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ARTICLE

Consumers' valuation for cultured meat: A multi-city choice experiment in China

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Abstract

Despite the rising interest in cultured meat, there remains scant information on whether consumers would value it. This study evaluated consumers' willingness-to-pay (WTP) for cultured chicken and examined how information affects WTP. Using a choice experiment with a total of 571 samples, the results found that consumers are unwilling to pay a premium price for cultured chicken. The provision of information significantly enhances consumers' WTP, resulting in an increase of 8.66RBM/500 g for cultured chicken. Consumers who are younger, males, have higher environmental awareness, and exhibit lower levels of new food neophobia are willing to pay more for cultured meat.

KEYWORDS

China, cultured chicken, Information effect, willingness to pay (WTP)

JEL CLASSIFICATION

Q13, Q18, C99

1 | INTRODUCTION

Global meat consumption is expected to increase 76% by 2050 (Post et al., 2020). This trend will lead to large challenges for food security, human health, food safety, environment, and animal welfare (Tuomisto, 2019; Zhang et al., 2020). Conventional meat production currently uses an estimated 70% of arable land for growing livestock feed and 8% of global fresh water (Post et al., 2020). Conventional meat production is also responsible for more than 15% of global greenhouse gas (GHG) emissions, which is more than the emissions from the global transportation sector

(Tuomisto, 2019). Furthermore, production of conventional meat is an important source of nitrogen, phosphorus, and other pollutants that affect biodiversity (Godfray et al., 2018). There are also other problems with the production of conventional meat, such as food safety scandals linked to the use of vaccinations and the outbreak of diseases like avian influenza (Zhang et al., 2020). In addition, there is evidence of a correlation between the increased risk of colorectal cancer and high intake of red and processed meat (Godfray et al., 2018). In terms of animal welfare, 99% of conventional meat is factory-farmed and considered to be industrial products, which leads to farm animal welfare concerns among consumers (Post et al., 2020).

A promising alternative to potentially address some of the challenges posed by conventional meat production is the production of cultured meat (Post, 2012), sometimes called in vitro meat, artificial meat, clean meat, lab meat, or cell-based meat (Bryant & Barnett, 2019). Cultured meat technology was considered as one of the 10 breakthrough technologies in the world, and is expected to be an efficient way to sustain the growing global population while complying with environmental safety, food safety, and animal welfare issues. In December 2020, Singapore was the first country in the world to approve the sale of cultured chicken produced by the company Eat Just, Inc. (Noyes, 2020; BBC News). Recently, the US has also been approved the sale of cultured meat. In China, the government unveiled its 5-year agricultural plan, which includes developing cultured meat technology to ameliorate the environmental effects of agriculture and improve sustainability and food security.

However, consumer acceptance is a critical challenge for cultured meat (Post et al., 2020). Previous studies have examined consumer acceptance of cultured meat in various countries, including Netherlands, the USA, Switzerland, Italy, India, Germany, China, and France (Bryant & Szejda, Parekh, et al., 2019; Dupont & Fiebelkorn, 2020; Gómez-Luciano et al., 2019; Siegrist & Hartmann, 2020; Weinrich et al., 2020; Zhang et al., 2020). Findings indicate that approximately 11.5% to 66.4% of consumers are willing to accept cultured meat (Bryant & Barnett, 2020). However, there is a gap in understanding consumers' valuation of cultured meat, especially in developing countries like China. China is an interesting and important case to study since it is the largest consumer of meat globally (Wang, 2022), with a consumption of 82.72 million tons in 2022 (FAOSTAT, 2022), and an expected significant increase in future meat demand (Bai et al., 2018). Several studies, such as those conducted by Ortega et al. (2022), Chen et al. (2023), Zhang et al. (2022), and Zhang et al. (2020), have explored Chinese consumers' willingness-to-pay for cultured meat. Results from these studies reveal that Chinese consumers, on average, are unwilling to pay a premium for cultured meat compared to conventional meat, though there is considerable heterogeneity in the values of willingness-to-pay. For example, Chen et al.(2023) revealed that Chinese consumers are willing to pay 5 to 25RBM/500 g for cultured meat, while Ortega et al. (2022) reported a WTP of 59.63 RMB/450 g for cultured steamed bun. Additionally, a segment of consumers is unwilling to purchase cultured meat even when offered for free (Carlsson et al., 2022). The literature lacks a segment analysis of Chinese consumers' preferences for cultured meat.

The provision of information is a widely employed and effective instrument for nudging consumers towards more sustainable food choices (Asioli, Bazzani, et al., 2022; Bryant & Dillard, 2019; Jiang et al., 2022; Ortega et al., 2022; Van Loo et al., 2020; Zhang et al., 2020). However, the handling of information requires careful consideration, as different types of information can yield varied effects on consumer preferences for cultured meat. For instance, technical communication may evoke negative associations among consumers, such as unnaturalness and disgust perceptions (Siegrist & Hartmann, 2020). On the other hand, information highlighting the environmental, animal welfare, and personal benefits of cultured meat could enhance consumer acceptance (Li et al., 2023; Rolland et al., 2020; Van Loo et al., 2020). Inconsistent results have been observed regarding how information influences consumers' valuation of cultured meat. Some studies, such as Van Loo et al. (2020) and Zhang et al. (2020), have found that providing information on cultured meat has only minor effects on consumers' valuation. In contrast, other studies, including Chen et al. (2023), Ortega et al. (2022), and Zhang et al. (2022), revealed that information significantly increases consumers' valuation of cultured meat. Moreover, there are studies, like that of Bryant and Dillard (2019), which found that the provision of information is not effective in increasing consumers' willingness-to-pay for cultured meat.

While the literature presents inconsistent results regarding the effectiveness of information provision on consumers' WTP for cultured meat. Furthermore, prior studies mainly focus on the influence of a singular type of information, such as environmental or health benefits, on consumers' preferences for cultured meat (Chen et al., 2023; Ortega et al., 2022). Considering that consumers often have diverse motivations for choosing cultured meat (Bryant & Barnett, 2020), providing information encompassing multiple benefits of cultured meat could be effective in enhancing consumer preference for cultured meat. Therefore, this study used a choice experiment and a between-subject design to achieve three primary objectives: (i) evaluate Chinese consumers' WTP for cultured chicken; (ii) investigate how the information affects consumers' WTP for cultured meat; (iii) explore heterogeneous preferences among consumers for cultured meat.

2 | MATERIALS AND METHODS

2.1 | Choice experiment

In the CE, respondents were asked to imagine a food purchasing decision in a typical retail store where they could choose from between 500 g packages of chicken breast that varied in four attributes: production method, carbon label, antibiotics use, and price (see Appendix Table A1). The four design attributes were used in the CE due to their importance in determining consumers' food choice. First, we included "production method" because we wished to test consumers' WTP for different chicken production methods as the main aim of the study. Thus, two levels of production method were specified: cultured meat and conventional meat. Second, we included the Carbon Trust label because consumers are increasingly interested in food products with a lower carbon footprint, and this attribute has been shown to influence consumer food choices (Asioli, Fuentes-Pila, et al., 2022; Godfray et al., 2018). Third, we included the attribute antibiotics use given that antibiotics might be used during chicken production (Chriki & Hocquette, 2020), which is a concern that could affect consumers' meat choices. In addition, there was a debate about the use of antibiotics in animal production, as this might have potential health risks for consumers (Boyer et al., 2017; Grunert et al., 2018; Lusk et al., 2006). Therefore, the antibiotics use attribute had two levels: a claim stating "no antibiotics ever" and no information reported. "No antibiotics ever" means that antibiotics were never used during the production process. Finally, price was included as it is a significant determinant of consumer food choice, and can be used to derive a monetary evaluation of WTP. Four price levels were used in the design (i.e., 8.90RMB/500 g, 13.9RBM/500 g, 18.9RBM/500 g, and 23.90RMB/500 g), which is guided by the average price of 500 g of chicken breast in China.

The design of the CE closely followed techniques developed by Kuhfeld (2005) using SAS software (SAS Institute Inc., 2013). The product attributes and corresponding levels were used to develop a full factorial design resulting in 1024 different combinations. Given that it is not feasible for a respondent (i.e., consumer fatigue) to perform all the choice tasks of 1024 combinations, a fractional factorial design that is both balanced and orthogonal was used instead. The D-Optimal criterion was used to identify the best combination of choice sets, resulting in 24 choice sets.[1] To limit the response time and consumer fatigue, and to increase the response rate, we split the 24 choice sets into three blocks of eight choice sets each. Each choice set included two chicken breast

[1]Before conducting a formal experiment task, we conducted a pilot study using zero priors, and then we adjusted the experiment design according to the priors obtained in the pre-test.

options and an "opt-out" option. An example of a choice task is shown in Appendix Figure A1. In addition, given that we are using stated preference method, to mitigate potential hypothetical bias a cheap talk script (Cummings & Taylor, 1999) was provided right before the series of choice tasks.

2.2 | Information treatment

We examine the effect of a comprehensive information on multiple benefits of cultured meat, including food safety, environmental friendliness and animal welfare benefits on consumers' valuation of cultured meat. Compared to prior studies that only focused on a single type of benefit related to cultured meat, our study reflects a more realistic approach in line with real-world scenarios. This is because publicly available information generally conveys multiple benefits associated with the production of cultured meat. We followed prior studies that employed a between-subject design to check the effect of information treatment (e.g., Caputo, 2020; Fang et al., 2020). The design involved a control group and an information treatment group, with participants randomly assigned to one of the groups. The control group had 285 respondents, while the information treatment group had 286 respondents. The Appendix shows the content of the information intervention.

2.3 | Econometric analysis

Our study employs the following empirical strategies: First, we used the random parameter logit (RPL) model specified in WTP space to evaluate consumers' WTP. In this model, the attribute coefficients enter the utility function directly as WTPs; thus, we can have individual WTP and directly in RMB. Furthermore, this model is more stable in the WTP estimates (Balcombe et al., 2009), accounts for interpersonal scale variations (Scarpa & Willis, 2010), and is more reasonable in WTP distribution (Train, 2009). Consistent with the Lancaster Theory (Lancaster, 1966), the total utility consumers derived from a product can be segregated into the marginal utilities given by the attributes of a product. As such, the specification of the utility (U_{njt}) function in our study can be defined as follows:

$$U_{njt} = \partial_n(-Price_{njt} + \theta_{n1}Cultured_{njt} + \theta_{n2}Carbon_{njt} + \theta_{n3}Antibiotics_{njt} + ASC) + \varepsilon_{njt}, \quad (1)$$

where ∂_n is a random positive scalar representing the scale parameter; $Price_{njt}$ is a continuous variable populated with the four price levels (i.e., 8.9 RMB, 13.9 RMB, 18.9 RMB, and 23.9RMB) in the design; $Cultured_{njt}$ is a dummy variable representing the production method, and takes a value of 1 when the production method is cultured meat and 0 otherwise; $Carbon_{njt}$ is a dummy variable representing the carbon trust label, and takes a value of 1 when the carbon trust label is reported and 0 otherwise; $Antibiotics_{njt}$ is a dummy variable for the information on antibiotics use, and takes a value of 1 when the claim "No antibiotics ever" is reported and 0 otherwise; ASC is the alternative specific constant of the no-purchase option ("opt-out" option); θ_s are the random coefficients of the estimated WTP values; and ε_{njt} is the random error term and follows a Type I extreme value distribution. In Equation (1), the attribute coefficients (cultured, carbon trust label, and antibiotics) were each specified as random and normally distributed in all four treatments with 500 Halton draws.[2]

Second, to test how information affects consumers' mWTP for cultured meat, we first use a log-likelihood (LR) test to test the null hypothesis of joint equality of marginal WTP values across

[2]We explore different distributions in modelling consumer preference for cultured chicken breast: normal, lognormal, and censored normal distributions. Based on model performance and the literature, we specify normally distributed parameters for cultured meat, carbon label, and antibiotics in all four treatments.

treatments. As shown in Caputo (2020), the test is based on the log-likelihood values of the segmented and joint models; it is calculated as $-2^{*}[L_{\text{Pooled}} - (L_{\text{NOINFO}} + L_{\text{INFO}})]$, which is chi-square-distributed with degree of freedom equal to *K(M-1)*, where *K* is the number of restrictions and *M* the number of treatments. A rejection of the null hypothesis of equality across the likelihood values of joint and segmented models suggests that that information on benefits of cultured meat significantly affected the parameter estimates (mWTPs) and thus indicates the need to explore the significance of attribute-specific effects across treatments. To explore the significance of attribute-specific effects across treatments, we then follow previous studies (e.g. Bazzani et al., 2017; Fang et al., 2020; De-Magistris et al., 2013), to create a pairwise test by pooling data for the two treatments involved. A dummy variable (*treat*) was developed to differentiate the information treatment over the control treatment. Based on utility Equation (1), we specify an extended utility with the *treat* dummy:

$$\begin{aligned} U_{njt} = \partial_n [&Price + \theta_{n1} Cultured_{njt} + \theta_{n2} Carbon_{njt} + \theta_{n3} Antibiotics_{njt} + ASC \\ &+ \gamma_1 (Cultured_{njt}{}^{*}treat) + \gamma_2 (Carbon_{njt}{}^{*}treat) + \gamma_3 (Antibiotics_{njt}{}^{*}treat)] + \varepsilon_{njt}, \end{aligned} \tag{2}$$

where *treat* is coded as 1 for the information treatment and 0 for the control treatment. The significance of the estimated γ and their signs enables us to confirm the effect of the marginal WTPs for cultured chicken of interest. The hypothesis is tested via Equation (2).

Third, we explore the interaction effects among design attributes. To do this, we specify an extended utility with the interactions among design attributes:

$$\begin{aligned} U_{njt} = \partial_n [&-Price_{njt} + \theta_{n1} Cultured_{njt} + \theta_{n2} Carbon_{njt} + \theta_{n3} Antibiotics_{njt} \\ &+ \gamma_1 (Cultured_{njt}{}^{*}Carbon_{njt}) + \gamma_2 (Cultured_{njt}{}^{*}Antibiotics_{njt}) \\ &+ \gamma_3 (Carbon_{njt}{}^{*}Antibiotics_{njt}) + \gamma_4 (Cultured_{njt}{}^{*}Price_{njt}) + \gamma_5 (Carbon_{njt}{}^{*}Price_{njt}) \\ &+ \gamma_6 (Antibiotics_{njt}{}^{*}Price_{njt}) + ASC] + \varepsilon_{njt} \end{aligned} \tag{3}$$

The definitions of variables are similar with in Equation (1). The parameters corresponding to the three non-price attributes were modelled as random parameters assumed to follow a normal distribution, while the opt-out and the interactions were modelled as fixed parameters.

Fourth, we investigated consumers' heterogeneity by calculating the distribution of the individual-level coefficients (i.e., mWTP) for cultured meat, "Carbon trust" label and "No antibiotics ever" using the kernel density estimation across individuals. We then performed the latent class logit (LCL) model in preference space (Greene & Hensher, 2003) to identify consumer segments. The LCL model assumes that the overall population can be divided into two or more clusters by assuming constant model parameters within each group, capturing consumer heterogeneity by assuming a mixed distribution for the clusters (Greene & Hensher, 2003). The probability of class membership s depends on individual *n* choosing alternative *j* at time *t*, which consists of a certain set of observable attributes (Greene & Hensher, 2003):

$$Prob_{jnt|s} = \frac{\exp\left[\left(Gender_{ntj+}Age_{ntj} + Heard_{ntj} + WTB_{ntj} + Environment_{ntj} + Animal_{ntj}\right) x'_{ntj}\beta_s\right]}{\sum_{j=1}^{Jn} \exp\left[\left(Gender_{ntj+}Age_{ntj} + Heard_{ntj} + WTB_{ntj} + Environment_{ntj} + Animal_{ntj}\right) x'_{ntj}\beta_s\right]}, \tag{4}$$

where $s = 1, \ldots S$ represents the number of classes, β's is the fixed (constant) parameter vector associated with class s, and x_{njt} is a vector of attributes associated with each product. Gender, Age, Heard, WTB, Environment, Animal and FTNS are covariate variables. The detailed definition of these variables was presented in Table 2. To establish the likelihood, these choice probabilities have to be multiplied across the choice sets and finally combined across all individuals.

All the models were estimated using Stata 16.1 software (Stata-Corp LP, College Station, USA).

3 | DATA

We conducted an online survey in January 2020. Respondents were recruited from three top-tier cities (Beijing, Shanghai, and Guangzhou). Several measures were taken to ensure the best possible data quality. First, following Alesina et al. (2018), before respondents started to do the questionnaire tasks, we informed them about the importance of providing truthful responses.[3] Second, after background questions and before the choice tasks, we showed an "attention check" question to nudge respondents to pay extra attention to the subsequent CE tasks. A total of 571 observations were used in the study: 285 observations in the NOINFO treatment, 286 in the INFO treatment. Informed consent was obtained from all study participants, and the study was approved by a University Ethics Committee.

Our survey consists of three sections. The first part involves hypothetical choice tasks as we describe in the experimental design section, the second part includes questions on attitudes about environment, health and cultured meat, and the third parts questions on demographics such as age, gender, income, and education and marital status. We included consumer attitudes such as environmental awareness, animal awareness, and degree of food technology neophobia because they affect consumers' acceptance of cultured meat (Dupont & Fiebelkorn, 2020; Siegrist & Hartmann, 2020). Environmental awareness was measured using an environment awareness scale following Chen (2009). Similarly, animal awareness was measured by using an animal awareness scale following Dowsett et al. (2018). Food technology neophobia was measured using the food technology neophobia scale (FTNS) (Cox & Evans, 2008). Measurements of attitudes used in the study were consistent and robust because all Cronbach alpha values exceeded 0.70 (Nunnally, 1978). Purchasing behavior variables included consumers' purchasing frequency of meat and whether they were responsible for food purchasing in their household. Consumers' prior beliefs were measured using questions about the familiarity with cultured meat, and a question of whether respondents had heard about cultured meat before the study. Appendix Table A2 exhibits these variables in more detail.

Appendix Table A3 reports the demographics of our sample and Chinese census data. Our sample is representative of the Chinese general population in terms of gender, with around half the sample being female (47.02%). The Chinese census data shows that the average age in China is 38.8 years, and our sample had 34.1 years. Our sample is slightly more representative of younger consumers, which is expected given our use of an internet survey (Yang et al., 2020). The majority of the sample have a monthly family income higher than 20,000RMB. Approximately 88% of the sample had an associate's and bachelor's degree or higher. In sum, our sample is generally younger and more educated than the Chinese census data.

Given the randomization to treatments, we checked if we had achieved balance for the observable socio-demographic characteristics across the treatments. The results are presented in Appendix Table A3. The hypotheses of equality of means between socio-demographic characteristics across treatments failed to be rejected at the 0.05 level. We also checked the difference of variables presented in Appendix Table A2 between NOINFO and INFO treatment, the test results indicated a balance between NOINFO and INFO.

[3]We warned respondents that "responding without adequate effort may result in their responses being flagged for low quality." At the same time, we appealed to respondents' sense of social responsibility by saying that we are researchers who seek to improve knowledge of social issues and added that "it is very important for the success of our research that you answer honestly and read the questions very carefully before answering."

4 | RESULTS AND DISCUSSION

4.1 | Consumer WTP estimates: Main effects

The results from the estimation of the RPL models in WTP space using Equation (1) are exhibited in Table 1. The coefficients represent the mean WTP (RMB) for 500 g of chicken breast. Several findings can be found in Table 1. First, we found that consumers prefer the conventional chicken over the cultured chicken across the treatment. The magnitude varies depending on the treatment, as the WTP values are less negative for INFO. In addition, we found sign SD(the SD for cultured meat is significant at the 0.01 level) meaning large consumer heterogeneity. Second, we observed that the carbon label does not impact consumer preferences for chicken products across the treatment. Although the magnitude of WTP for the carbon label has increased from—1.76RBM/500 g to 1.16RBM/500 g after information intervention, the coefficients are not significant at the level of 0.1. In addition, we found consumers have heterogeneous preference for carbon-label chicken as the SD coefficients of carbon label are significant across treatments. Third, the results revealed that consumers have a positive preference for chicken products labeled with the claim "No antibiotics ever" across treatments. The WTP for antibiotics is 5.88RBM/500 g and 6.61RBM/500 g in the NOINFO and INFO, respectively. The sign SD of antibiotics indicted consumers heterogeneity. In addition, the mean estimate for the opt-out option (ASC) was negative and significant across the treatments, suggesting that consumers tended to prefer one of the two product alternatives as opposed to the "opt-out" option. Overall, consumers preferred traditional chicken and labeled with the claim "No antibiotics ever." When examining WTP for the attributes of chicken breast, it became evident that the use of antibiotics held the highest magnitude, followed by carbon label and cultured meat.

4.2 | Effects of information on consumers' mWTP

To test the difference of consumer WTP for cultured chicken between control group and information treatment. First, we applied a likelihood ratio test to identify whether coefficients were equal between the control and information group, which was conducted by comparing the sum of the estimates from each treatment to the pooled model, and this yielded a chi-square value of 33.43 with 9 degrees of freedom (see Appendix Table A4). The null hypothesis (coefficients are equal across treatments) was rejected at $p < 0.001$, suggesting that there were differences in cultured chicken preferences between the two treatments.

Then, we employed a pairwise test to further explore the impact of information on consumers' WTP. The results of the pairwise tests, conducted using Equation (2), are presented in Table 2. The noteworthy coefficients associated with the interaction terms (Cultured*treat) signify that the information treatments significantly influenced consumers' preferences regarding cultured meat. This suggests the rejection of the null hypothesis that consumers' WTP for cultured meat is equal in the NOINFO and INFO. Specifically, consumers exhibited an increase of 8.66 RMB in their mWTP for cultured meat when exposed to the INFO as opposed to the NOINFO. Furthermore, the results did not reveal a significant impact of information on consumers' mWTP for other attributes, namely the Carbon Trust label and "No antibiotics ever."

4.3 | Consumer WTP estimates: Main effects and interactions with design attributes

The results derived from the estimation of the RPL model using Equation (3) within the WTP space, incorporating main effects and interactions with design attributes for the NOINFO group, are presented in Table 3. The coefficients of the interactions with cultured meat (i.e., "Cultured*Carbon," "Cultured*Antibiotics," and "Cultured*Price") are not statistically significant. This

TABLE 1 Estimates from RPL models specified in WTP space with uncorrelated variables (RMB/500 g).

Attributes	NOINFO ($N = 285$) mWTP (RMB/500 g) (SE)	INFO ($N = 286$) mWTP (RMB/500 g) (SE)	Pooled ($N = 571$) mWTP (RMB/500 g) (SE)
Cultured	−10.61***	−2.38	−6.16**
	(3.30)	(1.64)	(0.93)
Carbon	−1.76	1.26	1.74
	(2.58)	(1.28)	(0.27)
Antibiotics	5.88**	6.61***	5.69***
	(0.04)	(1.84)	(1.44)
ASC	−47.78***	−43.57***	−43.94***
	(8.35)	(5.90)	(9.85)
Standard deviation			
Cultured	21.95***	10.08***	16.31***
	(5.52)	(2.71)	(4.65)
Carbon	21.32***	1.89***	3.09***
	(6.16)	(0.03)	(1.18)
Antibiotics	12.80***	3.90***	8.03***
	(4.26)	(1.47)	(0.97)
Model parameters			
logL	−2380.93	−2390.43	−4803.92
AIC	4811.55	4798.85	9625.84
BIC	4873.03	4860.36	9693.57
N. obs	6840	6864	13,704

Note: ** and *** denote variables significant at 5% and 1%, respectively.

Abbreviations: AIC, Akaike's information criterion; BIC, Bayesian information criterion; logL, log likelihood function; mWTP, marginal willingness to pay; *N*. obs = number of observations; pooled; pooled NOINFO and INFOSE. SE = standard errors are presented in parentheses.

suggests that the presence of a Carbon Trust label and a "No antibiotics ever" claim label does not exert a discernible influence on consumers' mWTP for cultured meat.

4.4 | Distribution of individual mWTP value

Next, we conducted an estimation of the kernel density for individual mWTP values across all individuals for each attribute and treatments, as depicted in Figure 1. The distribution of mWTP values for cultured meat is left-skewed in the NOINFO, and the curve shifts to the right after the information intervention. Concerning the distribution of mWTP for Carbon Trust label, it initially presents as a flattened curve indicative of a normal distribution in the NOINFO, and the curve becomes noticeably more concentrated in the INFO. Similarly, the distribution of mWTP values for "No antibiotics ever" is right-skewed in the NOINFO, but it shifts to the right and becomes more

TABLE 2 The estimated mWTP for pairwise test: RPL models specified in WTP space with uncorrelated variables.

Pooled ($N = 571$)	
Attributes	mWTP (RBM/500 g) (SE)
Cultured	−6.39 (9.44)
Carbon	−4.7 (4.43)
Antibiotics	6.92 (4.75)
Cultured*treat	8.66*** (0.46)
Carbon*treat	3.94 (8.76)
Antibiotics*treat	12.8 (14.51)
ASC*treat	25.34 (33.64)
ASC	−21.95*** (5.52)
Standard deviation	
Cultured	19.9*** (3.96)
Carbon	14.62*** (5.50)
Antibiotics	0.82 (3.20)
logL	−4812.68
AIC	9651.36
BIC	9749.19
N. obs	13,704

Note: *** Denote variables significant at 1%, respectively.

Abbreviations: AIC, Akaike's information criterion; BIC, Bayesian information criterion; logL, log likelihood function; mWTP, marginal willingness to pay; *N*. obs = number of observations; pooled, pooled NOINFO and INFO. SE = Standard errors are presented in parentheses.

concentrated in the INFO. These findings suggest that the provision of information results in a larger and more concentrated distribution of consumers' mWTP values.

4.5 | WTP estimates: Latent class logit (LCL) model

Given that consumers show heterogeneous preference for cultured meat, “Carbon Trust label” and “No antibiotics ever” as shown in the previous section, we now investigate the possibility that there are distinct clusters of consumers. To investigate this form of consumer heterogeneity, we estimated the LCL models for the NOINFO and INFO treatment. Based on the AIC and BIC values

TABLE 3 Estimated mWTP space from RPL model with uncorrelated variables for main effects and interactions with design attribute.

Attribute	NOINFO ($N = 285$) mWTP (RMB/500 g) (SE)	INFO ($N = 286$) mWTP(RMB/500 g) (SE)	Pooled ($N = 571$) mWTP(RMB/500 g) (SE)
Cultured	−13.38	−11.99	−11.41
	(16.22)	(14.47)	(9.34)
Carbon	−27.62	−46.54	−37.11***
	(17.19)	(28.88)	(14.77)
Antibiotics	6.99	5.26	2.14
	(14.26)	(10.50)	(8.08)
Cultured*Carbon	−8.67	−20.10	4.96
	(8.27)	(16.46)	(5.49)
Cultured*Antibiotics	7.18	7.83	7.38
	(8.08)	(9.09)	(7.49)
Carbon*Antibiotics	2.28	2.96	2.67
	(7.01)	(7.36)	(4.65)
Cultured*Price	−0.53	−0.01	−0.28
	(0.82)	(0.65)	(0.47)
Carbon*Price	1.94*	2.55*	2.24***
	(1.08)	(1.50)	(0.83)
Antibiotics*Price	−0.12	−0.52	−0.13
	(0.64)	(0.49)	(0.36)
ASC	−46.63**	−44.35**	−42.69***
	(21.06)	-20.43	(12.35)
Standard deviation			
Cultured	20.95***	18.31***	12.60***
	(4.52)	(3.62)	(7.59)
Carbon	20.32***	26.87***	19.49**
	(5.11)	(6.41)	(9.14)
Antibiotics	11.80***	24.07***	24.92**
	(3.22)	(6.52)	(11.22)
logL	−2409.83	−2413.2	−4840.9
AIC	4849.65	4856.4	9711.8

TABLE 3 (Continued)

Attribute	NOINFO (*N* = 285) mWTP (RMB/500 g) (SE)	INFO (*N* = 286) mWTP(RMB/500 g) (SE)	Pooled (*N* = 571) mWTP(RMB/500 g) (SE)
BIC	4952.11	4958.91	9824.68
N. obs	6840	6864	13,704

Note: *, **, and *** denote variables significant at 10%, 5%, and 1%, respectively.

Abbreviations: AIC, Akaike's information criterion; BIC, Bayesian information criterion; logL, log likelihood function; mWTP, marginal willingness to pay; *N*. obs = number of observations; pooled, pooled, pooled NOINFO and INFO. SE = Standard errors are presented in parentheses.

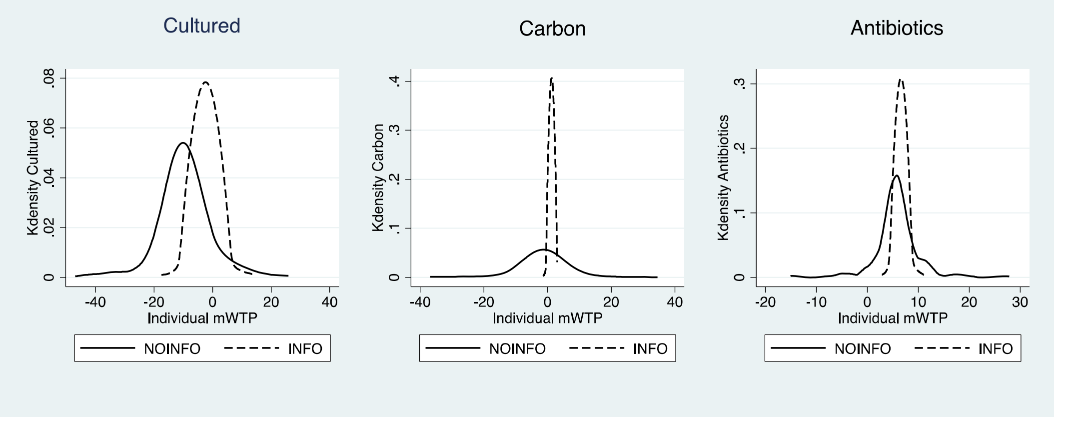

FIGURE 1 Distributions of mWTP across individuals for the attributes Cultured (left-side), Carbon (middle-side) and Antibiotics (right-side) for the NOINFO and INFO treatments.

(see Table A5), we choose the three-clusters solution for all treatments, in which the BIC values are the lowest for the three-clusters solution across the treatments.

The results of the LCL model for the NOINFO with the three clusters solution are reported in Table A6. Class 1 ("Innovators," 196 consumers, representing 68.9% of the sample) is the largest consumer group. In this class, consumers prefer cultured chicken and branded with the "Carbon Trust" label. Class 2 ("Undecided," 48 consumers, representing 16.9% of the sample) includes consumers who have not preference for any particular production method, while prefer chicken products labelled with the claim "No antibiotics ever". Class 3 ("Traditionalists," 41 consumers, representing 14.2% of the sample) is the smallest class, who prefer conventional chicken produced without the "Carbon Trust" label. In all three classes, consumers have preference for the claim "No antibiotics ever" and have not preference for chicken products with high price. Then, we have described the consumer groups based on several consumer characteristics. We found that "Innovators" consumers tend to be male, younger, have high environmental awareness and lower food technology neophobia.

The results of the LCL model for the INFO treatment, employing the three-cluster solution, are presented in Table A7. A consistent pattern was observed in the INFO treatment compared to the NOINFO condition. Class 1, labeled as "Innovators," emerges as the most substantial consumer group, followed by Class 2, labeled as "Undecided," and Class 3, labeled as "Traditionalists." The

TABLE 4 Estimated mWTPs from the LCL model for NOINFO and INFO.

	Class1 Innovators		Class2 Undecided		Class3 Traditionalists	
NOINFO						
Class share	68.90% ($N = 196$)		16.90% ($N = 48$)		14.20% ($N = 41$)	
Cultured	2.12	[0.66, 3.57]	−15.66	[−23.68, −7.63]	−7.34	[−10.43, −4.24]
Carbon	1.50	[−3.04, 6.04]	3.13	[−0.50, 6.76]	−7.85	[−14.06, −1.63]
Antibiotics	6.38	[0.45, 7.32]	7.34	[4.24,10.43]	0.13	[−2.72, 2.97]
INFO						
Class share	72.00% ($N = 205$)		21.90% ($N = 62$)		6.10% ($N = 19$)	
Cultured	8.83	[−0.43, 18.09]	−5.61	[−7.10, -4.12]	−1.47	[−4.39, 1.44]
Carbon	17.20	[2.35,32.05]	−2.07	[−3.49, −0.65]	−0.03	[−2.85, 2.78]
Antibiotics	14.34	[1.79, 26.88]	1.70	[0.28, 3.11]	3.46	[0.35, 6.57]

Note: mWTP, marginal willingness to pay. 95% confidence intervals are in parentheses.

distribution of sample shares across these three classes differs between NOINFO and INFO. The findings reveal an increased sample share for "Innovators" in the INFO treatment ($N = 205$, constituting 72% of the sample) compared to the NOINFO ($N = 196$, representing 68.9% of the sample). Concurrently, the sample share of Class 2, "Undecided," is also higher in INFO ($N = 62$, accounting for 21.9% of the sample) than in NOINFO ($N = 48$, comprising 16.9% of the sample). Conversely, the sample share of Class 3, "Traditionalists," is lower in INFO ($N = 41$, constituting 14.2% of the sample) than in NOINFO ($N = 19$, representing 6.1% of the sample). In the INFO treatment, we reaffirm the findings observed in the NOINFO condition that "Innovators" tend to be male, younger, possess a high level of environmental awareness, and exhibit lower food technology neophobia.

Next, we calculated consumers' mWTP for Cultured, Carbon and Antibiotics across the identified classes in both NOINFO and INFO treatments, with the results presented in Table 4. In the NOINFO, "Innovators" express a willingness to pay 2.12 RMB/500 g for cultured chicken, while "Undecided" and "Traditionalists" consumers are unwilling to pay premiums for cultured chicken. For the Carbon Trust label, "Innovators," "Undecided," and "Traditionalists" consumers exhibit mWTP values of 1.50 RMB/500 g, 3.13 RMB/500 g, and −7.85 RMB/500 g, respectively. All three classes display positive mWTP for chicken labeled as "No antibiotics use ever." In the INFO treatment, "Innovators," "Undecided," and "Traditionalists" consumers express a larger mWTP value for the attributes of Cultured, Carbon, and Antibiotics compared to the NOINFO.

5 | CONCLUSION

Our findings indicate that, on average, consumers are unwilling to pay an additional price for cultured meat when compared to conventional meat. However, the provision of information substantially increased consumers' willingness to pay for cultured meat, resulting in an average increase of 8.66RMB per 500 g. Furthermore, our research revealed a significant heterogeneity in consumer preferences, with approximately 70% of the sample falling into the category of "Innovators." This particular segment of consumers, referred to as "Innovators," exhibits a willingness to pay a premium for cultured meat, with an average WTP of 2.12 RMB per 500 g. Additionally, our results demonstrate that "Innovators" are more likely to be younger males who possess a higher level of environmental awareness and show a lower degree of neophobia toward new food technologies.

These insights offer valuable implications for producers and policymakers. First, the cultured meat industry may consider targeting their initial efforts towards the younger and males, who have lower food technology neophobia and high environmental awareness demographic. Second, cultured meat producers and policymakers should inform consumers about the benefits of cultured meat (i.e., environmental benefits and animal welfare benefits); thus, it is advisable to launch consumer education initiatives aimed at imparting information about the attributes and benefits of cultured meat. Such campaigns can contribute to a more informed and receptive consumer base, further advancing the prospects of cultured meat adoption. Third, producers can consider labeling cultured meat products with a "no antibiotics use" claim to encourage consumers to opt for cultured meat. Because consumers are willing to pay an extra price for chicken products with the claim of "No antibiotics use." Thus, this approach has the potential to incentivize consumers to choose cultured meat, aligning with the growing consumer preference for antibiotic-free products (Asioli, Fuentes-Pila, et al., 2022).

CONFLICT OF INTEREST STATEMENT

The author declares no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data available on request due to privacy/ethical restrictions. Data available on request from the authors.

ETHICS STATEMENT

This study obtained necessary ethical approvals from the ethical review committees of Reading University.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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