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European consumers' valuation for hybrid meat: Does information matter?

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Abstract

This study investigates for the first time how the use of different information messages (i.e., health, sensory, and convenience benefits) about hybrid meat shapes British, Spanish, and Danish consumers' willingness to pay (WTP) for such products. Hybrid meats are products whereby a proportion of the meat has been replaced by plant-based proteins. Using a choice experiment (CE) involving hybrid burgers that vary across four attributes (i.e., ingredient, fat content, Carbon Trust label, and price), our results show that consumers are generally not yet willing to pay a premium for such new products. Furthermore, we found that consumer valuation for hybrid burgers strongly depends on the type of information provided and consumer characteristics. These findings provide useful guidelines on how information can be used in communicating the nature of the hybrid meats to the public in a cross-country context.

KEYWORDS

consumer, European countries, hybrid meat, information provision, willingness to pay

JEL CLASSIFICATION

Q110 agriculture, Q130 agricultural markets and marketing, Q180 agricultural policy, agribusiness,

aggregate supply and demand analysisfood policy, cooperatives, prices

Continued growth in world population, incomes, urbanization, and food security issues has strongly raised the demand for meat (OECD-FAO, 2013). Meat production is also a main contributor of greenhouse gas (GHG) emissions (Xu et al., 2021) since it requires extensive use of land, energy, and water (FAO, 2006). Furthermore, there are increasing societal concerns about food safety, animal welfare, and human health issues, such as animal-transmitted pandemics, antibiotic resistance (Godfray et al., 2018; Reisch, 2021), and cardiovascular diseases (Apostolidis & McLeay, 2016) related to meat production and consumption. As a result, there is increasing consensus among many policy makers that a reduction in meat production is needed, which should be counterbalanced by an increase in alternative protein products.

Among the different alternative proteins available on the market (e.g., plant-based meat, mycoproteins, insect, etc.), plant-based meat tends to be more accepted by consumers (Onwezen et al., 2021). Nevertheless, consumers are often unfamiliar (Apostolidis & McLeay, 2016) and skeptical about the sensory characteristics of plant-based meat (Reipurth et al., 2019; Dekkers et al., 2018). Consumers also show reluctance to make drastic dietary shifts toward a more strictly vegan or vegetarian diet (Graça et al., 2015). These issues seem to put the policy efforts and achievement of the goal to reduce meat production and consumption further away in the future (Lentz et al., 2018). Consequently, there is a need for a more feasible approach and more actionable policy solutions that would be accepted by consumers (Spencer et al., 2018). One possible approach to support the transition from meat-based to plant-forward diets is the introduction of hybrid meat (Tarrega et al., 2020). Hybrid meat products are blends of meat (e.g., burgers, sausage, etc.) and plant-based ingredients (e.g., legume, vegetables, etc.) (Banovic et al., 2022; Grasso, Asioli, & Smith, 2022) which, unlike fully plant based alternatives, are perceived as satisfying and satiating as their meat-based counterparts (Spencer et al., 2018) since they share fairly similar sensory characteristics as meat.

Nevertheless, a main challenge for both policy-makers and producers is to convince consumers to try and purchase hybrid meat products (Michel et al., 2021). In this sense, the way in which hybrid products are communicated to consumers can play a pivotal role in terms of consumer acceptance as prior literature shows that the type of communication employed affects consumer acceptance for sustainable foods (e.g., de Boer & Aiking, 2017; Banovic & Barone, 2021). However, while prior research has mostly investigated consumer acceptance of hybrid meat (e.g., Banovic et al., 2022; Barone et al., 2021; Caputo et al., 2022; Lang, 2020; Neville et al., 2017), there is a dearth of research on how these products should be communicated when promoting their consumption to consumers (Banovic & Barone, 2021; Edenbrandt & Lagerkvist, 2021). Specifically, there are a few studies that investigate consumer acceptance of hybrid meat, and none that focuses on the communication of such new products to consumers in different countries.

Among the different types of information that can affect consumer acceptance for hybrid meat, health message is important because it is one of the main benefits of such products (Zhang et al., 2010) that consumers highly associate with plant-based meat (Loo et al., 2020). An example of using health information to advertise hybrid meat is from Marks & Spencer, which recently launched in the British market hybrid meats using the formula to deliver "*1 of your 5 a day*" per portion by focusing, among other benefits, on vegetables as healthy ingredients (Marks & Spencer, 2019). Another type of message that could affect consumers' valuation for hybrid

products is sensory information (de Bakker & Dagevos, 2012; Neville et al., 2017). Again, Marks & Spencer launched hybrid meats in the market by also focusing their communication on flavorful compounds ("*more veggies, more flavour*") (Marks & Spencer, 2019). In addition, convenience information could affect consumer acceptance for hybrid products because they are more convenient to prepare and cook compared to plant-based meat only (Grasso & Jaworska, 2020; Neville et al., 2017). This information has been used, for example, by Tesco (Tesco, 2019) to advertise hybrid meats. To the best of our knowledge, no studies have investigated the effect of different types of information on consumer valuation for hybrid meat in a cross-country context, which is important for the development of marketing and communication strategies for hybrid meat in different countries.

Our study fills this void by using a choice experiment (CE) to investigate how the use of different types of information about hybrid products (i.e., health, sensory, and convenience benefits) shapes British, Spanish, and Danish consumers' willingness to pay (WTP).[1] We also aim to identify potential sources of heterogeneity on consumer valuation of hybrid burgers in the United Kingdom, Spain, and Denmark. The selection of the countries was based on the main markets where hybrid products are already present such as Denmark (Fortune, 2019), important growing markets such as the United Kingdom (Mintel, 2019), and potential market like Spain. These countries also well represent the different geographical areas of Europe. As a basic hybrid product, we chose beef burger for several reasons: (i) beef is one of the most consumed meat products worldwide, and its demand is increasing (Sheng & Song, 2019), (ii) beef burger is one of the most popular meat products in the United Kingdom, Spain, and Denmark (Barone et al., 2021), (iii) several large companies and startup businesses are investing in hybrid burgers (e.g., Danish Crown, Tyson Food) (Coyne, 2021), and a lot of the industry interest in new plant-based foods has been on burgers (Lang, 2020), (iv) the beef industry is one of the larger contributors of GHG emission (Clune et al., 2017), which can potentially contribute more to reduce the negative environmental externalities caused by meat production, and (v) burger is the preferred type of meat cut component on hybrid products in the United Kingdom, Spain, and Denmark (Grasso, Asioli, & Smith, 2022).

There are two main contributions of this manuscript. First, we aim to provide useful information on how policy makers and food producers can inform consumers about the benefits of hybrid meat. Second, we aim to provide useful information for food producers and retailers that aim to sell hybrid meat in different European countries on how they can target their communication messages more effectively to specific consumer segments and suggest which information (i.e., claims) should be reported on food labels to increase consumer acceptance.

BACKGROUND

European Union (EU) policy makers have been pressed to address meat reduction and plant-based diets in new food policies (Fortuna, 2020). For example, the new Farm to Fork (F2F) strategy promises to make the EU food systems more sustainable and reduce negative impacts of meat consumption through information, transparency, and empowering consumers with harmonized mandatory front-of-pack nutrition information, synchronization of the green claims and creation of a sustainable labeling framework, which covers the nutritional, climate, environmental, and social aspects of food products (European Commission, 2020). However, even though efforts have been made, the EU's food policies and Common Agricultural Policy (CAP), in particular, are still criticized and regarded as failing with respect to biodiversity, climate, soil,

land degradation, as well as socio-economic challenges (Pe'er et al., 2020), largely as the livestock sector continues to receive robust CAP subsidies (European Commission et al., 2020).

Thus, to meet the above mentioned EU polices, it is important to reduce meat consumption and at the same time favorite the incorporation of plant-based food in consumer everyday life (Loo et al., 2020). At the same time, recent research has showed a large increase of plant-based food consumption in Europe (EU, 2022), and a further increase of consumption is expected over the next years (Euronews, 2022). Hybrid meat can represent an elegant way to move the transition from meat products to plant-based food for several reasons. First, hybrid meat combines the best of meat products such as good sensory and nutrition qualities (Bohrer, 2017; Grasso, Rondoni, et al., 2022; Tarrega et al., 2020), the healthiness and sustainability characteristics of plant-based food (de Boer & Aiking, 2021; Banovic et al., 2018). Second, hybrid meat include more variety since as alternatives to the full meat and full plant-based meat products that are currently on the market, hybrid meats do not require a drastic diet change, and the consumption of vegetables since the plant-based portion of hybrid meats in the market has been reported to be 20%–50% (Grasso, Asioli, & Smith, 2022). Third, hybrid meat provides more diversity, and a more flexible approach to enable a sustainable plant-forward transition because previous research has found that such products are generally liked because of their sensory attributes similarly to full meat products (Neville et al., 2017). Fourth, hybrid meat is more convenient than conventional meat because there is less or no need to purchase and prepare vegetables because they are already incorporated in hybrid meat (Grasso & Jaworska, 2020), and their preparation do not need additional cooking skills and time compared to plant-based meat only (Neville et al., 2017). Hybrid meat would thus allow and encourage a more nuanced plant-forward transition of those consumers with an attachment to meat who would like to decrease the meat consumption (e.g., flexitarian) but do not want to compromise on the taste and sensory reward (Graça et al., 2015). This in turn could generate more sustainable dietary habits, have a positive influence on individual health (Godfray et al., 2018), and would achieve substantial reduction in GHG emissions (Goldstein et al., 2017). In this sense, hybrid products would also ease the challenges of the EU livestock sector toward a more sustainable management of natural resources (Santini et al., 2017). Furthermore, the growing interest toward hybrid products in Europe is also signaled by the increasing number of food companies have started to produce hybrid meat products, such as for example Danish Crowns' in Denmark, BrewsDog's in the United Kingdom (Southey, 2021), and Novameat in Spain (Lorenzo, 2022).

Several academic articles have investigated consumer acceptance of hybrid meat. To illustrate, Grasso, Asioli, and Smith (2022) investigated European consumer preferences for hybrid meat and found that around 50% of them were willing to try and buy such products. They also found that hybrid meat products were considered healthy, ethical, and environmentally friendly, while full meat products were considered affordable, tasty, and enjoyable. Lang (2020) found that US consumers tend to accept hybrid burger blended with mushrooms and that their acceptance is influenced taste, health, sustainability, cost, and novelty. Banovic et al. (2022) investigated consumer attitudes for hybrid meat in some European countries and found that such products could represent an initial way for enabling a successful plant-forward transition because the meat content in such products would facilitate consumer acceptance. They also found that sensory perception play a major role in mediating the effect of consumer attitudes on intention to buy hybrid products. Caputo et al. (2022) conducted a sensory consumer study with hybrid burgers in the United States and found that consumers prefer full beef burger over plant-based alternatives and that providing information negatively affect consumer acceptance of hybrid burgers compared to alternatives.

TABLE 1 Attributes and levels

Attributes	Levels		
Ingredient	"100% beef" "50% beef and 50% plant-based" "100% plant-based"		
Fat content	"Reduced fat" "Regular fat"		
Carbon trust label	No label reported 		
Price	*United Kingdom*	*Spain*	*Denmark*
	£5.00/kg	5.51 €/kg	41 kr/kg
	£17.50/kg	19.29 €/kg	143.6 kr/kg
	£30.00/kg	33.07 €/kg	246.1 kr/kg

MATERIALS AND METHODS

Choice experiment design

In the CE, we used four attributes to describe the different types of hybrid burgers: ingredient, fat content, Carbon Trust label, and price (Table 1). First, we included the ingredient because as main aim of the study we would like to investigate consumer WTP for hybrid burgers with a proportion of the meat replaced by plant-based proteins (i.e., grains, pulses, and vegetables). Therefore, three levels of ingredients type were specified: "100% beef," "50% beef and 50% plant-based ingredients," and "100% plant-based burger." Second, we included the information about the fat content because this information is a top concern when consumers are purchasing meat (Barone et al., 2021; Lusk & Parker, 2009). Consumers also shown interest for the claim "reduced fat" on hybrid meat (Grasso, Asioli, & Smith, 2022). Therefore, two levels for fat content were specified by the phrases "regular fat" or "reduced fat." Third, 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 CO_2 emissions. We included information about the environmental impact because it is currently one of the top key concerns of the meat production (Godfray et al., 2018). Thus, the two levels of this attribute were i) use of the Carbon Trust label or ii) no label used at all. Lastly, three price levels were specified based partly on the current market prices for uncooked burgers in retail stores in the United Kingdom (£5.00/kg, £17.50/kg, and £30.00/kg), the equivalent for Spain (5.51, 19.29, and 33.07 €/kg), and Denmark (41, 143.6, and 246.1 kr./kg).[2]

The selected attributes and their levels were then used to generate an orthogonal fractional factorial design using Ngene 1.2.1 (ChoiceMetrics, Sidney, Australia) that resulted in the creation of 36 choice sets, which were then divided into four blocks of nine choice tasks each to prevent respondents' fatigue. Each choice task was composed of two product alternatives (options A and B) and an "opt-out" option (option C) (see an example in Appendix A). The choice tasks within each block were randomly presented to respondents.

TABLE 2 Information treatments

Treatment	Description	Additional information	Name
1	Only CE questions	/	CONTROL
2	CE questions + Health information	By consuming burgers made with a combination of beef and plant-based ingredients you will get more vegetables, pulses and grains into your diet which contain a range of nutrients such as fiber, vitamins and minerals which are good for your health.	HEALTH
3	CE questions + Sensory information	By consuming burgers made with a combination of beef and plant-based ingredients, the burgers will taste more savory, juicier, have more flavor, and will have an improved texture (Adapted from Lang, 2020).	SENSORY
4	CE questions + Convenience information	By consuming burgers made with a combination of beef and plant-based ingredients, your shopping and cooking will be easier because you do not need to buy and prepare vegetables separately to complete the meal.	CONVENIENCE

The CE was introduced to the consumers with the clear explanation and description of the attributes and levels. Before the choice tasks, participants also received the instructions that they should imagine themselves to be shopping in a grocery store, and instructions were provided on how to complete the CE. We also included a cheap talk (CT) script to mitigate hypothetical bias (Silva et al., 2011) (see Appendix B for the CT script). Upon completion of the choice tasks, the respondents were asked to complete a questionnaire to collect information on their socio-demographics and attitudes. Specifically, we included questions about socio-demographics (i.e., age, gender, and education), religion preferences, familiarity with plant-based meat substitutes or meat alternatives, and attitudes toward meat attachment using the meat attachment questionnaire (MAQ) (Graça et al., 2015), and the participants' degree of neophobia toward new foods using the food neophobia scale (FNS) (Pliner & Hobden, 1992). The complete questionnaire is available in Appendix C.

Experimental treatments and research hypotheses

We implemented a between-subjects design based on the use of four CE treatments (Table 2). Hence, each respondent was randomly assigned to only one of the CE treatments. The four treatments only differed in terms of the information given about hybrid products prior the series of choice tasks. Treatment 1 is the control treatment, named "CONTROL"; 651 consumers (228 in the United Kingdom, 202 in Spain, and 221 in Denmark) were given general information about hybrid products. In Treatment 2, named "HEALTH," 606 respondents (201 in the United Kingdom, 204 in Spain, and 201 in Denmark) were provided general information about hybrid products and supplied with additional information about the health benefits of hybrid products. In Treatment 3, named "SENSORY," 611 consumers (203 in the United Kingdom, 205 in Spain, and 203 in Denmark) were exposed to general information about hybrid meat and

supplied with other information about the sensory benefits of hybrid meat. In Treatment 4, named "CONVENIENCE," 609 respondents (203 in the United Kingdom, 201 in Spain, and 205 in Denmark) were exposed to general information about hybrid products and were given additional information about the convenience benefits of hybrid meat.

With these CE treatments, we constructed a series of hypotheses to examine whether the information about the benefits of the hybrid burgers would affect consumer marginal willingness to pay (mWTP) for these new products. To determine the effect of the different types of information, we compared the estimates from the four treatments by testing whether:

i. health information would affect respondents' mWTP for hybrid burgers (i.e., CONTROL vs. HEALTH): H_{01}: $mWTP^{HEALTH} > mWTP^{CONTROL}$,
ii. sensory information would affect respondents' mWTP for hybrid burgers (i.e., CONTROL vs. SENSORY): H_{02}: $mWTP^{SENSORY} > mWTP^{CONTROL} = 0$,
iii. convenience information would affect respondents' mWTP for hybrid burgers (i.e., CONTROL vs. CONVENIENCE): H_{03}: $mWTP^{CONVENIENCE} > mWTP^{CONTROL} = 0$,
iv. consumer evaluations for hybrid burgers differ when health information vs. sensory information was provided (i.e., HEALTH vs. SENSORY): H_{04}: $mWTP^{SENSORY} \neq mWTP^{HEALTH}$,
v. consumer evaluations for hybrid burgers differ when health information versus convenience information was provided (i.e., HEALTH vs. CONVENIENCE): H_{05}: $mWTP^{HEALTH} \neq mWTP^{CONVENIENCE}$,
vi. consumer evaluations for hybrid burgers differ sensory information versus convenience information was provided (i.e., SENSORY vs. CONVENIENCE): H_{06}: $mWTP^{SENSORY} \neq mWTP^{CONVENIENCE}$.

Data

The data[3] used in this study are drawn from an online survey involving a total of 2477 consumers in the United Kingdom (835 consumers), Spain (812 consumers), and Denmark (830 consumers) using the online platform Qualtrics LLC (Provo, US) conducted in Autumn 2020. Only consumers who were at least 18 years old, who were responsible for food shopping and cooking in the household always or sometimes, purchase uncooked burgers at least once every three months, and were full meat eaters or flexitarians or macrobiotic consumers were included in the study.

To ensure data quality, we took two main steps. First, before the series of choice tasks, as suggested by Meade and Craig (2012) to stimulate respondents to pay extra attention to the subsequent questions, 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 (see questionnaire in Appendix C). We strategically placed this question right before the most important questions, such as the CE tasks. Second, we included in the study only consumers who took more than one-third of the median time duration to complete the survey.

Respondents in each country were selected for the study using convenience samples following specific quotas for gender (50% females and 50% males) and age (50% 18–45 years and 50% 46–75 years) (see Table D1 in Appendix D for the socio-demographic characteristics). The final

sample for the United Kingdom has similar gender and age distributions compared to the census data slightly more consumers between 48 and 62 years than older than 63 years (Office for National Statistics, 2019). The final sample for Spain has similar gender distribution compared to the census data (INE, 2020), while the final sample for Denmark has similar gender and age distributions compared to the census data (Statistics Denmark, 2021). In addition, the hypotheses of equality of means between socio-demographics characteristics across the four treatments within three countries were not rejected at the 5% significance level (see Tables D2, D3, and D4 in Appendix D) for gender, age, income, education, and household size. Only for the United Kingdom, the treatment 1 (CONTROL) has more males than the other treatments, and for Denmark it has more younger participants for treatments 1 (CONTROL) and 4 (CONVENIENCE) compared to the other treatments.

ECONOMETRIC ANALYSIS

To test the research hypotheses, we estimated the effect of the treatments on WTP using the Discrete Choice Models (DCMs) that are normally used to analyze choice data (Hensher & Green, 2015). Specifically, DCMs are based on modeling utility as a function of the attributes which describe the products under consideration (Hensher & Green, 2015).

In this study, we used the Mixed Logit (MIXL) model with specification of the utility function in WTP space, which provides estimates directly in WTP terms (i.e., currencies). 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 attributes of a product. As such, the specification of the utility (U) function in our study can be defined as follows:

$$U_{njt} = \alpha_n \left(\text{ASC} - \text{PRICE}_{njt} + \theta_{n1}\text{HYBRID}_{njt} + \theta_{n2}\,\text{PLANT}_{njt} + \theta_{n3}\,\text{FAT}_{njt} + \theta_{n4}\text{CARBON}_{njt}\right) + \in_{njt} \quad (1)$$

where n refers to individual, j denotes each of the three alternatives available in the choice set, t is the number of choice occasions, and 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 three price levels (i.e., United Kingdom: £5.00, £17.50, and £30.00/kg; Spain: 5.51, 12.29, and 33.07€/kg; Denmark: 41, 143.6, and 246.1 kr./kg). HYBRID_{njt} is a variable representing the type of main ingredients of the burgers, taking the value of 1 if it is composed by "50% beef and 50% plant-based" and 0 otherwise. PLANT_{njt} is a variable representing the type of main ingredients of the burgers, taking the value of 1 if it is composed by "100% plant-based" and 0 otherwise. FAT_{njt} is a dummy variable for information about the fat content of the hybrid products taking the value of 0 if the claim "Reduced fat" is reported, and 1 if the phrase "Regular fat" is stated. 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. $\theta n1$, $\theta n2$, $\theta n3$, and $\theta n4$ are the coefficients of the estimated mWTP values for HYBRID, PLANT, FAT, and CARBON, respectively. Finally, $\in_{njt}$ is an unobserved random term that is distributed following an extreme value type I (Gumbel) distribution, independent, and identically distributed (i.i.d.) over alternatives. The parameters corresponding to the three nonprice attributes were modeled as

random parameters assumed to follow a normal distribution, while the opt-out parameter was modeled as a fixed parameter.

The differences in the mWTPs among the four treatments involved in our six hypotheses (i.e., H_{01}, H_{02}, H_{03}, H_{04}, H_{05}, and H_{06}) can be tested by conducting pairwise tests using data from the two respective treatments involved in the particular hypothesis. Then, following Asioli, Bazzani, and Nayga Jr (2021), we created interactions between the nonprice attributes, and the treatment (*dtreat)* parameters, which were modeled as a fixed parameters. The interaction effects were specified as dummy variables to differentiate one treatment over the other treatment (*dtreat*). Accordingly, the model can be specified as follows:

$$\begin{aligned} U_{njt} = & \alpha\left(\mathrm{ASC} - \mathrm{PRICE}_{njt} + \theta_{n1}\mathrm{HYBRID}_{njt} + \theta_{n2}\,\mathrm{PLANT}_{njt} + \theta_{n3}\,\mathrm{FAT}_{njt} + \theta_{n4}\,\mathrm{CARBON}_{njt}\right. \\ & + \eth_1\left(\mathrm{HYBRID}_{nj} \times dtreat\right) + \eth_2\left(\mathrm{PLANT}_{nj} \times dtreat\right) + \eth_3\left(\mathrm{FAT}_{nj} \times dtreat\right) \\ & \left. + \eth_4\left(\mathrm{CARBON}_{nj} \times dtreat\right)\right) + \in njt \end{aligned} \tag{2}$$

where *dtreat* is coded as 1 for the first treatment in the analyzed hypothesis and 0 otherwise. The significance of the estimated ð coefficients, and their signs indicate the effect of the treatment on the mWTPs for the attribute of interest.

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

Next, we investigated consumer heterogeneity into two steps. First, we calculated the distribution of the individual-level coefficients (i.e., mWTP) for HYBRID. This is because we would like to investigate the effect of health, sensory, and convenience information on the distribution of the individual mWTP using the kernel density estimation across individuals with the *kdensity* command in Stata. Second, we performed a postregression analysis by pooling together all the treatments for each country to investigate the potential sources of heterogeneity, such as individual consumer characteristics (see for details on the econometric analysis Appendix E).

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

RESULTS

WTP estimates: United Kingdom, Spain, and Denmark

The results from the estimation of the MIXL models using Equation (1) in WTP space using the main effects for the United Kingdom, Spain, and Denmark are exhibited in Table 3. Specifically, we reported the estimates (mWTP) for HYBRID, PLANT, FAT, CARBON, PRICE, OPT-OUT, and significances for the attributes (*p*-value).

Overall, results show that in all the three countries and treatments, the mean estimate 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. Specifically, in the United Kingdom results show that both in the treatments 1 and 3 (CONTROL and SENSORY, respectively) consumers prefer burgers made with only beef, and branded with the "Carbon

TABLE 3 Estimated mWTP space from MIXL models for the United Kingdom, Spain, and Denmark

	Treatment: CONTROL			Treatment: HEALTH			Treatment: SENSORY			Treatment: CONVENIENCE		
Attribute	**United Kingdom (*N* = 228) mWTP (£/kg) (se)**	**Spain (*N* = 202) mWTP (€/kg) (se)**	**Denmark (*N* = 221) mWTP (kr./kg) (se)**	**United Kingdom (*N* = 201) mWTP (£/kg) (se)**	**Spain (*N* = 204) mWTP (€/kg) (se)**	**Denmark (*N* = 201) mWTP (kr./kg) (se)**	**United Kingdom (*N* = 203) mWTP (£/kg) (se)**	**Spain (*N* = 205) mWTP (€/kg) (se)**	**Denmark (*N* = 203) mWTP (kr./kg) (se)**	**United Kingdom (*N* = 203) mWTP (£/kg) (se)**	**Spain (*N* = 201) mWTP (€/kg) (se)**	**Denmark (*N* = 205) mWTP (kr./kg) (se)**
Hybrid	−14.90*** (2.78)	−21.01*** (2.24)	−252.69*** (23.26)	−7.11** (3.45)	−3.55* (1.89)	−137.62*** (15.61)	−1.80 (1.29)	−12.03*** (2.35)	−141.57*** (18.42)	−10.18* (5.66)	−1.03 (1.26)	−127.36*** (10.68)
Plant	−25.75*** (3.75)	−40.24*** (3.60)	−412.60*** (3.41)	−24.48*** (4.25)	−20.37*** (2.04)	−316.43*** (26.70)	−17.09*** (2.56)	−36.33*** (4.25)	−338.73*** (23.24)	−23.31*** (5.07)	−32.21*** (3.15)	−289.19*** (24.94)
Fat	−4.20* (2.24)	−8.59*** (1.81)	−20.86* (12.39)	−5.00** (1.78)	−4.34*** (1.48)	0.05 (12.31)	−1.36 (1.37)	−7.62*** (1.54)	1.61 (11.86)	−5.21*** (1.68)	−0.64 (1.34)	22.78** (10.77)
Carbon	5.60*** (1.62)	1.43 (1.59)	−1.29 12.31	2.02 (1.48)	5.06*** (1.55)	3.02 (9.28)	6.96*** (1.16)	7.04*** (1.68)	0.18 (8.70)	3.36 (2.06)	9.20*** (1.82)	6.32 (8.84)
Price	−2.11*** (0.10)	−2.29*** (0.12)	−4.15*** (0.11)	−2.31*** (0.13)	−2.09*** (0.15)	−4.04*** (0.13)	−2.10*** (0.12)	−2.10*** (0.12)	−3.74*** (0.13)	−2.28*** (0.14)	−1.99*** (0.11)	−4.10*** (0.14)
Optout	−31.54*** (1.37)	−40.60*** (2.19)	−318.00*** (18.04)	−33.00*** (2.03)	−26.74*** (2.16)	−280.58*** (10.80)	−29.86*** (0.61)	−33.11*** (1.20)	−264.43*** (8.18)	−36.39*** (3.26)	−23.24*** (1.45)	−260.16*** (7.98)
Model fit statistics												
N. obs.	6156	5454	5967	5427	5508	5427	5481	5535	5481	5481	5427	5535
Wald chi2	921.54	599.68	1586.66	392.89	402.54	1307.63	2562.95	1073.00	1559.95	370.81	633.07	1724.07
Prob > chi2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
logL	−1551.75	−1384.86	−1327.73	−1445.66	−1421.16	−1246.737	−1401.58	−1360.15	−1181.86	−1404.04	−1340.98	−1305.296
df	21	21	21	21	21	21	21	21	21	21	21	21
AIC	3145.51	2810.92	2697.45	2933.32	2884.33	2535.475	2845.15	2762.30	2405.71	2850.07	2723.95	2652.59
BIC	3286.74	2949.61	2838.02	3071.91	3023.22	2674.057	2983.94	2901.30	2544.50	2988.86	2862.54	2791.59

Note: Asterisks indicate *$p < 0.1$, **$p < 0.05$, and ***$p < 0.01$.

Abbreviations: AIC, Akaike's information criterion; BIC, Bayesian information criterion; df, degree of freedom; mWTP, marginal willingness to pay; N. obs, number of observations; SE, standard error; Wald chi2, Wald test; logL, log likelihood function.

Trust label" while in the treatments 2 and 4 (HEALTH and CONVENIENCE, respectively), consumers prefer burgers made with only beef, and labeled with the claim "reduced fat."

The results for Spain indicate that in treatment 1 (CONTROL) consumers prefer burgers made with only beef and labeled with the claim "reduced fat." In the treatments 2 and 3 (HEALTH and SENSORY, respectively), consumers prefer burgers made with only beef, labeled with the claim "reduced fat," and branded with the "Carbon Trust label," while in the treatment 4 (CONVENIENCE), consumers prefer burgers made with only beef and branded with the "Carbon Trust label."

Table 3 shows that in the treatments 1, 2, and 3 (CONTROL, HEALTH, and SENSORY, respectively), Danish consumers prefer burgers made with only beef, while in the treatment 4 (CONVENIENCE), consumers prefer burgers made with only beef and labeled with the claim "regular fat."

Hypothesis tests: United Kingdom, Spain, and Denmark

Next, we tested the hypothesis that the information provision about hybrid burgers significantly affect mWTP estimates (Table 4). Across the three countries, we found that providing health, sensory, and convenience information of hybrid burgers will increase consumer WTP for such products (i.e., hypothesis $H_{01,}$ H_{02}, and H_{03}), while when comparing the different types of information provision, we can find some difference among the countries. Specifically, in Spain, WTP will be higher when consumers are provided with information about health benefits compared to when sensory information is provided. In addition, both in Spain and Denmark, WTP will be higher when consumers are provided with information about sensory benefits compared to when convenience information is provided.

TABLE 4 Hypothesis test across four treatments and countries (hybrid × dtreatment)

Hypothesis test	United Kingdom WTP: £/kg	Spain WTP: €/kg	Denmark WTP: Kr./kg
H_{01}: $mWTP^{HEALTH} - mWTP^{CONTROL} = 0$	10.94***	7.33***	80.39**
H_{11}: $mWTP^{HEALTH} - mWTP^{CONTROL} \neq 0$	(2.74)	(2.73)	(34.01)
H_{02}: $mWTP^{SENSORY} - mWTP^{CONTROL} = 0$	6.32**	6.34**	113.05***
H_{12}: $mWTP^{SENSORY} - mWTP^{CONTROL} \neq 0$	(2.86)	(2.37)	(25.16)
H_{03}: $mWTP^{CONVENIENCE} - mWTP^{CONTROL} = 0$	7.56**	5.72**	98.34***
H_{13}: $mWTP^{CONVENIENCE} - mWTP^{CONTROL} \neq 0$	(3.02)	(2.18)	(28.90)
H_{04}: $mWTP^{SENSORY} - mWTP^{HEALTH} = 0$	−1.95	−5.58**	17.88
H_{14}: $mWTP^{SENSORY} - mWTP^{HEALTH} \neq 0$	(3.24)	(2.83)	(8.29)
H_{05}: $mWTP^{HEALTH} - mWTP^{CONVENIENCE} = 0$	−3.78	−1.93	21.26
H_{15}: $mWTP^{HEALTH} - mWTP^{CONVENIENCE} \neq 0$	(3.44)	(2.28)	(13.19)
H_{06}: $mWTP^{SENSORY} - mWTP^{CONVENIENCE} = 0$	−4.16	5.49**	74.69***
H_{16}: $mWTP^{SENSORY} - mWTP^{CONVENIENCE} \neq 0$	(3.42)	(2.79)	(31.21)

Note: Asterisks indicate *$p < 0.1$, **$p < 0.05$, and ***$p < 0.01$.
Abbreviations: mWTP, marginal willingness to pay; SE, standard error.

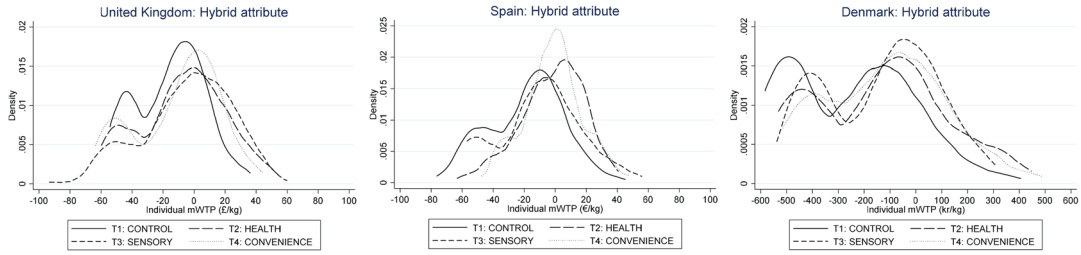

FIGURE 1 Distributions of mWTP across individuals for the HYBRID attribute for the United Kingdom (left-side), Spain (middle), and Denmark (right-side) [Color figure can be viewed at wileyonlinelibrary.com]

WTP estimates: Distribution of individual mWTP values for the United Kingdom, Spain, and Denmark

Figure 1 presents the distribution of mWTP values across individuals (kernel density estimates) for the HYBRID attribute in the United Kingdom, Spain, and Denmark. First, we notice that compared to the treatment T1-CONTROL, when we provide information about the benefits of hybrid products (i.e., treatments: T2-HEALTH, T3-SENSORY and T4-CONVENIENCE) consumers' mWTP for hybrid meat increase. This corroborates the findings from the MIXL models of the previous section. Moreover, across all treatments and countries, especially in Denmark and the United Kingdom, we can notice a bimodal distribution with the mWTP for two subgroups of respondents particularly sensitive to the HYBRID attribute, which indicates the presence of two consumer segments. Specifically, we can see one large consumer segment with mWTP quite well distributed around zero mWTP (i.e., United Kingdom: −30 and +20£/kg; Spain: −30 and +40€/kg; and Denmark: −300 and +300 kr./kg), and a smaller segment of consumers with strongly negative mWTP for hybrid products (i.e., United Kingdom: −30 and −60£/kg; Spain: −30 and −60€/kg; and Denmark: −300 and −600 kr./kg).

Moreover, in the United Kingdom (left-side of the Figure 1), we can notice that the individual mWTP distributions are similar and more concentrated for the treatments 1 (CONTROL) and 4 (CONVENIENCE), while it is a bit more diffuse for the treatments 2 (HEALTH) and 3 (SENSORY), which means that health and sensory information effect consumer valuation differently, while convenience information not. Similarly, in Spain (middle side in the Figure 1), we can see that when providing information about the convenience benefits of hybrid products the effect is similar for all consumers, while is not when health and sensory information are provided. In Denmark (right-side of the Figure 1) the individual mWTP distributions are similar across treatments which means that the effect of information on consumer valuation for hybrid meat is similar independently than the type of information provided.

Consumer heterogeneity: Post – Regression analysis

Table 5 shows that the consumer characteristics explain 20%, 17% and 26% of the variance on consumer preferences for hybrid burger in the United Kingdom, Spain, and Denmark, respectively. Specifically, a number of consumer characteristics affect consumer preferences for hybrid

TABLE 5 Effect of consumer characteristics on consumer preference for HYBRID

Variable	United Kingdom ($N = 835$) Coefficient (SE)	Spain ($N = 812$) Coefficient (SE)	Denmark ($N = 830$) Coefficient (SE)
Intercept	36.67*** (7.47)	3.21 (7.56)	388.38*** (58.80)
Age	−0.31*** (0.06)	−0.14** (0.06)	−3.38*** (0.42)
Gender	−2.16 (1.67)	2.15 (1.56)	−13.09 (14.81)
Education	3.19*** (0.82)	−0.59 (0.78)	12.05* (6.34)
Religion	2.37 (1.77)	4.41*** (1.58)	27.16* (16.29)
MAQ	−7.83*** (0.82)	−3.61*** (0.74)	−86.68*** (7.54)
FNS	−2.47** (0.96)	−1.61* (0.93)	−21.51** (8.89)
Familiarity	1.04 (0.91)	5.56*** (0.72)	20.05*** (6.05)
Model fit statistics			
Number of obs	835	812	830
Prob > F	0.00	0.00	0.00
R-squared	0.20	0.17	0.26
Adj R-squared	0.20	0.16	0.26

Note: Asterisks indicate *$p < 0.1$, **$p < 0.05$, and ***$p < 0.01$.
Abbreviations: N. obs, number of observations; SE, standard error.

burgers with some similarities, and differences among countries. Overall, we can see that across the United Kingdom, Spain, and Denmark younger consumers and those who have lower meat attachment tend to prefer hybrid burgers. In addition, British higher educated and religious people in Spain prefer hybrid burgers. Also, Danish, and British consumers with lower food neophobia as well as Spanish and Danish consumers with high familiarity for plant-based meat have higher preference for hybrid meat than those with lower familiarity.

DISCUSSION

We investigated for the first time the United Kingdom, Spain, and Denmark consumers' WTP for hybrid meat products. Several main outcomes were identified. First, we found that across the three countries and treatments, consumers generally reject hybrid products and more strongly reject plant-based meat-only burgers while they prefer meat-only burgers. This finding is corroborated by Caputo et al. (2022) and Grasso, Asioli, and Smith (2022). This finding could be due to the fact that the market for hybrid products is still small (Apostolidis & McLeay, 2016) because of the low familiarity with the plant-based concept of consumers (van der Weele et al., 2019) and that we

focused on consumers who purchase meat-only burgers. Second, we found that generally British and Spanish consumers prefer burgers labeled with the claim "reduced fat" while Danish consumers are not interested in this information. These finding is corroborated by Grasso, Asioli, and Smith (2022) in a study conducted in Europe. We also found that British and Spanish consumers have preference for hybrid meat branded with the "Carbon Trust label" on the label of such products. Third, we found that when consumers are informed about the benefits of hybrid products (i.e., health, sensory, and convenience), their WTP for these new products increases. These findings are corroborated by Lang (2020) who found that consumer acceptance for plant-based food is affected by sensory and health information, among others. Similarly, Loo et al. (2020) found that information has an impact on US consumers valuation for meat alternatives, but contrasted by Tonsor et al. (2022) in a study conducted in US. Fourth, we found that the effect of information differs depending on the type of messages, and on the country. This finding is corroborated by previous research which shows that the type of communication employed affects consumer preferences for food products, including sustainable food (Banovic & Barone, 2021; Loo et al., 2020). Specifically, we found that in the United Kingdom, the provision of health, sensory or convenience information about hybrid meat products similarly increases consumer WTP for them while in Spain, the provision of information about health benefits about hybrid products increases consumer WTP more than the provision of sensory information, and in turn the latter rise consumer WTP more than convenience information. Moreover, in Denmark we found that the provision of sensory benefits increases WTP more than the provision of convenience information. Fifth, consumer preference for hybrid meat products depends on different consumer attributes and in some cases on the country. Specifically, in all the three countries investigated younger consumers and those who have lower meat attachment tend to prefer hybrid meat. This finding is corroborated by studies from Banovic et al. (2022) in Europe while contrasting Lang (2020) in the United States. In addition, we found that more educated British people and religious consumers in Spain and Denmark like more hybrid meat than lower educated and not religious consumers, respectively. Moreover, British, and Danish consumers with higher food neophobia towards new foods tend to dislike more hybrid meat while Spanish and Danish consumers with higher familiarity with plant-based meat alternatives prefer more hybrid meat. These findings corroborate the findings from Bryant et al. (2019) who reported that the increasing of familiarity of plant-based meat and lowering food neophobia increase consumer preference for hybrid meat.

These findings have important implications for food businesses that aim to produce and sell hybrid meat. Firstly, we can see that it is important to inform consumers about the benefits of hybrid meat products, perhaps through communication campaigns and on food labels. Overall, in the British, Spanish, and Danish markets it may be advisable to focus on health, sensory or convenience benefits information. Specifically, in Spain it is advised to focus more on health compared to sensory or convenience benefits information while in Denmark may focus more on health or sensory information. Secondly, it is important to target the initial sales of hybrid products to specific consumer segments who can be more sensitive to hybrid meat. Specifically, overall in the three countries it is recommended to focus the initial sales of hybrid burger more on younger consumers and those who have lower meat attachment. In addition, it is proposed to focus more on consumers who have lower food neophobia in the United Kingdom and Denmark and those who have high familiarity with plant-based meat in Spain and Denmark. Thirdly, it is suggested both in the British and Spanish markets, to report on the food label of

hybrid burgers the claim "Reduced fat", and the brand "Carbon trust label" which increase consumer acceptance towards these new products.

Several policy implications can be derived from this study. First, the fact that on average British, Spanish and Danish consumers value hybrid burger significantly differently than meat-only burgers indicate a need for labeling regulations to help consumers make more informed purchase decisions by allowing them to identify hybrid meat. Indeed, consumers are likely to demand transparency and the right to know what they are purchasing. Thus, it is of crucial importance that policy makers support to establish a regulatory framework controlled by authorities to ensure an effective and standardized hybrid meat labeling which consumers can trust and use to make more informed choices. Second, consumer preferences for beef produced with lower carbon footprint and with lower fat may lead to a risk of opportunistic behavior from hybrid meat producers in the market, for instance by using unverified claims. Thus, we suggest that in the initial period of introduction of hybrid meat, public authorities should provide standards, information, and control procedures for hybrid meat labelling to reduce the potential negative issues of information asymmetry between practitioners and consumers. Third, our findings suggest that older people and those who have higher levels meat attachment are more reluctant to purchase hybrid meat thus governments and private businesses should promote consumer education campaigns aimed to inform consumers about the benefits of hybrid meat maybe focusing more on health, sensory or convenience information. Fourth, our findings suggest that provision of certain types of information and the focus on consumer segments could increase the acceptance for hybrid meat. To this respect, a major policy challenge is how information can be used to engage consumers who can contribute to reduce meat consumption.

Further research is needed to test the robustness of our findings with other hybrid beef products, other types of meat (i.e., chicken, pork, lamb), and ingredient mixes (e.g., 30%–70%). Similar studies should also be conducted with plant-based meat-only and in other countries given the expected increase in demand of plant-based products. Moreover, future studies should further investigate consumers' WTP by conducting non-hypothetical experiments using experimental auctions (Lusk & Shogren, 2007), multiple price list (MPL) (Asioli, Mignani, & Alfnes, 2021) or real choice experiments (RCE) (Fang et al., 2021) combined with sensory evaluations of hybrid meat products (Asioli et al., 2017) to provide information in real purchasing contexts (e.g., stores). Also, further research can use scanner data to investigate the hybrid meats that are currently on the market.

CONCLUSIONS

In conclusion, our findings show that consumers' WTP for hybrid products depends on the country, information provided and by consumer socio-demographics and attitudes. Our results provide insights into consumers' psychology that can be useful for effectively communicating the potential benefits of hybrid products to the public that can support the transition from meat-centric to plant-forward diets.

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ENDNOTES

[1] WTP is used as a measure of stated consumer preferences.

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

[3] We obtained informed consent from all participants in the study, and our study was approved by an institutional ethical clearance board.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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