

Consumer co-creation of hybrid meat products: a cross-country European survey

Article

Accepted Version

Creative Commons: Attribution-Noncommercial-No Derivative Works 4.0

Grasso, S., Asioli, D. ORCID: <https://orcid.org/0000-0003-2274-8450> and Smith, R. ORCID: <https://orcid.org/0000-0002-1546-3847> (2022) Consumer co-creation of hybrid meat products: a cross-country European survey. *Food Quality and Preference*, 100. 104586. ISSN 0950-3293 doi: <https://doi.org/10.1016/j.foodqual.2022.104586> Available at <https://centaur.reading.ac.uk/104191/>

It is advisable to refer to the publisher's version if you intend to cite from the work. See [Guidance on citing](#).

To link to this article DOI: <http://dx.doi.org/10.1016/j.foodqual.2022.104586>

Publisher: Elsevier

All outputs in CentAUR are protected by Intellectual Property Rights law, including copyright law. Copyright and IPR is retained by the creators or other copyright holders. Terms and conditions for use of this material are defined in the [End User Agreement](#).

www.reading.ac.uk/centaur

CentAUR

Central Archive at the University of Reading

Reading's research outputs online

Consumer co-creation of hybrid meat products: a cross-country European survey

Simona Grasso^a, Daniele Asioli^b, Rachel Smith^a

^a Institute of Food, Nutrition and Health, School of Agriculture Policy and Development, University of Reading, Reading, United Kingdom

^b Department of Applied Economics and Marketing, School of Agriculture Policy and Development, University of Reading, Reading, United Kingdom

Corresponding author: simona.grasso@ucdconnect.ie

Abstract

Hybrid meat products are blends of meat and plant-based ingredients that could bridge the gap for consumers who want to reduce their meat intake, without sacrificing the taste, convenience and familiarity of traditional processed meat products. However, little is known about consumers' preferred formulations, willingness to try (WTT), willingness to buy (WTB), and how they are perceived compared to meat products and plant-based meat-free alternatives. Therefore, this study aimed to: 1) identify hybrid recipes with the most potential for acceptance using a co-creation approach; 2) understand WTT and WTB for hybrid products and 3) compare hybrid meat products vs meat products and plant-based meat-free alternatives on several attributes (healthy, ethical, environmentally friendly, convenient, affordable, tasty, enjoyable, acceptable, aspirational, nutritious, simple, safe). The online survey with a total of 2,405 consumers in Denmark, Spain and the UK, revealed that across countries consumers prefer a hypothetical beef burger made with 25% or 50% plant-based ingredients (onions, herbs, spices, garlic and mushrooms) and with a nutritional claim on protein or fat. At least 57% of consumers were willing to try and at least 46% were willing to buy hybrid meat products. Across countries and for most attributes, hybrid meat products scored similarly to plant-based meat-free alternatives and differently from meat products. Hybrid meat products and plant-based meat-free alternatives were considered as healthy, ethical and environmentally friendly, while meat products were considered affordable, tasty, enjoyable and simple. These findings provide insights and practical suggestions for companies manufacturing healthier innovative solutions for meat products and policy makers aiming to promote more varied healthier diets.

Keywords

Co-creation; Hybrid meat products; Flexitarianism; Plant-based meat-free alternatives; New product development; European countries.

1. Introduction

Consumer food selections are known to have a significant impact on the environment (Siegrist & Hartmann, 2019), as such feeding the world in a sustainable way has been deemed one of the futures most pressing challenges (Ritchie & Roser, 2017). In particular, animal protein consumption has a major environmental impact (Shukla et al., 2019) and its reduction is an essential compromise of an

48 environmentally sustainable diet (Siegrist & Hartmann, 2019). In high proportions, meat consumption
49 is associated with many negative health outcomes, such as cancer, diabetes and cardiovascular
50 disease (Yip, Lam, & Fielding, 2018). Yet, many consumers are highly attached to meat (Graça,
51 Calheiros, & Oliveira, 2015) and are not motivated to cut it completely from their diet (Lentz, Connelly,
52 Miroso, & Jowett, 2018).

53 Research suggests that rather than eliminate it, consumers are more likely to reduce their meat
54 consumption. Thus, a diet which is mostly plant-based and includes a modest amount of meat should
55 be encouraged (Corrin & Papadopoulos, 2017). Kim et al. (2020) reported that in the majority of
56 countries investigated, diets that included animal products for only one meal per day were less
57 greenhouse gas (GHG)-intensive than lacto-ovo vegetarian diets (with no terrestrial and aquatic
58 meats) in part due to the GHG-intensity of dairy foods. Such unrestricted, meat-reducing diet, known
59 as 'flexitarianism', is also likely to support weight loss and promote metabolic health benefits including
60 reduced diabetes risk and blood pressure (Derbyshire, 2017). Flexitarian eaters employ strategies that
61 include both spreading meat consumption throughout the week and occasionally eating entirely plant-
62 based meat-free meals, and also reducing meat portion sizes whilst increasing consumption of plant-
63 based proteins and other vegetables (Kemper & White, 2021).

64 Meat consumption behaviours are driven by numerous factors that influence choice and attitudes,
65 including social norms and concerns about the environment (Cheah, Sadat Shimul, Liang, & Phau,
66 2020). Key egoistic factors for purchase choice in meat-reducers also include price, health, nutrition
67 and taste (Malek & Umberger, 2021). Health is a particularly strong driver of consumption (Kemper &
68 White, 2021) and perceived benefits of meat reduction include weight control, decreased saturated
69 fat and prevention of diseases (Cheah et al., 2020). Interestingly, whilst those adhering to a flexitarian
70 diet are accepting of milk substitutes, they have indicated that they would personally avoid meat
71 substitutes over health concerns because the products are seen as over-processed (Kemper & White,
72 2021).

73 Hybrid meat products combine a blend of meat and plant-based ingredients in a convenient ready-to-
74 cook form, such as sausages, burgers and mince (Grasso & Jaworska, 2020). There are no set ratios of
75 meat to plant based ingredients nor specific limitations to the plant-based component of the hybrid
76 meat product, which can include legumes, fruit and vegetables as a blend or single ingredient. It has
77 been suggested that one possible pathway to make substitution of meat more compatible with
78 convenience culture is by introducing unfamiliar foods into the existing foods that convenience
79 orientated consumers like (Schösler, Boer, & Boersema, 2012). Thus, hybrid meats aim to reformulate
80 these familiar products and deliver in taste and convenience without dramatically altering consumer's
81 diets (Grasso & Jaworska, 2020).

82 As future resilience of the meat industry will require responding to food expenditure patterns and
83 trends of meat consumption (James, Lomax, Birkin, & Collins, 2021), these hybrid products support
84 value growth by providing an opportunity to build a strategy around the growing flexitarian
85 demographic (Hicks, Knowles, & Farouk, 2018).

86 There is currently enough scientific knowledge available to manufacture healthier meat products
87 incorporating plant-based ingredients (Grasso, Brunton, Lyng, Lalor, & Monahan, 2014) and meat
88 products with claims such as "one of your five a day" and "source of fibre" have been launched in the
89 market (Grasso & Jaworska, 2020; Waitrose, 2018), however it is not well known which reformulations
90 would be most accepted by consumers. Soliciting consumer insights early in the new food
91 development process is critical for achieving consumer acceptability (Fileri, 2013; Olsen, 2015). In
92 particular, flavour has been highlighted as a key area for influencing perception of hybrid products
93 (Shan et al., 2017), and so it is essential to capture consumers preferred flavours to give manufacturers

94 confidence that they are delivering on what consumers desire (Dijksterhuis, 2016). Whilst previous
95 research has found consumers are accepting of a hybrid burger blended with mushrooms (Lang, 2020),
96 more research is needed to explore a broader range of meat and plant-based ingredients that could
97 be used based on individual preferences. Co-creation is defined as a process of collective creativity
98 (Sanders & Stappers, 2008). It involves consumers from the early stages of new product development
99 and leads to products with higher chance of success in the market (Filieri, 2013). Barone et al. (2021)
100 recently co-created new meat solutions with European consumers using focus groups (n=48) which
101 highlighted consumers' values and showed potential for implementation on a larger scale. Therefore
102 in this study we aimed to: 1) investigate the preferred hybrid meat product formulations using a novel
103 co-creation approach with a large sample of European consumers, 2) explore consumers' willingness
104 to try (WTT) and willingness to buy (WTB), 3) compare hybrid meat products vs meat products and
105 plant-based meat-free alternatives on several attributes. Participants were recruited from three
106 countries in Europe (UK, Spain and Denmark) with particularly high meat consumption rates (~80 kg
107 per person/year in UK and Denmark and >100 kg per person/year in Spain)(Ritchie & Roser, 2017).
108 This paper will describe the methodological approach, the results, and the findings which provide
109 valuable insights for both manufacturers and policy makers.

110 2. Material and methods

111 2.1 Participants and survey structure

112 During September 2020, a survey was distributed via the online survey tool and market research
113 company Qualtrics to a total of 2,405 participants (Denmark n = 802, Spain n = 801, UK n = 802). The
114 survey was written in English, translated into Spanish and Danish and then back-translated to ensure
115 it was comprehensible in the participants' native language. Participants were screened on the basis of
116 age, gender, being partly or primarily responsible for food purchases, as well as on the basis of their
117 frequency of meat purchase and consumption. Only participants who consumed meat products were
118 eligible to take part in the survey. Quotas were implemented to ensure participants in each country
119 were equally distributed in terms of age and gender. The study was granted ethical approval by the
120 School's Ethics committee (Ethical Clearance Application Reference Number 1327D).

121 The questionnaire recorded several factors to understand consumer eating behaviours. A summary of
122 the survey questions is reported in Table 1.

123 **Table 1.** Summary of survey questions

-
- 1) Introduction to the study and consent to participate.
 - 2) Preliminary questions: screener (cheap talk, age, gender, food purchase responsibility, purchase and consumption of fresh meat and meat products), purchase and consumption of plant-based meat-free substitutes.
 - 3) Intended future consumption of fresh meat, meat products and plant-base meat substitutes.
 - 4) Definition of meat product with plant-based ingredients.
 - 5) Closed questions: 1) have you ever purchased meat products where a part of the meat has been replaced with plant-based ingredients 2) had you heard of meat products with plant-based ingredients before taking the survey.
-

- 6) Willingness to try and willingness to buy scales from 1 (Definitely would not) to 7 (Definitely would).
- 7) Rating meat products, hybrid meat products and plant-based meat-free alternatives using the attributes on a scale of 1 (Not at all) to 7 (Extremely).
- 8) Hybrid meat product co-creation: selection of meat product, type of meat, ratio of meat to plant-based ingredients, nutritional claims, plant-based ingredients.
- 9) ~~Final scales and~~ Socio-demographic questions.

124

125 The first part included screening questions and questions on purchasing and consumption habits.
 126 Consumers were then asked about their intended consumption for fresh meat (defined as “fresh meat
 127 has not undergone any preserving process other than chilling or freezing, including meat that is
 128 vacuum-wrapped or wrapped in a controlled atmosphere”), meat products (defined as “the result
 129 from the processing of meat, so that the cut surface shows no characteristics of fresh meat, e.g.,
 130 burgers, sausages, meatballs”) and plant-based meat-free substitutes (defined as “products that
 131 mimic the taste, texture, and appearance of animal-based products”). using the question “In the next
 132 3-6 months, what is your intended consumption for the below products? Thank you for being honest!”
 133 (Bryant, 2019). Consumers were asked two closed questions (if they had ever purchased meat
 134 products where a part of the meat has been replaced with plant-based ingredients and if they had
 135 heard of meat products with plant-based ingredients before taking the survey) and how willing would
 136 they be to try and buy hybrid meat products (on 7-point scales, from 1 = Definitely would not to 7 =
 137 Definitely would). Next, consumers were given a series of attributes and were asked to rate fresh
 138 meat, hybrid meat products and plant-based meat-free alternatives using the attributes on a scale of
 139 1 (Not at all) to 7 (Extremely). Attributes included: healthy, ethical, environmentally friendly,
 140 convenient, affordable, tasty, enjoyable, acceptable, aspirational, nutritious, simple (with few
 141 ingredients), safe. The first ten attributes were taken from Bryant (2019) and the last two were added
 142 by the researchers as they were considered relevant to this study.

143 The questionnaire then presented consumers with a novel co-creation task to elicit their preferences
 144 for hybrid meat. Participants were asked five hypothetical questions (on the preferred type of meat
 145 product, base meat, ratio of meat to plant-based ingredients, nutritional claims and plant-based
 146 ingredients) to ascertain the hybrid meat combination that would be most preferable to them. In the
 147 first four questions, consumers were asked to rank the options given from most preferred to least
 148 preferred (1 = most preferred), while for the last question a check-all-that-apply (CATA) list was used.
 149 A summary of the five co-creation questions is shown below:

150 Q1: Which of the below meat products would you prefer to be made with plant-based ingredients?
 151 Rank from the most preferred (1) to the least preferred (5). Options given: sausages, burgers,
 152 meatballs, chicken nuggets, minced meats.

153 Q2: So (answer carried over from Q1) are your preferred meat product to be made with plant-based
 154 ingredients. Now rank the below types of meats from the most preferred (1) to the least preferred (4)
 155 to be used with your chosen meat product with plant-based ingredients. Options given: pork, beef,
 156 chicken, lamb.

157 Q3: So (answer carried over from Q1) made from (answer carried over from Q2) are your preferred
158 meat product to be made with plant-based ingredients. Now rank the below ratios of meat to plant-
159 based ingredients from the most preferred (1) to the least preferred (3) to be used on your chosen
160 meat product with plant-based ingredient. Options given: 75% meat:25% plant-based, 50% meat:50%
161 plant-based, 25% meat:75% plant-based. The options 100% meat and 100% plant based were not
162 provided to keep the focus on the co-creation of hybrid options only.

163 Q4: So (answer carried over from Q1) made from (answer carried over from Q2) with meat to plant-
164 based ratio (answer carried over from Q3) are your preferred meat product to be made with plant-
165 based ingredients. Below you can find a list of nutritional claims that could be made in your chosen
166 meat products with plant-based ingredients, please rank them from the most preferred (1) to the least
167 preferred (8). Options given: fibre (source of or high in), fat (reduced or low in), salt (reduced or low
168 in), protein (source of or high in), omega-3 fatty acids (source of or high in), minerals such as calcium
169 or iron (source of or high in), vitamins such as vitamin C or B12 (source of or high in), no claim.

170 Q5: So (answer carried over from Q1) made from (answer carried over from Q2) with meat to plant-
171 based ratio (answer carried over from Q3) with nutritional claim (answer carried over from Q4) are
172 your preferred meat product to be made with plant-based ingredients. When thinking about the plant-
173 based portion of your chosen meat product, which ingredients would you prefer to have in it? Check
174 all that apply. Options given: garlic, onion, herbs (parsley, thyme, coriander, etc), spices (chili, black
175 pepper, paprika, etc), pulses (lentils, chickpeas, beans, peas, etc), grains (wheat, barley, rice, oats, etc),
176 mushroom, soy sauce, tomato, pepper, spinach, beetroot, cauliflower, soya, carrot, nuts, seeds,
177 sweetcorn, other (please specify).

178 At the end of the co-creation task, participants were presented with a summary of their responses
179 and the final hybrid meat product created. They were asked to confirm if they were happy with their
180 choices or not. Those who were happy with their choices proceeded to the next question and those
181 who were not had the option to go back and edit their answers. The choices given were “go back” or
182 “next”. Due to the novel nature of this task, it was possible that some consumers had no prior
183 experience of creating a product via a questionnaire, so it was important to provide participants with
184 the opportunity to validate their answers.

185 The questionnaire ended with scales (not analysed as part of this work, including meat attachment
186 questionnaire, food neophobia scale, new ecological paradigm) and socio-demographic questions
187 (education, marital status, children, employment, income).

188 **2.2 Statistical analysis**

189 Friedman tests with pairwise comparisons were conducted to assess the ranking data for preferred
190 meat product, base meat, ratio of meat to plant-based ingredients and the most appealing nutritional
191 claims. For the attribute ratings, a Kruskal-Wallis H test with multiple pairwise comparison was used.
192 Contingency tables were generated for the CATA data by counting the frequency of the plant-based
193 ingredients for each country. For WTT and WTB, answers to “would”, “probably would” and “definitely
194 would” were added together and computed as percentages of the total sample. Statistical analyses
195 were performed using SPSS (version 26) statistical software (IBM Inc. Chicago, IL, USA) and graphs
196 were created using Excel 2016 (Microsoft Co.).

197 **3. Results**

198 **3.1 Sample characteristics**

199 The socio-demographic characteristics of the sample are presented in Table 2. The recruitment quotas
200 were effective at achieving an equal split across gender in all countries. Similarly, the proportions of
201 age groups across countries were well matched. Overall, 25.63% were 18-32 years old, 24.74% were
202 33-46 years old, 31.68% were 47-61 years old and 17.95% were aged 62-75 years old. Over 60% had
203 no children in their household. Over 50% of the sample had an annual income before tax less than
204 £39,000 (equivalent to ≈US\$53,000), while almost 60% of the respondents were public or private
205 sector employees. In terms of education, over 80% of the consumers had an undergraduate university
206 degree. Over 60% of participants were primarily responsible for food shopping. In the UK and Spain
207 the majority of the sample purchased fresh meat once a week (51.6% in the UK and 47.7% in Spain),
208 while in Denmark a third selected the option “once a week” (33.2%) and a third “2-3 times a week”
209 (34.3%). In terms of fresh meat consumption, across countries at least 33% reported consuming fresh
210 meat 2-3 times a week. The purchase of meat products was once a week for 29-51% of the sample
211 and less than once a week for 28-51%. For the UK sample, the most selected options for frequency of
212 meat product consumption were “once a week” (29.7%) and “2-3 times a week” (31.3%). In Spain the
213 most selected options for meat product consumption were “less than once a week” (39.8%), “once a
214 week” (30.3%) and “2-3 times a week” (24.1%). In Denmark more than a third of participants (33.2%)
215 reported consuming meat products 2-3 times a week. Across countries, the majority of the sample (at
216 least 59%) never purchased or consumed plant-based meat-free substitutes.

217 **Table 2.** Socio-demographic characteristics of the consumers in UK, Spain and Denmark (total N =
218 2,405)

Socio demographics: number (%)	UK (N = 802)	Spain (N = 801)	Denmark (N = 802)
Gender			
Male	393 (49.0%)	402 (50.2%)	401 (50%)
Female	409 (51.0%)	399 (49.8%)	401 (50%)
Age			
18-32	180 (22.4%)	205 (25.6%)	225 (28.1%)
33-46	220 (27.4%)	196 (24.5%)	179 (22.3%)
47-61	251 (31.3%)	269 (33.6%)	242 (30.2%)
62-75	150 (18.7%)	131 (16.4%)	155 (19.3%)
Children			
Yes	526 (65.5%)	512 (63.9%)	588 (73.3%)
No	276 (34.5%)	289 (36.1%)	214 (26.7%)
Annual household income before taxes*			
Less than £10,000	59 (7.4%)	37 (4.6%)	36 (4.5%)
£10,000 to £19,999	144 (18.0%)	155 (19.4%)	61 (7.6%)
£20,000 to £29,999	133 (16.6%)	177 (22.1%)	103 (12.8%)
£30,000 to £39,999	128 (16.0%)	128 (16.0%)	81 (10.1%)
£40,000 to £49,999	102 (12.7%)	101 (12.6%)	90 (11.2%)
£50,000 to £59,999	71 (8.9%)	54 (6.7%)	59 (7.4%)
£60,000 to £69,999	32 (4.0%)	35 (4.4%)	53 (6.6%)
£70,000 to £79,999	26 (3.2%)	23 (2.9%)	55 (6.9%)
£80,000 to £89,999	15 (1.9%)	11 (1.4%)	49 (6.1%)
£90,000 to £99,999	21 (2.6%)	7 (0.9%)	45 (5.6%)
£100,000 to £149,999	20 (2.5%)	10 (1.2%)	60 (7.5%)
£150,000 or more	9 (1.1%)	5 (0.6%)	12 (1.5%)
I do not want to declare	31 (3.9%)	40 (5.0%)	75 (9.4%)
I do not know	11 (1.4%)	18 (2.2%)	23 (2.9%)
Employment			
Student	23 (2.9%)	64 (8.0%)	94 (11.7%)
Independent worker (e.g. consultant)	32 (4.0%)	117 (14.6%)	25 (3.1%)
Private-sector worker	297 (37.0%)	244 (30.5%)	240 (29.9%)
Public-sector worker	149 (18.6%)	106 (13.2%)	140 (17.5%)
Retired	120 (15.0%)	113 (14.1%)	162 (20.2%)
Unemployed (seeking work)	60 (7.5%)	95 (11.9%)	66 (8.2%)
Not in paid employment (not seeking work)	87 (10.8%)	18 (2.2%)	19 (2.4%)
	34 (4.2%)	44 (5.5%)	56 (7%)

Education			
<i>Primary school</i>	6 (0.7%)	6 (0.7%)	60 (7.5%)
<i>High school</i>	217 (27.1%)	109 (13.6%)	124 (15.5%)
<i>Higher education (not university)</i>	266 (33.2%)	218 (27.2%)	236 (29.4%)
<i>Bachelor's Degree</i>	221 (27.6%)	333 (41.6%)	240 (29.9%)
<i>Master's Degree</i>	65 (8.1%)	110 (13.7%)	132 (16.5%)
<i>Postgraduate University Degree (PhD)</i>	27 (3.4%)	25 (3.1%)	10 (1.2%)
Responsibility for food shopping			
<i>Partly</i>	239 (29.8%)	296 (37.0%)	317 (39.5%)
<i>Primarily</i>	563 (70.2%)	505 (63.0%)	485 (60.5%)
Frequency of fresh meat purchase/consumption			
<i>Never</i>	0	0	0
<i>Less than once a week</i>	160 (20.2%)/116 (14.5%)	144 (18.0%)/147 (18.4%)	159 (19.8%)/129 (16.1%)
<i>Once a week</i>	414 (51.6%)/200 (24.9%)	382 (47.7%)/231 (28.8%)	266 (33.2%)/175 (21.8%)
<i>2-3 times a week</i>	175 (21.8%)/278 (34.7%)	218 (27.2%)/309 (38.6%)	275 (34.3%)/266 (33.2%)
<i>More than 3 times a week</i>	42 (5.2%)/158 (19.7%)	43 (5.4%)/90 (11.2%)	71 (8.9%)/172 (21.4%)
<i>Daily</i>	11 (1.4%)/50 (6.2%)	14 (1.7%)/24 (3.0%)	31 (3.9%)/60 (7.5%)
Frequency of meat products purchase/consumption			
<i>Never</i>	0	0	0
<i>Less than once a week</i>	226 (28.2%)/174 (21.7%)	344 (42.9%)/319 (39.8%)	413 (51.5%)/321 (40.0%)
<i>Once a week</i>	412 (51.4%)/238 (29.7%)	321 (40.1%)/243 (30.3%)	234 (29.2%)/212 (26.4%)
<i>2-3 times a week</i>	126 (15.7%)/251 (31.3%)	101 (12.6%)/193 (24.1%)	124 (15.5%)/171 (21.3%)
<i>More than 3 times a week</i>	30 (3.7%)/99 (12.3%)	27 (3.4%)/38 (4.7%)	26 (3.2%)/65 (8.1%)
<i>Daily</i>	8 (1.0%)/40 (5.0%)	8 (1.0%)/8 (1.0%)	5 (0.6%)/33 (4.1%)
Frequency of plant-based meat-free substitutes purchase/consumption			
<i>Never</i>	478 (59.6%)/473 (59.0%)	544 (67.9%)/551 (68.8%)	587 (73.2%)/597 (74.4%)
<i>Less than once a week</i>	194 (24.2%)/179 (22.3%)	170 (21.2%)/154 (19.2%)	152 (19.0%)/139 (17.3%)
<i>Once a week</i>	89 (11.1%)/84 (10.5%)	52 (6.5%)/63 (7.9%)	52 (6.5%)/47 (5.9%)
<i>2-3 times a week</i>	27 (3.4%)/44 (5.5%)	27 (3.4%)/21 (2.6%)	8 (1.0%)/16 (2.0%)
<i>More than 3 times a week</i>	7 (0.9%)/18 (2.2%)	4 (0.5%)/7 (0.9%)	3 (0.4%)/3 (0.4%)
<i>Daily</i>	7 (0.9%)/4 (0.5%)	4 (0.5%)/5 (0.6%)	0/0

219 * Euros and Danish Kroner were converted into Great British Pound equivalents

220 3.2 Intended consumption of fresh meat, meat products and plant-based meat-free 221 substitutes

222 Table 3 shows European consumers intended future consumption of fresh meat, meat products and
223 plant-based meat-free substitutes. It suggests that the majority of consumers (75-80%) intended to
224 maintain their current eating frequency of fresh meat at the same level and 14-20% were looking to
225 decrease consumption. For meat products, 55% in Spain intended to maintain the same level of
226 consumption, while this percentage was 66% for the UK and 74% for Denmark. In Spain, almost 40%
227 of consumers intended to decrease their meat product consumption, while this figure was lower in
228 the other two countries (29% in the UK and 22% in Denmark). As for plant-based meat-free
229 substitutes, consumers were more spread out across the categories, with 40-60% of consumers
230 intending to keep the consumption the same, 14-40% intending to eliminate them and 16-25%
231 intending to increase their consumption. Interestingly, in the three countries there were more people
232 intending to eliminate plant-based meat-free substitutes from their diets than eliminate meat
233 products or fresh meat.

234 **Table 3.** Intended consumption of fresh meat, meat products and plant-based meat-free substitutes
235 in UK, Spain and Denmark (percentages shown).

Fresh meat

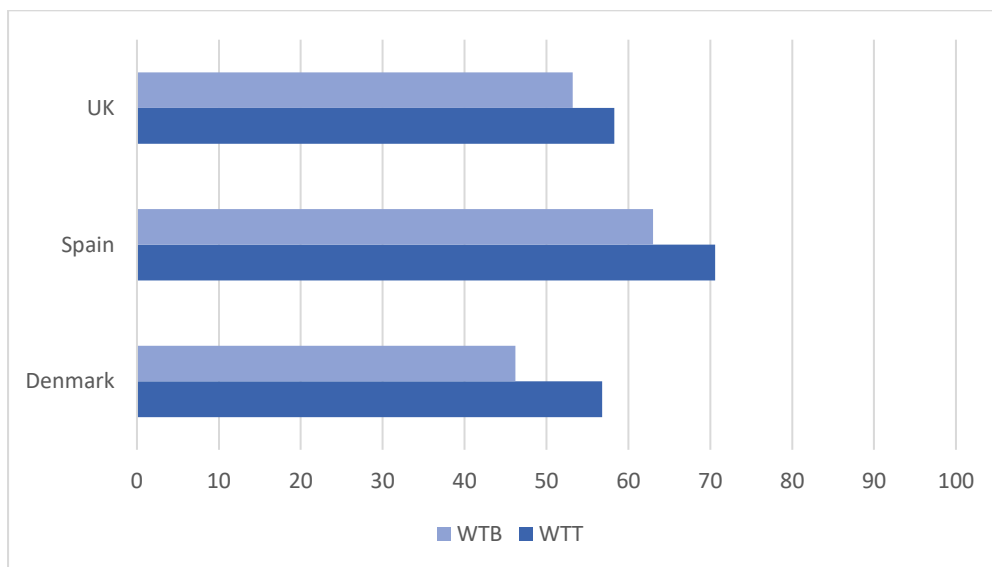
Meat products

Plant-based meat-free
substitutes

	UK	Spain	Denmark	UK	Spain	Denmark	UK	Spain	Denmark
Eliminate	0.7%	1.0%	1.1%	1.5%	3.0%	1.7%	14.5%	28.2%	40.0%
Greatly decrease	3.2%	6.2%	1.9%	7.4%	17.1%	4.7%	1.9%	2.9%	1.0%
Slightly decrease	15.3%	14.0%	11.8%	21.2%	22.7%	17.2%	3.6%	4.2%	1.2%
Maintain the same	75.1%	75.7%	80.3%	66.2%	55.1%	74.2%	59.6%	40.1%	41.9%
Slightly increase	4.5%	2.7%	4.2%	3.2%	2.0%	1.9%	17.3%	22.6%	14.3%
Greatly increase	1.1%	0.4%	0.6%	0.5%	0.1%	0.2%	3.1%	2.0%	1.5%

236 **3.3 Awareness and consumption of hybrid meat**

237 The concept of hybrid meat was introduced to consumers as “meat products where part of the meat
 238 had been replaced with plant-based ingredients”. When consumers were asked if they had heard of
 239 these before, the majority said yes (UK = 71.4%; Spain = 84.3%, Denmark = 92.4%). They were also
 240 asked if they had previously purchased this type of product before and fewer people said yes (UK =
 241 35.2%, Spain = 45.5%, Denmark = 39.9%). The most popular hybrid meat products that consumers
 242 had purchased were sausages and burgers (UK = sausages 21.3% and burgers 20%) burgers (Spain =
 243 burgers 41.4%) and minced meat (Denmark = 26.4%). Figure 1 indicates that at least 50% of
 244 consumers were willing to try hybrid meats (they selected “would”, “probably would” or “definitely
 245 would” try), but they were less willing to buy them. Spanish consumers seemed to be the most
 246 favourable, with 71% willing to try and 63% willing to buy.



247
 248 **Figure 1.** Consumer willingness to try and buy hybrid meat products in UK, Spain and Denmark.

249 **3.4 Preferred type of meat product**

250 The rankings of the preferred meat product for hybrid meat are listed in Table 4. Overall, burgers
 251 were universally ranked the most favourably and chicken nuggets were ranked the least favourably.
 252 In all countries there was a significant difference in the preferred meat product ($p < 0.0001$ in all
 253 countries) In the UK the most preferred product was burgers, followed by sausages and with no

254 significant difference between the two. In Spain burgers were also ranked as the most preferred
 255 product, followed by meatballs (significantly lower). Danish consumers also ranked burgers as the
 256 preferred meat product, followed by mincemeat and with no significant difference between the two.

257 **Table 4.** Preferred meat product in UK, Spain and Denmark (means and standard deviations).

UK		Spain		Denmark	
Meat product	Mean±SD	Meat product	Mean±SD	Meat product	Mean±SD
1 st Burgers	2.53±1.31 ^a	1 st Burgers	2.04±1.27 ^a	1 st Burgers	2.79±1.28 ^a
2 nd Sausages	2.65±1.33 ^{ab}	2 nd Meatballs	2.87±1.24 ^b	2 nd Mincemeat	2.81±1.59 ^{ab}
3 rd Meatballs	3.09±1.29 ^c	3 rd Mincemeat	3.17±1.38 ^c	3 rd Sausages	3.04±1.33 ^c
4 th Mincemeat	3.26±1.41 ^{cd}	4 th Sausages	3.25±1.27 ^{cd}	4 th Meatballs	3.07±1.30 ^{cd}
5 th Nuggets	3.46±1.50 ^{de}	5 th Nuggets	3.67±1.38 ^e	5 th Nuggets	3.29±1.49 ^e

258 Values with the same letter in the same column are not significantly different at P < 0.05. Options
 259 given: burger, sausages, meatballs, mincemeat and nuggets.

260 **3.5 Preferred base meat**

261 The rankings of the preferred base meat are listed in Table 5. Overall, beef was universally ranked
 262 the most favourably and lamb was ranked the least favourably. In the three countries there was a
 263 significant difference in preferred base meat (p < 0.0001 in all countries). In all countries, beef was
 264 ranked as the most preferred base meat for a hybrid meat product, followed by chicken, then pork
 265 and finally lamb. However in Spain there was no significant difference between beef and chicken,
 266 while for UK and Denmark this difference is significant.

267 **Table 5.** Preferred base meat in UK, Spain and Denmark (means and standard deviations).

UK		Spain		Denmark	
Base meat	Mean±SD	Base meat	Mean±SD	Base meat	Mean±SD
Beef	2.03±0.99 ^a	Beef	1.95±0.98 ^a	Beef	1.98±1.0 ^a
Chicken	2.30±1.15 ^b	Chicken	2.09±1.0 ^{ab}	Chicken	2.27±1.0 ^b
Pork	2.60±1.05 ^c	Pork	2.50±0.93 ^c	Pork	2.46±0.96 ^c
Lamb	3.07±0.99 ^d	Lamb	3.45±0.84 ^d	Lamb	3.29±0.99 ^d

268 Values with the same letter in the same column are not significantly different at P < 0.05.

269 **3.6 Preferred ratio of meat to plant-based ingredients**

270 The rankings of the preferred ratio of meat to plant-based ingredients are listed in Table 6. Overall,
 271 the ratios with at least 50% meat were preferred. The least preferred ratio was 25:75 in all countries.
 272 There was a significant difference in preferred meat to plant ratio in all countries (p < 0.0001 in all

273 countries). In the UK and Denmark there was no significant difference between the ratios 75:25 and
 274 50:50, indicating that both ratios were deemed equally preferable. Spanish consumers ranked the
 275 50:50 ratio as the most preferable, followed by 75:25 (significantly lower).

276 **Table 6.** Preferred ratio of meat to plant-based ingredients in UK, Spain and Denmark (means and
 277 standard deviations).

Meat : Plant Ratio	UK Mean±SD	Meat : Plant Ratio	Spain Mean±SD	Meat : Plant Ratio	Denmark Mean±SD
75:25	1.73±0.86 ^a	50:50	1.76±0.52 ^a	75:25	1.77±0.89 ^a
50:50	1.78±0.52 ^{ab}	75:25	1.92±0.91 ^b	50:50	1.77±0.50 ^{ab}
25:75	2.49±0.79 ^c	25:75	2.32±0.86 ^c	25:75	2.46±0.80 ^c

278 Values with the same letter in the same column are not significantly different at P < 0.05.

279 3.7 Preferred nutritional claims

280 The rankings of the preferred nutritional claims are listed in Table 7. Overall, claims which stated the
 281 hybrid product was 'high in or a source of protein' or 'reduced or low in fat' were the most
 282 preferred. There was a significant difference in the preferred claims across all countries (p < 0.0001).
 283 In the UK consumers ranked 'high in or a source of protein' as their most preferred nutritional claim,
 284 followed by 'reduced or low in fat', with no significant difference between the two. In Denmark the
 285 most preferred nutritional claim was 'high in or a source of protein', followed by the 'reduced or low
 286 in fat' an 'high in or a source of fibre' claims (significantly less preferred). In Spain the most preferred
 287 claims were those on fat and protein, with no significant difference between the two.

288 **Table 7.** Preferred nutritional claims in UK, Spain and Denmark (means and standard deviations).

UK		Spain		Denmark	
Claim	Mean ±SD	Claim	Mean ±SD	Claim	Mean ±SD
Protein	3.35±2.17 ^a	Fat	3.18±2.18 ^a	Protein	3.16±2.05 ^a
Fat	3.56±2.23 ^{ab}	Protein	3.53±2.16 ^{ab}	Fat	3.62±2.25 ^b
Fibre	4.09±1.97 ^c	Fibre	4.32±1.96 ^c	Fibre	3.91±1.93 ^{bc}
Salt	4.28±2.15 ^{cd}	Salt	4.35±2.11 ^{cd}	Omega	4.51±1.97 ^d
Vitamins	4.48±2.01 ^{de}	Vitamins	4.44±1.95 ^{cde}	Minerals	4.60±1.90 ^{de}
Minerals	4.68±1.87 ^{ef}	Omega	4.52±1.94 ^{cdef}	Vitamins	4.75±1.94 ^{def}
Omega	4.89±1.92 ^{fg}	Minerals	4.53±1.89 ^{cdefg}	Salt	4.87±2.08 ^{defg}
No claim	6.64±2.35 ^h	No claim	7.14±1.89 ^h	No claim	6.58±2.45 ^h

289 Values with the same letter in the same column are not significantly different at P < 0.05.

290 **3.8 Preferred plant-based ingredients**

291 The contingency table (Table 8) summarises the frequency of use for each CATA ingredient by
 292 consumers. The five most frequently selected plant-based ingredients in UK and Spain were onion,
 293 herbs, spices, garlic and mushrooms, while in Denmark they were onion, spices, herbs, garlic and
 294 pulses.

295 **Table 8.** Most to least selected CATA ingredients in the UK, Spain and Denmark.

	UK		Spain		Denmark
Onion	552	Onion	530	Onion	544
Herbs	503	Herbs	498	Spices	530
Spices	468	Garlic	430	Herbs	475
Garlic	466	Spices	416	Garlic	472
Mushroom	450	Mushroom	399	Pulses	396
Pepper	399	Tomato	395	Carrot	395
Pulses	330	Carrot	388	Mushroom	377
Tomato	327	Pulses	376	Spinach	327
Carrot	281	Pepper	331	Pepper	282
Grains	260	Spinach	310	Cauliflower	273
Spinach	249	Nuts	272	Tomato	270
Sweetcorn	216	Seeds	270	Nuts	244
Soy sauce	172	Grains	250	Grains	231
Cauliflower	159	Soya	202	Sweetcorn	204
Nuts	157	Soy sauce	165	Beetroot	191
Soya	148	Sweetcorn	120	Seeds	164
Beetroot	145	Cauliflower	93	Soya	146
Seeds	142	Beetroot	90	Soy sauce	107
Other	8	Other	19	Other	32

296

297 **3.9 Attitudes towards meat products, hybrid meat products and plant-based meat-free**
 298 **substitutes**

299 Consumer attitudes towards meat products, hybrid meat products and plant-based meat-free
 300 substitutes are shown in Table 9.

301 **Table 9.** Rating of attributes across the three countries for meat products, hybrid meat products and
 302 plant-based meat-free alternatives using a scale of 1 (Not at all) to 7 (Extremely).

	UK			Spain			Denmark		
	Meat products	Hybrid	Plant-based	Meat products	Hybrid	Plant-based	Meat products	Hybrid	Plant-based
Healthy	4.09±1.69 ^b	4.90±1.50 ^a	4.89±1.55 ^a	3.61±1.81 ^b	4.59±1.71 ^a	4.38±1.79 ^a	3.45±1.63 ^b	4.55±1.53 ^a	4.45±1.57 ^a
Ethical	3.86±1.69 ^b	4.76±1.59 ^a	4.92±1.60 ^a	3.45±1.75 ^b	4.27±1.76 ^a	4.19±1.81 ^a	3.45±1.60 ^b	4.44±1.72 ^a	4.40±1.76 ^a
Env. friendly	3.72±1.73 ^b	4.84±1.59 ^a	4.94±1.58 ^a	3.40±1.83 ^b	4.41±1.76 ^a	4.41±1.79 ^a	3.20±1.73 ^b	4.68±1.60 ^a	4.65±1.66 ^a
Convenient	5.27±1.38 ^a	4.39±1.58 ^b	4.46±1.55 ^b	3.69±1.72 ^b	4.21±1.73 ^a	4.04±1.83 ^a	4.59±1.54 ^a	3.77±1.56 ^b	3.74±1.61 ^b
Affordable	4.80±1.49 ^a	3.57±1.61 ^b	3.64±1.62 ^b	4.10±1.55 ^a	3.11±1.56 ^b	3.03±1.55 ^b	4.37±1.43 ^a	3.22±1.37 ^b	3.21±1.39 ^b

Tasty	5.25±1.56 ^a	3.76±1.80 ^b	3.67±1.87 ^b	4.52±1.66 ^a	3.60±1.76 ^b	3.49±1.77 ^b	4.36±1.66 ^a	3.35±1.70 ^b	3.23±1.74 ^b
Enjoyable	5.21±1.56 ^a	3.70±1.81 ^b	3.63±1.86 ^b	4.20±1.57 ^a	3.70±1.70 ^b	3.59±1.69 ^b	4.16±1.66 ^a	3.30±1.68 ^b	3.17±1.73 ^b
Acceptable	4.82±1.48 ^a	4.53±1.67 ^b	4.54±1.73 ^b	4.07±1.53 ^{ns}	4.01±1.64 ^{ns}	3.87±1.69 ^{ns}	4.14±1.52 ^{ns}	4.18±1.74 ^{ns}	4.04±1.73 ^{ns}
Aspirational	3.50±1.72 ^b	3.91±1.84 ^a	3.94±1.86 ^a	3.96±1.62 ^a	3.65±1.66 ^b	3.54±1.67 ^b	3.77±1.58 ^a	3.34±1.62 ^b	3.36±1.71 ^b
Nutritious	4.55±1.54 ^{ns}	4.56±1.61 ^{ns}	4.57±1.67 ^{ns}	4.06±1.65 ^b	4.29±1.63 ^a	4.16±1.74 ^{ab}	3.89±1.61 ^b	4.30±1.53 ^a	4.17±1.57 ^a
Simple	4.80±1.51 ^a	4.08±1.61 ^b	4.18±1.59 ^b	3.68±1.60 ^a	3.36±1.62 ^b	3.40±1.68 ^b	3.99±1.60 ^a	3.42±1.51 ^b	3.47±1.52 ^b
Safe	4.75±1.45 ^{ns}	4.79±1.48 ^{ns}	4.85±1.50 ^{ns}	3.86±1.59 ^b	4.33±1.61 ^a	4.17±1.69 ^a	3.96±1.50 ^{ns}	4.01±1.54 ^{ns}	3.98±1.58 ^{ns}

303
304

Within each country, values with the same letter in the same row are not significantly different at $P < 0.05$. Means and standard deviations are reported.

305
306
307
308
309
310

In the UK, hybrid meat products scored similarly to plant-based **meat-free** substitutes for all attributes. Hybrid and plant-based **meat-free** substitutes scored higher than meat products for healthy, ethical, environmentally friendly and aspirational. Meat products scored higher than hybrid and plant-based **meat-free** substitutes for convenient, affordable, tasty, enjoyable, acceptable and simple. There were no significant differences among the three products for the attributes nutritious and safe.

311
312
313
314
315

In Spain, there was no significant difference among the three product categories for the attribute acceptable. Hybrid meat products scored similarly to plant-based **meat-free** substitutes for all attributes. Hybrid and plant-based **meat-free** alternatives scored higher than meat products for the attributes healthy, ethical, environmentally friendly, convenient and safe, while meat products scored higher for affordable, tasty, enjoyable, aspirational and simple.

316
317
318
319
320
321

In Denmark, there was no significant difference among the three product categories for the attributes acceptable and safe. Hybrid meat products scored similarly to plant-based **meat-free** substitutes for all attributes. Hybrid and plant-based **meat-free** alternatives scored higher than meat products for the attributes healthy, ethical, environmentally friendly and nutritious. Meat products score higher than the other two categories for convenient, affordable, tasty, enjoyable, aspirational and simple.

322

4. Discussion & conclusions

323
324
325
326
327

This is the first study to co-create hybrid meat products with consumers from the UK, Spain and Denmark. The preferred hybrid meat product formulations using a novel co-creation approach were investigated in each country, consumers' WTT and WTB for hybrid meat products were explored, and several attributes were used to compare hybrid meat products, meat products and plant-based **meat-free** alternatives.

328
329
330
331
332
333
334
335
336
337
338

The co-creation task showed that although some differences were found cross country, some overarching similarities also apply. Results in fact indicated that future hybrid meat product development should focus on a beef burger type product with added whole foods such as onions, mushrooms, pulses and natural flavourings like herbs, spices, and garlic. These findings agree with a co-creation study using online focus groups, indicating hybrid meat products as the most promising in terms of healthier meat product formulations (Barone et al., 2021). Consumers were also keen on seeing on-pack nutritional claims on hybrid meat products, especially those on protein (source of or high in) and fat (reduced or low in). Therefore, new hybrid meat products should be suitably formulated to be able to carry such nutrition claims and the use of these claims should be encouraged on-pack to communicate the health benefits to consumers. Research has shown that it is possible to manufacture hybrid meat products with such nutritional characteristics (Baune et al., 2021; Grasso,

339 Pintado, Pérez-Jiménez, Ruiz-Capillas, & Herrero, 2020; Pérez-Montes, Rangel-Vargas, Lorenzo,
340 Romero, & Santos, 2021) and several meat products with nutrition claims are available in the market
341 (Danish Crown, 2019; Waitrose, 2018)

342
343 Another interesting finding is that the majority of consumers had heard of the concept of hybrid meat
344 products and were willing to try such products. This familiarity could be beneficial in the adoption of
345 hybrid meat products in the diet and a transition to a more plant-based diet, as it has been reported
346 that consumers tend to refuse or avoid unfamiliar food products (Tuorila & Hartmann, 2020). However
347 it is important to note that this study did not compare WTT of hybrid vs other plant-based foods or
348 meat products, therefore it is unknown if hybrids would be more easily adopted compared to plant-
349 based foods for example.

350
351 Looking at the result from the attribute-scoring task, we found some differences across countries, but
352 overall hybrid meat products were seen as more similar to plant-based **meat-free** alternatives than to
353 meat products. Hybrid meat products and plant-based **meat-free** alternatives were considered as
354 healthy, ethical and environmentally friendly, while meat products were considered affordable, tasty,
355 enjoyable and simple. This is an interesting finding because even though hybrid products possess both
356 meat and plant-based ingredients, consumers in the three countries perceived them as closer to the
357 plant-based category. A recent study reported that plant-based attitudes positively affected
358 participants' attitude towards hybrid products both in Denmark and the UK (Banovic, Barone, Asioli,
359 & Grasso, 2022). The authors concluded that even though regularly eating meat, in these countries
360 participants open towards a plant-based diet still consider hybrid products as acceptable. Our findings
361 are also consistent with those of another study on vegetarian and vegan diets (Bryant, 2019). Indeed,
362 this study reported that UK consumers consider a plant-based diet to be healthy, ethical, and
363 environmentally friendly, but less affordable, enjoyable, tasty and simple.

364
365 As for the motivations to consume hybrid meat products, two consumer studies reported that hybrid
366 meat products would be chosen for health reason rather than for environmental or animal welfare
367 concerns (Lang, 2020; Profeta et al., 2021), while another consumer study reported that both health
368 consciousness and environmental self-identity would facilitate consumers' purchase intention
369 towards hybrid products (Banovic et al., 2022).

370 It is well known that consumers are not willing to compromise taste for health (Verbeke, 2006). It is
371 therefore of paramount importance that future hybrid meat products are formulated to deliver first
372 of all in taste. Some promising results on the sensory acceptability of hybrid meat products vs plant-
373 based **meat-free** alternatives and meat products have been reported (Grasso, Rondoni, Bari, Smith, &
374 Mansilla, 2021; Neville, Tarrega, Hewson, & Foster, 2017). For example Grasso et al. (2021) in a blind
375 consumer test with commercial samples reported that hybrid burgers scored significantly higher in
376 overall acceptability than both beef and plant-based **meat-free** burgers. The authors concluded that
377 "hybrid meat products could represent an effective way for consumers to lower their meat
378 consumption without compromising too much on the sensory quality and could represent a transition
379 product to a more plant-based diet". Neville et al. (2017) compared the sensory acceptability of
380 hybrid, meat and meat-free products with consumers. They found no significant difference between
381 hybrid and meat products, while meat-free products were less accepted.

382 A limitation of this study lies in the creative nature of this task, which allowed consumers to design
383 hypothetical hybrid meat products that could potentially not work in real life. The addition of the
384 plant-based ingredients in a meat product would in fact lead to changes in taste, flavour, texture and
385 functionality. For example the creation of a burger with 50% onion might not be feasible from a food
386 manufacturing point of view. These results should be taken as a first creative effort, with initial ideas
387 to develop further, rather than as definitive recipes.

388 Future research avenues are suggested. First, choice experiments should be conducted to elicit
389 consumer willingness to pay using commercially available hybrid meat products in real market settings
390 and in conjunction with consumer sensory analysis to be able to better capture consumer valuations
391 towards these new products. Further, experiments should be conducted to test if providing
392 information messages with specific goals (e.g., taste, health, and environment) may further allow to
393 identify persuasive paths for adoption of hybrid products. Moreover, the replication of this study in
394 other countries, especially non-European, would be useful to deepen the understanding of
395 consumers' attitudes towards hybrid products.

396 Funding

397 This work was supported by EIT Food project number 20206 titled "consumer attitudes towards
398 healthier processed meat products".

399 References

- 400
401 Banovic, M., Barone, A. M., Asioli, D., & Grasso, S. (2022). Enabling sustainable plant-
402 forward transition: European consumer attitudes and intention to buy hybrid products.
403 *Food Quality and Preference*, 96, 104440.
- 404 Barone, A. M., Banovic, M., Asioli, D., Wallace, E., Ruiz-Capillas, C., & Grasso, S. (2021).
405 The usual suspect: How to co-create healthier meat products. *Food Research*
406 *International*, 143, 110304.
- 407 Baune, M.-C., Jeske, A.-L., Profeta, A., Smetana, S., Broucke, K., Van Royen, G., et al.
408 (2021). Effect of plant protein extrudates on hybrid meatballs – Changes in nutritional
409 composition and sustainability. *Future Foods*, 4, 100081.
- 410 Bryant, C. J. (2019). We Can't Keep Meating Like This: Attitudes towards Vegetarian and
411 Vegan Diets in the United Kingdom. *11*(23).
- 412 Cheah, I., Sadat Shimul, A., Liang, J., & Phau, I. (2020). Drivers and barriers toward
413 reducing meat consumption. *Appetite*, 149, 104636.
- 414 Corrin, T., & Papadopoulos, A. (2017). Understanding the attitudes and perceptions of
415 vegetarian and plant-based diets to shape future health promotion programs. *Appetite*,
416 109, 40-47.
- 417 Danish Crown. (2019). Minced meat from Danish Crown – now with 50 per cent vegetables.
418 [https://www.danishcrown.com/news/minced-meat-from-danish-crown-now-with-50-](https://www.danishcrown.com/news/minced-meat-from-danish-crown-now-with-50-per-cent-vegetables/)
419 [per-cent-vegetables/](https://www.danishcrown.com/news/minced-meat-from-danish-crown-now-with-50-per-cent-vegetables/).
- 420 Derbyshire, E. J. (2017). Flexitarian Diets and Health: A Review of the Evidence-Based
421 Literature. *Frontiers in Nutrition*, 3(55).
- 422 Dijksterhuis, G. (2016). New product failure: Five potential sources discussed. *Trends in*
423 *Food Science & Technology*, 50, 243-248.
- 424 Filieri, R. (2013). Consumer co-creation and new product development: a case study in the
425 food industry. *Marketing Intelligence & Planning*, 31(1), 40-53.
- 426 Graça, J., Calheiros, M. M., & Oliveira, A. (2015). Attached to meat?(Un) Willingness and
427 intentions to adopt a more plant-based diet. 95.
- 428 Grasso, Brunton, N. P., Lyng, J. G., Lalor, F., & Monahan, F. J. (2014). Healthy processed
429 meat products - Regulatory, reformulation and consumer challenges. *Trends in Food*
430 *Science & Technology*, 39(1), 4-17.
- 431 Grasso, & Jaworska. (2020). Part Meat and Part Plant: Are Hybrid Meat Products Fad or
432 Future? *Foods*, 9(12).

- 433 Grasso, Pintado, T., Pérez-Jiménez, J., Ruiz-Capillas, C., & Herrero, A. M. (2020). Potential
434 of a sunflower seed by-product as animal fat replacer in healthier frankfurters. *Foods*,
435 9(4), 445.
- 436 Grasso, Rondoni, A., Bari, R., Smith, R., & Mansilla, N. (2021). Effect of information on
437 consumers' sensory evaluation of beef, plant-based and hybrid beef burgers. *Food*
438 *Quality and Preference*, 104417.
- 439 Hicks, T. M., Knowles, S. O., & Farouk, M. M. (2018). Global provisioning of red meat for
440 flexitarian diets. *Frontiers in nutrition*, 5, 50.
- 441 James, W. H. M., Lomax, N., Birkin, M., & Collins, L. M. (2021). Geodemographic Patterns
442 of Meat Expenditure in Great Britain. *Applied Spatial Analysis and Policy*, 14(3),
443 563-590.
- 444 Kemper, J. A., & White, S. K. (2021). Young adults' experiences with flexitarianism: The
445 4Cs. *Appetite*, 160, 105073.
- 446 Kim, B. F., Santo, R. E., Scatterday, A. P., Fry, J. P., Synk, C. M., Cebren, S. R., et al.
447 (2020). Country-specific dietary shifts to mitigate climate and water crises. *Global*
448 *Environmental Change*, 62, 101926.
- 449 Lang, M. (2020). Consumer acceptance of blending plant-based ingredients into traditional
450 meat-based foods: Evidence from the meat-mushroom blend. *Food Quality and*
451 *Preference*, 79, 103758.
- 452 Lentz, G., Connelly, S., Miroso, M., & Jowett, T. (2018). Gauging attitudes and behaviours:
453 Meat consumption and potential reduction. *Appetite*, 127, 230-241.
- 454 Malek, L., & Umberger, W. J. (2021). Distinguishing meat reducers from unrestricted
455 omnivores, vegetarians and vegans: A comprehensive comparison of Australian
456 consumers. *Food Quality and Preference*, 88, 104081.
- 457 Neville, M., Tarrega, A., Hewson, L., & Foster, T. (2017). Consumer-orientated development
458 of hybrid beef burger and sausage analogues. *Food Science & Nutrition*, 5(4), 852-
459 864.
- 460 Olsen, N. V. (2015). Design Thinking and food innovation. *Trends in Food Science &*
461 *Technology*, 41(2), 182-187.
- 462 Pérez-Montes, A., Rangel-Vargas, E., Lorenzo, J. M., Romero, L., & Santos, E. M. (2021).
463 Edible mushrooms as a novel trend in the development of healthier meat products.
464 *Current Opinion in Food Science*, 37, 118-124.
- 465 Profeta, A., Baune, M.-C., Smetana, S., Bornkessel, S., Broucke, K., Van Royen, G., et al.
466 (2021). Preferences of German Consumers for Meat Products Blended with Plant-
467 Based Proteins. 13(2).
- 468 Ritchie, H., & Roser, M. (2017). Meat and dairy production. *Our World in Data*.
- 469 Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design.
470 *Co-design*, 4(1), 5-18.
- 471 Schösler, H., Boer, J. d., & Boersema, J. J. (2012). Can we cut out the meat of the dish?
472 Constructing consumer-oriented pathways towards meat substitution. *Appetite*, 58(1),
473 39-47.
- 474 Shan, L. C., Regan, Á., Monahan, F. J., Li, C., Lalor, F., Murrin, C., et al. (2017). Consumer
475 preferences towards healthier reformulation of a range of processed meat products: A
476 qualitative exploratory study. *British Food Journal*.
- 477 Shukla, P., Skea, J., Calvo Buendia, E., Masson-Delmotte, V., Pörtner, H., Roberts, D., et al.
478 (2019). IPCC, 2019: Climate Change and Land: an IPCC special report on climate
479 change, desertification, land degradation, sustainable land management, food security,
480 and greenhouse gas fluxes in terrestrial ecosystems.
- 481 Siegrist, M., & Hartmann, C. (2019). Impact of sustainability perception on consumption of
482 organic meat and meat substitutes. *Appetite*, 132, 196-202.

- 483 Tuorila, H., & Hartmann, C. (2020). Consumer responses to novel and unfamiliar foods. 33.
484 Verbeke, W. (2006). Functional foods: Consumer willingness to compromise on taste for
485 health? *Food Quality and Preference*, 17(1–2), 126-131.
- 486 Waitrose. (2018). Pork and Lentil Sausages? Just One New Way to Good Health. Available
487 online:
488 https://waitrose.pressarea.com/pressrelease/details/78/product%20news_12/9090
489 (accessed on 14 January 2022).
- 490 Yip, C. S. C., Lam, W., & Fielding, R. (2018). A summary of meat intakes and health
491 burdens. *European Journal of Clinical Nutrition*, 72(1), 18-29.
492