European Consumer Valuation for Cultured Beef Burger: A Multi-country Investigation using Choice Experiments

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ABSTRACT

Currently, there is an ongoing, uncertain, and controversial debate related to consumers' valuation for cultured meat. This study investigates and compares, for the first-time British, Spanish, and French consumers' preferences and willingness to pay (WTP) for cultured beef burger. Using a choice experiment (CE) involving beef burgers that vary across four attributes (i.e., production method, carbon trust label, antibiotics use, and price), our results show that on average Spanish, and French consumers reject cultured beef burger while British consumers exhibit a more positive valuation for this new product. Furthermore, we found that younger consumers and those with lower degree of neophobia towards new food technologies tend to accept more cultured beef burger. Results also suggest that there is heterogeneity in consumer preferences and WTP where 47% of British, 38% of Spanish, and 30% of French consumers are willing to pay a premium price for cultured beef burger. These findings provide insights into the psychology of consumers' acceptance and attitudes that can be used in communicating the nature of the cultured meat to the public. They also have important implications for marketers of cultured meat and future labelling policies.

Key words: Comparison; Consumers' willingness to pay; Cultured beef burger; France; Spain; United Kingdom.

1. INTRODUCTION

Continuing growth in world population, incomes, urbanization, and hungry issues have significantly increased the demand for meat products (OECD-FAO, 2013). However, conventional meat production can cause environmental harms in terms of large greenhouse emissions (Gerber et al., 2013), and extensively uses of land, energy and water (FAO, 2006; Tuomisto, 2019). There are also increasing societal concerns about food safety and human health issues related to meat consumption, such as animal-transmitted pandemics, and antibiotic resistance (Godfray et al., 2018). In addition, animal welfare is another worrisome issue since some conventional meat production systems are perceived to be conducted under inhumane conditions such as animal suffering and slaughtering (Bryant and Barnett, 2019; Lymbery and Oakeshott, 2014).

For these reasons, there is increasing interest in novel livestock farming systems (Dumont et al., 2018) as well as in innovative alternatives to conventional meat. Among the different types of meat alternatives (e.g., plant-based food, mycoproteins, insects food products, etc.), consumer desires for meat similar to conventional meat is pushing the development of what is termed cultured meat (sometimes also called in-vitro meat, clean meat, animal-free meat, etc.) (Post and Hocquette, 2017). Cultured meat is the result of recent scientific advances on regenerative medicine techniques where muscle-specific stem cells are taken from an animal, and then grown in large numbers until they form muscle tissues that can then be considered as edible meat (Post, 2012). One of the key advantages of cultured meat is that it could produce meat in unlimited quantities that would alleviate the increasing meat demand and feed more people and also can be potentially produced more sustainably in terms of lower greenhouse gas emissions, land, and water use (Mattick et al., 2015)[1]. Another advantage is that cultured meat technology can produce meat ethically from an animal welfare perspective since there is no animal suffering and slaughtering if cultured meat is produced without foetal calf serum (Chriki and Hocquette, 2020). Furthermore, it is speculated that cultured meat technology can produce meat without using antibiotics (Dempsey and Bryant, 2020) as well as cultured meat can theoretically be produced with more flexibility, such with more variants (e.g., meat with different content and type of fat, B12 vitamin, etc.) which can be personalized to the specific wishes and needs of consumers (Treich, 2021).

[1] However, recent research have been inconclusive as to the environmental sustainable advantages of cultured meat over conventional meat (Lynch and Pierrehumbert, 2019).

However, in addition to current challenges that cultured meat is facing, such as cost of growth media, industry scale-up of specific components of the cell culture process, high costs of production, intellectual property sharing issues and regulatory hurdles mean (Warner, 2019), consumer acceptance is one of the most relevant barriers for the market development of cultured meat (Sharma, Thind, and Kaur 2015). In the existing literature, an increasing number of studies have investigated consumer acceptance for cultured meat. To illustrate, Bryant and Barnett (2018, 2020) provided two systematic reviews of a large number of empirical studies (14, and 26 respectively) about consumers' acceptance for cultured meat. Some interesting outcomes are identified. First, a majority of consumers are at least willing to try cultured meat, while a substantial but lower number of them would consume it regularly or as a replacement for conventional meat (Bryant and Dillard 2019; Weinrich, Strack, and Neugebauer 2020; Gómez-Luciano et al. 2019). Second, consumers mostly perceive cultured meat to be providing more social benefits rather than personal benefits (Lupton and Turner, 2018; Mancini and Antonioli, 2019). Third, consumers' acceptance of cultured meat can be increased by providing positive and less technical information (Bekker et al., 2017; Rolland et al., 2020; Slade, 2018), and message framing that emphasizes both the societal and personal benefits of cultured meat or its similarity with conventional meat seems to have a positive effect on consumer acceptance (Bryant and Dillard 2019). Fourth, several studies have shown that consumer acceptance for cultured meat vary among countries, e.g., it is larger in India and China than in the United States (Bryant et al., 2019b). Fifth, cultured meat appeals more to young (Slade, 2018; Zhang et al., 2020), urbans (Shaw, 2019), higher educated consumers (Gómez-Luciano et al., 2019; Weinrich et al., 2020), and sometimes, but not always males (Weinrich et al., 2020; Zhang et al., 2020), meat eaters (Arora et al., 2020; Mancini and Antonioli, 2019), or consumers with higher meat attachment (Bryant et al. 2019; Circus and Robison 2019). Sixth, there are ambiguous findings about consumers' perceptions for environmental benefits of cultured meat where some studies reported that consumers perceived cultured meat providing environmental benefits (Mancini and Antonioli, 2020; Weinrich et al., 2020) while other studies revealed that consumers' perceive cultured meat as more harmful for the environment (Gómez-Luciano et al., 2019; Specht et al., 2020). Seventh, some studies revealed that the reduction of animal suffering and death to be a strong driver for cultured meat acceptance (Mancini and Antonioli, 2019; Weinrich et al., 2020). Eighth, consumers could be open to cultured meat as potential way for improving food safety (Gómez-Luciano et al., 2019), and to address global hunger (Mancini and Antonioli, 2019; Weinrich et al., 2020). Ninth, several studies identified some potential barriers towards consumer acceptance of cultured meat such as perceived unnaturalness (Laestadius and Caldwell, 2015; Weinrich et al., 2020), and food safety concerns (Tucker 2018; Shaw 2019) as in China (Liu et al., 2021), disgust (Dupont and Fiebelkorn 2020; Weinrich, Strack, and

Neugebauer 2020), especially in Western countries (Bryant et al. 2019), nutrition concerns (Laestadius and Caldwell, 2015; Lupton and Turner, 2018), neophobia (Bryant et al. 2019; Dupont and Fiebelkorn 2020), distrust in food scientists and food safety authority (Wilks and Phillips, 2017; Zhang et al., 2020), economic anxiety of the impact of cultured meat on farming and rural communities (Circus and Robison, 2019; Shaw, 2019), ethical concerns (Circus and Robison, 2019), perceived high price (Gómez-Luciano et al., 2019; Valente et al., 2019; Verbeke et al., 2015) while contrasting results were found in terms of negative perceived sensory expectations (Lupton and Turner 2018; Shaw 2019; Tucker 2014) and consumers' WTP for cultured meat (Mancini and Antonioli, 2019; Tucker, 2018), with for instance, Chinese consumers willing in great majority to pay less for it compared to conventional meat (Liu et al., 2021).

However, to the best of our knowledge, there are only a few studies that examine consumers' WTP for cultured meat. For example, Van Loo et al. (2020) investigated US consumers by comparing conventional, plant-based and cultured burger and found that latter has a potential market share of 5% while Asioli et al. (2018) found that US consumers are willing to pay higher price for conventional chicken compared to cultured chicken. Carlsson et al. (2021) found that Swedish consumers are not willing to pay a premium price for cultured beef burger compared to conventional beef burger while Zhang et al. (2020) found that Chinese consumers were willing to pay a premium price for cultured meat compared to conventional meat, but this was not confirmed by a more recent study (Liu et al., 2021). Rolland et al. (2020) examined Dutch consumers' WTP for cultured beef and found that if information and sensory experience (taste) are provided to consumers, most of them are willing to pay a premium price for cultured beef burger compared to conventional beef burger. Importantly, there is a lack of cross-country studies which compare consumers' preferences and WTP for cultured meat across different countries, which is important, among others, for food businesses that would like to market cultured meat in different countries.

Our study fills this void by using a hypothetical choice experiment (CE) to investigate and compare for the first time British, French, and Spanish consumers' preferences and WTP for hypothetical refrigerated and uncooked beef burgers, hereafter called "beef burger", that vary on a theoretical point of view across four attributes (i.e., production method, carbon trust label, antibiotics use, and price). We chose beef burger for four main reasons: (i) beef is one of the most consumed meat products worldwide, and the demand for beef is increasing (Sheng and Song, 2019), (ii) beef industry is one of the larger contributors of greenhouse gas (GHG) emission (Clune et al., 2017), thus cultured beef can potentially contribute more to reduce environmental pollution, (iii) several large companies and

startup businesses (e.g., Mosa Meat, etc.) are investing in cultured beef, and (iv) cultured beef burger is the most popular meat product, and is easier to produce using the cultured meat technologies compared to other types of meat (Chriki and Hocquette, 2020).

The remainder of this manuscript is organized as follows. First, we will describe the methodological approach we have implemented, including experimental design, and data. Second, we will explain our econometric analysis. Third, we will describe the results we have obtained from our analysis. Finally, we will discuss the results, provide several policy and industry implications as well as we will give some conclusions together with several future research avenues.

2. MATERIALS AND METHODS

2.1 Choice Experiment Design

In the CE, four attributes were used to describe the different types of beef burger: "production method", "carbon trust label", "antibiotics use", and "price" (Table 1). First, we included "production method" because as main aim the study we would like to investigate consumers' WTP for beef burger produced using different production methods. Thus, two levels of production method were specified: "Conventional" or "Cultured". Second, we included the attribute "Carbon Trust Label" referring to the environmental impact of food production, transportation, and use of the food products in terms of CO2 emissions. We included information about the environmental impact of meat production because it is currently one of the top key concerns of the conventional meat production method (Godfray et al., 2018). Thus, two levels of "Carbon Trust Label" were used to pertain to the presence of "Carbon Trust Label" or no label was reported. Third, we included the information about "antibiotics use" given the fact that antibiotics might be used during the beef burger production (Chriki and Hocquette, 2020). This information is a top concern when consumers are purchasing meat (Boyer, Neth, & Nunlist., 2017). Therefore, two levels for "antibiotics use" were specified by the phrase "No antibiotics ever" or no information about this was reported. Lastly, four price levels were specified based partly on the current market prices for beef burger in retail stores in the United Kingdom (£3.20/kg, £7.70/kg, £12.30/kg, and £16.80/kg), and the equivalent for Spain, and France (3.50€/kg, 8.50€/kg, 13.50€/kg, and 18.50€/kg)[2].

Table 1 - Attributes and levels.

ATTRIBUTES	LEVELS

[2]The prices for beef burgers were based on prices recorded in different United Kingdom, Spain, and France stores including grocery stores, farmers' markets, specialty stores, organic stores, and supercentres.

Production method	"Conventional" "Cultured"		
Carbon Trust Label	No label reported 		
Antibiotics use	No information reported "No antibiotics ever"		
Price	**United Kingdom**	**Spain**	**France**
	£3.20/kg	3.50€/kg	3.50€/kg
	£7.70/kg	8.50€/kg	8.50€/kg
	£12.30/kg	13.50€/kg	13.50€/kg
	£16.80/kg	18.50€/kg	18.50€/kg

Then, the selected attributes and their levels were used to generate an orthogonal fractional factorial design using Ngene 1.2.1 (ChoiceMetrics, Sidney, Australia) to collect preliminary data (i.e., pilot study) among a small number of consumers (i.e., 75) not selected for the final study. The pilot study was performed during Summer 2020 and provided the prior parameters necessary to generate the final Bayesian optimal choice design which resulted in the creation of 18 choice sets. Then, the 18 choice sets were divided into two blocks of 9 choice tasks each to prevent respondents' fatigue. The Bayesian sequential design was developed, as recommended by the current state of practice (Sándor and Wedel, 2001; Scarpa et al., 2007). Each choice task was composed of two product alternatives (options A and B), and an "opt-out" option (option C). The choice tasks within each block were randomly presented to consumers.

The CE was introduced to the consumers with the explanation and clear description of the attributes and levels. Before the choice tasks, respondents were asked to read a cheap talk (CT) script in an attempt to mitigate possible hypothetical bias that typically affects WTP estimates in stated preference studies (Cummings and Taylor, 1999). Upon completion of the nine choice tasks, the respondents were then asked to fill out a questionnaire to collect several consumers' characteristics.

In addition, the existing literature indicates that several socio-demographics and attitudinal factors may shape consumers' preference for cultured meat. For this reason, we also investigated the effect of several socio-demographics and attitudinal variables on respondents' WTP formation for the different beef burger. We particularly focus on:

- Effect of gender (GENDER): according to prior research (Weinrich et al., 2020; Zhang et al., 2020), our hypothesis is that males have higher WTP for cultured beef burger compared to females;
- Effect of age (AGE): according to previous studies (Slade, 2018; Zhang et al., 2020), our hypothesis is that younger consumers have higher WTP for cultured meat compared to older participants;
- Effect of education (EDUCATION): according to past studies (Gómez-Luciano et al., 2019; Weinrich et al., 2020), our hypothesis is that more educated consumers have higher WTP for cultured meat compared to less educated consumers;
- Effect of religion orientation (RELIGION): prior research has shown that religion could affect consumers' acceptance for cultured meat. Indeed, Marcu et al. (2014) found that consumers characterize cultured meat as 'playing God' while others authors found that, in principle, religious people were open to cultured meat if it comes from animal species allowed in their religion (Bryant, 2020);
- Effect of having heard or not heard about cultured meat (HEARING) prior to the study: following past studies, our hypothesis is that consumers who heard the term "cultured meat" prior to the study have a higher WTP for cultured meat than consumers who have not heard such term;
- Effect of pro-animal welfare attitude (AAS): our hypothesis is that consumers who have higher pro-animal welfare attitude have higher WTP for cultured meat, because cultured meat is produced without animal slaughtering, and that previous consumer research found that animal welfare is one of the most important perceived benefits of cultured meat (Bryant & Barnett, 2018);
- Effect of the degree of neophobia towards new food technologies (FTNS): previous research shows ambiguous results (Dupont & Fiebelkorn, 2020; Gómez-Luciano, de Aguiar, Vriesekoop, & Urbano 2019) about the effect of degree of neophobia towards new food technologies on consumers WTP for cultured meat;
- Effect of pro-environmental attitude (NEP): authors reported that environmental benefits are one of the major perceived benefits of cultured meat (Bryant & Barnett, 2018), while other authors found that consumers perceive that cultured meat can harm the environment (Gómez-Luciano et al., 2019; Specht et al., 2020). Our hypothesis is that consumers who have higher pro-environmental attitude have higher WTP for cultured meat.

2.2 Data

The data used in this study are drawn from an online survey involving 648 consumers in the United

Kingdom (216 consumers), Spain (216 consumers), and France (216 consumers) using the online platform Qualtrics LLC (Provo, US) conducted in Summer 2020. Consumers where randomly recruited by Qualtrics using sampling quotas in terms of age (50% between 18 - 46 years and 50% between 47 - 75 years), and gender (50% males and 50% females). Only consumers who were at least 18 year-old, who are you responsible for food shopping in your household always or sometimes were included in the study.

We obtained the informed consent from all the participants of the study. Our study was approved by an Institutional Ethical Clearance board.

To ensure data quality, we took several steps. First, at the beginning of the survey, we asked consumers to "thoughtfully provide your best answer" and only participants who answered "I will provide my best answers" have been able to proceed filling out the survey[3]. Second, before the series of choice tasks, we asked respondents whether they have "devoted [their] full attention to the questions so far" and whether, in their honest opinion, they believe that we should use their responses for the study[4]. This "attention check" question has been shown by Meade and Craig (2012) to stimulate respondents to pay extra attention to the subsequent questions (not to detect dishonest replies). We strategically placed this question right before the most important questions such as the choice tasks. Third, we included in the study only consumers who took more than 1/3 of the median survey duration to complete the survey.

Respondents in each country were randomly selected for the study. The results show that the hypotheses of equality of means between socio-demographics characteristics across the three countries was not rejected at the 5% significance level (Table 2) for gender, age, and income while Spanish consumers are more educated and have larger families than British and French participants.

[3] We care about the quality of our survey data and hope to receive the most accurate measures of your opinions, so it is important to us that you thoughtfully provide your best answer to each question in the survey. Do you commit to providing your thoughtful and honest answers to the questions in this survey?
- I will provide my best answers.
- I will not provide my best answers.
- I can't promise either way.

[4] Before proceeding to the next set of questions, we want to ask for your feedback about the responses you provided so far. It is vital to our study that we only include responses from participants who devoted their full attention to this study. In your honest opinion, should we use your responses, or should we discard your responses since you did not devote your full attention to the questions so far?
- Yes, I have devoted full attention to the questions so far and I think you should use my responses for your study.
- No, I have not devoted full attention to the questions so far and I think you should not use my responses for your study.

Given the quota sampling, the final samples were composed in each country by 50% females and 50% males which is very similar to the most recent census data from the United Kingdom (50.64% females, and 49.36% males) (Office for National Statistics, 2019), Spain (51.00% females, and 49.00% for males) (INE, 2020), and France (51.65% females and 48.35% males) (INSEE, 2020). In terms of age, in the United Kingdom 26.39% of participants were 18-32 years old, 25.93% were 33-47 years old, 39.35% were 48-62 years old, and 8.33% were 63+ years old which are similar to the census population, respectively 27.30%, 25.09%, 27.99% and 16.63% (Office for National Statistics, 2019). In Spain 22.22% of consumers were 18-32 years old, 30.09% were 33-47 years old, 37.50% were 48-62 years old, and 10.19% were 63+ years old which are similar to the census population 20.26% (20-34 years old), 29.26% (35-49 years old), 26.53% (50-64 years old), and 24.56% (65+ years) (INE, 2020). In France 23.15% of participants were 18-32 years old, 31.48% were 33-47 years old, 37.50% were 48-62 years old, and 7.87% were 63+ years old similar to the census population, 21.59% (18-32 years old), 23.39% (33-47 years old), 24.62% (48-62 years old), and 30.46% (63+ years old) (INSEE, 2020).

Table 2 - Socio-demographic characteristics of the consumers among United Kingdom, Spain, and France.

SOCIO-DEMOGRAPHICS	**United Kingdom** ***(N=216)***	**Spain** ***(N=216)***	**France** ***(N=216)***
Gender			
Female	108 (50%)	108 (50%)	108 (50%)
Male	108 (50%)	108 (50%)	108 (50%)
Pearson chi2(2) = 0.0000			
Pr = 1.00			
Age			
18-32 yr	57 (26.39%)	48 (22.22%)	50 (23.15%)
33-47 yr	56 (25.93%)	65 (30.09%)	68 (31.48%)
48-62 yr	85 (39.35%)	81 (37.50%)	81 (37.50%)
63 yr +	18 (8.33%)	22 (10.19%)	17 (7.87%)
Chi-squared with ties =0.46 with 2 d.f.			
Probability = 0.79			
Annual household income before taxes			
Less than £/€10,000	18 (8.53%)	16 (7.55%)	20 (9.62%)
£/€10,000 to £/€19,999	31 (14.69%)	48 (22.64%)	33 (15.87%)
£/€20,000 to £/€29,999	50 (23.70%)	46 (21.70%)	49 (23.56%)

£/€30,000 to £/€39,999	38 (18.01%)	34 (16.04%)	49 (23.56%)
£/€40,000 to £/€49,999	26 (12.32%)	37 (17.45%)	20 (9.62%)
£/€50,000 to £/€59,999	21 (9.95%)	14 (6.60%)	16 (7.69%)
£/€60,000 to £/€69,999	6 (2.84%)	6 (2.83%)	7 (3.37%)
£/€70,000 to £/€79,999	3 (1.42%)	6 (2.83%)	2 (0.96%)
£/€80,000 to £/€89,999	4 (1.90%)	2 (0.94%)	3 (1.44%)
£/€90,000 to £/€99,999	5 (2.37%)	-	5 (2.40%)
£/€100, 000 to £/€149,999	9 (4.27%)	-	1 (0.48%)
£/€150,000 or more	-	3 (1.42%)	3 (1.44%)
I do not want to declare/I do not know	5 (2.37%)	4 (1.90%)	8 (3.70%)
Chi-squared with ties = 2.54 with 2 d.f.			
Probability = 0.28			
Education			
Primary school/Educación primaria/Cycle primaire	1 (0.47%)	3 (1.39%)	1 (0.47%)
Secondary-Middle school/ Educación secundaria obligatoria/Cycle secondaire	39 (18.14%)	18 (8.33%)	30 (14.22%)
High school/ Educación secundaria posobligatoria /College qualification/ Niveau d'études secondaires	85 (39.53%)	70 (32.41%)	87 (41.23%)
University Degree/Educación superior Niveau d'études universitaires	90 (41.86%)	125 (57.87%)	93 (44.08%)
Others			
Chi-squared with ties = 14.10 with 2 d.f.			
Probability = 0.00	1 (0.47%)	-	5 (2.31%)
Household size			
1-2	110 (50.93%)	68 (31.48%)	118 (54.63%)
3-4	89 (41.20%)	131 (60.65%)	80 (37.04%)
5-6	15 (6.94%)	16 (7.41%)	18 (8.33%)
7+	2 (0.93%)	1 (0.46%)	-
Chi-squared with ties = 20.72 with 2 d.f.			
Probability = 0.00			

As mentioned above, after the choice tasks described in the above section, we included in the questionnaire questions in order to test our hypotheses concerning attitudinal factors. Specifically, we included questions reflecting (i) whether respondents have heard or not heard (i.e., HEARING) the term "cultured meat" prior to the study; (ii) the pro-animal welfare attitude using the animal attitude scale (AAS) (Herzog et al., 2015), (iii) the degree of neophobia towards adoption of new food technologies using the food technology neophobia scale (FTNS) (Cox and Evans, 2008), (iv) the pro-

environmental attitude using the new environmental paradigm (NEP) scale (Dunlap et al., 2000), and (v) religion orientation.

Table 3 exhibits the descriptive statistics of the attitudinal factors. We found that there is no statistically significant difference for HEARING and pro-environmental attitude (NEP) across the three countries, while British consumers have higher pro-animal attitude (AAS) compared to French and Spanish participants. In addition, French consumers have also higher degree of food neophobia towards new food technologies (FTNS) compared to Spanish and British participants while Spanish consumers are more religious than British, and French consumers.

Table 3 - Consumer knowledge of cultured meat and attitudes among United Kingdom, Spain, and France consumers.

ATTITUDES: Mean/Frequency, (*SE*), Cronbach's alpha	**United Kingdom *(N=216)***	**Spain *(N=216)***	**France *(N=216)***
Hearing			
No	90 (41.67%)	88 (40.74%)	102 (47.22%)
Yes	126 (58.33%)	128 (59.26%)	114 (52.78%)
Pearson chi2(2) = 2.16			
Pr = 0.34			
Pro-animal attitude (AAS)	3.63^{a} (*0.05*)	3.43^{b} (*0.05*)	$3.56^{a,b}$ (*0.04*)
Chi-squared with ties = 8.51 with 2 d.f.	0.66	0.57	0.52
probability = 0.01			
Degree of neophobia towards new food technology (FTNS)	4.21^{a} (*0.05*)	4.30^{a} (*0.05*)	4.50^{b} (*0.05*)
	0.82	0.85	0.77
Chi-squared with ties = 19.56 with 2 d.f.			
probability = 0.00			
Pro-environmental attitude (NEP)	3.53^{a} (*0.04*)	3.60^{a} (*0.04*)	3.64^{a} (*0.04*)
Chi-squared with ties = 4.34 with 2 d.f.	0.83	0.85	0.84
probability = 0.11			
Religion			
No	150^{a} (69.44%)	118^{b} (54.63%)	178^{c} (82.41%)
Yes	66^{a} (30.56%)	98^{b} (45.37%)	38^{c} (17.59%)
Pearson chi2(2) = 38.90			
Pr = 0.00			

Note. SE: Standard error.

[a,b,c] Significant differences based on Chi-squared and Pearson chi-squared tests. Same letter indicates that there is no statistically significant difference at a 5% level.

3. ECONOMETRIC ANALYSIS

Data collected from CE can be estimated using the so-called discrete choice models (DCMs) (Hensher et al., 2015; Louviere et al., 2000; Train, 2009). Consistent with the Lancaster Theory (Lancaster, 1966), DCMs assume that the total utility consumers derive from a product can be segregated into the marginal utilities given by the design attributes of a product. Furthermore, DCMs are consistent with random utility theory (McFadden, 1974) which states that the utility of an individual *n* of choosing alternative *j* in choice situation *t* can be represented as:

$$U_{njt} = \beta' x_{njt} + \varepsilon_{njt} \quad (1)$$

where x_{njt} is a vector of observed variables relating to alternative *j* and individual *n*; β' is a vector of structural taste parameters which characterizes choices; ε_{njt} is the unobserved error term, which is assumed to be independent of the vectors β and *x*.

In this study we used the Random Parameter Logit (RPL) model with specification of the utility function in WTP space. This model provides estimates directly in WTP terms (i.e., currencies such as £ for United Kingdom, and € for Spain and France) which has also several advantages over the preference space models (see for details, Balcombe et al., 2009; Scarpa and Willis, 2010; Train and Weeks, 2005).

We analyzed data in three steps. First, we investigated consumers marginal WTP (mWTP) for beef burger considering the design attributes' main effects only. As such, the specification of the utility (*U*) function in our study can be defined as follows:

$$U_{njt} = \alpha_n(ASC - PRICE_{njt} + \theta_{n1}PRODUCT_{njt} + \theta_{n2}CARBON_{njt} + \theta_{n3}ANTIBIOTICS_{njt}) + \in_{njt} \quad (2)$$

where *n* refers to individual, *j* denotes each of the three alternatives available in the choice set, and *t* is the number of choice occasions α_n is the price scale parameter that is assumed to be random and to follow a log-normal distribution. The ASC is the alternative constant indicating the selection of the opt-out option. The price ($PRICE_{njt}$) attribute is represented by four experimentally defined price levels (i.e., United Kingdom: £3.20/kg, £7.70/kg, £12.30/kg, and £16.80/kg; Spain, and France: 3.50€/kg, 8.50€/kg, 13.50€/kg, and 18.50€/kg). $PRODUCT_{njt}$ is a dummy variable representing the production method of beef burger taking the value of 0 if the production method is "Conventional",

and 1 if it is "Cultured". $CARBON_{njt}$ is a dummy variable representing the "Carbon Trust Label" taking the value of 0 if the no label is reported, and 1 if the Carbon Trust Label is reported. $ANTIBIOTICS_{njt}$ is a dummy variable for information about antibiotics use taking the value of 0 if no information is reported, and 1 if the phrase "No antibiotics ever" is reported. θ_{n1}, θ_{n2} and θ_{n3} are the coefficients of the estimated mWTP values for the production method, the carbon trust label and the "No antibiotics ever" claim, respectively. Finally, $\in_{njt}$ is an unobserved random term that is distributed following an extreme value type I (Gumbel) distribution, i.i.d. over alternatives. The parameters corresponding to the three non-price attributes were modelled as random parameters assumed to follow a normal distribution, while the opt-out parameter was modelled as a fixed parameter.

Second, we investigated consumers mWTP for beef burger considering the design attributes main effects plus the interactions with several consumer characteristics with the attribute PRODUCT to test whether consumer mWTP for beef burger is affected by those characteristics. As such, the specification of the utility (U) function in our study can be defined as follows:

$$U_{njt} = \alpha_n(ASC - PRICE_{njt} + \theta_{n1}PRODUCT_{njt} + \theta_{n2}CARBON_{njt} + \theta_{n3}ANTIBIOTICS_{njt} + \theta_4 PRODUCT_{jt} X\ GENDER_n + \theta_5 PRODUCT_{jt} X\ AGE_n + \theta_6 PRODUCT_{jt} X\ EDUCATION_n + \theta_7 PRODUCT_{jt} X\ RELIGION_n + \theta_8 PRODUCT_{jt} X\ HEARING_n + \theta_9 PRODUCT_{jt} X\ AAS_n + \theta_{10} PRODUCT_{jt} X\ FTNS_n + \theta_{11} PRODUCT_{jt} X\ NEP_n) + \in_{njt} \quad (3)$$

where θ_4, θ_5, θ_6, θ_7, θ_8, θ_9, θ_{10}, and θ_{11} are the coefficients of the interaction terms between the attribute *PRODUCT*, and the consumer characteristics. Specifically, GENDER is a dummy variable representing the gender of the consumer taking the value of 0 for females and 1 for males. AGE is a continuous variable representing the age of the consumer in years. EDUCATION is an ordinal variable representing the education level of the consumer taking the value of 1 for primary school, 2 for secondary/middle school, 3 for high school/college qualification (e.g., diploma), and 4 for university degree. RELIGION is a dummy variable representing if the consumer follows or not religion taking the value of 1 if he/she follows religion and 0 otherwise. HEARING is a dummy variable representing if the consumer has heard the term "cultured meat" (or "lab-grown meat, "artificial meat", "clean meat", "in-vitro meat" or "synthetic meat") prior to the study taking the value of 1 if the consumer heard such term, and 0 otherwise. AAS is a variable representing the pro-animal welfare attitude of the consumers using 5-point scale anchored from 1 (strongly disagree) to 5

(strongly agree). FTNS is a variable representing the degree of neophobia towards new food technologies of the consumers using 7-point scale anchored from 1 (strongly disagree) to 7 (strongly agree). NEP is a variable representing the pro-environmental attitude of the consumers using 5-point scale anchored from 1 (strongly disagree) to 5 (strongly agree). The rest of the variables are specified as in Eq. (2).

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 of PRODUCT with consumer characteristics (i.e., GENDER, AGE, EDUCATION, RELIGION, HEARING, AAS, FTNS, and NEP) parameters were modelled as a fixed parameter.

The RPL model in wtp space was estimated using the Stata module *mixlogitwtp*. We run different RPL models using different number of draws both with correlated and not correlated variables. Based on LL, AIC, and BIC parameters, the best model was five hundred Halton draws with correlated variables that were used in the simulations.

Third, we investigated consumers' heterogeneity by calculating the distribution of the individual-level coefficients (i.e., mWTP) for product, carbon, and antibiotics using the kernel density estimation across individuals with the *kdensity* command in Stata.

Finally, based on the results from the distribution of the individual-level coefficients which indicate the presence of consumer groups, we performed the Latent Class Logit (LCL) model (Greene and Hensher 2003) to identify consumer segments. The LCL model assumes that the overall population can be shared into two or more groups (also called segments, classes, etc.) by assuming constant model parameters within each group, capturing consumer heterogeneity assuming a mixing distribution for the groups (Greene and 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 x' (Greene and Hensher, 2003):

$$Prob_{jnt|s} = \frac{exp(\boldsymbol{x'}_{ntj}\boldsymbol{\beta}_s)}{\sum_{j=1}^{Jn} exp(\boldsymbol{x'}_{ntj}\boldsymbol{\beta}_s)} \quad (4)$$

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. To establish the

likelihood, these choice probabilities have to be multiplied across the choice sets and finally combined across all individuals.

To estimate the LCL model, we used the expectation–maximization (EM) algorithm, which allows for a good numerical stability and good performance in terms of runtime (Bhat 1997; Train 2008). The LCL model was estimated using the modules *lclogit2, lclogitml2*, and *lclogitwtp* (Hong Il, 2020) on Stata.

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

4. RESULTS

4.1 WTP Estimates: main effects.

The results from the estimation of the RPL models using equation (2) in WTP space using the main effects for the three countries are exhibited in Table 4. Specifically, we reported the estimates (mWTP) for production method, carbon trust label, antibiotics use, and opt-out parameters, as well as the corresponding standard errors (SEs), and significances for the attributes (*p-values*).

In all three countries, the mean estimate of mWTP for the opt-out option is negative and significant suggesting that consumers tended to prefer one of the two product alternatives in a choice set as opposed to the "opt-out" option. Results show that on average consumers reject cultured beef burger, especially in France (mWTP: -5.27 €/kg, *p-value*: 0.00) and Spain (mWTP: -4.18 €/kg, *p-value*: 0.00), while British consumers do not show a particular preference for either conventional or cultured beef (mWTP: 0.59 £/kg, *p-value*: 0.39). In addition, in all three countries, consumers prefer beef burger branded with the "Carbon Trust Label" and labelled with the claim "No antibiotics ever". Specifically, if we look at the mWTP magnitudes for the individual attributes, we can notice that carbon has high positive magnitude (mWTP: 8.92 £/kg, *p-value*: 0.00 for United Kingdom; mWTP: 6.47 €/kg, *p-value*: 0.00 for Spain; mWTP: 17.71 €/kg, *p-value*: 0.00 for France), and antibiotics (mWTP: 7.36 £/kg, *p-value*: 0.00 for United Kingdom; mWTP: 9.43 €/kg, *p-value*: 0.00 for Spain; mWTP: 20.61 €/kg, *p-value*: 0.00 for France). In addition, we can see that the magnitudes in mWTPs terms for both carbon and antibiotics are higher in France compared to the United Kingdom and Spain.

Table 4 – Estimated mWTP space from RPL models with correlated variables for United Kingdom, Spain, and France.

ATTRIBUTE	United Kingdom *(N=216)*		Spain *(N=216)*		France *(N=216)*	
	mWTP (£/kg) (SE)	***p-value***	**mWTP (€/kg) (SE)**	***p-value***	**mWTP (€/kg) (SE)**	***p-value***
Product	0.59 (0.68)	0.39	-4.18 (0.64)	0.00	-5.27 (1.31)	0.00
Carbon	8.92 (1.25)	0.00	6.47 (0.78)	0.00	17.71 (2.60)	0.00
Antibiotics	7.36 (0.95)	0.00	9.43 (1.11)	0.00	20.61 (3.27)	0.00
Optout	-9.50 (0.62)	0.00	-13.17 (0.60)	0.00	-14.69 (1.32)	0.00
N. obs.	5832		5832		5832	
Wald chi2	515.95		933.75		528.37	
Prob > chi2	0.00		0.00		0.00	
logL	-1579.66		-1585.60		-1655.14	
df	15		15		15	
AIC	3189.33		3201.21		3340.29	
BIC	3289.40		3301.28		3440.35	

Note. mWTP: marginal willingness to pay.

Note. SE: standard error.

Note. N. obs: number of observations.

Note. Wald chi2: Wald test.

Note. logL: log likelihood function.

Note. df: degree of freedom.

Note. AIC: Akaike's information criterion.

Note. BIC: Bayesian information criterion.

4.2 WTP Estimates: main effects and interactions with consumer characteristics.

The results from the estimation of the RPL models using equation (3) in WTP space using the main effects and interactions with consumer characteristics for the three countries are exhibited in Table 5. Specifically, we reported the estimates for production method, carbon trust label, antibiotics use, interactions of consumer characteristics with production method, and opt-out parameters, as well as the corresponding standard errors (SEs), and significances for the attributes (*p-values*).

In all three countries, the mean estimate of mWTP for the opt-out option is negative, and significant suggesting that consumers tended to prefer one of the two product alternatives as opposed to the "opt-out" option. Results show that consumer WTP for cultured beef burger is affected by the degree of neophobia towards new food technologies (FTNS), age, and pro-environmental attitude (NEP) with differences across countries. Indeed, results suggest that the across the three countries, the degree of neophobia towards new food technologies (FTNS) strongly negatively affect consumers' WTP for cultured beef burger with a larger magnitude in France (mWTP: -5.65 €/kg, *p-value*: 0.00), followed by Spain (mWTP: -5.34 €/kg, *p-value*: 0.00), and United Kingdom (mWTP: -3.22 £/kg, *p-value*: 0.00). Furthermore, age has a negative influence on consumers' WTP for cultured beef burger in France (mWTP: -0.49 €/kg, *p-value*: 0.00), and Spain (mWTP: -0.36 €/kg, *p-value*: 0.00). Thus, young consumers are willing to pay a premium price for cultured beef burger in Spain and France, but not in the United Kingdom. In addition, we found that in France consumers with higher degree of pro-environmental attitude (NEP) reject more cultured beef (mWTP: -6.67 €/kg, *p-value*: 0.01).

Table 5 – Estimated mWTP space from RPL models with correlated variables for main effects and interactions with consumer characteristics for United Kingdom, Spain, and France.

ATTRIBUTE	**United Kingdom** ***(N=216)***		**Spain** ***(N=216)***		**France** ***(N=216)***	
	mWTP (£/kg) (SE)	***p-value***	**mWTP (€kg) (SE)**	***p-value***	**mWTP (€/kg) (SE)**	***p-value***
Product	21.77 (6.34)	0.00	34.40 (13.03)	0.01	66.51 (14.67)	0.00
Carbon	8.63 (0.93)	0.00	7.24 (1.07)	0.00	15.49 (8.87)	0.00
Antibiotics	7.90 (0.91)	0.00	9.56 (1.29)	0.00	18.43 (2.94)	0.00
Product X Gender	0.00 (1.25)	0.99	1.53 (2.16)	0.48	0.46 (2.37)	0.85
Product X Age	-0.07 (0.04)	0.09	-0.36 (0.08)	0.00	-0.49 (0.10)	0.00
Product X Education	-0.26 (0.63)	0.68	1.53 (2.16)	0.18	0.30 (1.88)	0.87
Product X Religion	0.22 (1.53)	0.89	-2.18 (2.02)	0.28	-3.76 (6.41)	0.56
Product X Hearing	1.13 (1.28)	0.38	-3.09 (2.18)	0.16	-4.81 (2.99)	0.11

Product X AAS	0.20 (0.86)	0.81	1.33 (1.57)	0.40	0.61 (3.07)	0.84
Product X FTNS	-3.22 (0.73)	0.00	-5.34 (1.24)	0.00	-5.65 (1.60)	0.00
Product X NEP	-1.51 (1.22)	0.22	-2.57 (1.79)	0.15	-6.77 (2.53)	0.01
Optout	-9.15 (0.61)	0.00	-14.37 (1.06)	0.00	-14.04 (1.37)	0.00

N. obs.	5805	5832	5697
Wald chi2	743.27	541.97	516.52
Prob > chi2	0.00	0.00	0.00
logL	-1549.51	-1568.17	-1597.43
Df	23	23	23
AIC	3145.02	3182.34	3240.85
BIC	3298.35	3335.77	3393.75

Note. mWTP: marginal willingness to pay.

Note. SE: standard error.

Note. N. obs: number of observations.

Note. Wald chi2: Wald test.

Note. logL: log likelihood function.

Note. df: degree of freedom.

Note. AIC: Akaike's information criterion.

Note. BIC: Bayesian information criterion.

4.3 WTP estimates: distribution of individual mWTP values.

Figure 1 presents the distribution of mWTP values across individuals (kernel density estimates). Not only did the mean values for each mWTP differ, but some mWTP distributions were considerably more diffused than others. Specifically, for PRODUCT, British consumers' individual mWTP distribution was much more concentrated indicating the presence of two possible homogeneous groups of consumers while for Spanish and French consumers, the distribution is more heterogenous. For the attributes CARBON and ANTIBIOTIC, for the British and Spanish consumers the individual mWTP distributions show two possible consumer groups both with positive mWTP while for French consumers the distribution is much more diffused, but with a large segment at high mWTP values.

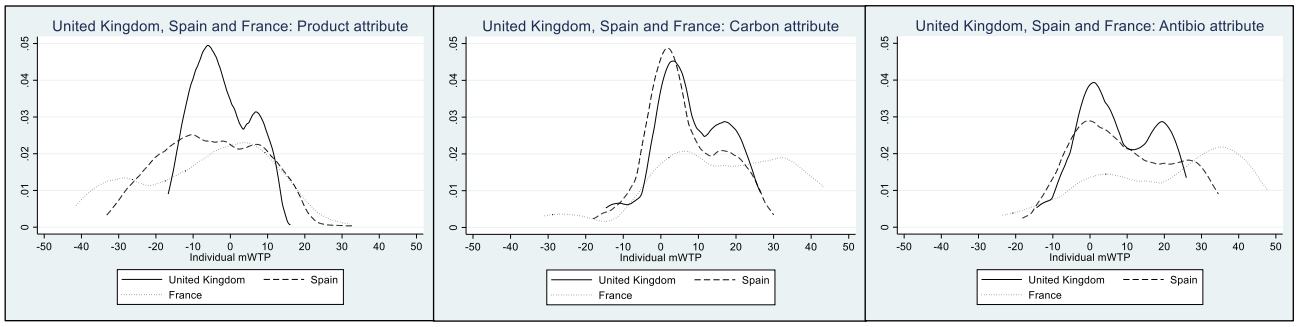

Figure 1 - Distributions of mWTP across individuals for the attributes: product, carbon and antibiotic for the United Kingdom, Spain, and France.

4.4 WTP Estimates: Latent Class Logit (LCL) model.

In view of the multimodality of some of the attributes within the RPL models as shown in the previous section, we now investigate the possibility that there are distinct groups of consumers. To investigate this form of consumer heterogeneity, we estimated the LCL models for each country.

Based on the BIC values, size of the segments and to make easier the comparison among the three countries, we choose the three clusters-solution in all the countries.

For the United Kingdom, the results of the LCL model with the three-groups solution are reported in Table 6 including the mWTP for PRODUCT, CARBON, ANTIBIOTICS, and OPTOUT parameters, as well as the corresponding standard errors (SEs), and significances for the attributes (*p-values*). Group 1 is the smallest segment ("Traditionalists", 44 consumers – 20% of the sample), which includes consumers who, although with some noise, tend to prefer conventional production method, branded with the carbon trust label, and labelled with the claim "No antibiotics ever". Group 2 ("Undecided", 71 consumers – 33% of the sample) contains consumers who do not show a particular significance preference to any of the attributes investigated. Group 3 ("Innovators", 101 consumers – 47% of the sample) is the larger group of consumers who are willing to pay a premium price for cultured beef burger (5.10 £/kg, *p-value*: 0.00), without the claim "No antibiotics ever" (-2.06 £/kg, *p-value*: 0.04). Furthermore, for both groups 2 and 3, the mean estimate of mWTP for the opt-out option is negative, and significant suggesting that consumers in those groups tended to prefer one of the two product alternatives as opposed to the "opt-out" option.

Table 6 – Estimated mWTPs from Latent Class Logit (LCL) Model for the United Kingdom.

ATTRIBUTE	GROUP 1 "Traditionalists" (*N=44*)		GROUP 2 "Undecided" (*N=71*)		GROUP 3 "Innovators" (*N=101*)	
	mWTP (£/kg) (SE)	***p-value***	**mWTP (£/kg) (SE)**	***p-value***	**mWTP (£/kg) (SE)**	***p-value***
Product	-23.17 (23.13)	0.11	-1.10 (0.59)	0.06	5.10 (1.11)	0.00
Carbon	49.52 (29.04)	0.09	0.91 (0.62)	0.14	0.64 (0.93)	0.49
Antibiotic	45.84 (25.76)	0.08	0.89 (0.59)	0.13	-2.06 (0.99)	0.04
Optout	-63.49 (35.49)	0.07	-3.55 (0.59)	0.00	-14.84 (1.20)	0.00
BIC	3084.8					

Note. mWTP: marginal willingness to pay.

Note. SE: standard error.

Note. BIC: Bayesian information criterion.

For Spain, the results of the LCL model with the three-groups solution are reported in Table 7. Group 1 ("Undecided", 69 consumers – 32% of the sample) involves consumers who do not show a particular preference to any of the attribute investigated. In Group 2 ("Traditionalists", 66 consumers – 30% of the sample), consumers prefer beef burger produced with conventional method (-13.76 €/kg, *p-value*: 0.00), and labelled with the claim "No antibiotics ever" (3.83 €/kg, *p-value*: 0.00). Group 3 ("Innovators", 81 consumers – 38% of the sample), is the largest group of consumers who are willing to pay a premium price for cultured beef burger (3.35 €/kg, *p-value*: 0.00). Furthermore, for both groups 2 and 3, the mean estimate of mWTP for the opt-out option is negative and significant suggesting that consumers in those groups tended to prefer one of the two product alternatives as opposed to the "opt-out" option.

Table 7 – Estimated mWTPs from Latent Class Logit (LCL) Model for Spain.

ATTRIBUTE	GROUP 1 "Undecided" (*N=69*)		GROUP 2 "Traditionalists" (*N=66*)		GROUP 3 "Innovators" (*N=81*)	
	mWTP (€/kg) (SE)	***p-value***	**mWTP (€kg) (SE)**	***p-value***	**mWTP (€/kg) (SE)**	***p-value***
Product	0.41 (5.02)	0.94	-13.76 (2.14)	0.00	3.35 (0.80)	0.00

Carbon	-28.00		2.40		0.86	
	(14.62)	0.06	(1.26)	0.06	(0.78)	0.27
Antibiotic	-38.36		3.83		-0.59	
	(20.02)	0.06	(1.30)	0.03	(0.79)	0.46
Optout	43.40		-7.15		-15.13	
	(23.96)	0.07	(1.22)	0.00	(1.06)	0.00
BIC	3129.57					

Note. mWTP: marginal willingness to pay.

Note. SE: standard error.

Note. BIC: Bayesian information criterion.

For France, the results of the LCL model with the three-groups solution are reported in Table 8. In Group 1 ("Innovators", 64 consumers – 30% of the sample), consumers are willing to pay a premium price for cultured beef burger (2.68 €/kg, *p-value*: 0.02), and branded with the carbon trust label (2.50 €/kg, *p-value*: 0.01). Group 2 ("Undecided", 88 consumers – 40% of the sample) includes consumers who do not show a particular preference for production method, but they dislike beef burger branded with the carbon trust label (-17.16 €/kg, *p-value*: 0.00), and labelled with the claim "No antibiotics ever" (-18.64 €/kg, *p-value*: 0.00). Group 3 ("Traditionalists", 64 consumers – 30% of the sample) involves consumers who prefer beef burger produced with conventional method (-22.49 €/kg, *p-value*: 0.00), branded with the carbon trust label (6.13 €/kg, *p-value*: 0.01), and labelled with the claim "No antibiotics ever" (12.23 €/kg, *p-value*: 0.00). Furthermore, for group 1, the mean estimate of mWTP for the opt-out option is negative, and significant suggesting that consumers in this group tended to prefer one of the two product alternatives as opposed to the "opt-out" option.

Table 8 – Estimated mWTPs from Latent Class Logit (LCL) Model for France.

ATTRIBUTE	**GROUP 1 "Innovators" (*N=64*)**		**GROUP 2 "Undecided" (*N=88*)**		**GROUP 3 "Traditionalists" (*N=64*)**	
	mWTP (€/kg) (SE)	***p-value***	**mWTP (€kg) (SE)**	***p-value***	**mWTP (€/kg) (SE)**	***p-value***
Product	2.68 (1.10)	0.02	-0.48 (2.38)	0.84	-22.49 (5.14)	0.00
Carbon	2.50 (0.95)	0.01	-17.16 (5.50)	0.00	6.13 (2.38)	0.01
Antibiotic	-0.48 (1.09)	0.66	-18.64 (6.16)	0.00	12.23 (3.02)	0.00

Optout	-20.38 (2.19)	0.00	10.65 (6.47)	1.00	2.73 (3.22)	0.40
BIC	3281.71					

Note. mWTP: marginal willingness to pay.

Note. SE: standard error.

Note. BIC: Bayesian information criterion.

5. DISCUSSION & CONCLUSIONS

This study investigated and compared for the first-time United Kingdom, Spain, and French consumers' preferences and WTP for hypothetical cultured beef burger. Several main results were identified. First, we found that on average the United Kingdom is the most promising market for cultured beef burger with a more positive acceptance of this new product compared to Spanish, and French markets. Second, in each country we found a clear market segment of consumers who are willing to pay a premium price for cultured beef burgers such as 47% of British, 38% of Spanish, and 30% of French consumers. Third, we found that on average consumers prefer cultured beef burger branded with the "Carbon Trust Label" and labelled with the claim "No antibiotics ever". Fourth, we found that younger consumers accept more cultured beef than older consumers. This finding is corroborated by Slade (2018) and Zhang et al. (2020), who found that younger consumers have more positive attitude than older for cultured beef. Fifth, we found that consumers with higher degree of neophobia towards new food technologies strongly reject cultured beef although previous research shows contrasting results regarding the effect of degree of neophobia towards new food technologies on consumer preferences for cultured meat (Dupont & Fiebelkorn, 2020; Gómez-Luciano, de Aguiar, Vriesekoop, & Urbano 2019).

These findings have important implications for food businesses. Since the United Kingdom show a larger market potential for cultured beef, compared to Spain and France, cultured beef producers should target the initial launch of this new product in the United Kingdom being a hypothetical larger market for this product. However, smaller markets for cultured beef can also be identified in Spain, and France. Food businesses should also market cultured beef burger branded with the "Carbon Trust Label" and labelled with the claim "No antibiotics ever". In addition, cultured beef producers should focus the launch of the new product to younger people and consumers with low degree of food technology neophobia towards new food technologies since those might be the early adopters of cultured beef burgers. Generally, our results imply that consumers' WTP for cultured meat is quite lower than conventional meat in Spain and France, at least under the context upon which we

conducted our study. Hence, this suggests that consumers will likely demand the right to know whether the product they are purchasing is produced using the cultured meat technology or not.

Further research is needed to test the robustness of our findings, explore the market potential of cultured beef with larger samples of consumers, with other cuts of cultured beef, and other types of meat (i.e., chicken, pork, lamb). Similar studies should also be conducted in other countries given the expected increase in meat demand of cultured meat in many parts of the world. Moreover, future studies should investigate consumers' WTP by conducting non-hypothetical experiments in real market contexts (e.g., stores) using experimental auctions (Lusk and Shogren, 2007) or real choice experiments (RCE) (Alfnes and Rickertsen, 2010) combined with sensory evaluations of cultured meat to obtain more comprehensive, and realistic results (Asioli et al., 2017).

In conclusion, our findings show that consumers' WTP for cultured beef depends on the country, age, and the degree of neophobia towards new food technologies. Our results provide insights into consumers' acceptance psychology that can be useful for effectively communicating the benefits of cultured meat to the public to maximize the chances of making them commercially viable.

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