Carlsson et al., 2022). Notably, we observed a significantly lower WTP for low carbon footprint labeling in the Japanese treatment group than the control group. In other words, young Japanese consumers may make trade-offs between health and environmental benefits. Yang et al. (2021) found a similar substitution effect, in which the consumer premium decreased with the simultaneous appearance of health-related and low-carbon attributes.

4.3. Implications for promoting alternative meat products [RQ3]

4.3.1. Marketing messaging

Marketing messages can increase consumers' familiarity with, and positive perceptions of, alternative meats (Apostolidis and McLeay, 2016; Tosun et al., 2021). Since young consumers in both countries currently have limited knowledge of alternative meats, particularly cultured meat, marketing messages have the potential to significantly influence their preferences. For example, nutritional information significantly increased the WTP for plant-based meat among consumers in Beijing (Wang et al., 2022). Our results indicated heterogeneity in consumer preferences in both Japan and China (Table 5), which implied the diversity of consumer segments. This study identified the following two consumer segments by estimating the interaction terms in both countries: respondents with a high GCV and those with a high FNS. They differed in their preferences for burger patties, and the information intervention had different effects on their preferences (Table 5). Hence, marketing messages should be customized to suit different consumer segments in both countries (Tosun et al., 2021).

We found that providing certain information alone could unexpectedly reduce consumers' preferences for alternative meat in both countries. Such messages can increase consumers' knowledge but can induce and direct consumers' attention to an aspect that is negatively perceived. An American study revealed that when respondents received only technical information on cultured meat production, the perceived unnaturalness discouraged them from consuming it (Bryant and Dillard, 2019). To promote alternative meat efficiently, marketers in Japan and China should disseminate designed messages about the product to consumers in a multidimensional manner to overcome the diversity of consumer segments and avoid triggering negative consumer perceptions.

4.3.2. Food labeling

Food labeling can be an effective method to promote alternative meat (Apostolidis and McLeay, 2016; Profeta et al., 2020; Ortega et al., 2022). Our study revealed that young consumers in both countries were willing to pay a premium for "antibiotic-free," "traceable," and low carbon footprint labeling. The premium for "antibiotic-free" and "traceable" labeling reflects respondents' health concerns. Globally, the largest use of antibiotics is in agriculture and, today, the consumer demand for antibiotic-free food is increasing steadily (Larsen, 2018). The "antibiotic-free" labeling enables young consumers in both countries to positively assess the health benefits of alternative meat. Since the information intervention significantly enhanced Chinese respondents' preference for "antibiotic-free" labeling, providing education or sending marketing messages about the health risks of antibiotic residues would make "antibiotic-free" labeling very effective in China.

Traceability is another credence attribute of food products. Food companies use different levels of traceability labeling to differentiate their products from the products of their competitors (Liu et al., 2019). Japan has introduced a traceability system for beef products and enacted the Beef Traceability Act (Godo, 2015). Consumers can trace beef information online by entering the product's ID number (MAFF, 2023). In comparison, China's food traceability system remains inadequate to this day. The lack of food supply chain databases, insufficiency of relevant laws and regulations, and use of outdated traceability technologies are challenges to establishing a sound food traceability system in China (Tang et al., 2015). To increase consumers' confidence in alternative meat products, both countries must incorporate the traceability of alternative meat products into the construction of food traceability systems.

Since alternative meat is often marketed as an environmentally friendly product, carbon footprint labeling has the potential to encourage alternative meat consumption (Apostolidis and McLeay, 2016). Both Japan and China have started implementing carbon footprint labeling for various products (Fu, 2023; SuMPO, 2023). The carbon footprint labeling of alternative meat products is expected to be beneficial in attracting environmentally concerned consumers in both countries. However, in FGs, we found that participants from both countries had a poor understanding of the concept of the carbon footprint, with one participant confusing it with carbohydrates. Therefore, policymakers and marketers must enhance young consumers' awareness of carbon footprint labeling in both countries. In this study, we adopted specific carbon footprint values (i.e., 1-, 4-, 7-, and 10-kg CO_2eq) that may not be easily comparable by consumers in real consumption situations. However, as carbon footprint labeling becomes more popular and public awareness of environmental protection increases, consumers may become more sensitive to specific carbon footprint values. Notably, compared with the control group, the Japanese treatment group showed a significantly less WTP for low carbon footprint labeling. Therefore, in Japan, the combination of carbon footprint labeling and marketing messages on health benefits should be applied with caution.

4.3.3. Product development

Alternative meat products should mimic real meat products to attract meat consumers in both countries. As respondents in both countries were predominantly omnivores, with only a small percentage being vegetarians and vegans (Table 3), the effect of dietary preference on consumers' perceptions of and preferences for alternative meats cannot be inferred. However, targeting meat consumers appears to be the most strategic and profitable approach for alternative meat producers in both countries, aligning well with the goal of promoting sustainable food consumption. In addition, we found that respondents in both Japan and China perceived meat alternatives as substitutes to conventional meat and mentioned product experience in free associations about meat alternatives (Figures 4, 5). Therefore, in future, alternative meat products should be similar to conventional meat in terms of product experience, such as taste and texture, in both countries. Some food retailers have already adopted this marketing strategy. For example, Burger King and Impossible Foods co-created the Impossible Whopper, which emphasizes the similarities between new plant-based meat products and real meat products (Schwab, 2019).

5. Conclusion

A dietary shift from conventional to alternative meats is often considered beneficial in shaping a sustainable food system. To promote alternative meat consumption, many earlier studies examined consumer preferences for alternative meats (e.g., Apostolidis and McLeay, 2016; Profeta et al., 2020; Wang et al., 2022). However, few studies have investigated young consumers' perceptions and preferences for alternative meats, and comparative studies on consumer preferences for alternative meats among key markets in Asia remain limited. Our study applied DCE and co-occurrence networks to examine the perceptions and preferences of young Japanese and Chinese consumers regarding plant-based and cultured meats.

Our study has several important findings. First, Japanese respondents were less familiar with alternative meats than Chinese respondents; however, they had some similar perceptions of meat alternatives. For example, respondents in both countries perceived meat alternatives to be substitutes to conventional meat and associated them with plant-based proteins, processed products, and health benefits. Second, our results revealed young consumers' preferences for plant-based and cultured meats. Notably, Japanese respondents preferred cultured meat to conventional meat. Third, respondents from both countries showed heterogeneity in their preferences for plant-based and cultured meat. Further, we examined the preferences of two consumer segments: respondents with a high GCV and those with a high FNS. The estimates of various consumer segments' preferences for alternative meats facilitate the development of effective marketing messages (Tosun et al., 2021). Fourth, our results revealed the complexity of the impact of information interventions on consumer preferences. The information intervention can have a positive impact on consumer preferences for alternative meats, such as the preference for plant-based meat among respondents with a high GCV in both countries. Interestingly, the health information on antibiotics can also have an unanticipated negative impact on consumer preferences for alternative meats. This may be because the information intervention directed consumers' attention to an aspect that was negatively perceived (e.g., the health benefits of plant-based meat). Fifth, the respondents in both countries had a positive WTP for "antibiotic-free," "traceable," and low-carbon footprint labeling. Hence, the adoption of health and environmental labeling can make alternative meat appealing to young consumers in both countries.

Our study has some limitations: First, this study adopted a stated preference survey, whose results might not be consistent with real consumption behavior (Nguyen et al., 2015; Wang et al., 2022). It

would be interesting to corroborate the results by conducting revealed preference studies to avoid hypothetical bias. Second, burgers were the only products considered in our study. Young consumers may have different perceptions of alternative meats for different foods. An earlier study found that consumers in the United Kingdom had a lower WTP for cultured beef burgers than that for conventional beef burgers but a similar WTP for cultured and conventional chicken nuggets (Vural et al., 2023). Hence, future research should compare consumers' perceptions of alternative meat applications for different types of foods. Third, edible insects were not included as a promising meat alternative in this study. Insect proteins are superior to plant proteins in terms of total protein levels, essential amino acid content, and bioavailability (Lee et al., 2020). Moreover, insect farming is less expensive and more environmentally friendly than livestock farming (Gravel and Doyen, 2020). Therefore, edible insects form an important part of the alternative meat market; accordingly, future research should examine young consumers' perceptions of and preferences for edible insects. Fourth, future research should examine Japanese and Chinese consumers' attitudes toward the use of "meat" labels on alternative meat products. A United States study found that more than 70% of respondents were opposed to the use of "beef" labeling on plant-based and cultured meat products (Van Loo et al., 2020). Consumers may be confused or misled when these alternative products are labeled as meat. In the Japanese FG, a participant stated that she considered plant-based meat to be a mixture of plant ingredients and animal meat, rather than purely plant-based. Such misconceptions can lead to undesirable dietary shifts; for example, consumers may not realize that the protein content in purely plant-based meat is not equivalent to that in animal meat. Finally, our information intervention solely centered on the antibiotic use in conventional meat production, emphasizing the positive aspect of alternative meats. In a real marketing environment, consumers are exposed to various types of information, such as environmental and nutritional information, some of which may also be negative. Therefore, future research should test the effects of different information interventions on consumers' preferences. The continued exploration of effective marketing strategies is crucial, since products are continually updated and the consumer perceptions of alternative meats vary continuously.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

SH: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft. TU: Data curation, Funding acquisition, Investigation, Project administration, Software, Supervision, Writing – review & editing.

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Conflict of interest

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

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2023.1290131/full#supplementary-material

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