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Does information about environmental considerations affect Chinese and UK consumers' purchase intentions for traced foods? A path analysis

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Abstract
Consumers are increasingly focused on making sustainable food choices, necessitating transparent and trusted systems for providing sustainability information. This can be implemented, for instance, through application of traceability systems that "carry" sustainability information about production and distribution. Currently, the literature on traceability mainly addresses consumer perceptions regarding the benefits of traceability concerning food safety and recalls. This research assessed consumers' perceptions of the benefits of tracing food sustainability information in relation to purchase decisions. Data were collected using online surveys in China ($n=1515$) and the UK ($n=1656$). Path analysis indicated that higher perceived benefits of tracing sustainability information had small positive impacts on purchase intentions in both countries, with these being more pronounced for traced beef compared to milk and apples. The impacts of perceived environmental benefits on purchase intentions were partially mediated by perceptions of improved food safety and quality. This indirect influence was more prominent among UK respondents, implying potentially stronger safety and quality "halo" effects associated with environmental sustainability information compared to Chinese respondents. Stronger pro-environmental attitudes and greater perceived environmental threats linked to food production correlated with higher perceived environmental benefits of tracing food sustainability information and purchase intentions for traced foods in both countries. Positive correlations between pro-environmental attitudes and perceived environmental threats were only observed for UK respondents, suggesting that environmental issues related to food production might be more integrated into the general environmental attitudes of UK respondents. Implications for marketing strategies and policymaking are proposed considering diverse consumer responses to traced foods between the UK and China, food categories, and socio-demographic groups.

Keywords Sustainability · Traceability · Environmental attitudes · Environmental benefits · Purchase intention · Halo effect

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1 Introduction

Agri-food systems significantly contribute to anthropogenic greenhouse gas (GHG) emissions, deforestation, and habitat destruction. Scientific evidence indicates that GHG emissions from agri-food systems constitute 25–42% of total anthropogenic GHG emissions, with agriculture and related land use and land-use change activities (often associated with deforestation and habitat destruction) accounting for 71% of these emissions (Crippa et al., 2021). To reduce GHG emissions from agri-food systems, preserve biodiversity, and enhance the multifunctionality of farming land, stakeholders such as food producers, retailers and others involved in food systems must transition towards more sustainable practices (Marques et al., 2019; UNEP et al., 2023). Consumer food preferences and choices can serve as an important driver of this transition. Changing consumer consumption patterns towards sustainable food choices can accelerate the transition towards more sustainable food systems (Dowd & Burke, 2013; Jorgenson et al., 2019; Yildirim, 2020).

While there is currently a growing interest in sustainable food products among consumers worldwide, a lack of knowledge and information about sustainable production practices associated with specific products may act as a barrier to consumers' purchases (Ammann et al., 2024; Boccia & Sarnacchiaro, 2018; Li & Kallas, 2021). It is therefore important to effectively record and communicate sustainability-related information to consumers to facilitate informed decision-making, for example, by establishing traceability systems that track agri-food production and transportation characteristics through the supply chain (Biswas et al., 2023; Spence et al., 2018). Such traceability systems can provide authenticated sustainability information to consumers, while simultaneously enabling regulatory authorities and food companies to more efficaciously monitor sustainability (Biswas et al., 2023; Spence et al., 2018). Indeed, there is growing demand from different stakeholders (e.g., government environmental authorities, food companies and consumers) for tracing and authenticating sustainability information associated with primary production and transportation along food supply chains (Biswas et al., 2023; Spence et al., 2018). Understanding consumer responses to sustainably produced food and the associated information provision can inform relevant decision-making by the authorities, food companies and food producers to ensure changes towards more sustainable food systems align with consumer preferences. This, in turn, may drive changes in environmental regulations associated with food systems, increase adoption of environmentally sustainable procurement practices by food wholesalers and retailers, and facilitate implementation of more environmentally friendly practices, thereby reshaping the agri-food systems (Biswas et al., 2023; Garcia-Torres et al., 2019).

Consumers' responses to tracing sustainability-related information within food supply chains have been found to vary by country and food category. For example, Myae and Goddard (2012) found that Canadian and US consumers perceived higher importance to be associated with provision of the means to verify environmentally sustainable production practices when compared to Japanese consumers. The purchase of sustainable fish products ("Best Aquaculture Practices" or "Friend of the Sea" labels) was higher among Spanish consumers compared to Italian consumers, although both Spanish and Italian consumers had relatively low awareness of fish sustainability labels (Fiorile et al., 2023). Spanish consumers were found to place greater importance on the provision of information about sustainable production methods and

carbon footprints from the supply and distribution chains for sustainable food products, when compared to consumers in the Czech Republic, Sweden, Switzerland, and the UK (Yue et al., 2024). In some developing economies such as China and Egypt, consumers also expressed preferences for food labels that display the information to indicate sustainability levels (Rondoni & Grasso, 2021). Consumers may perceive certain food categories to cause higher negative impacts on the environment compared to other food categories, potentially leading to a greater need to trace these food categories in relation to their environmental characteristics (e.g., meat *versus* dairy and plant-based products) (Jin et al., 2023; Lazzarini et al., 2016). Consumers may be willing to pay more for a food product with a sustainability label, especially if it represents a lower share of their monthly household expenses on food compared to food products with a higher share (Echeverría et al., 2014). However, to date, most research into consumer perceptions of, and attitudes towards, traceability has focused on the perceived benefits associated with improved food safety and food quality (see e.g., Kendall et al., 2019; Qian et al., 2020) rather than the potential authentication of information about production and supply chain sustainability characteristics, and associated environmental benefits (Vriezen et al., 2023). Furthermore, few existing studies have directly compared consumer responses to tracing food sustainability characteristics across countries and food categories (Rondoni & Grasso, 2021).

This research aimed to address these knowledge gaps by investigating Chinese and UK consumers' responses to tracing sustainability characteristics for three food categories (apples, milk and beef). China and the UK represent important food traceability markets (BIS Research, 2021). However, there is a need to harmonise food supply chain practices and standards due to the increasing trade in food products between the two countries and indeed internationally (China-Britain Business Council, n.d.). Of the selected food categories, milk and beef represent food categories that are associated with more negative environmental impacts in relation to production compared to apple production according to environmental assessments (Clark et al., 2022). However, consumers' concern over the environmental impacts of the same food categories might differ between the two countries, as there is evidence that Chinese citizens tend to have stronger environmental attitudes compared to UK citizens (Miller et al., 2022). In this context, the present research was intended to address three main questions:

- To what extent do Chinese and UK consumers perceive benefits to be associated with tracing sustainability information along food supply chains?
- How do benefit perceptions associated with tracing sustainability information shape Chinese and UK consumers' purchase intentions towards the traced foods;
- What are the similarities and differences in consumers' responses to tracing sustainability information by country and food category?

By addressing the research questions, this study adds to the existing literature on consumers' food decision-making, particularly focusing on food for which sustainability information along its supply chain has been traced. It can also better inform future development and promotion of traceability for sustainable food products targeting Chinese and UK consumers, which, in turn, may accelerate the transition of other stakeholders involved in food systems towards more sustainable practices.

2 Literature review and conceptual model development

2.1 Benefit perceptions of tracing sustainability information

Previous research indicates that consumers associate the concept of food sustainability with various characteristics. For example, consumers may perceive food to be more sustainable if its primary production and transportation have low environmental impacts or if it is locally produced (Grunert et al., 2014; Van Loo et al., 2017). Providing authenticated sustainability information for specific products can enhance consumers' capability to identify foods aligned with their preferred sustainability attributes (van Rijswijk et al., 2008; Wang & Tsai, 2019). When traceability information about the environmental impacts of food production and transportation is associated with specific products, consumers tend to form positive perceptions regarding the benefits of the traced food to the environment (Shew et al., 2022). For example, consumers perceive that traced beef, where the information about food origin, producers, and food miles is available, is more environmentally friendly compared to non-traced beef, leading greater consumer intentions to buy the traced beef (Spence et al., 2018). Coffee beans with traceability information about "food miles"[1] were also perceived by consumers to be more environmentally friendly compared to non-traced coffee beans, which in turn contributed to increased purchase intentions (Dionysis et al., 2022). It is therefore assumed:

H1 *The greater the perceived benefits to the environment associated with tracing sustainability information in a specific food supply chain, the greater the intention to buy the traced food.*

Perceived food safety has been reported to have a significant positive and direct influence on consumers' food purchases. Establishing traceability in the supply chains of specific food products can further enhance the perceived safety of foods (Qian et al., 2020; Suhaimi et al., 2021). For example, sustainability-related information such as pesticide use in vegetable and fruit production and veterinary treatments of farm animals can be traced through the supply chain and communicated to consumers (Dudeja & Singh, 2017; Khouryieh et al., 2019). Offering authenticated information about the origin of food, together with other information (e.g. food miles) increases transparency within food supply chains, at the same time positively influencing consumers' perceptions that the food is safe and hence their purchase of traced foods (Lam et al., 2020; Nardi et al., 2020; Schillhorn van Veen, 2005).

Product quality can be defined as perceived superiority and excellence of a product compared with competing alternatives (Magnier et al., 2016; Zeithaml, 1988). Previous research has shown the important role of product quality in informing consumers' food decision-making (Boccia et al., 2024; Pradana et al., 2024; Sun et al., 2024). When they make food choices, consumers evaluate a food product's performance based on, for example, the (perceived) taste, nutritiousness, and naturalness of foods (Konuk, 2021; Magnier et al., 2016; Pelletier et al., 2013). Providing details regarding the avoidance of the use of artificial chemicals in production (e.g., pesticides and fertilisers for vegetables and

[1] Food miles refer to the distance food is transported from the time of its making until it reaches the consumer.

veterinary treatments of farm animals) and information about enhanced animal welfare practices could influence consumers' perceptions of food naturalness, freshness and taste, shaping their perceived quality of traced foods (Gross et al., 2021; Nadricka et al., 2020; Román et al., 2017). As such, tracing sustainability information along food supply chains could evoke greater perceived food safety and quality, positively influencing their purchase intentions towards these traced foods (Lassoued et al., 2023; Lazzarini et al., 2016; Magnier et al., 2016; Myae & Goddard, 2012; van Bussel et al., 2022; van Rijswijk et al., 2008). Thus, it is assumed:

H2 *The greater the perceived improved food safety associated with tracing sustainability information in a specific food supply chain, the greater the intention to buy the traced food.*

H3 *The greater the perceived improved food quality associated with tracing sustainability information in a specific food supply chain, the greater the intention to buy the traced food.*

A sustainability "halo effect" might exist in consumers' assessment of the safety and quality of traced foods, during which an initial positive perception of food environmental sustainability influences consumers' overall evaluation of that food, leading them to perceive other aspects more positively than they might otherwise (Donato et al., 2021; Koenig-Lewis et al., 2022). Providing third-party certified eco-labels and fair-trade labels can evoke perceived environmental benefits associated with traced food, which, in turn, positively affects consumer perceptions of food safety and quality, as well as their purchase intentions (Berry & Romero, 2021; Lanero et al., 2021; Potter et al., 2021). Similar effects were identified to be associated with consumers' choice of organic foods, where an organic label could lead to perceived lower calorific content, greater healthiness and better hedonic properties compared to non-organic products, thereby leading to higher consumption (Besson et al., 2019; Nadricka et al., 2020). Therefore, it is assumed:

H4 *Higher perceived environmental benefits of a traced food are associated with* ***a)*** *greater perceived safety and* ***b)*** *greater perceived quality of the traced food, thereby indirectly increasing purchase intention.*

2.2 Environmental attitudes and perceived environmental threat

Environmental attitudes can be defined as "a psychological tendency expressed by evaluating the natural environment with some degree of favour or disfavour" (Milfont & Duckitt, 2010, p. 80). They are influenced by demographic factors (e.g. gender, age, income, and education) and socially constructed factors (e.g. conservatism, economic value, egoistic value, feminism, and religiosity) (Dietz et al., 1998, 2005; Kim & Kim, 2010). For example, pro-environmental attitudes are often more frequently observed in women (Domingues & Gonçalves, 2020; Martín-Ezpeleta et al., 2022; Meyer, 2015), people with higher incomes (Grandin et al., 2022; Lo, 2016; Olli et al., 2001), those who have spent longer in education (Meyer, 2015; Wang et al., 2022), who are more altruistic (Aprile & Fiorillo, 2023), people holding a less materialistic world view (Hedlund-de Witt et al., 2014), and who have more liberal political views (Wyss et al., 2022). There are inconsistent findings regarding the relationship between age and environmental attitudes, as increased age has been reported to be associated with both more

positive and more negative environmental attitudes (Bleidorn et al., 2021; Domingues & Gonçalves, 2020; Hawcroft & Milfont, 2010; Kim & Kim, 2010).

Environmental attitudes can be linked to people's assessment of specific environmental issues (Frondel et al., 2017; Ogunbode et al., 2020), and pro-environmental behaviour change (Bamberg, 2003; Fujii, 2006; Righi et al., 2023). People with more positive environmental attitudes may more actively seek information about specific environmental threats (Baierl et al., 2022) and have more favourable perceptions of strategies that can potentially mitigate negative environmental impacts (Baierl et al., 2022; Henn et al., 2020; Syropoulos & Markowitz, 2022; Wyss et al., 2022). Given the increased information available in general circulation about environmental issues in food production and the benefits of different environmental impact reduction strategies (Atkinson et al., 2023; Ortega et al., 2015; Simeone & Scarpato, 2020), those with stronger environmental attitudes are more likely to be aware of the adverse impacts caused by food production and seek authenticated sustainable foods. For example, Ammann et al., (2024) found a positive correlation between environmental attitudes and benefit perceptions of providing sustainability information for sustainably produced meat and dairy products among consumers in the Czech Republic, Spain, Sweden, Switzerland and the UK. Stronger environmental attitudes have also been reported to predict pro-environmental behaviours, such as purchasing organic food (Azzurra et al., 2019; Kushwah et al., 2019; Wang et al., 2020a, 2020b) and choosing low carbon diets (Panzone et al., 2016; Righi et al., 2023). It is assumed:

H5 *Greater pro-environmental attitudes correlate with **a)** stronger perceived environmental threats within food supply chains, **b)** greater perceptions of the environmental benefits linked to the traced foods, and **c)** higher intention to purchase the traced foods.*

From a protection motivation theory perspective, people can be motivated to behave in a way that is perceived to be effective in mitigating a potential environmental threat (Bockarjova & Steg, 2014; Marikyan & Papagiannidis, 2023; Rogers, 1975; Wang et al., 2020a, 2020b). People with greater concerns about environmental threats are more likely to inform themselves about, search for, and pay for food with relatively lower environmental impacts (Hoffmann & Schlicht, 2013; Jin et al., 2023; Onwezen et al., 2021). For example, Slamet and Nakayasu (2017) reported that consumers with a higher concern for environmental issues are more likely to consider buying traced fruit and vegetables compared to those who are less concerned about environmental issues. It is therefore assumed:

H6 *Stronger perceived environmental threat associated with producing a specific food correlates with **a)** higher perceived environmental benefits of traced sustainability information in the associated supply chain, and **b)** greater intention to buy the traced food.*

A model has been developed based on the hypotheses to test interrelationships of the different factors involved (see Fig. 1).

3 Method

3.1 Survey development

A structured survey was designed, including questions measuring environmental attitudes, perceived environmental threats associated with producing specific foods (apples, milk and

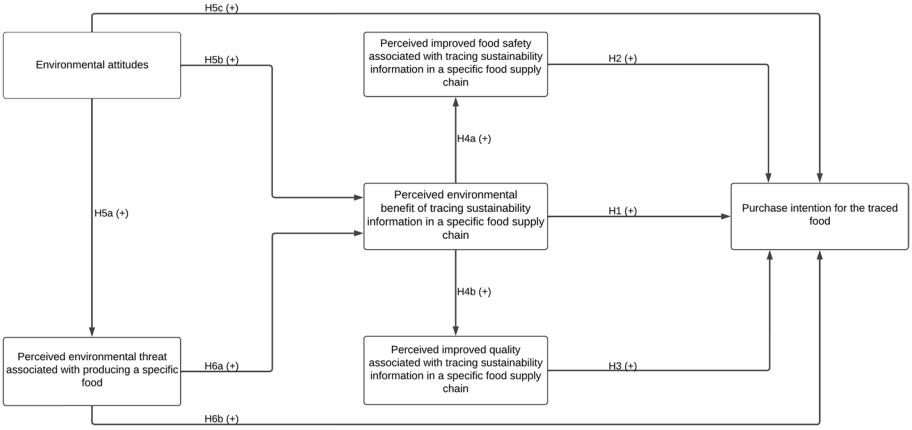

Fig. 1 The proposed model explaining how environment attitudes and perceived environmental threat within food supply chains affect consumers responses to traced foods with sustainability information

beef), perceived benefits associated with tracing sustainability information in specific food supply chains, purchase intentions in relation to the traced foods, and socio-demographic information. Environmental attitudes were measured using the shorter 24-item environmental attitudes inventory (EAI) (Milfont & Duckitt, 2010), a reliable instrument previously employed in various countries, including China and the UK (Tate et al., 2014; Yue et al., 2023). The EAI items are divided into two underlying constructs: *preservation attitude* assesses the extent to which an individual perceives that preserving nature should be prioritised over human use: and *utilisation attitude* the extent appropriate and necessary for nature to be used for human objectives (Milfont & Duckitt, 2010). The general environmental attitude scores were computed by reversing the utilisation attitude items and then averaging the responses to all twenty-four items for each country. Cronbach's alpha for the EAI scale was 0.76 among Chinese respondents and 0.83 among UK respondents, indicating acceptable internal reliabilities.

The perceived environmental threats associated with food supply chains and three types of perceived benefits associated with traced food (i.e. reduced environmental impacts, improved food safety, and improved food quality) were measured using single items, informed by previous research indicating these factors predict consumer attitudes and purchase intentions (Chen & Huang, 2013; Dionysis et al., 2022; Hansen, 2005; Hoffmann & Schlicht, 2013; Onwezen et al., 2021; Spence et al., 2018). Three items were used to measure purchase intentions for traced foods (Nguyen et al., 2022; Spence et al., 2018; Wang & Tsai, 2019). The purchase intention scores were computed by averaging the responses to three items for each food category. Cronbach's alpha ranged from 0.65 to 0.74 for three traced food categories among Chinese respondents, and 0.87 to 0.90 among UK respondents, indicating acceptable internal reliabilities. Eleven items were used to measure respondents' perceived importance of tracing different types of food supply chain-related information (Jin & Zhou, 2014; Jin et al., 2017; van Rijswijk et al., 2008). The respondents were asked to rate statements of the relevant constructs on five-point Likert scales (1 = "strongly disagree" to 5 = "strongly agree") (see Supplementary Material Table A). The items used to assess consumers' annual household income were different between UK and Chinese surveys due to the difference average income between the two countries.

The survey was developed in English, translated into Chinese and then back translated into English by a member (SJ) of the project team.

3.2 Data collection and sample description

Ethics approval for this research was granted by the Newcastle University Research Ethics Committee in December 2019 (Ref: 18,226/2019). The Chinese and English surveys were first piloted using 50 Chinese and 50 UK consumers, which were then adjusted to ensure the relevance of questions to consumers in both countries based on the feedback. The final surveys were then distributed online to 2000 Chinese and 2000 UK consumers by a social research company (Qualtrics LLC) between January and March 2022, quota sampled on the basis of gender, age and education. A total of 1515 Chinese responses and 1656 UK responses remained for further analysis after removing inconsistent data and incomplete surveys. The samples were approximately evenly divided according to gender for both countries, with a mean age of 41.21 ($SD = 14.82$) for Chinese respondents and 46.28 ($SD = 16.00$) for UK respondents. Respondents that have received tertiary education accounted for 18.5% of the Chinese respondents and 40.7% of the UK respondents. These demographics approximate the Chinese and UK population characteristics reported by the 2020 Chinese Census (National Bureau of Statistics of China, 2021) and the 2011 UK Census (Office for National Statistics, 2013) and mid-2020 population estimates (Office for National Statistics, 2021), which ensures that the samples are socio-demographically representative of the populations within each country. Detailed socio-demographic information of respondents is presented in Table 1.

3.3 Data analysis

Descriptive analyses were conducted to summarise Chinese and UK respondents' perceived importance of tracing different types of food sustainability-related information, environmental attitudes, perceived environmental threats associated with producing specific foods and perceived benefits and purchase intentions in relation to traced foods. Independent-samples t-tests compared Chinese and UK respondents' scores for the constructs included in the proposed model for each food category. Repeated measures ANOVA was used to compare Chinese and UK respondents' scores for the same constructs across the three food categories, including pairwise comparisons between each pair of the food categories. Comparisons between women and men were conducted using an independent-samples t-test, and those across different age, employment status, educational attainment and annual household income groups were conducted using one-way ANOVA and Turkey post hoc tests. The analyses were undertaken using IBM SPSS Statistics Version 27.

Path analysis was used to investigate the direct and indirect relationships between the constructs included in the model (Fig. 1). Path analysis is a methodological tool that has been widely used in social science research to disentangle the various processes underlying a particular outcome (Dennis Cook & Forzani, 2023). It enables the use of quantitative data to analyse more complicated models, especially those involving "chains" of influence (such as the assumed mediation effect in our model), compared to multiple regression analysis (Streiner, 2005). The model was tested using the collected data on Chinese and UK respondents' responses to three different traced foods (i.e. a total of six sets of data for tests) based on 10,000 bootstrap subsamples using SmartPLS 4 software (Ringle et al., 2022). There was no collinearity between constructs, given that all

Table 1 Sample characteristics

Characteristics	*n* (%)	
	China *n* = 1515	UK *n* = 1656
Sex		
Male	801 (52.9%)	807 (48.7%)
Female	713 (47.1%)	846 (51.1%)
Prefer not to say	1 (0.1%)	3 (0.2%)
Age	*Mean = 41.21 (SD = 14.82)*	*Mean = 46.28 (SD = 16.00)*
18–24 years	247 (16.3%)	182 (11%)
25–34 years	324 (21.4%)	277 (16.7%)
35–44 years	309 (20.4%)	293 (17.7%)
45–54 years	264 (17.4%)	335 (20.2%)
Over 54 years	371 (24.5%)	569 (34.4%)
Education attainment		
Upper-secondary education or less	1235 (81.5%)	982 (59.3%)
Undergraduate degree or diploma	263 (17.4%)	525 (31.7%)
Postgraduate	17 (1.1%)	149 (9%)
Employment status		
Employed	875 (57.6%)	881 (53.2%)
Self-employed	170 (11.2%)	151 (9.1%)
Student	89 (5.9%)	50 (3.0%)
Unemployed	93 (6.1%)	200 (12.1%)
Retired	257 (17.0%)	258 (15.6%)
Others	33 (2.2%)	116 (7.0%)
Annual household income (China, CNY/UK, GBP)		
less than 65,000/Less than 25,000	159 (10.5%)	490 (29.6%)
6,5000–74,999/25,000–34,999	122 (8.1%)	318 (19.2%)
7,5000–84,999/35,000–44,999	171 (11.3%)	281 (17%)
8,5000–94,999/45,000–54,999	352 (23.2%)	208 (12.6%)
Over 94,999/Over 54,999	711 (46.9%)	359 (21.7%)

the outer variance-inflation-factor values were below 5 (Hair et al., 2017). Standardised values of path coefficients β and 95% confidence intervals were calculated for both direct and indirect relationships between constructs. The t value > 1.96 (two-tailed tests, significance level = 5%) and p-value < 0.05 represent a significant correlation between two constructs. The f^2 represents the total effect size between two constructs (the values of 0.02, 0.15 and 0.35 represent a small, medium and large effect, respectively) (Hair et al., 2017), while v^2 represents effect size of an indirect relationship between two constructs (the values of 0.01, 0.04 and 0.09 represent a small, medium and large effect, respectively) (Gaskin et al., 2023). On average, the model explained approximately 31% of the variance in purchase intentions of three traced foods among Chinese respondents and about 44% of the variance in purchase intentions among UK respondents. Given that the primary aim of this model is to explore the intricate interactions among the various included constructs rather than solely maximising explanatory power regarding purchase intentions, the moderate

levels of explained variance in purchase intentions and the significant testing of most proposed hypotheses suggest a satisfactory level of model fit (Boccia & Sarnacchiaro, 2018; Ozili, 2023).

4 Results

4.1 Environmental attitudes and preferred sustainability information

Moderate levels of pro-environmental attitudes were identified among both Chinese (mean = 3.65, *SD* = 0.45) and UK respondents (mean = 3.43, *SD* = 0.48). The results of an independent t-test indicated pro-environmental attitudes were significantly higher for Chinese respondents than UK respondents, $t(3,169) = 13.5$, $p < 0.001$. Chinese and UK respondents' perceived importance of different sustainability information being traced is presented in Table 2. Chinese respondents ranked fair trade certification in food traceability systems as their top priority, followed by country of origin (2nd), veterinary treatments of farm animals (3rd), and pesticides used in vegetable and fruit production (3rd). Lower importance was assigned to information regarding negative environmental impacts caused by food production and transportation. UK respondents ranked animal welfare information as their highest priority, followed by country of origin (2nd) and pesticides used in vegetable and fruit production (3rd), but perceived detailed location of food production, energy used for food processing, and environmental impacts caused by food transportation to be less important. Overall, Chinese respondents rated tracing all types of information as highly important (mean values ranging from 4.03 to 4.28), while UK respondents perceived tracing most types of information to be moderately important (mean values ranging from 3.62 to 4.13). UK respondents rated the importance of animal welfare information slightly higher than Chinese respondents (4.13 *versus* 4.11 for mean values), although the independent t-test did not reveal a significant difference between the two groups.

Table 2 Perceived importance of different types of traced information

Types of information	China		UK	
	Mean	SD	Mean	SD
The country in which the food is produced	**4.22**	0.674	**4.00**	0.876
The town in which the food is produced or more detailed location information	4.10	0.783	3.62	0.873
Veterinary treatments of farm animals	**4.18**	0.769	3.81	0.921
Animal welfare standards of farm animals	4.11	0.752	**4.13**	0.877
The pesticides used in vegetable and fruit production	**4.18**	0.740	**4.00**	0.930
The fertilizers used in vegetable and fruit production	4.16	0.771	3.90	0.926
Environmental impacts caused by producing food	4.09	0.787	3.82	0.929
The amount of energy used to process food	4.04	0.790	3.67	0.939
The distance food has travelled from farm to the retailer	4.03	0.772	3.80	0.943
Environmental impacts caused by transporting food	4.07	0.798	3.74	0.958
Fair trade certification in food traceability systems	**4.28**	0.738	3.96	0.890

The information types ranked as top three most important are indicated in bold

Table 3 Responses to traced foods among Chinese and UK respondents

Constructs	Apples				Milk				Beef			
	China		UK		China		UK		China		UK	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
PET	3.49	1.20	2.77	1.06	3.63	1.13	3.13	1.13	3.72	1.10	3.41	1.13
PEB	3.93	0.81	3.39	0.93	3.99	0.83	3.38	0.97	4.01	0.87	3.42	1.00
PIS	4.17	0.71	3.70	0.89	4.19	0.66	3.77	0.88	4.20	0.65	3.87	0.87
PIQ	4.01	0.82	3.65	0.91	4.04	0.81	3.65	0.93	4.07	0.82	3.78	0.91
PI	4.16	0.56	3.46	0.84	4.19	0.56	3.49	0.87	4.19	0.57	3.54	0.86

PET refers to perceived environmental threats linked to producing a specific food; PEB refers to perceived environmental benefits of tracing sustainability information in a specific food supply chain; PIS refers to perceived improved food safety associated with tracing sustainability information in a specific food supply chain; PIQ refers to perceived improved quality associated with tracing sustainability information in a specific food supply chain; PI refers to purchase intentions for the traced food

4.2 Perceived environmental threat associated with non-traced foods

Table 3 indicates that Chinese respondents perceived moderate levels of environmental threat to be associated with three food supply chains, whereas UK respondents perceived a low level for the non-traced apple supply chain and moderate levels for the non-traced supply chains of milk and beef. The results of the independent t-tests revealed that Chinese respondents perceived environmental threat to be significantly higher than UK respondents for each non-traced food supply chain (see Supplementary Material Table B). Repeated measures ANOVA was used to compare the respondents' perceptions of environmental threat associated with the three non-traced foods for each country (Supplementary Material Table C). The results revealed that Chinese respondents perceived the non-traced beef and milk supply chains to be associated with significantly stronger environmental threats than the non-traced apple supply chain. For UK respondents, significant differences were observed between each pair of categories regarding perceived environmental threats associated with producing specific non-traced foods (beef ranked the highest, followed by milk and apples).

4.3 Perceptions and purchase intentions towards traced foods

Table 3 indicates that Chinese respondents perceived relatively high levels of benefits associated with traced sustainability information, improved food safety and improved quality, whereas UK respondents perceived moderate levels of these benefits. The results of the independent t-tests revealed that Chinese respondents' perceived benefits were all significantly higher than the benefits perceived by UK respondents for each traced food category (Supplementary Material Table B). The results of repeated measures ANOVA revealed that Chinese respondents perceived traceability in beef supply chains to be associated with greater environmental benefits than tracing apple supply chains. No significant differences in perceived benefits of food safety and quality were observed. In contrast, the results of repeated measures ANOVA revealed that for UK respondents, no significant differences in perceived environmental benefits of tracing

sustainability information in the food supply chains were observed across three food categories. UK respondents associated higher improved food safety and quality with tracing sustainability information in beef supply chain compared to apple and milk supply chains (Supplementary Material Table C).

Three types of perceived benefits concerning each traced food were compared in both countries using the repeated measures ANOVA (Supplementary Material Table D). In terms of tracing sustainability information in specific food supply chains, both Chinese and UK respondents perceived significantly higher levels of benefit about improved food safety compared to the benefits about reduced environmental impacts and improved food quality. However, UK respondents associated significantly higher level of benefits with improved food quality compared to the reduced environmental impacts for all three food categories, while Chinese respondents associated slightly higher level of benefits with improved food quality compared to the reduced environmental impacts only for apples.

Chinese respondents had relatively high levels of purchase intentions for three traced foods (mean values ranging from 4.16 to 4.19), whereas UK respondents had moderate levels (mean values ranging from 3.46 to 3.54) (see Table 3). The results of the independent t-tests indicated that Chinese respondents had significantly stronger purchase intentions for three traced foods compared to UK respondents (Supplementary Material Table B). The results of repeated measures ANOVA indicated that no differences in purchase intentions for traced foods were observed for different traced food categories among Chinese respondents (Supplementary Material Table C). However, UK respondents had significantly stronger intentions to buy the traced beef compared to the traced apples (Supplementary Material Table C).

4.4 Comparisons across socio-demographic groups

Respondents' responses were compared across different socio-demographic groups using independent t-tests (between women and men) and one-way ANOVA and Turkey post hoc tests (across different age, employment status, educational and annual household income groups) (Supplementary Material Table E and F). The key findings are summarised in Table 4. Profile attributes associated with stronger pro-environmental attitudes, perceived environmental threats associated with producing specific foods, and higher perceived benefits of tracing sustainability information in specific food supply chains (reduced environmental impacts, improved food safety and improved food quality) and purchase intentions for the traced foods are provided in Table 5.

4.5 Interrelationships between constructs of the model

Standardised values of path coefficients β, their respective *t*-values, 95% confidence intervals and effect size (f^2 for total effects and v^2 for indirect effects) are shown in Table 6. The t values > 1.96 (two-tailed tests, significance level $= 5\%$) and p values < 0.05 represented a significant correlation between two variables. For the Chinese respondents, H5a was rejected (Table 6), suggesting general environmental attitudes had no direct effect on perceived environmental threat associated with producing specific foods. For the UK respondents, all the hypotheses were supported (Table 6). The integration of direct and indirect effects allowed comparing them between two countries, and the key findings have been summarised in Table 7.

Table 4 Comparisons of responses across socio-demographic groups

Socio-demographic groups	Environmental attitudes	Perceived environmental threat linked to producing specific foods	Perceived benefits of tracing sustainability information & purchase intentions for the traced foods
Age	Chinese respondents aged between 25 and 44 had strongest pro-environmental attitudes, while those aged between 18 and 24 and over 54 had weakest pro-environmental attitudes. UK respondents aged over 54 had strongest pro-environmental attitudes, while those aged between 18 and 34 had the weakest attitudes	Those aged between 35 and 44 perceived higher environmental threats associated with producing different foods compared to the other age groups in China. Those aged between 18 and 44 perceived higher environmental threats than those aged over 45 in the UK	For Chinese respondents, those aged between 25 and 54 had higher benefit perceptions compared to the other age groups, and those aged between 25 and 34 had the strongest purchase intentions. For UK respondents, those aged between 35 and 54 perceived higher environmental benefits of tracing sustainability information in food supply chains (except for apples) compared to the other age groups, and those aged between 45 and 54 perceived higher benefits to be associated with improved food safety and quality compared to the other age groups. Those aged between 35 and 44 had highest purchase intentions for traced foods
Gender	Male respondents had stronger pro-environmental attitudes than female respondents in both China and the UK	Female respondents perceived stronger environmental threats associated with different food supply chains than male respondents in the UK. No differences in relation to gender were observed in China	In China, male respondents perceived higher benefits to be associated with tracing sustainability information about reduced environmental impacts and improved food safety and had stronger purchase intentions compared to female. Female respondents perceived higher benefits to the environment of tracing milk and beef supply chains and higher improved quality associated with tracing milk supply chain than male respondents in the UK, but no differences in purchase intentions were observed

Table 4 (continued)

Socio-demographic groups	Environmental attitudes	Perceived environmental threat linked to producing specific foods	Perceived benefits of tracing sustainability information & purchase intentions for the traced foods
Education	No differences were observed for educational level in China and the UK	Those having received upper-secondary education or less perceived higher environmental threats associated with producing milk and beef compared to the other educational level groups in China. Those having received upper-secondary education or less perceived lower environmental threats associated with producing different foods compared to the other educational level groups in the UK	Those having received upper-secondary education or less reported lower perceived benefits associated with improved safety and quality and weaker purchase intentions regarding traced milk compared to the other educational level groups in China. UK respondents had lower perceived benefits and purchase intentions for traced foods
Employment status	In China, employed respondents had the strongest pro-environmental attitudes, while the unemployed and retired had weakest pro-environmental attitudes. In the UK, the retired had strongest pro-environmental attitudes, followed by the employed and self-employed, while the unemployed and students had weakest pro-environmental attitudes	Retired and unemployed respondents perceived weaker environmental threats associated with producing foods compared to the other employment status groups in the UK. No differences in perceived environmental threats were observed across employment status groups in China	The employed and self-employed respondents perceived higher benefits of tracing sustainability information in food supply chains and had stronger purchase intentions compared to the others in China. No differences in perceived benefits of tracing sustainability information in food supply chains were observed across distinct employment status groups in the UK, while students had lowest intentions to buy traced beef

Table 4 (continued)

Socio-demographic groups	Environmental attitudes	Perceived environmental threat linked to producing specific foods	Perceived benefits of tracing sustainability information & purchase intentions for the traced foods
Annual household income	Those with an annual household income over 85,000 CNY had stronger pro-environmental attitudes than the others in China. No differences were observed in the UK across different household income groups	Those with an annual household income below 65,000 CNY perceived weakest environmental threats associated with food supply chains in China. Those with an annual household income below 2,5000 GBP perceived the lowest environmental threats associated with milk and beef supply chains in the UK	Those having an annual household income below 6,5000 CNY in China perceived lowest benefits associated with reduced environmental impacts and improved food safety for traced sustainability information in food supply chains and had weakest purchase intentions for the traced foods, while those between 6500 and 74,999 CNY perceived the lowest benefits associated with improved food quality. In the UK, those with an annual household income below 2,5000 GBP perceived slightly lower benefits associated with reduced environmental impacts and improved food quality for traced beef, while had weakest purchase intentions towards different traced foods

Table 5 Profile attributes of respondents with different responses to traced foods

Responses	Profile of Chinese respondents	Profile of UK respondents
Higher pro-environmental attitudes	**Age**: 25–44; *Gender*: male; *Education:* higher **Employment:** employed *Household income:* higher	*Age*: over 54; *Gender*: male; *Education:* higher *Employment:* retired *Household income:* higher
Higher perceived environmental threats	**Age**: 35–44; *Gender*: male; **Education:** lower *Employment:* NS *Household income:* higher	*Age*: 18–54; *Gender*: female; *Education:* higher *Employment:* NS *Household income:* higher
Higher perceived environmental benefits	**Age**: 25–54; *Gender*: male; **Education:** NS **Employment:** employed and self-employed *Household income:* higher	*Age*: 35–54; *Gender*: female; *Education:* higher *Employment:* NS *Household income:* higher[1]
Higher perceived benefits regarding improved food safety	**Age**: 25–34; *Gender*: male; *Education:* higher[2] **Employment:** Employed and self-employed **Household income:** higher	*Age*: over 35; *Gender*: NS; *Education:* higher *Employment:* NS *Household income:* NS
Higher perceived benefits regarding improved quality	**Age**: 25–34; *Gender*: NS; *Education:* higher[3] **Employment:** Employed and self-employed **Household income:** higher	*Age*: 45–54; *Gender*: female[3]; *Education:* higher *Employment:* NS *Household income:* higher[1]
Stronger purchase intentions	**Age**: 25–34; *Gender*: male; *Education:* higher[3] *Employment:* employed and self-employed *Household income:* higher	*Age*: 35–44; *Gender*: NS; *Education:* higher *Employment:* employed and self-employed *Household income:* higher

1: only for traced beef; 2: excluding traced apples; 3: only for traced milk; NS: No significant differences. Bold refers to different effects of the same socio-demographic factors between countries

Table 6 Results of path analysis across traced foods

(a) China													
Direct effect		**Apples**				**Milk**				**Beef**			
		β	***t***	f^2	**95% CI**	**β**	***t***	f^2	**95% CI**	**β**	***t***	f^2	**95% CI**
H1	PEB -> PI	0.202***	7.684	0.051	[0.158, 0.245]	0.188***	7.613	0.043	[0.148, 0.229]	0.245***	9.81	0.075	[0.204, 0.287]
H2	PIS -> PI	0.296***	10.845	0.104	[0.25, 0.341]	0.315***	12.066	0.118	[0.272, 0.358]	0.307***	13.231	0.118	[0.269, 0.345]
H3	PIQ -> PI	0.154***	6.039	0.028	[0.112, 0.196]	0.147***	6.115	0.026	[0.106, 0.185]	0.111***	4.536	0.015	[0.071, 0.151]
H4a	PEB -> PIS	0.259***	9.31	0.072	[0.213, 0.305]	0.264***	9.189	0.075	[0.216, 0.312]	0.194***	6.801	0.039	[0.146, 0.24]
H4b	PEB -> PIQ	0.234***	8.752	0.058	[0.19, 0.277]	0.241***	8.331	0.062	[0.193, 0.288]	0.275***	10.023	0.082	[0.229, 0.32]
H5a	EA -> PET	0.001	0.039	0	[-0.041, 0.043]	0.014	0.566	0	[-0.028, 0.057]	0.027	0.99	0.001	[-0.018, 0.071]
H5b	EA -> PEB	0.174***	7.251	0.033	[0.135, 0.214]	0.178***	7.633	0.035	[0.139, 0.217]	0.198***	8.287	0.043	[0.158, 0.237]
H5c	EA -> PI	0.110***	4.759	0.015	[0.072, 0.148]	0.123***	5.666	0.019	[0.087, 0.159]	0.126***	5.818	0.021	[0.091, 0.163]
H6a	PET -> PEB	0.187***	7.259	0.037	[0.145, 0.229]	0.242***	8.856	0.065	[0.197, 0.287]	0.24***	9.215	0.064	[0.198, 0.283]
H6b	PET -> PI	0.111***	4.949	0.017	[0.074, 0.149]	0.050**	2.577	0.005	[0.021, 0.096]	0.09***	4.261	0.011	[0.055, 0.125]
Indirect effect		**Apples**				**Milk**				**Beef**			
		β	***t***	v^2	**95% CI**	**β**	***t***	v^2	**95% CI**	**β**	***t***	v^2	**95% CI**
PET -> PI		0.059***	6.137	0.003	[0.043, 0.075]	0.074***	7.157	0.005	[0.057, 0.092]	0.081***	7.881	0.007	[0.065, 0.098]
PEB -> PI		0.113***	7.935	0.013	[0.09, 0.137]	0.119***	8.635	0.014	[0.096, 0.142]	0.09***	6.83	0.008	[0.069, 0.112]
EA -> PI		0.055***	5.188	0.003	[0.038, 0.073]	0.057***	5.897	0.003	[0.041, 0.073]	0.071***	6.254	0.005	[0.053, 0.09]
(b) UK													
Direct effect		**Apples**				**Milk**				**Beef**			
		β	***t***	f^2	**95% CI**	**β**	***t***	f^2	**95% CI**	**β**	***t***	f^2	**95% CI**
H1	PEB -> PI	0.179***	6.867	0.037	[0.137, 0.222]	0.207***	8.157	0.056	[0.165, 0.248]	0.209***	8.384	0.052	[0.168, 0.25]
H2	PIS -> PI	0.226***	7.311	0.04	[0.174, 0.276]	0.288***	9.71	0.067	[0.239, 0.336]	0.242***	7.635	0.043	[0.19, 0.294]
H3	PIQ -> PI	0.25***	8.025	0.048	[0.199, 0.302]	0.217***	6.914	0.036	[0.167, 0.269]	0.222***	6.873	0.034	[0.169, 0.275]
H4a	PEB -> PIS	0.504***	20.769	0.341	[0.464, 0.543]	0.497***	20.759	0.329	[0.457, 0.536]	0.469***	20.246	0.283	[0.431, 0.507]
H4b	PEB -> PIQ	0.537***	23.666	0.404	[0.500, 0.573]	0.535***	23.456	0.4	[0.496, 0.571]	0.522***	24.634	0.375	[0.487, 0.557]
H5a	EA -> PET	0.048*	1.751	0.002	[0.003, 0.093]	0.258***	10.355	0.071	[0.217, 0.299]	0.339***	14.184	0.13	[0.3, 0.378]
H5b	EA -> PEB	0.207***	8.395	0.049	[0.168, 0.249]	0.124***	4.829	0.016	[0.081, 0.165]	0.103***	3.689	0.01	[0.056, 0.148]
H5c	EA -> PI	0.121***	5.628	0.023	[0.085, 0.157]	0.095***	4.787	0.015	[0.062, 0.128]	0.077***	3.037	0.008	[0.036, 0.119]
H6a	PET -> PEB	0.269***	10.466	0.082	[0.225, 0.309]	0.244***	8.681	0.061	[0.197, 0.29]	0.224***	7.412	0.048	[0.173, 0.273]
H6b	PET -> PI	0.12***	5.857	0.023	[0.085, 0.153]	0.113***	5.369	0.021	[0.079, 0.147]	0.096***	3.98	0.013	[0.055, 0.136]
Indirect effect		**Apples**				**Milk**				**Beef**			
		β	***t***	v^2	**95% CI**	**β**	***t***	v^2	**95% CI**	**β**	***t***	v^2	**95% CI**
PET -> PI		0.115***	8.793	0.013	[0.093, 0.136]	0.114***	7.796	0.013	[0.09, 0.138]	0.098***	6.781	0.01	[0.074, 0.122]
PEB -> PI		0.248***	13.803	0.062	[0.219, 0.278]	0.259***	14.437	0.067	[0.23, 0.289]	0.23***	13.357	0.053	[0.202, 0.259]
EA -> PI		0.1***	7.195	0.01	[0.077, 0.123]	0.116***	8.174	0.013	[0.093, 0.139]	0.111***	7.405	0.012	[0.085, 0.135]

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; β = path coefficients; *t* = t statistic; 95% CI = 95% confidence interval. PET refers to perceived environmental threats linked to producing a specific food; PEB refers to perceived environmental benefits of tracing sustainability information in a specific food supply chain; PIS refers to perceived improved food safety associated with tracing sustainability information in a specific food supply chain; PIQ refers to perceived improved quality associated with tracing sustainability information in a specific food supply chain; PI refers to purchase intentions for the traced food.

5 Discussion

The aim of this research was to compare Chinese and UK consumers' responses to tracing sustainability characteristics for the supply chains of apples, milk and beef. The results suggest that Chinese and UK respondents hold positive perceptions to be associated with tracing food sustainability characteristics, which are at the same time associated with greater perceived safety, perceived quality, and purchase intentions. However, similarities and differences exist between Chinese and UK respondents regarding how the different factors interact and shape their purchase intentions.

Chinese respondents perceived information related to environmental impacts caused by food production and transportation to be more important, and they had higher levels of perceived benefits associated with tracing sustainability information for food products compared to UK consumers. However, UK respondents regarded animal welfare as the most important, and more important than Chinese respondents. This finding aligns with a recent study where UK consumers valued animal welfare information more than environmental attributes such as food miles and carbon footprint, a trend also observed among consumers in the Czech Republic, Spain, Sweden, and Switzerland (Ammann et al., 2024). In contrast,

Table 7 Key findings of interrelationships between constructs included in the model

Themes	Chinese respondents	UK respondents	Summary of comparisons
Total impacts of perceived benefits on purchase intentions	Of the different benefits associated tracing sustainability information in food supply chains, perceived improved food safety had biggest positive impacts (f^2 ranging from 0.104 to 0.118) on purchase intentions for traced foods, followed by perceived reduced environmental impacts (f^2 ranging from 0.043 to 0.075) and improved food quality (f^2 ranging from 0.015 to 0.028). Perceived environmental benefits were more influential on purchase intentions towards traced beef ($f^2 = 0.075$) compared to traced apples ($f^2 = 0.051$) and milk ($f^2 = 0.043$)	Perceived improved food safety (f^2 ranging from 0.04 to 0.067), improved food quality (f^2 ranging from 0.034 to 0.048) and reduced environmental impacts (f^2 ranging from 0.037 to 0.056) had similar positive impacts on purchase intentions towards traced foods. Perceived environmental benefits were more influential on purchase intentions towards traced milk ($f^2 = 0.056$) and beef ($f^2 = 0.053$) compared to traced apples ($f^2 = 0.037$)	Perceived improved food safety associated tracing sustainability information in food supply chains played a dominant role in influencing purchase intentions among Chinese respondents, while three types of perceived benefits had similar effects on purchase intentions among UK respondents
Indirect impacts of perceived environmental benefits on purchase intentions	Perceived environmental benefits associated with tracing sustainability information in food supply chains positively affected purchase intentions indirectly (except for traced beef) via increasing perceived improved food safety and quality, indicating small effects ($v^2 = 0.013$ for tracing apples and $v^2 = 0.014$ for tracing milk). Indirect effects were smaller than direct effects by comparing the values of β for the direct and total indirect relations between perceived environmental benefits and purchase intentions	Perceived environmental benefits positively affected purchase intentions indirectly via increasing perceived improved food safety and quality, indicating medium effects (v^2 ranging from 0.053 to 0.067). Indirect effects were slightly bigger than direct effects by comparing the values of β	Perceived environmental benefits more directly influenced purchase intentions among Chinese respondents, but more indirectly among UK respondents

Table 7 (continued)

Themes	Chinese respondents	UK respondents	Summary of comparisons
Impacts of perceived environmental benefits on perceived improved food safety and quality	Perceived environmental benefits associated with tracing sustainability information in food supply chains had small positive effects on perceived improved food safety (f^2 ranging from 0.039 to 0.075) and quality (f^2 ranging from 0.058 to 0.082). Perceived environmental benefits tended to have more influence on perceived improved food safety for tracing apples and milk, but were more influential in relation to perceived improved quality for tracing beef supply chain	Perceived environmental benefits associated tracing sustainability information in food supply chains had medium and large positive effects on perceived improved food safety (f^2 ranging from 0.283 to 0.341) and quality (f^2 ranging from 0.375 to 0.404), respectively	Compared with Chinese respondents, perceived environmental benefits had bigger impacts on perceived improved food safety and quality associated tracing sustainability information in food supply chains for UK respondents
Impacts of perceived environmental threats on perceived environmental benefits and purchase intentions of traced foods	Perceived environmental threats associated with producing specific foods had small positive impacts on perceived environmental benefits associated with tracing sustainability information in food supply chains (f^2 ranging from 0.037 to 0.065) and limited total impacts on purchase intentions for the traced foods (f^2 ranging from 0.005 to 0.017). The direct and indirect impacts of perceived environmental benefits on purchase intentions were similar	Perceived environmental threats associated with producing specific foods had small positive impacts on perceived environmental benefits (f^2 ranging from 0.048 to 0.082) and small total impacts on purchase intentions (f^2 ranging from 0.013 to 0.023). The direct and indirect impacts of perceived environmental benefits on purchase intentions were similar	The impacts of perceived environmental threats associated with producing specific foods on purchase intentions towards the traced foods were greater for UK respondents than Chinese respondents

Table 7 (continued)

Themes	Chinese respondents	UK respondents	Summary of comparisons
Impacts of environmental attitudes on perceived environmental threats, perceived environmental benefits and purchase intentions	Environmental attitudes had small positive impacts (f^2 ranging from 0.015 to 0.021) on purchase intentions for traced foods, with bigger impacts for traced milk and beef. Environmental attitudes also indirectly affected purchase intentions, but the effect sizes were negligible (v^2 ranging from 0.003 to 0.005)	Environmental attitudes had small positive impacts on purchase intentions for traced apples ($f^2 = 0.023$) and milk ($f^2 = 0.015$), and negligible positive impact for traced beef ($f^2 = 0.008$). Environmental attitudes indirectly affected purchase intentions, with small effect sizes (v^2 ranging from 0.01 to 0.013)	Environmental attitudes had small impacts on purchase intentions for both countries, but more indirectly took effect among UK respondents
Impacts of environmental attitudes on perceived environmental threats, perceived environmental benefits	Environmental attitudes had no significant impacts on perceived environmental threats associated with producing specific foods, but they had small positive impacts on perceived environmental benefits of tracing sustainability information in food supply chains (f^2 ranging from 0.033 to 0.043)	Environmental attitudes had a nearly medium positive impact ($f^2 = 0.13$) on perceived environmental threats associated with beef production, a small impact ($f^2 = 0.071$) for milk production, and a negligible impact ($f^2 = 0.002$) for apple production. Conversely, environmental attitudes had a highest positive impact on perceived environmental benefits of tracing sustainability information in apple supply chain ($f^2 = 0.049$), followed by milk ($f^2 = 0.016$) and beef supply chains ($f^2 = 0.001$)	Environmental attitudes had no significant effects on perceived environmental threats associated with producing different foods for Chinese respondents. In contrast, for UK respondents, environmental attitudes had the greatest impacts on perceptions of environmental threats associated with beef production, followed by milk and apple production

most Chinese consumers are less engaged in animal welfare issues in food production, although there are indications that awareness has increased in recent years (Carnovale et al., 2021). Similarly, Chinese and UK respondents both regarded country of origin as one of the most important factors determining the need to trace sustainability information. However, Chinese respondents might use this information with the aim of safeguarding the integrity of imported food (Kendall et al., 2018), while UK respondents might use this information to better identify locally produced food (Connors et al., 2022).

Perceived environmental benefits, improved food safety and improved food quality associated with tracing sustainability information were all associated with greater purchase intentions towards three traced foods for both Chinese and UK respondents. In particular, perceived improved food safety was more influential on purchase intentions for all three traced foods for Chinese respondents, in comparison to the perceived environmental benefits. This is consistent with previous research conducted in China, in which food safety rather than environmental issues has been found to be the consumers' main focus of concern (Maitiniyazi & Canavari, 2020; Zhou et al., 2010). Chinese respondents reported the highest perceived environmental benefit and purchase intention of traced beef, implying that, in China, food categories perceived to cause more serious environmental problems might evoke stronger societal demands for tracing sustainability information in food supply chains. In contrast, for the UK respondents, the impacts of perceived environmental benefits, perceived improved safety and perceived improved food quality associated with tracing sustainability information on purchase intentions were similar, consistent with UK consumers' purchase intentions in relation to traced beef (Spence et al., 2018) and traced coffee beans (Dionysis et al., 2022). It should be noted that the observed impact of perceived environmental benefit on purchase intention of traced beef was slightly higher here than perceived improved safety and quality.

The positive impacts of perceived benefits associated with higher food safety and quality regarding e.g., organic, locally produced and traced food on consumers' purchase intentions were linked to consumers' egoistic motivations (i.e. relevant to individuals' self-interest), while the positive impacts of perceived environment-related benefits were identified as altruistic motivations (i.e. related to concerns about wider social issues) (Birch et al., 2018; Garaus & Treiblmaier, 2021; Kareklas et al., 2014; Wei et al., 2022; Yadav, 2016). However, the results of this research showed that besides the direct impacts, perceived environmental benefits of tracing sustainability information also increased purchase intentions through positively affecting Chinese and UK respondents' perceived improved food safety and quality. This suggests the positive impacts of perceived environment-associated benefits on purchase intentions may relate to both altruistic and egoistic motivations of consumers, resonating with the significant positive correlation of consumers' egoistic values with their environmental concerns and consumption of organic food in previous research (Wei et al., 2022). The indirect impacts of perceived environmental benefits on purchase intentions were stronger than the direct impacts for UK respondents but weaker for Chinese respondents. This suggests the influence of perceived environmental benefits on purchase intentions for traced foods might be driven more by individual self-interest among UK respondents but more by altruistic values among Chinese respondents. Informing consumers of lower environmental impacts through implementing traceability systems may create a "halo effect", which could influence perceived benefits associated with food safety and quality, and result in stronger purchase intentions. This is consistent with previous research suggesting that the halo effects of sustainability information in relation to consumers' more positive evaluations of food quality and healthiness exist (Donato et al., 2021; Lanero et al., 2021; Sörqvist et al., 2015), particularly for UK participants.

Chinese respondents showed significantly stronger purchase intentions for foods associated with traced sustainability information compared to UK respondents. There were no significant differences observed in Chinese respondents' purchase intentions across three traced food categories. This suggests a higher societal demand for enhancing the sustainability level of the current entire food system, irrespective of specific food categories, through e.g. implementing supply chain traceability in China, which could relate to the prevalent problem with trust about food industry in Chinese society (Chen et al., 2023; Yang et al., 2022). In contrast, significant differences in purchase intentions across three traced food categories were observed among UK respondents, with stronger purchase intentions for traced beef compared to traced apples. This may imply that, within the UK, there exists a relatively high level of societal trust in the food industry (Armstrong et al., 2022). This also suggests that UK consumers' prioritisation of tracing a specific food category is driven by a higher perceived need to address health and environmental risks associated with this food category (e.g., higher perceived risks of beef compared apples) (Lazzarini et al., 2016; van der Vossen-Wijmenga et al., 2022), and not by the lower share of household expenses compared to the other categories (Echeverría et al., 2014). This is because UK consumers tend to spend more on meat than fruit and vegetables (Food Standards Agency & Food Standards Scotland, 2023).

Perceived environmental threats associated with producing specific foods positively affected both Chinese and UK respondents' purchase intentions for foods where sustainability information had been traced. Similarly, a positive correlation between consumers' environmental concerns about conventional food production and their demand for organic food has been observed (Hoffmann & Schlicht, 2013). Jin et al., (2017) suggested Chinese consumers' higher perceived threat associated with a particular food category represents overall lower confidence in the quality of that food category (even if the food has been being traced), thereby acting as a negative predictor of attitudes towards the traced food (Jin et al., 2017). Here, perceived environmental threat associated with producing a specific food was a positive predictor of purchase intentions of the traced foods. This different result might relate to distinct personal attributes between the two studies, such as potentially lower food technology neophobia or higher risk propensity of our study respondents compared to the respondents in Jin et al., (2017)'s study (Li et al., 2022; Palmieri et al., 2022). Therefore, our study respondents could be more likely to perceive tracing sustainability information as effective in mitigating environmental threats associated with production and have greater benefit perceptions (Bockarjova & Steg, 2014; Marikyan & Papagiannidis, 2023), resulting in an intended switch to a more environmentally positive choice signposted by the traceability information (Wang et al., 2020a, 2020b).

Female respondents in China had weaker general pro-environmental attitudes, lower perceived environmental threat linked to food production, lower perceived environments of tracing sustainability information, and lower purchase intentions for the traced foods compared to the male respondents. The existing literature, in contrast, indicates that women tended to have stronger pro-environmental attitudes and greater engagement in pro-environmental behaviours compared to men e.g., in European countries (see e.g. Domingues & Gonçalves, 2020; Martín-Ezpeleta et al., 2022; Meyer, 2015). However, a large-scale national survey undertaken in China indicated that women held weaker pro-environmental attitudes and were less engaged in pro-environmental behaviours compared to men, which was attributed to women's relatively lower levels of environmental knowledge (Xiao & Hong, 2018). In the UK, despite having weaker general pro-environmental attitudes, female respondents perceived stronger environmental threats linked to food production and higher environmental benefits to be associated with tracing sustainability information in specific food supply chains compared to the male

respondents. This could relate to women in the UK potentially being more sensitive towards specific risk-related environmental issues, including those linked to food production, without necessarily having more positive attitudes towards the environment in general (Hayes, 2001).

Stronger pro-environmental attitudes were associated with higher perceived environmental benefits of tracing sustainability information and greater purchase intentions for the traced foods for both Chinese and UK respondents, in line with research focused organic food and low carbon diets (see e.g., Ahmed et al., 2021; Michaelidou & Hassan, 2010; Panzone et al., 2016; Wang et al., 2020a, 2020b). The impacts of perceived environmental benefits of tracing sustainability information on purchase intentions were bigger than general pro-environmental attitudes, and varied between food categories. Consumers may depend on a "case-by-case" analysis of environmental issues associated with specific food categories to inform their perceptions and purchase intentions in relation to traced foods. In other words, tracing sustainability information in specific food supply chains associated with higher perceived environmental threat (e.g., beef) might evoke higher perceived environmental benefits, posing greater impact on purchase intentions compared to the food categories perceived to be associated with lower environmental threat. Interestingly, stronger pro-environmental attitudes were associated with higher perceived environmental threat associated with producing different foods among UK respondents, with the strongest association for beef, followed by milk and apples. No significant associations were observed among Chinese respondents. This implies that food-related environmental issues might have been integrated into most consumers' general environmental attitudes in the UK but not in China, signifying an important cultural difference between the two countries. Therefore, the Chinese respondents are unlikely to have developed personal norms associated with sustainable food consumption, which can impede their actual purchase of food with traced sustainability information (Klöckner, 2013).

5.1 Implications for marketing and policymaking

Food companies that intend to sell traced foods in Chinese and UK markets can prioritise specific demographic groups of consumers in marketing, i.e. those aged between 25 and 34, male, having received higher education, employed or self-employed, with higher household income in China, and those aged between 35 and 44, having received higher education, employed or self-employed, with higher household income in the UK, as they indicated greater purchase intentions compared to the other demographic groups. When developing interventions aimed at increasing purchase intentions, food companies can select strategies that can affect the influencing factors on consumers' purchase intentions (Table 5). For example, the description of traced food framed in line with Chinese women's preferences and specific normative information (e.g., many women in their cities are buying traced foods) can be used to increase their benefit perceptions of tracing food sustainability information, thereby leading to greater purchase intentions among women in China (Higgs et al., 2019; Lehner et al., 2016).

While consumers in Chinese market may be more interested in implementing traceability for the entire food system irrespective of food categories, (suggesting the communication should focus on the nexus of traceability overall), the UK market might prioritise communicating about tracing sustainability information in the supply chains of specific food categories which are associated with higher perceived environmental and health risks, such as beef. Addressing national preferences for sustainability information may be important when developing traceability systems, although developing a common approach will be important in the context of international trade. Thus, national regulatory frameworks

for food traceability can be harmonised with international standards which benefits both national and international food trades. This, however, requires collaboration between Chinese and UK food companies, as well as food safety and trade authorities, at both national and international levels.

Policymakers in both countries may need to take actions beyond strategies solely aimed at increasing consumer purchase intentions. In China, despite the observation of a moderate level of pro-environmental attitudes among consumers, there might be a gap between general pro-environmental attitudes and people's comprehension of the environmental threats posed by food production. This gap should be addressed in future national environmental education initiatives, which might be made more relevant to individuals with weaker pro-environmental attitudes. In the UK, policymakers need to address the potential halo effects of environmental sustainability information on consumers' evaluation of food safety and quality, as this misleads consumers into assuming improved sustainability automatically results in improved nutrition and other quality attributes (Caso et al., 2023). These could be considered in the initiatives aimed at better labelling sustainability, nutrition and other food-related information (UK Research & Innovation, 2022), for example in relation to how different labelling strategies influence the potential halo effects among UK consumers (Neuhofer et al., 2023). Notably, in both countries, there needs to be collaboration between environment- and food-related agencies for effective actions to be developed and implemented. For example, this collaboration could occur between the Ministry of Ecology and Environment and the Ministry of Agriculture and Rural Affairs in China, and between the Department for Environment, Food and Rural Affairs, the Food Standards Agency, and the Food Standards Scotland in the UK.

5.2 Research limitations

Although the findings of this research enrich the existing literature on consumer' responses to traced foods, there are a few important limitations to consider. First, the use of online surveys for data collection might have excluded individuals with limited internet access in both countries, despite efforts to ensure national representativeness among research participants through socio-demographic quota sampling. Future research could recruit those with limited internet access and potentially compare their responses with the responses obtained via online platforms. Second, the use of survey methodology may mean that the results reflect correlations rather than causations. Future research can use experiments (e.g. discrete choice experiments) and qualitive approaches to gain more insights into the causal relationship between consumers' consideration of environmental issues and their decision-making about choosing traced foods. A real-world approach (e.g., "the living lab") could also be used to assess the relationship between environmental attitudes, traceability of sustainability information, and actual product choices rather than purchase intentions.

6 Conclusion

Consumers' general pro-environmental attitudes, perceived environmental threats linked to food production, perceptions of tracing sustainability information, and purchase intentions for traced food varied between the UK and China, different food categories and socio-demographic groups. The perceived environmental benefits of tracing sustainability information play a less significant role in influencing purchase intentions compared to perceived improved

food safety for Chinese consumers, while they hold a similar level of importance for UK consumers. Stronger halo effects information associating food safety and quality with traced food sustainability were observed for UK consumers. Pro-environmental attitudes may positively influence perceived environmental benefits of tracing sustainability information and purchase intentions in both countries. However, the positive influence of pro-environmental attitudes on perceived environmental threats linked to food production was observed only for UK respondents. These results contribute to a deeper understanding of the role that tracing sustainability information plays in consumers' decision-making about buying traced food, considering differences across countries and food categories. Moreover, for both countries, these results inform food companies on how to develop more targeted marketing strategies, emphasise the importance of harmonising national regulatory frameworks for food traceability with international standards, and suggest collaboration between food- and environment-related authorities to take actions that go beyond strategies solely aimed at increasing consumer purchase intentions.

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Data availability Data and code will be made available on request.

Declarations

Conflict of interest None.

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