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Consumers' willingness to purchase three alternatives to meat proteins in the United Kingdom, Spain, Brazil and the Dominican Republic

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Abstract

One of the current trends in dietary preferences involves the transition to a low- or reduced-meat diet, which is often desirable for health and environmental reasons. This change in dietary preferences requires an in-depth insight into consumers' preferences towards a variety of alternative/non-meat proteins. This study aimed to investigate the consumers' preferences and willingness to purchase three alternative dietary protein sources, namely plant-, cultured meat- and insect-based proteins in four countries with dissimilar economic development status (the United Kingdom, Spain, Brazil and the Dominican Republic). It also aimed to determine which factors would most-influence the willingness to purchase. From a total sample of 729 valid respondents, psychographic variables were analysed. The alternative protein deemed the respondents' most preferred willing to purchase was the plant-based type since that option tended to be more widely available in the market. Among the analysed economic groups, the countries classified in the higher economic groups tended to show more readiness to replace traditional meats for the three alternatives. Models suggest that the respondents regarded the alternative characteristics and/or the attributes compared to meat as being the most important factors that influence their willingness to purchase rather than environmental, convenience or healthy buying decisions, or a low level of neophobia. If the perception of healthiness, safety and nutritiousness increases one-unit for the cultured meat in Brazil, the probability of willingness to purchase would increase 86.82%. One-unit stronger belief in Spanish that plant-based are healthy, safe and nutritious higher the probability of willingness to purchase 68.74%. One-unit higher perceive the characteristics of healthiness, safety and nutritional content of the insects-based products would increase 68% the probability of willingness to purchase in the United Kingdom, 72% in Brazil and 58% in the Dominican Republic.

Keywords: Consumers' attitudes; psychographics; meat-alternative perceptions; plant-based proteins; cultured meat-based proteins; insect-based proteins.

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44 1. Introduction

45

46 Low-meat diets are becoming increasingly popular for various health reasons and to
47 reduce the cost of climate change mitigation (de Boer, Schösler & Aiking, 2014; Sabaté
48 & Soret, 2014; Schösler, de Boer, Hoogland & Boersema, 2007). In order to achieve
49 this, alternative protein sources are being explored as possible substitutes for traditional
50 meat (Verbeke, Sans & Van Loo, 2015). However, the public's preferences and the
51 consumers' responses remain largely unknown. Although, trends towards eating less
52 meat have been observed and labelled under different terms in the literature, i.e., meat-
53 reduced diet (Hayley, Zinkiewicz & Hardiman, 2015), flexitarianism (Raphaely &
54 Marinova, 2014), semi-vegetarianism (Clarys et al., 2014) or conscious omnivorism
55 (Rothgerber, 2015). More research is needed to ascertain consumers' food patterns and
56 mechanisms so that an effective transition to sustainable low-meat diets could be
57 achieved. Due to the overall popularity of meat in diets, the transition to a low-meat diet
58 has the potential to cause a profound societal transformation. As such, it is essential to
59 know that products derived from novel non-meat proteins mitigate the environmental
60 and animal welfare concerns (Gerber et al., 2013), and provide a healthy diet that will
61 be acceptable to consumers (Schösler, de Boer & Boersema, 2012).

62

63 In light of the context mentioned above, the consumers' preferences towards three
64 different non-meat dietary proteins, including plant-, cultured meat- and insect-based
65 proteins, were investigated in this study. Plant-based proteins are a well-ingrained and
66 growing market segment, and constitute the majority of meat replacement products (de
67 Boer & Aiking, 2011). Cultured or *in vitro* meat is derived from a biotechnological
68 tissue-culture approach, which produces animal proteins on an industrial scale, and is
69 being developed and launched in several different countries (Keefe, 2018; Post, 2014).
70 Insect-based proteins, deemed as an alternative that delivers high protein content, are
71 regulated under novel foods legislation in the European Union and being promoted in
72 many western countries (Lombardi, Vecchio, Borrello, Caracciolo & Cembalo, 2018;
73 Verbeke, 2015). To the best of our knowledge, no previous research has analysed the
74 consumers' preferences towards these three alternatives to conventional meat,
75 simultaneously, but rather one at a time (Goodwin & Shoulders, 2013; Post, 2014;
76 Schösler et al., 2012; Verbeke et al., 2015). Hence, this study provides a more realistic
77 approach to consumers' decision-making processes regarding alternative dietary protein
78 sources since the consumers evaluate and decide among a range of alternatives
79 (Symmank et al., 2017). Furthermore, this study allows an insight into the preferences
80 and aversions towards various alternative dietary protein sources, across multiple
81 nations.

82

83 Plant-based meat substitutes are well established in the market and, hence, represent one
84 alternative to animal proteins for containing the bulk of their calories from plant
85 materials. In comparison to conventional meat, plant-based proteins are deemed to be
86 less detrimental to the environment (de Boer & Aiking, 2011), healthier (Sabaté, 2003)
87 and prevent animal suffering (Foer, 2010). Several factors highlighted in the literature

88 that positively affect the adoption of a plant-based diet include gender, age, education
89 (Graça, Oliveira & Cardoso, 2015), vegetable preparation skills and familiarity with
90 suitable plants (Schösler et al., 2012), situations of weight control (de Boer et al., 2014;
91 Herman & Polivy, 2008), health (Gerber et al., 2013; Sadler, 2004; Tilman & Clark,
92 2014), environmental sustainability concerns (de Boer et al., 2014; Sabaté & Soret,
93 2014; Tilman & Clark, 2014), ethical considerations (de Boer et al., 2007), animal
94 welfare concerns (Bryant & Barnett, 2018), naturalness (Sadler, 2004) and
95 physiological factors, such as low bitter taste sensitivity (Drewnowski & Gomez-
96 Carneros, 2000) and trendiness/peer-pressure (Schösler et al., 2012).

97

98 Cultured meat grown from bovine skeletal muscle stem cells using tissue-engineering
99 techniques has also been developed as an effective, sustainable, potential meat source
100 (Arshad et al., 2017; Post, 2014). The main factors affecting the adoption or rejection of
101 this novel product appear to be related to contextual factors, such as media coverage
102 (Goodwin & Shoulders, 2013), trust in science, policy and society, public involvement
103 (Verbeke et al., 2015) and comparative price and sensory expectations (Adámek, Mlček,
104 Borkovcová & Bednářová, 2018; Verbeke et al., 2015).

105

106 Finally, this research also considers insects as a potential alternative protein source to
107 conventional meat. Due to the high nutritional value and protein-rich nature, insects
108 have historically and regularly been used as a part of the diet of a variety of cultures
109 (Ramos-Elorduy, 1997). Entomophagy is now gaining acceptance in western society
110 (Lombardi et al., 2018; van Huis, 2017; Verbeke, 2015), especially among wealthy
111 urban dwellers, who consider it a gourmet dish or delicacy. Verbeke et al. (2015) found
112 that gender, age, familiarity, convenience, environmental food choice motives, meat-
113 related attitudes, future consumption intentions and food neophobia worked as
114 significant predictors for western consumers adopting or rejecting insects as meat
115 substitutes.

116

117 Nevertheless, it remains largely unknown how consumers will react to the uptake of
118 alternative proteins and whether, and under which conditions, consumers would be
119 willing to purchase these non-meat proteins. For example, in a study in the Netherlands,
120 respondents indicated that 63% supported the development of cultured meat, but only
121 23% of the respondents answered 'certainly' when asked whether they would buy
122 cultured beef (Post, 2014). For this reason, the present study analyses the willingness to
123 purchase (WTPu) three alternative dietary protein sources, rather than focusing on the
124 "willingness to try" or "consider" alternatives to meat proteins, as studied elsewhere
125 (Verbeke et al., 2015).

126

127 In order to gain insight into the consumers' WTPu three alternative dietary protein
128 sources, the concept of psychographic motivations driving consumers' choices served as
129 a framework. Furthermore, scales that capture specific attitudinal aspects of consumers
130 that could inhibit or motivate their WTPu alternative dietary proteins were used. Current
131 literature has identified a general distrust of novel foods and caution towards novel food

132 technologies as important attitudinal barriers for consumption of some alternatives to
133 conventional meat proteins (House, 2016). Moreover, the environmental impact of food
134 choice, convenience, as well as interest in the health characteristic, are main consumers'
135 concerns that appear important in motivating the consumption of alternative proteins
136 sources compared with conventional meat (Tilman & Clark, 2014; Verbeke et al.,
137 2015). Sensory expectations and product characteristics of alternative dietary proteins
138 compared with conventional meat have also been documented (Verbeke et al., 2015). In
139 the present study, several variables were investigated, using validated scales consistent
140 with the experimental design, such as the Food Neophobia Scale (FNS; Pliner &
141 Hobden, 1992), Food Technology Neophobia Scale (FTNS; Cox & Evans, 2008),
142 attitudes towards healthiness of foods (Roininen, Lähteenmäki & Tuorila, 1999),
143 attention to the environmental impact of the consumers' food choices (Roberts, 1996;
144 Verbeke et al., 2015), and the convenience orientation in relation to food and its
145 preparation (Candel, 2001).

146

147 It is natural to expect the transition towards a low-meat diet to differ from country-to-
148 country (Schnettler et al., 2013) and between different consumer segments. Therefore, it
149 is necessary to address consumers regarding their individual preferences and WTPu (de
150 Boer et al., 2014). Much of the literature shows that research on meat substitution has
151 focused on developed countries (de Boer et al., 2014; Graça et al., 2015; Sabaté &
152 Soret, 2014; Schösler et al., 2012). In contrast, little research has been carried out in
153 developing countries where rising incomes and urbanisation are driving a rapid increase
154 in meat consumption (Tilman & Clark, 2014). Consequently, there is a lack of empirical
155 studies that focus on countries classified in different economic groups. Therefore, this
156 research aims at comparing consumers' preferences and WTPu alternative/non-meat
157 proteins in four countries (the United Kingdom [UK], Spain [SP], Brazil [BR] and the
158 Dominican Republic [DR]). For the purpose of this study, the countries were selected
159 based on a ranking of 100 countries, as proposed by Tilman & Clark (2014), according
160 to their 2000–2007 average per capita real gross domestic product (in 1990 international
161 dollars). Each of the countries selected belonged to the first four economic groups: the
162 UK as part of Group A (top 15 countries), SP in Group B, BR in Group C and, finally,
163 the DR in Group D. According to Tilman & Clark (2014), the top richest 15 nations
164 (Group A) had a 750% greater per capita demand for meat protein from ruminants,
165 seafood, poultry and pork than the bottom 24 poorest nations (Group F).

166

167 Despite meat consumption being highest in high-income countries (FAO, 2019),
168 changes in meat consumption in high-income countries have been sluggish, stagnating
169 in many, or even decreasing in some over the last 50 years. The average annual meat
170 consumption per person in the UK was 69.24 kg in 1961 and 81.48 kg in 2013 (FAO,
171 2019). This trend constitutes a relatively slow increase in meat consumption by the
172 British (Table 1). In SP, the average consumption was 21.78 kg in 1961 and 94.04 kg in
173 2013, which represents a substantially large, relative increase (4.32-fold) in meat
174 consumption between 1961 and 2013. However, meat consumption in SP peaked in
175 2000 at 113.25 kg per person, which represents a greater than 5-fold increase since 1961

176 (FAO, 2019). The increase in per capita meat consumption has been most marked in
 177 countries that have undergone a strong economic transition, for example, the per capita
 178 consumption in BR has nearly quadrupled in the same period (from 27.49 kg in 1961 to
 179 97.58 kg in 2013) while meat consumption in the DR was 15.34 kg in 1961 and 47.2 kg
 180 in 2013 (FAO, 2019). In the same period, South American meat production grew more
 181 than six-fold, from 7.17 million tonnes in 1961 to 41.45 million tonnes in 2014 (FAO,
 182 2019). The Caribbean meat output has approximately tripled, from 395,556 tonnes to
 183 1.21 million tonnes while in Europe, the meat output has just about doubled in the same
 184 period.

185

186 Table 1. Meat consumption: kg per person per year by country, fold increase from 1961 and 2013.

187 Source: United Nations Food and Agriculture Organisation (FAO, 2019).

Country	Year						Fold increase 1961–2013
	1961	1970	1980	1990	2000	2013	
United Kingdom	69.24	72.64	70.64	72.51	77.06	81.49	1.17
Spain	21.78	46.15	70.38	96.66	113.25	94.04	4.32
Brazil	27.49	30.47	41.00	52.64	78.98	97.58	3.55
Dominican Republic	15.34	15.29	24.36	30.44	40.00	47.20	3.08

188

189 The aim of this study was to provide insight into consumer preferences and the WTPu
 190 any of three alternative dietary protein sources (plant-, cultured meat- and insect-based
 191 proteins) in the UK, SP, BR and the DR. Furthermore, we aimed to determine the
 192 important factors most likely influencing the WTPu. In doing so, we hope to predict the
 193 purchase of these three non-meat dietary proteins in achieving low-meat diets.

194

195 2. Material and methods

196 2.1. Data collection and sample

197

198 A sample of 983 responses in total was obtained. It consisted of 366 respondents from
 199 the UK (from which a sub-sample of 180 responses validated the country population),
 200 200 from SP, 216 from BR and 201 from the DR (from which a sample of 133 validated
 201 the country population). A valid sample of 729 respondents was used. The socio-
 202 demographic characteristics of the participants are presented in Table 2.

203

204 Table 2. Socio-demographics profile of the consumers' sample (n=729) expressed as a percentage (%) of
 205 each sub-sample with respect to the country population (World Bank, 2019).

Variable	Cases	United Kingdom		Spain		Brazil		Dominican Republic	
		Sample	World Bank	Sample	World Bank	Sample	World Bank	Sample	World Bank
		n=180	data	n=200	data	n=216	data	n=133	data
Gender	Male	48.3	49.3	50.5	51.0	43.1	49.1	47.4	48.6
	Female	51.7	50.7	47.0	49.0	56.9	50.9	50.4	51.4
	Prefer no answer	0.0		2.5		0.0		2.2	
Age	0–24 years	35.0	29.6	28.5	25.0	25.8	39.2	51.1	45.4
	25–54 years	48.9	40.8	56.0	45.3	58.0	43.8	45.1	39.5
	55–64 years	13.9	11.8	8.0	11.9	11.1	8.9	2.3	7.7
	≥65	2.2	17.8	7.5	17.8	5.1	8.1	1.5	7.4
Food allergies	Yes	22.4		12.0		19.4		17.2	
	No	77.6		88.0		80.6		82.8	

206

207

Chi-squared values for each of the socio-demographic data are gender, $X^2 = 30.014$, $df = 9$, $p = 0.000$; age, $X^2 = 86.375$, $df = 9$,
 $p = 0.000$; food allergies, $X^2 = 74.802$, $df = 9$, $p = 0.000$.

208

209 The participants responded to a combination of digital and paper versions of the same
210 surveys. Data collection started in February 2017 and finished in October 2017. The
211 questionnaire was firstly written in English and was then translated into Castilian
212 Spanish, Dominican Spanish and Brazilian Portuguese by native speakers fluent in both
213 English and their native language (the authors), to improve the accuracy of meaning and
214 avoid misunderstandings by the various lingual cohorts. The translated versions were
215 back-translated into English to ensure that the meaning had not deviated from the initial
216 wording. The research collaborators from each country were responsible for rolling out
217 the survey at a national level while all data gathered was centrally collected and collated
218 at Harper Adams University (HAU) in the UK. Additionally, as part of the ethics
219 declaration, each questionnaire also included a contact e-mail at HAU, so that questions
220 arising from answering the questionnaire could be addressed. For each country, the
221 most appropriate data gathering method was selected. In the UK and BR, social media
222 and existing contact lists were used to distribute the digital questionnaire by e-mail. In
223 SP, the digital questionnaire was launched in a similar fashion as in the UK and BR;
224 however, some older respondents requested and were presented with a paper version of
225 the questionnaire. In the DR, data were mainly collected through using a paper version
226 of the questionnaire, which is a reflection of the relatively scant access to the digital
227 questionnaire.

228

229 **2.2. Questionnaire and scaling**

230

231 The questionnaire included various distinct groups of questions and statements
232 consistent with the study's sub-objectives. The survey was approved by the HAU
233 Research Ethics Committee. Before answering any questions, all participants were
234 asked to acknowledge an informed consent statement.

235

236 The first group of statements probed the respondents' attitudes towards new foods, new
237 food technologies, health, convenience and environmental impact of food choices. More
238 specifically, the following survey tools were used in the questionnaire to measure the
239 variables: the FNS (10 items that were merged into one food neophobia score named
240 FNS) (Pliner & Hobden, 1992); the FTNS (6 items that were merged into one FTNS
241 score) (Cox & Evans, 2008); healthiness of food choices (3 items that were merged into
242 one score named "impact of the healthiness of food choices") (Roininen et al., 1999);
243 convenience orientation in relation to food (4 items that were merged into one score
244 named "convenience in relation of the food") (Candel, 2001); consumer attention to the
245 environmental impact on food choices (5 items that were merged into one score named
246 "environmental impact of food choices") (Roberts, 1996; Verbeke, 2015). These
247 questions were presented in the form of statements to which the respondents expressed
248 their opinion using a five-point Likert scale ranging from 1 ("strongly disagree") to 5
249 ("strongly agree") (Table 3).

250

251

252 Table 3. Order, variables, questions and scale of the first block question of food neophobia scale (FNS),
 253 food technology neophobia scale (FTNS), health, convenience and environmental impact of food choices.

Order	Variable	Question	Scale
1	FNS	I am constantly sampling new and different foods	[1; 5]
2	FNS	I do not trust new foods	[1; 5]
3	FNS	I like foods from different countries	[1; 5]
4	FNS	If I do not know what is in a food, I will not eat it	[1; 5]
5	FNS	At dinner parties, I will try a new food	[1; 5]
6	FNS	Some foods look too weird to eat	[1; 5]
7	FNS	I am afraid to eat things I have never had before	[1; 5]
8	FNS	I am very particular about the foods I eat	[1; 5]
9	FNS	I will eat almost anything	[1; 5]
10	FNS	I like to try new foods from all over the world	[1; 5]
11	FTNS	The benefits of new food technologies are often grossly overstated	[1; 5]
12	FTNS	There are plenty of tasty foods around so we do not need to use new food technologies to produce more	[1; 5]
13	FTNS	New food technologies decrease the natural quality of foods	[1; 5]
14	FTNS	The media (TV, radio, newspapers, magazines, internet sources, etc.) usually provide a balanced and unbiased view of new food technologies	[1; 5]
15	FTNS	New products using new food technologies can help people have a balanced diet	[1; 5]
16	FTNS	Innovations in food technology can help us produce foods in a sustainable manner	[1; 5]
17	Impact of the healthiness of food choices	The healthiness has little impact on my food choices	[1; 5]
18	Impact of the healthiness of food choices	I am very particular about the healthiness of the food I eat	[1; 5]
19	Impact of the healthiness of food choices	I eat what I like, and I do not worry much about its healthiness	[1; 5]
20	Convenience in relation of the food	The less I have to do to prepare a meal - the better!	[1; 5]
21	Convenience in relation of the food	I love cooking and will spend a lot of time and effort to prepare foods on a daily basis	[1; 5]
22	Convenience in relation of the food	At home, I preferably eat meals that can be prepared quickly	[1; 5]
23	Convenience in relation of the food	Even though I live a busy life, whenever possible, I love to cook and bake	[1; 5]
24	Environmental impact of food choices	When I buy foods, I try to consider how my use of them will affect the environment	[1; 5]
25	Environmental impact of food choices	I am worried about humankind's ability to provide the nutritional needs of the current world's population	[1; 5]
26	Environmental impact of food choices	Something drastic has to change in order to feed all the people on earth by 2050	[1; 5]
27	Environmental impact of food choices	The world can easily sustain the food demands of a growing population in one or two generations time	[1; 5]
28	Environmental impact of food choices	Global warming is a fad, dreamt up by a bunch of hippies	[1; 5]

254

255 The second group of statements probed the consumers' perceptions of the likely health
 256 and nutritional benefits of meat, and their opinion on the sensory experience (Table 4).

257

258 Table 4. Order, variables, questions and scale of the perception of health and nutritional benefits of meat
 259 and sensory experience.

Order	Variable	Question	Scale
29	Meat is necessary for obtaining beneficial nutrients	Eating meat is necessary for obtaining beneficial nutrients	[1; 5]
30	Meat is an important part of a healthy and balanced diet	The nutritional benefits of meat can easily be matched by alternative protein sources	[1; 5]
31	The nutritional benefits of meat can easily be matched by alternative protein sources	Meat is an important part of a healthy diet	[1; 5]
32	Taste	The taste of meat is important to me	[1; 5]
33	Texture	The texture of meat is important to me	[1; 5]
34	Smell	The smell of meat is important to me	[1; 5]

260

261 Following that, the questionnaire included descriptions of the three alternatives to meat
 262 proteins that formed the basis of this study, namely, plant-, cultured meat- and insect-
 263 based protein foods. For each alternative, consumers were asked about their WTPu,
 264 their perception of healthiness, safety and nutritional content (3 items that were merged

265 into one score named “X” characteristics), attitude towards sustainability, the taste and
 266 price relative to conventional meat (3 items that were merged into one score named “X”
 267 versus traditional characteristics) (Table 5).

268

269 Table 5. Order, variables, questions and scale of the characteristics of the three alternatives to meat
 270 proteins. “X” (the alternative protein): plant-, cultured meat- and insect-based alternative protein foods.

Order	Variable	Question	Scale
35	Consider	Would you consider x-alternative protein as a source of dietary proteins?	[1; 5]
36	“X” characteristics	“X” is healthy	[1; 5]
37	“X” characteristics	“X” is safe to eat	[1; 5]
38	“X” characteristics	“X” is nutritious	[1; 5]
39	“X” versus traditional characteristics	“X” is much more sustainable than traditional meat	[1; 5]
40	“X” versus traditional characteristics	“X” is much tastier than traditional meat	[1; 5]
41	“X” versus traditional characteristics	“X” is much cheaper than traditional meat	[1; 5]
42	Try	Would you personally be willing to try “X”?	[1; 5]
43	Purchase	Would you personally be willing to purchase “X”?	[1; 5]
44	Pay more	Would you personally be willing to pay more for “X”?	[1; 5]

271

272 The questionnaire also inquired about the respondent’s gender and age demographic
 273 characteristics.

274

275 **2.3. Data analysis**

276

277 WTPu was analysed as a discrete decision (yes/no) (see also Verbeke, 2015) by
 278 specifying the response categories “totally agree” and “agree” as “yes” and the other
 279 response categories as a “no”. Considering consumers’ WTPu alternative proteins as a
 280 substitute for meat as a binary choice is consistent with the recommendation by Hoek et
 281 al. (2011) who suggest using this kind of dichotomous seeker/avoider segmentation
 282 when the product category is not frequently purchased and/or when there is a strong
 283 attitude towards product category. Both conditions are clearly fulfilled for consumers’
 284 attitudes towards these alternatives to meat proteins.

285

286 To model this dichotomous decision we used a binary logistic regression (Verbeke,
 287 2015) after a principal component analysis (PCA). PCA was used to reduce the
 288 variables and eliminate the possible multicollinearity among variables (Rahayu,
 289 Sugiarto, Madu, Holiawati & Subagyo, 2017). From each component of the PCA, the
 290 highest loads of the eigenvectors were selected as predictors to model current WTPu.
 291 Then, binary logistic regression was used to predict the odds of being WTPu based on
 292 the values of the predictors. Regression coefficients were estimated using maximum
 293 likelihood estimation and were presented with Wald χ^2 -statistics and as odds ratios, by
 294 using the Wald forward stepwise method. The models revealed the most important
 295 predictor/s of WTPu the alternative to meat proteins and predicted future WTPu. SPSS
 296 v.23 software was used.

297

298 To compare the variation of the variables between countries against the variation within
 299 groups we used an analysis of variance (ANOVA). The statistically significant

300 differences between countries means were determined (F and p -value). The significance
 301 ($p < 0.05$) was obtained using Levene's test. Following that, Fisher's least significant
 302 difference (LSD) post hoc test was used to explore all possible pair-wise means of the
 303 countries' comparisons to identify which pair of countries was statistically different.

304

305 To test the likely correlation between independent variables, the bivariate Pearson
 306 correlation was used ($p < 0.05$). As such the bivariate *Pearson correlation* was
 307 employed to test the variables of perception of the importance and benefits of meat
 308 (Verbeke, 2015), and the benefits of the alternatives to conventional meat existed, and
 309 to test correlations among the WTPu plant-, cultured meat- and insect-based protein
 310 foods.

311

312 **3. Results**

313 **3.1. Descriptive statistics**

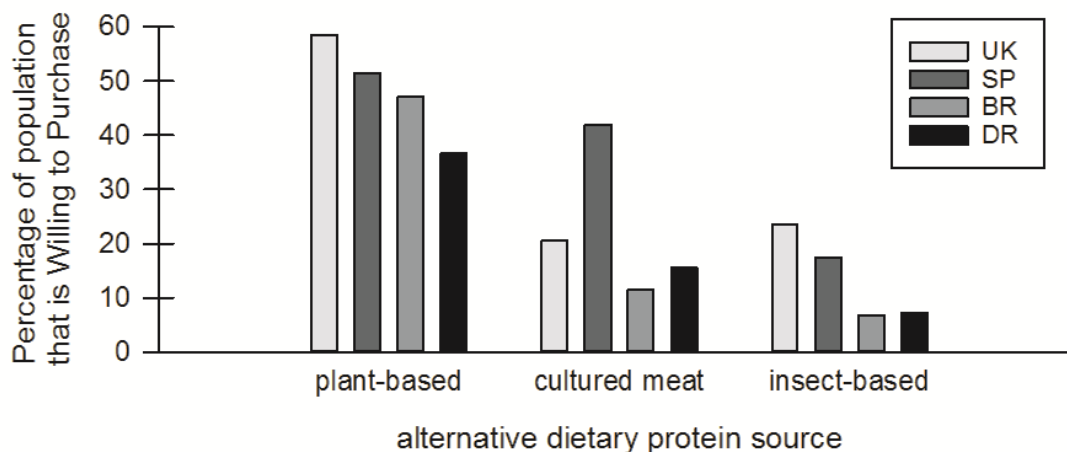
314 The number of respondents who believed that the alternative protein sources could
 315 readily match the nutritional benefits of meat ranged from 20.8% (BR) to 53.8% (the
 316 UK). When considering whether meat was an important part of a healthy and balanced
 317 diet, the British respondents indicated it to be significantly less than respondents from
 318 SP, the DR or BR ($p=0.000$) (Table 7). The correlation test showed an increase in the
 319 belief that meat is needed for obtaining beneficial nutrients and a healthy diet decreased
 320 the view that the nutritional benefits of meat could easily be matched by alternative
 321 proteins sources (Pearson's correlation $r=-0.363$ and $r=-0.506$, respectively, both
 322 $p=0.000$).

323 Table 7. The need and importance of meat, the benefits of alternative protein sources and sensorial
 324 importance of meat expressed as mean \pm standard deviation. ANOVA (F and p -values) by rows indicates
 325 the significant differences for each variable among countries. Different superscript letters across the same
 326 variable denote a significant difference between countries ($p<0.05$), n.s. = "not significant".

Variable	United Kingdom	Spain	Brazil	Dominican Republic	F	p
Meat is necessary for obtaining beneficial nutrients	3.38 \pm 1.23 ^a	2.36 \pm 1.06 ^b	3.70 \pm 1.12 ^c	2.76 \pm 1.12 ^d	56.660	0.000
Meat is an important part of a healthy and balanced diet	3.06 \pm 1.29 ^a	3.64 \pm 1.08 ^b	3.62 \pm 1.18 ^b	3.84 \pm 1.10 ^b	13.936	0.000
The nutritional benefits of meat can easily be matched by alternative protein sources	3.33 \pm 1.25	3.17 \pm 1.19	3.18 \pm 1.18	3.43 \pm 1.02	n.s.	n.s.
Taste	3.88 \pm 1.28 ^a	4.30 \pm 0.89 ^b	4.09 \pm 1.14 ^a	4.37 \pm 0.85 ^b	7.257	0.000
Texture	3.82 \pm 1.30 ^a	4.26 \pm 0.85 ^b	4.00 \pm 1.19 ^a	4.27 \pm 0.87 ^b	6.978	0.000
Smell	3.69 \pm 1.34 ^a	4.26 \pm 0.84 ^b	3.98 \pm 1.14 ^c	4.43 \pm 0.88 ^b	14.665	0.000

327

328 The WTPu alternative dietary proteins ranged from 36.7% in the DR to 58.5% in the
 329 UK for plant-based proteins, and from 11.5% in BR to 42% in SP for cultured meat-
 330 based proteins, as well as from 6.9% in BR to 23.5% in the UK for insect-based food
 331 (Figure 1).



332

333

334 Figure 1. Willingness to purchase plant-, cultured meat- and insect-based protein foods in the United
 335 Kingdom (UK), Spain (SP), Brazil (BR) and the Dominican Republic (DR).

336

337 In almost all instances, plant-based proteins scored the highest in regards to the various
 338 characteristics (Table 8). For healthiness, safety, sustainability and expected cost, the
 339 respondents from the UK, SP and BR scored insect-based proteins higher than cultured
 340 meat. Conversely, respondents from the DR indicated that their predicted opinions were
 341 in favour of plant-based proteins, followed by cultured meat, followed by insect-based
 342 proteins, in regards to healthiness, safety, nutritiousness, sustainability, and expected
 343 taste and cost. Interestingly, respondents from the UK and BR indicated a higher taste
 344 preference for cultured meat, while in all other instances, plant-based proteins received
 345 the highest preference score. While the UK respondents believed that insect-based
 346 proteins were healthy, safe, nutritious and sustainable, with scores significantly higher
 347 than in other countries, those in the DR mostly disagreed, thus, presenting the lowest
 348 scores. Table 8 shows the significant differences in the appreciation of plant-, cultured-
 349 meat and insect-based proteins among the UK, SP, BR and the DR.

350

351 Table 8. Opinions about characteristics of the plant-, cultured-meat and insect-based proteins expressed as
 352 mean \pm standard deviation. ANOVA by rows evaluates the significant differences for each characteristic
 353 among countries. Different superscript letters across the same variable denote a significant difference
 354 between countries ($p < 0.05$), n.s. = "not significant".

Variable	United Kingdom	Spain	Brazil	Dominican Republic	F	<i>p</i>
Healthiness of plant-based	4.16 \pm 0.77 ^a	4.36 \pm 0.69 ^b	4.06 \pm 0.83 ^a	4.38 \pm 0.84 ^b	7.402	0.000
Safe to eat plant-based	4.22 \pm 0.70 ^a	4.15 \pm 0.80 ^a	3.89 \pm 0.83 ^b	4.21 \pm 0.84 ^a	7.245	0.000
Plant-based proteins are nutritious	4.21 \pm 0.75 ^a	4.21 \pm 0.77 ^a	4.03 \pm 0.80 ^b	4.29 \pm 0.74 ^a	3.581	0.014
Plant-based more sustainable	3.67 \pm 1.12 ^a	3.30 \pm 1.00 ^b	3.37 \pm 1.21 ^b	3.67 \pm 1.12 ^a	7.165	0.000
Plant-based tastier than meat	2.41 \pm 1.15 ^a	2.52 \pm 1.06 ^a	1.93 \pm 0.89 ^c	2.85 \pm 1.12 ^b	23.369	0.000
Plant-based proteins cheaper	3.34 \pm 1.06 ^a	3.31 \pm 1.14 ^b	3.16 \pm 1.20 ^a	3.49 \pm 1.08 ^a	3.271	0.021
Healthiness of cultured meat	3.06 \pm 0.91	2.81 \pm 0.96	2.94 \pm 0.87	2.88 \pm 0.90	n.s.	n.s.
Safe to eat cultured meat	3.13 \pm 0.92 ^a	2.81 \pm 0.95 ^b	2.94 \pm 0.88 ^b	3.18 \pm 0.92 ^a	6.254	0.000
Cultured meat is nutritious	3.34 \pm 0.87 ^a	3.16 \pm 0.94 ^{ab}	3.25 \pm 0.83 ^a	3.03 \pm 1.03 ^a	3.153	0.024
Cultured meat more sustainable than traditional	3.08 \pm 1.10	2.99 \pm 1.08	3.00 \pm 0.97	2.81 \pm 0.99	n.s.	n.s.

Cultured meat tastier than traditional meat	2.57±0.81 ^a	2.36±0.84 ^b	2.41±0.85 ^b	2.65±0.99 ^a	4.062	0.007
Cultured meat cheaper than traditional meat	2.57±0.93 ^{ac}	2.65±1.00 ^a	2.40±0.88 ^c	2.86±1.04 ^b	6.548	0.000
Healthiness of insect-based	3.58±1.04 ^a	3.34±0.97 ^b	3.31±0.88 ^b	2.71±1.15 ^c	16.014	0.000
Safe to eat insect-based	3.50±0.98 ^a	3.09±0.99 ^b	2.92±0.89 ^b	2.45±1.10 ^c	26.766	0.000
Insect-based proteins are nutritious	3.73±0.97 ^a	3.49±0.98 ^b	3.51±0.88 ^b	2.74±1.17 ^c	21.232	0.000
Insects more sustainable than meat	3.53±1.14 ^a	3.23±1.05 ^b	3.16±1.06 ^b	2.43±1.18 ^c	22.885	0.000
Insect-based protein tastier than traditional meat	2.29±0.92 ^a	2.30±0.93 ^a	1.93±0.89 ^b	2.07±1.05 ^b	7.366	0.000
Insect-based cheaper than traditional meat	3.28±1.02 ^a	3.16±1.02 ^a	3.13±1.00 ^a	2.89±1.14 ^b	3.632	0.013

355

356 **3.2. Principal component analysis results**

357

358 The PCA reduction of the variables revealed four new components for plant-based
 359 variables, related to i) Alternative to meat product characteristics, ii) Food technology
 360 neophobia, iii) Buying decisions (responses related to the healthiness of food and
 361 environmental consequences of buying food) and iv) Convenience-buying decision and
 362 food neophobia (Table 9).

363

364 Table 9. Eigenvectors in the principal component analysis of the plant-based protein variables. Rotated
 365 components using varimax. The selected predictor was the variable with the highest loads.

Variables	Principal components			
	1	2	3	4
FNS				0.589
FTNS		0.802		
Impact of the healthiness of food choices			0.527	
Convenience in relation of the food				0.817
Environmental impact of food choices			0.865	
Plant-based protein characteristics	0.865			
Plant-based versus traditional characteristics	0.829			
Type of variables represented by each component	Product characteristics	Food technology neophobia	Buying decisions	Convenience-buying decision and food neophobia

366 FNS= Food neophobia scale, FTNS=Food technology neophobia scale

367

368 The PCA reduction of the variables of the cultured meat- and insect-based protein
 369 variables revealed three new components for each alternative. These components were
 370 related to i) Product characteristics, ii) Buying decisions and iii) Neophobia (Table 10).

371

372

373 Table 10. Eigenvectors in the principal component analysis of the cultured meat and insect-based protein
 374 variables. Rotated components using varimax. The selected predictor was the variable with the highest
 375 loads.

	Principal components			376
	1	2	3	377
Variables related to cultured meat proteins				
FNS			0.690	
FTNS			0.745	378
Impact of the healthiness of food choices		0.616		379
Convenience in relation of the food		0.673		
Environmental impact of the food choices		0.662		380
Cultured meat characteristics	0.875			
Cultured meat versus traditional characteristics	0.883			381
Variables related to insect-based proteins	1	2	3	382
FNS			0.653	
FTNS			0.756	383
Impact of the healthiness of food choices		0.510		384
Convenience in relation of the food		0.696		385
Environmental impact of the food choices		0.714		
Insect-based protein characteristics	0.903			386
Insect-based protein versus traditional characteristics	0.886			387
Type of variables represented by each component	Product characteristics	Buying decisions	Neophobia	388
				389

390 FNS= Food neophobia scale, FTNS=Food technology neophobia scale

391

392 **3.3. Binary logistic regression results**

393 The WTPu plant-based proteins models (Table 11) revealed that the healthiness, safety
 394 and nutritional characteristics were the most important descriptor regarding WTPu
 395 plant-based proteins in the UK, SP and BR. Nevertheless, in the DR, the most important
 396 factor was the ‘food technology neophobia’. In the DR, the ‘convenience of the food’
 397 and ‘food neophobia’ were negatively correlated with WTPu. The remaining variables
 398 were positively correlated.

399

400 The goodness-of-fit of the predictive model (Table 11 footnotes) indicates that in SP,
 401 that there is a 95.0% likelihood of predicting the WTPu plant-based proteins, based on
 402 the plant-based characteristics of healthiness, safety and nutritional content. A similar
 403 prediction can be made for the DR consumers, with a likelihood of 89.5%.

404

405 The exponentiated values of the coefficients [$\text{Exp}(\beta_i)$] representing the ratio change in
 406 the odds of the WTPu for a unit change in the score given by respondents in the value
 407 of the respective predictor, all other things being equal, were calculated. In SP, the
 408 estimated coefficient of the predictor product characteristics was 1.686, and the
 409 exponentiated value was 5.397 (Table 11). Considering an initial 0.5 probability (p)
 410 (i.e., 50% probability of responding “Yes, I would purchase plant-based proteins”
 411 against 50% probability of responding “No, I wouldn’t purchase”) at a certain value of
 412 the characteristics of healthiness, safety and nutritiousness of plant-based, the
 413 corresponding odds of 1 for the WTPu [$O(\text{WTPu})$] would be $O(\text{WTPu}) = p / (1 - p)$ for
 414 that subject. Since the odds ratio for the product characteristics was 5.397 for SP
 415 respondents (Table 13), the odds of 1 would become 5.397 if the score given by the
 416 respondent to product characteristics increased by a unit value. Now, the probability

417 of the WTPu will be 0.843, which is 68.74% higher than the initial 0.5 probability
 418 (Mathew, Jha & Rawat, 2009).

419

420 Table 11. Consumers' willingness to purchase (WTPu) the plant-based proteins in the United
 421 Kingdom(UK), Spain(SP), Brazil(BR) and the Dominican Republic(DR) using coefficient estimates and
 422 diagnostics from binary logistic regression and Wald forward stepwise method.

Determinant factor	β	Standard error	Wald	Significance	Exp(β_i)
<i>United Kingdom WTPu plant-based model</i>					
-Product characteristics	1.115	0.300	13.833	0.000	3.048
-Buying decisions	0.925	0.337	7.577	0.006	2.526
<i>Spain WTPu plant-based model</i>					
-Product characteristics	1.686	0.556	9.198	0.002	5.397
<i>Brazil WTPu plant-based model</i>					
-Product characteristics	1.436	0.253	32.12	0.000	4.203
<i>Dominican Republic WTPu plant-based model</i>					
-Technology neophobia	1.249	0.573	4.760	0.029	3.487
-Convenience-buying decision and neophobia	-1.215	0.489	6.180	0.013	0.297

423 Goodness-of-fit statistics of the model associated with WTPu plant-based proteins in the UK: -2Log likelihood
 424 statistic=221.19; Overall success rate=70.0%

425 Goodness-of-fit statistics of the model associated with WTPu plant-based proteins in SP: -2Log likelihood
 426 statistic=68.55; Overall success rate=95.0%

427 Goodness-of-fit statistics of the model associated with WTPu plant-based proteins in BR: -2Log likelihood
 428 statistic=256.24; Overall success rate=68.1%

429 Goodness-of-fit statistics of the model associated with WTPu plant-based proteins in the DR: -2Log likelihood
 430 statistic=79.53; Overall success rate=89.5%

431

432 The healthiness, safety and nutritional characteristics of cultured meat were the most
 433 important factor in predicting WTPu in all countries (Table 12), with all the variables
 434 being positively correlated.

435

436 The goodness-of-fit of the predictive model (Table 12 footnotes) indicated that in BR,
 437 there was a 90.7% likelihood of predicting the WTPu cultured meat proteins, based on
 438 the cultured meat characteristics such as healthiness, safety and nutritional content. The
 439 exponentiated value was 14.169 (Table 12) for a Brazilian with a 50% probability of
 440 WTPu cultured meat at a certain product characteristics value (50% WTPu against a
 441 50% not to purchase cultured meat). According to the model, the odds of 1 will
 442 become 14.169, if the score of the cultured meat product characteristics increases by
 443 one unit value. Now, the probability of the Brazilian to WTPu will be 0.934, which is
 444 86.82% higher than the initial 50% probability.

445

446 Table 12. Consumers' willingness to purchase (WTPu) cultured meat in the United Kingdom(UK),
 447 Spain(SP), Brazil(BR) and the Dominican Republic(DR) using coefficient estimates and diagnostics
 448 from binary logistic regression and Wald forward stepwise method.

Determinant factor	β	Standard error	Wald	Significance	Exp(β_i)
<i>United Kingdom WTPu cultured meat model</i>					
-Product characteristics	1.307	0.333	15.441	0.000	3.695
<i>Spain WTPu cultured meat model</i>					
-Product characteristics	1.138	0.231	24.282	0.000	3.121
<i>Brazil WTPu cultured meat model</i>					
-Product characteristics	2.651	0.579	20.938	0.000	14.169
-Neophobia	-1.932	0.593	10.613	0.001	6.901
<i>Dominican Republic WTPu cultured meat model</i>					
-Product characteristics	0.738	0.218	11.515	0.001	2.092

449 Goodness-of-fit statistics of the model associated with WTPu cultured meat proteins in the UK: -2Log likelihood
 450 statistic=190.785; Overall success rate=72.8%
 451 Goodness-of-fit statistics of the model associated with WTPu cultured meat proteins in SP: -2Log likelihood
 452 statistic=242.296; Overall success rate=69.5%
 453 Goodness-of-fit statistics of the model associated with WTPu cultured meat proteins in BR: -2Log likelihood
 454 statistic=104.564; Overall success rate=90.7%
 455 Goodness-of-fit statistics of the model associated with WTPu cultured meat proteins in the DR: -2Log likelihood
 456 statistic=161.287; Overall success rate=71.4%
 457

458 The models for WTPu insect-based proteins (Table 13) revealed the ‘insect product
 459 characteristics’ was the most important factor regarding WTPu insect-based proteins, in
 460 all the countries. All the variables were positively correlated. The goodness-of-fit of the
 461 predictive models indicated that the UK (overall success rate=78.9%), BR (overall
 462 success rate=93.1%) and the DR (overall success rate=78.9%) models for WTPu had a
 463 predictive ability. When the scores of the healthiness, safety and nutritional
 464 characteristics of insects-based product increased one unit value, the probability of the
 465 WTPu would be 0.843 in the UK, 0.861 in BR and 0.793 in the DR, which were
 466 68.70%, 72.12% and 58.56%, respectively, higher than the initial 50% probability of
 467 WTPu versus not WTPu insect-based products.
 468

469 Table 13. Consumers’ willingness to purchase (WTPu) insect-based proteins in the United
 470 Kingdom(UK), Spain(SP), Brazil(BR) and the Dominican Republic(DR) using coefficient estimates and
 471 diagnostics from binary logistic regression and Wald forward stepwise method.

Determinant factor	β	Standard error	Wald	Significance	Exp(β_i)
<i>United Kingdom WTPu insect-based proteins model</i>					
-Product characteristics	1.684	0.324	27.075	0.000	5.389
<i>Spain WTPu insect-based proteins model</i>					
-Product characteristics	0.980	0.208	22.262	0.000	2.666
<i>Brazil WTPu insect-based proteins model</i>					
-Product characteristics	1.820	0.447	21.853	0.000	6.174
<i>Dominican Republic WTPu insect proteins model</i>					
-Product characteristics	1.342	0.287	16.591	0.000	3.826

472 Goodness-of-fit statistics of the model associated with WTPu insect-based proteins in the UK: -2Log likelihood
 473 statistic=170.863; Overall success rate=78.9%
 474 Goodness-of-fit statistics of the model associated with WTPu insect-based proteins in SP: -2Log likelihood
 475 statistic=248.293; Overall success rate=62.5%
 476 Goodness-of-fit statistics of the model associated with WTPu insect-based proteins in BR: -2Log likelihood
 477 statistic=88.429; Overall success rate=93.1%
 478 Goodness-of-fit statistics of the model associated with WTPu insect-based proteins in the DR: -2Log likelihood
 479 statistic=124.231; Overall success rate=78.9%
 480

481 4. Discussion

482
 483 The aim of this study was to provide insight into consumer preferences and the WTPu
 484 three alternative dietary protein sources (plant-, cultured meat- and insect-based
 485 proteins) in the UK, SP, BR and the DR. Furthermore, we aimed to determine the
 486 important factors most likely influencing the WTPu that would predict future WTPu.
 487

488 Several consumers from across the countries included in this study believed that the
 489 nutritional benefits of meat could readily be matched by alternative protein sources,
 490 ranging from 20.8% (in BR) to 53.8% (in the UK). However, that was fewer than the
 491 72% reported by Verbeke et al. (2015) in their study in Flanders (Belgium). The most

492 preferred alternative source to meat protein with regards to WTPu was plant-based
493 proteins but in declining order of preference for the UK<SP<BR<the DR. In contrast,
494 the lowest WTPu meat alternative was insect-based proteins, in both BR and the DR.
495 Both were representative of the least economically-developed countries included in this
496 study, which were also the countries with the greatest increased rates in meat
497 consumption over the last decades (FAO, 2019). The notion of greater increased meat
498 consumption is also noted by Sabaté & Soret (2014), who suggested that meat
499 consumption has increased by 300% in developing countries since the early 1960s while
500 worldwide consumption had increased by only 62% in the same period. In Latin
501 America, meat tends to be a relatively cheap commodity because meat production is a
502 prominent agricultural activity (Austin, 2010). This statement holds particularly true in
503 BR, which has the largest commercial bovine herd in the world and is also a major
504 exporter of not only beef but other meats too. However, about 80% of all beef produced
505 in Brazil is consumed domestically (ABIEC, 2019).

506
507 The UK respondents indicated a greater willingness to substitute meat with alternative
508 dietary protein sources compared with SP, BR or the DR, by suggesting that meat does
509 not necessarily have an important role in a healthy and balanced diet. Overall, the UK
510 respondents' perception of the characteristics of the insect-based products was
511 significantly higher and differed from those of the SP, BR and the DR respondents. The
512 DR respondents had significantly lower WTPu insects as food. This outcome is
513 probably directly attributable to the notion that the respondents in the DR also indicated
514 insects as significantly less safe, less healthy and less nutritious than any other protein
515 source. Furthermore, the DR respondents did not perceive insects as a more sustainable
516 source of protein than meat. These findings are in agreement with the prediction by
517 Tilman and Clark (2014) that developing cultures would continue to prefer a greater
518 proportion of meat in their diet and avoid protein sources that are locally perceived as
519 unaligned with an affluent status. As such, when annual incomes increase in less
520 economically-developed countries, the per capita daily demand for meat protein also
521 increased (Tilman & Clark, 2014). Conversely, the respondents from the UK, which
522 belongs to the highest economic group studied, demonstrated the greatest readiness to
523 substitute conventional meat for the three alternatives and to achieve low-meat diets.

524
525 The PCA reduction of the psychographic variables differed for plant-based, cultured
526 meat and insect-based products (refer tables 9 and 10). This may be explained by the
527 recent history of some of these products. Plant-based alternative options have been more
528 well-established in the retail market, thus offering a varied range of products (de Boer et
529 al., 2014; Sabaté & Soret, 2014; Tilman & Clark, 2014). Instead, insect-based proteins
530 have only recently entered the retail market, while cultured meat is still to make its full,
531 widespread commercial entry into it. For the plant-based alternative, the 'neophobia'
532 variable may become blurred into the consumers' buying decisions because of its
533 common availability (Pliner & Salvy, 2006); while 'food technology neophobia' takes
534 prominence. For potential product alternatives with immature markets, the neophobia

535 factor is of relevance and is represented by its own importance component (Schösler et
536 al., 2012).

537

538 The consumers' perceptions of healthiness, safety and nutritional characteristics of the
539 alternative dietary proteins and/or the higher sustainability, taste and lower price
540 compared with conventional meat showed to be the most important factors influencing
541 consumers' WTPu in the UK, SP and BR, which is in agreement with the findings of
542 Verbeke et al. (2015). However, this did not apply to the Dominicans WTPu plant-
543 based proteins. Instead 'food technology neophobia' and 'buying decisions' played a
544 more prominent role in shaping their WTPu plant-based proteins. The 'buying
545 decisions' also appeared important in influencing a WTPu plant-based proteins in the
546 UK, which agrees with the arguments of Gerber et al. (2013), Sadler (2004) and Tilman
547 and Clark (2014) while 'neophobia' influenced the WTPu of cultured meat in BR.

548

549 For the future development of alternatives to meat proteins, the focus should be given to
550 healthiness, safety and nutritional characteristics of the alternatives and/or the higher
551 sustainability, taste and lower price compared with conventional meat. The models
552 predicted that, in the Brazilian case, when the perception of healthiness, safety and
553 nutritiousness for cultured meat increased by one-unit, the probability of the
554 willingness to purchase would increase by 86.8%. In Spain, the models indicated that
555 one-unit increase in the belief that plant-based proteins were healthy, safe and
556 nutritious would cause the probability of the willingness to purchase to go up by
557 68.7%. Furthermore, one-unit increase in the perception of healthiness, safety and
558 nutritional content of insect-based product characteristics would cause an increase of
559 the probability of the willingness to purchase by 68.7% in the United Kingdom, 72.1%
560 in Brazil and 58.6% in the Dominican Republic.

561

562 The transition to alternative dietary proteins may vary, depending on the alternative
563 proteins readily available in the market (Schösler et al., 2012) and the country in which
564 the transition is observed (Schnettler et al., 2013). Despite this, some interesting
565 predictions based on our models could be made to predict a transition to a low-meat
566 diet. To encourage meat substitution, future research should focus on improving the
567 specific perception of the characteristics of healthiness, safety and nutritional content of
568 the commodity and/or their higher sustainability, taste and lower price compared with
569 conventional meat (Graça et al., 2015). While our research focussed on the WTPu
570 alternative dietary protein sources, future research could focus on investigating
571 consumers' feelings, beliefs, attitudes and motivations for the transition to low-meat
572 diets; using, for instance, qualitative methods, such as focus groups. Furthermore, it
573 would be of interest to capture the consumers' attitudes towards meat alternatives by
574 analysing the product characteristics with respect to their shapes, formats and types of
575 food carriers (i.e., insects incorporated in pasta or into chocolate bars, etc.), as proposed
576 by Lombardi et al. (2018). Finally, further insights could be provided by studies
577 examining how consumers' motives and preferences towards alternatives to dietary
578 meat proteins may vary across different contexts (e.g., consumption moment, purchase

579 occasion, usage situation). The media information in the countries is also of interest to
580 be analysed because various authors have highlighted the influence of media coverage
581 on the consumers' attitudes towards novel and alternative dietary protein sources
582 (Goodwin & Shoulders, 2013; Lombardi et al., 2018). In this sense, the current
583 widespread media information circulating Europe may influence the attitudes, especially
584 towards insect-based products (Algemeen Dagblad, 2016; Der Standard, 2018; La
585 Vanguardia, 2018; The Guardian, 2015).

586

587 Our research approach has given rise to several limitations that restrict the scope of
588 generalisations. Firstly, a convenience sampling method in the distribution of the
589 questionnaires was used. While convenience sampling is affordable, easy and the
590 subjects are readily contactable (Etikan, Musa & Alkassim, 2016), it still relies on
591 potential subjects to respond to the questionnaire. An alternative method would have
592 been to use paid subjects through an online market research company (e.g., Kellershohn,
593 Walley & Vriesekoop, 2018); however, the use of pre-screened subjects through an
594 online market research company does not necessarily result in more truthful data. An
595 argument could be made that respondents in a convenience sample participate in the
596 study because they want to voice their opinion on the given topic, whereas respondents
597 recruited through an online market research company participate because of a financial
598 gain and may not have an interest in the topic. Secondly, the selective bias and the
599 ambiguity of the inferred research questions could have limited the scope of
600 generalisation of the findings of this study. However, it should be acknowledged that
601 when answering a survey, respondents are keen to concentrate fully on the specific
602 environment, describing attitudes that may vary beyond what would occur in a typical
603 market environment (Yen, 2009). Thirdly, the dichotomisation of the WTPu variable
604 although common, because it greatly simplifies the statistical analysis and leads to easy
605 interpretation and presentation of results is gained at some cost. Firstly, much
606 information is lost, so the statistical power to detect a relation between the variable and
607 subject outcome is reduced. It may also increase the risk of a positive result being a
608 false positive. Secondly, one may seriously underestimate the extent of variation in
609 outcome between groups, such as the risk of some event, and considerable variability
610 may be subsumed within each group (Altman & Royston, 2006). Another minor
611 shortcoming stems from the specific nature of the meat alternatives analysed, which, for
612 cultured meat and insects as food (Loughnan, Bastian & Haslam, 2014), could be
613 unknown by the respondents due to the immaturity of these markets. As such, it might
614 be difficult for the respondents to imagine what it would be like as an alternative protein
615 source, which means that describing attitudes towards unfamiliar products could be a
616 challenge.

617

618 **5. Conclusions**

619

620 The willingness to purchase non-meat dietary protein namely plant-, cultured meat- and
621 insect-based proteins, varied from alternative-to-alternative, and country-to-country. The
622 most probable willingness to purchase alternatives to meat was found to be plant-based

623 proteins. Plant-based proteins tend to be more widely available than the other alternative
 624 protein sources, as well as being a mature product in the market. The respondents in the
 625 United Kingdom and Spain showed a greater readiness to replace traditional meats with
 626 the three protein alternatives than those in Brazil and the Dominican Republic which
 627 represented the least economically-developed countries included in this study. When
 628 comparing alternative proteins to traditional meat, the respondents attributed more
 629 importance to meat characteristics such as healthiness, safety and nutritional content,
 630 and/or higher sustainability, taste and lower price than the buying decisions or neophobia
 631 per se. The models predicted that a one unit increase in the plant-based the healthiness,
 632 safety and nutritional content might be associated with a 68.7% increase in the probability
 633 of willingness to purchase plant-based proteins in Spain. A one-unit stronger belief in the
 634 cultured meat healthiness, safety and nutritional content may be associated with an 86.8%
 635 increase in the probability of willingness to purchase cultured meat in Brazil. A one-unit
 636 stronger belief in the perception of the insect-based characteristics of healthiness, safety
 637 and nutritional content might be associated with a 68.7% increase in the probability of
 638 willingness to purchase insect-based products in the United Kingdom, a 72.1% in Brazil
 639 and a 58.6% in the Dominican Republic. The future development of the three alternatives
 640 to meat proteins in the economic groups studied should focus on the perceived
 641 healthiness, safe and nutritional characteristics and/or higher sustainability, taste and
 642 lower price of the alternative dietary protein sources compared with meat.

643
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