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Toward a reduced meat diet: University North American students' acceptance of a blended meat-mushroom burger

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*Original*

Toward a reduced meat diet: University North American students' acceptance of a blended meat-mushroom burger / Sogari, G.; Li, J.; Wang, Q.; Lefebvre, M.; Huang, S.; Mora, C.; Gomez, M. I.. - In: MEAT SCIENCE. - ISSN 0309-1740. - 187:(2022), p. 108745.108745. [10.1016/j.meatsci.2022.108745]

*Availability:*

This version is available at: 11381/2916064 since: 2022-02-23T07:22:31Z

*Publisher:*

Elsevier Ltd

*Published*

DOI:10.1016/j.meatsci.2022.108745

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24 April 2024

1 **Title:** Toward a reduced meat diet: university students' acceptance of a blended meat-mushroom  
2 burger

3

4 **Abstract**

5 Reduction of meat intake and increase in vegetable consumption have attracted considerable  
6 attention from researchers and food businesses. We conducted a field experiment in a university  
7 canteen with the aim of investigating the main behavioral factors determining the consumption of  
8 a blended meat-mushroom burger. 296 students who consumed the blended burger completed a  
9 structured survey including hedonic and attitudinal questions. We then contacted the same sample  
10 after one month to measure their reported behavior. Our results show that providing information  
11 highlighting the sustainability attributes of mushrooms has the most significant and positive impact  
12 on acceptability in comparison to information related to nutrition and indulgence. In addition, the  
13 participants' beliefs about the health and sustainable benefits of mushrooms positively impact their  
14 attitude toward the blended burger. This then significantly influences their behavioral intention to  
15 purchase the product, which proves to be a good predictor of the consumption behavior. Our  
16 findings suggest marketing opportunities arising from blending plant-based ingredients with meat  
17 products.

18 *Keywords:* alternative meat, behavioral intention, sensory, hybrid meat, marketing, sustainability

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## 24 **1. Introduction**

25 Meat is ubiquitous in almost all human diets. While its consumption offers vital nutrients  
26 (i.e., proteins and vitamins), excess meat production and (over)consumption can contribute to a  
27 broad range of environmental issues and diet-related chronic diseases (Arnaudova, Brunner, &  
28 Götze, 2022; Donati et al., 2016; Godfray et al., 2018). The increasing global consumer demand  
29 for meat products has negative consequences on the environment due to the inefficient conversion  
30 of plant proteins to meat proteins, which produces significant amount of greenhouse gas emissions,  
31 generates large land and water footprints, and requires large amount of energy resources (de Boer  
32 & Aiking, 2011, 2017; Donati et al., 2016; Tucker, 2014). Besides the burden on the environment,  
33 high intakes of meat-based products have a negative impact on human health. The World Health  
34 Organization suggests reducing meat intake as part of an overall healthy diet to prevent non-  
35 communicable diseases (NCD) such as obesity, type II diabetes, hypertension, and heart diseases  
36 (World Health Organization, 2017, 2018).

37 Consumers in North America are considered to have a meat-centric diet, which is  
38 associated with there being a deficit in plant-based foods and vegetables, and excess availability  
39 of animal protein (U.S. Department of Health and Human Services and U.S. Department of  
40 Agriculture, 2015). The reasons for the heavy consumption of animal-based foods include the  
41 appeal to the sensory properties preferred by many consumers, the food culture, and the tradition  
42 embedded in many Western countries (Heinz & Lee, 1998). Not surprisingly, in recent years, food  
43 scientists have increasingly addressed the growing demand for meat products with a range of  
44 creative solutions aimed at achieving more sustainable levels of meat consumption from the  
45 standpoints of human health and environmental protection (Alexander et al., 2017; Tucker, 2014).  
46 As a result, both the scientific community as well as the private sector have investigated the  
47 potential of moving toward meat alternatives, including cultured meat, algae, edible insects, and  
48 plant-based meat substitutes (Onwezen et al., 2021; Payne et al., 2019).

49 The transition from a primarily meat-based diet to one with lower meat content and an  
50 increased proportion of vegetarian ingredients has attracted considerable attention from  
51 researchers and food businesses alike (de Boer et al., 2017; Miller et al., 2014). As government  
52 and non-government organizations incentivize consumers to use more plant-based protein, it is  
53 important for the food industry to understand how and why consumers behave differently toward  
54 plant-based vs animal-based proteins. This will help the development of marketing and

55 communication strategies that can facilitate the leveraging of benefits arising from this emerging  
56 trend. However, many barriers exist to potentially encourage less meat-intensive diets among  
57 consumers, such as the strength of consumption habits (Arnaudova et al., 2022; Lentz et al., 2018).  
58 Another main challenge to increasing the consumer acceptance of novel protein-based foods,  
59 including alternatives to popular meat products (e.g., burgers), is the reduction of recurrent sensory  
60 objections (Tucker, 2014).

61 Consequently, the desirable sensory attributes of plant-forward products are crucial,  
62 particularly among heavy meat consumers (Ruby & Heine, 2012; Spencer & Guinard, 2018). To  
63 address this barrier, in 2014, the Culinary Institute of America collaborated with the National  
64 Mushroom Council to develop a meat-mushroom blended burger in which approximately 30% of  
65 the beef is replaced by mushrooms (Culinary Institute of America, 2016). Several studies suggest  
66 that the meat-mushroom blended burger can contribute to healthier diets (Summers et al., 2015;  
67 Wong, Corradini, Autio, & Kinchla, 2019) and to reduce negative environmental impacts  
68 (Robinson, Winans, Kendall, Dlott, & Dlott 2019; Perez-Montes et al. 2021) relative to a 100%  
69 beef burger.

70 While it has been several years since the transition to plant-forward products started and  
71 the meat-mushroom blended burger has come to be widely served in various dining venues, no  
72 rigorous research has been carried out to study consumer behavior, particularly consumer  
73 acceptance and consumption behavior, on such products. To fill this gap, we conducted a field  
74 experiment in a dining venue of a university campus to investigate the factors that discourage or  
75 encourage the consumption of a blended burger among university students. Guided by the Theory  
76 of Planned Behavior (TPB), this study investigates the following: (1) whether and how the  
77 information about the attributes of the blended burger (to be precise, sustainability, nutritional, and  
78 indulgent attributes) influences acceptance; (2) whether attitudes toward the blended burger is a  
79 good predictor of behavioral intention (i.e., willingness to try); and (3) whether the behavioral  
80 intention predicts the consumption behavior.

81 Having employed a structural equation model to analyze the data, we find that the  
82 information highlighting the sustainability attributes had the most significant and positive impact  
83 on the acceptability of the blended burger. In addition, the participants' attitudes toward this  
84 product significantly influences their behavioral intention, which is a good predictor of the actual  
85 consumption behavior.

86           These findings can help develop and guide future marketing communication strategies  
87 (e.g., messaging and promotion) by delivering product information that has the greatest impact on  
88 acceptance, which in turn could contribute toward the encouragement of healthier diets among  
89 younger generations.

## 90 **2. Relevant Literature**

91           In light of increasing environmental and health concerns regarding excessive meat  
92 consumption, especially among young adults, public and private authorities have been seeking  
93 ways to reduce the intake of meat in diets, including education on healthy diets and promotion of  
94 meat substitutes (de Boer et al., 2017; Onwezen et al., 2021; Schösler et al., 2012). For instance,  
95 Menus of Change Research Collaborative (MCURC), founded by the Standard University and the  
96 Culinary Institute of America, is seeking to replace animal proteins with vegetarian ingredients in  
97 their menus without compromising the sensory aspects. This is crucial considering that college  
98 students often consume excessive animal protein and lack the self-control or motivations necessary  
99 to maintain a healthy diet, especially because of the low sensory appeal of a plant-based diet  
100 (Spencer et al., 2018).

101           By changing the menus in college dining facilities, the Menus of Change initiative aims to  
102 provide students more nutritious and sustainable food choices, and to emphasize the impact of  
103 food production on the human health and environment (e.g., carbon emissions from animal  
104 production as a contributing factor in climate change). Instead of meat-reducing interventions like  
105 “meatless day” or replacing meat meals with meat-free options (Apostolidis & McLeay, 2016), the  
106 Menus of Change initiative aims to introduce meat hybrid substitutes across several campuses.  
107 Hybrid meats are products that combine meat and non-meat ingredients (Grasso, 2020). In general,  
108 the inclusion of plant-based ingredients in animal origin products has been highlighted because of  
109 their nutritional properties (e.g., no cholesterol, low fat ingredients) (Patinho et al., 2019). For  
110 example, in recent years, the use of mushrooms as a high nutritional value source of bioactive  
111 compound to partially replace ground beef in the production of healthier meat products has gained  
112 popularity (Pérez-Montes, Rangel-Vargas, Lorenzo, Romero, & Santos, 2021; Wong et al., 2017;  
113 Wong, Corradini, Autio, & Kinchla, 2019). Several nutritional benefits of including mushroom as  
114 a meat extender in beef patty formulation have been assessed, including the reduction of caloric  
115 content and improvement in terms of protein and carbohydrate content (Pérez-Montes et al., 2021;  
116 USDA National Nutrient Database for Standard Reference, 2021; Wong et al., 2019). One of the

117 studies (Summers et al., 2015) conducted a nutrient comparison between a blend burger and a beef  
118 burger. The study reported that the blend burger had lower total and saturated fat composition,  
119 caloric composition, and sodium content in comparison to the 100% beef burger. Moreover,  
120 mushrooms are rich in complex carbohydrates like dietary fiber, which is usually lacking in meat  
121 products (Mehta et al., 2015). In addition, mushrooms (e.g., fresh shiitake mushrooms) contain  
122 less sodium (9mg/100g) than ground beef meat (66mg/100g) and higher level of naturally  
123 occurring free glutamate (71mg/100g) that acts as natural sodium salt for flavor enhancement (Jo  
124 Feeney, Miller, & Roupas, 2014). As a result, past studies have shown how mushrooms can  
125 mitigate the sodium content of ground beef in meat-based products without a significant change in  
126 sensory appeal (Mattar et al., 2018; Guinard et al., 2016; Miller et al., 2014). For example, Wong  
127 et al., (2019) shows how a patty formulation with 20% mushroom extender and 80% ground beef  
128 has a lower salt content (1.1 % Weight) in comparison to an all-beef patty (1.5 % Weight), with a  
129 consumer hedonic sensory analysis showing similar saltiness liking scores. The flavor-enhancing  
130 properties of mushrooms are associated with umami taste, contributing to a more savory and meaty  
131 taste sensation (Jo Feeney et al., 2014; Zhang et al., 2013). In addition, mushrooms are a good  
132 replacement for ground beef because of the similarities in sensory properties like color and texture  
133 (Miller et al., 2014; Patinho et al., 2019 Spencer, Cienfuegos, et al., 2018). For instance, Patinho  
134 et al. (2021) has shown how a reformulation containing 15% mushrooms (*Agaricus bisporus*) as a  
135 fat replacement in beef burgers can be considered a promising strategy for commercial products  
136 to increase the nutritional profile without compromising the sensory appeal.

137 An emerging literature suggests that increasing mushroom in diets can contribute to  
138 environmental sustainability. For example, a few life cycle assessment (LCA) studies have  
139 examined the environmental impact of mushrooms production. Recently, Robinson, Winans,  
140 Kendall, Dlott, & Dlott (2019) conducted a LCA on mushroom production in the USA from  
141 cultivation to harvesting and preparation for bulk packaging. They concluded that, while most of  
142 the processes are fairly optimized for water and waste recycling, energy consumption is the most  
143 impactful process. In general, growing mushrooms can be considered as a sustainable cultivation  
144 as mushrooms require relatively little space and are considered to be “fast-growing organisms with  
145 a high yield” (Pérez-Montes et al., 2021).

146 As a result, several college foodservice settings (e.g., school canteens/cafeterias) across the  
147 US have started to introduce a blended meat-mushroom burger as a healthy and sustainable option

148 in their menus in recent years (Jacewicz, 2016, Sogari et al., 2021). Besides college dining halls,  
149 marketplaces have also come to offer increasing number of hybrid meat alternatives (Grasso &  
150 Jaworska, 2020). The development of hybrid vegetable-meat products is indeed a novel area and  
151 could be considered as an effective strategy to encourage meat reduction among those who are  
152 resistant to fully shift to vegetarian or vegan diets. These new products (e.g., burger, sausages)  
153 allow consumers to continue eating familiar foods with a reduced meat content without  
154 compromising on the desirable sensory attributes (Sogari et al., 2021). The inclusion of a non-  
155 meat ingredient (such as mushrooms) can lead to a transition to a more plant-based diet (Grasso,  
156 2020). However, little is known about the consumers' acceptance of and their behaviors toward  
157 blended vegetable-meat products. Previous research on mixed or hybrid vegetable-meat products  
158 has focused mainly on identifying the sensory properties of such products, including texture,  
159 flavor, and appearance (Miller et al., 2014; Spencer, Cienfuegos, et al., 2018; Spencer & Guinard,  
160 2018). Only a few studies have investigated the consumer preferences of dishes in which beef had  
161 been partially substituted by mushrooms (e.g., burgers). Lang (2020) investigated U.S. consumers'  
162 acceptance and consumption of the mushroom and meat combination and found the most preferred  
163 form of blended food products to be burgers. Prusaczyk, Earle, & Hodson (2021) examined the  
164 effectiveness of information (i.e., an education intervention and nudge) to encourage the  
165 consumption of a beef-mushroom burger among a group of US consumers. Sogari et al. (2021)  
166 found that, with the motivation to process sustainability and nutrition information, and with a  
167 positive attitude toward food innovation, college students are more likely to purchase a meat-  
168 mushroom blended burger.

169 While these past authors made substantial contributions to the literature, all these studies  
170 were based on surveys without the actual tasting experience of the products. Therefore, a call is  
171 needed for extending this field of research exploring how consumers perceive mushrooms as a  
172 meat replacement in a burger (Patinho et al., 2019). This study contributes to the understanding of  
173 how the actual consumption of a blended meat-mushroom burger affects the attitude, the intention,  
174 and the reported purchasing behavior in the near future. In addition, we investigated consumers'  
175 expectations and hunger level before tasting, and their acceptance (overall liking) during  
176 consumption. We then further investigate how these factors could influence the following repeat  
177 purchase, measured as the actual purchase of the product after one month. The investigation of the  
178 overall liking and preferences is crucial to trigger the first trial and the following repeat purchase

179 (Hung & Verbeke, 2018).

180 Using models that integrate both consumers' hedonic-based expectations (driven by  
181 information given before tasting) and the role of consumers' actual liking/disliking of food has led  
182 to a better understanding of consumer experience (Deliza, 2018). These types of studies that  
183 combine both research and development and marketing of a product are crucial in a situation where  
184 the private sector is developing and launching new food products. Without a better understanding  
185 of consumer behavior toward the blended burger, marketing strategies and policy intervention  
186 initiatives to encourage its consumption may be ineffective. Our work fills this gap in the literature  
187 by developing a conceptual behavioral framework and empirically testing the factors influencing  
188 the acceptance of and intention to consume the meat-mushroom blended burger.

### 189 **3. Conceptual Framework and Hypotheses**

190 The conceptual framework of this study is presented in Figure 1. The starting point is to  
191 measure the links between 1) the perceived level of hunger, and 2) the past experience of having  
192 eaten the product on the 'desire to eat and the expected liking' (Mela, 2006). We expect a positive  
193 relationship between the level of hunger and the desire to eat as hunger is the intrinsic motivation  
194 to eat. We also expect a positive relationship that between the level of hunger and the expected  
195 liking of the meat-mushroom burger due to the anticipation of pleasure. Past experience with the  
196 blended burger is expected to increase the desire to consume and the expected liking of the product.  
197 Expected liking tends to have a positive influence on food choices and is considered as a strong  
198 determinant of the actual enjoyment and acceptance of a food product (Cardello & Wright, 2010;  
199 Robinson et al., 2013). Therefore, we hypothesize that an increase in expected liking results in  
200 higher overall perceived liking and acceptance of the meat-mushroom blended burger.

201 [Insert Figure 1]

202 Figure 1. Structural model of the behavior toward consuming a meat-mushroom burger

203

204 Many studies have brought out the effectiveness of information (e.g., informative posters  
205 or nudges) at the point-of-purchase to alter the eating behavior of students with the aim to  
206 encourage a healthy diet (Peterson et al., 2010; Prusaczyk et al., 2021; Sogari et al., 2019). We  
207 hypothesize that the consumer acceptance of the blended meat-mushroom burger is influenced by  
208 the information provided (Caporale et al., 2006). Three different types of information were



209 provided: nutrition, sustainability, and indulgence. Cognitively-oriented information, such as  
210 nutrition and sustainability, is supposed to increase consumers' knowledge. This is crucial because,  
211 in order to encourage a more pro-environmental behavior, including a diet with substantial  
212 reductions in meat, consumers should be educated about the potential environmental and health  
213 benefits (Lee et al., 2014; Willett et al., 2019). The indulgent information is an affectively-oriented  
214 message that seeks to influence how consumers feel about the hedonic consequences of eating the  
215 product (Cadario & Chandon, 2018).

216 To assess consumer behavior toward the blended burger, our conceptual model follows the  
217 Theory of Planned Behavior (TPB) (Ajzen, 1991; Ajzen & Madden, 1986) and includes two  
218 constructs of the Theory: attitude and behavioral intention. The TPB is widely used in the literature  
219 to explain the adoption of healthy and sustainable behaviors (Biasini et al., 2021). Considering our  
220 aim is to investigate the motivational factors related to the inclusion of a healthier meat product in  
221 the diet of the students, we believe this decision-making model is appropriate in our study.

222 We hypothesize that the behavior under investigation (consumption of a blended burger)  
223 is determined by intention and attitude (i.e., people's overall evaluation of a behavior). We assume  
224 that, the more positive one's attitude is toward eating this blended mushroom-meat burger, the  
225 higher the intention to consume the product in the coming month. The reason to include a  
226 timeframe when measuring intention is suggested by Fishbein and Ajzen (2011).

227 In social psychology, attitudinal change can also be altered by expectations (Hovland et al.,  
228 1957). Therefore, we assume attitude and intention to be influenced by expected liking before  
229 tasting and level of acceptance after tasting. In addition, the TPB postulates that the behavioral  
230 beliefs are the antecedents of the attitude toward the behavior. Consumers' beliefs about the  
231 attribute of a product can link the behavior to a specific outcome. Based on this assumption and  
232 considering the high percentage of mushrooms in this burger, we assume that the belief of eating  
233 mushrooms is healthy and sustainable could also be a predictor of the positive attitude toward and  
234 acceptance of this product. The TPB further postulates behavioral intention to be the most  
235 important determinant to explain the performance of the respective behavior. Therefore, we  
236 hypothesize that the intention of eating the meat-mushroom burger at Time 1 (i.e., the likelihood  
237 that a person is going to consume this burger in the future) is a good predictor of the (reported)  
238 behavior at a later time (Time 2).

239 **4. Materials and Methods**

240 *4.1 Participants*

241 In this study, a between-subject experiment using a college student sample was conducted.  
242 Data was collected (n = 296) from the dining foodservice setting of a US university in New York  
243 State during lunch and dinner meals in the fall semester of 2018. The demographics of the students  
244 were as follows: mixed representation on the basis of gender, with 51.01% being females; majority  
245 of the students were from North America (i.e., USA and Canada); and the students' ages ranged  
246 from 18 to 35 years (M = 19.21, SD = 1.95) (Table 1).

247 [Insert Table 1]

248 We approached only the diners who had chosen the meat-mushroom blended burger, a new  
249 item on the menu, and then asked for their consent to participate in a short survey about eating  
250 habits. The participants received \$5 in “meal bucks” in exchange for their participation in the study.  
251 They were asked to sign an informed consent. This study was deemed exempt by the Institutional  
252 Review Board (IRB) of the Office of Research Integrity and Assurance of Cornell University  
253 (Protocol ID#: 1808008184).

254 *4.2 Design with information treatment*

255 In the study design, before starting the questionnaire, subjects were randomly assigned to  
256 one of the following four treatments: nutrition information, sustainability information, indulgence  
257 information, or a control group with no messaging.

258 Respondents who received an information treatment were asked to read a short text which  
259 reported some of the positive characteristics of consuming the product (e.g., nutrition,  
260 sustainability, or indulgence attributes). The message about nutrition provided some nutritional  
261 information about the consumption of mushrooms for a healthy diet (e.g., rich in proteins and  
262 nutrients). Another message focused on the environmental sustainability of growing mushrooms  
263 (e.g., lower carbon footprint and less water usage). Then, the indulgence message considered the  
264 sensory appeal of mushrooms related to its flavor-enhancing properties (e.g., umami taste, juicier,  
265 and flavorful).

266 It is essential that any type of information provided to encourage consumption is  
267 appropriately presented at the point of purchase/selection, otherwise, it will not be salient to the  
268 consumers (Balcombe et al., 2016). Therefore, the information was provided on a single sheet

269 using a colored image, incorporating the message in a format that is similar to the communication  
270 campaigns that have run in the past in the dining venues. The content of the information treatment  
271 was agreed upon and supported by the representatives of The National Mushroom Council  
272 (<https://www.mushroomcouncil.com/>)<sup>1</sup>.

### 273 *4.3 Questionnaire and measures*

274 In this study, three questionnaires, comprising psychographic and product-oriented  
275 questions, were used at three different times: (1) pre-eating at the dining venue, (2) post-eating at  
276 the dining venue, and (3) a follow-up survey four weeks later, administered online.

277 First, the students who decided to participate in this study were asked to complete a short  
278 preliminary questionnaire (Table A.1 in the Appendix) before consuming the burger. This  
279 questionnaire included a rating of the participants' state of hunger (Bacon & Krpan, 2018), their  
280 desire to eat (Liem et al., 2012) and their rating of hedonic attributes (i.e., past and expected overall  
281 liking) via the use of a 7-point hedonic scale (Peryam & Pilgrim, 1957; Vad Andersen & Hyldig,  
282 2015).

283 After the participants ate the burger, the primary survey (Table A.2 in the Appendix) was  
284 distributed in the dining hall (Time 1 in Figure 1). It included two items investigating the  
285 participants' beliefs about the sustainability and nutritional implications of consuming mushrooms  
286 and two items investigating the perceived overall liking and desire to eat the blended burger again.  
287 In our analysis, we grouped the overall liking and desire to eat in one latent construct, namely  
288 "Food Acceptance" to represent the liking/disliking ratings of the foods that have actually been  
289 tasted/eaten (Cardello et al., 2000). The plating and presentation of the burger was identical every  
290 day; this way, we controlled the visual aspects of the food that can influence expectations. Finally,  
291 measures based on the TPB model were adopted to understand participants' attitude and behavioral  
292 intention to consume the product in the near future. These measures were focused on the attitudinal  
293 variables of introducing this product to college students, rather than the sensory profile and  
294 pleasantness of the product in comparison to a traditional burger. The last part of the questionnaire  
295 elicited demographic information such as age, gender, and country of origin.

296 Approximately one month after completing the primary survey, the respondents received  
297 an online follow-up questionnaire. They were asked about their meat-mushroom burger  
298 consumption frequency in the past month (from "never" to "almost always"). Inclusion of the  
299 question about past consumption (i.e., reported behavior) was relevant to measure if the intention

300 to eat a meat-mushroom blended burger would translate into there being an actual eating behavior  
301 in the future (Time 2 in Figure 1).

#### 302 *4.4 Data analysis*

303 A Structural Equation Model (SEM) technique was employed to test the hypotheses posited  
304 in Figure 1. This statistical method has been used in the previous literature via the use of TPB to  
305 examine the behavioral decision making toward a healthy and sustainable diet (Biasini et al., 2021;  
306 Menozzi, Sogari, & Mora, 2017; Ricci et al., 2018). First, a confirmatory factor analysis (CFA) of  
307 all the measured variables tested the relationship with the latent factors. Second, this model tested  
308 the hypothesized relationship of the latent constructs obtained in the first step. The Full  
309 Information Maximum Likelihood method was specified to estimate the parameters of our dataset.

### 310 **5. Results**

311 The analysis was conducted using the statistical software STATA, version 15. The factor  
312 analysis results are present in Table 2. The SEM results identified in Figure 1 are presented in  
313 Table 3.

314 The measurement model fit was assessed through the CFA to assess the validity of the  
315 following constructs: expected liking and desire, food acceptance, beliefs regarding the health and  
316 sustainability with respect to mushroom consumption, as well as the attitude, and behavioral  
317 intention to try the blended burger. Convergent and discriminant validation, and the overall fit with  
318 data were examined to ensure model validity and reliability. To test the internal consistency of the  
319 indicators of each construct, the commonly used method to calculate the coefficient alpha of a  
320 given construct was adopted (Kang et al., 2013; Menozzi et al., 2017). Table 2 presents the  
321 Cronbach's  $\alpha$  coefficients for each construct. Their values exceed the recommended minimum  
322 value of 0.7 (Nunnally & Bernstein, 1994), suggesting that all the constructs were internally  
323 consistent and reliable.

324 [Insert Table 2]

325 Table 3 presents the results of the structural model and the standardized path effects among  
326 the constructs in the structural model in Figure 1. Different goodness of fit indices are used to test  
327 whether the measurement model has a good fit with the data. The obtained values of the root mean  
328 square error of approximation (RMSEA) and the lower bound for the 90% confidence interval are  
329 0.063 and 0.040, respectively, which meet the maximum criteria values of 0.08 and 0.05 (Hooper

330 et al., 2008). The chi-square is 54.676 with 25 degrees of freedom (df), and the ratio of the chi-  
331 square value to the df is 2.187, which is within the recommended intervals, between 2 and 5  
332 (Hooper et al., 2008; Marsh & Hocevar, 1985). The comparative fit index is 0.932, above the  
333 recommended value of 0.900, suggesting that the measurement model has a good fit with the data.

334 [Insert Table 3]

335 The results show that both past experience and hunger have a statistically positive  
336 significant effect on the expected liking and desire to eat the blended burger, which support our  
337 hypotheses H1 and H2 ( $coefficient_{past\ experience} = 0.559, p = 0.000$ ;  $coefficient_{hunger} = 0.116, p =$   
338  $0.001$ ). These expectations and the beliefs that eating mushrooms is healthy and sustainable  
339 positively influence the acceptance of the blended burger, supporting our hypotheses H3 and H4  
340 ( $coefficient_{expected\ liking} = 0.418, p = 0.000$ ;  $coefficient_{beliefs} = 0.118, p < 0.05$ ). The results also  
341 indicate that the sustainability message treatment significantly increased the participants' food  
342 acceptance rating relative to the control treatment ( $coefficient_{sustainable} = 0.262, p < 0.05$ ), while  
343 neither the indulgence nor the nutrition information were found to be significant. This result  
344 suggests that the product information highlighting the sustainability attributes of the burger  
345 influences the acceptance (answering the research question identified in Figure 1). The  
346 participants' characteristics such as gender, age, and country of origin were not found to be  
347 statistically significant.

348 In terms of estimating the consumer attitudes toward the meat-mushroom burger, the  
349 results indicate that the acceptance and beliefs about the health and sustainability benefits of  
350 mushrooms have significant and positive impacts on their attitudes toward the blended burger,  
351 supporting our hypotheses H5 and H6 ( $coefficient_{acceptance} = 0.521, p = 0.000$ ;  $coefficient_{beliefs} =$   
352  $0.236, p = 0.000$ ). Participants' attitudes further positively influenced the behavioral intention to  
353 consume in the future, supporting H7 ( $coefficient_{attitudes} = 0.479, p = 0.000$ ;  $coefficient_{acceptance} =$   
354  $0.341, p = 0.000$ ).

355 We tested the direct effects for the model identified in Figure 1. No significant direct effects  
356 were found between "Expected Liking and Desire" and both "Attitude" ( $p > 0.05$ )  
357 and "Behavioral Intention" ( $p > 0.05$ ). In addition, no significant direct effects were found  
358 between communication messages and both "Attitude" ( $p > 0.05$ ) and "Behavioral Intention" ( $p >$   
359  $0.05$ ). However, we found "Health and Sustainable Related Beliefs of Mushrooms" to have a  
360 significant direct effect on "Behavioral Intention" ( $coefficient = 0.185, p < 0.01$ ). As discussed in

361 the above results, the beliefs pertaining to mushrooms also have a direct impact on “Attitude,”  
362 suggesting that beliefs pertaining to mushrooms influence “Behavioral Intention” directly, and  
363 also indirectly via “Attitude.”

364 The last part of Table 3 presents the SEM results of the follow-up questionnaire in the  
365 structural model, which are used to test hypothesis H8 (“Time 2” in Figure 1). The obtained values  
366 of RMSEA and the lower bound are 0.045 and 0.000, respectively, which are lower to the criteria  
367 values of 0.07 and 0.05 (Hooper et al., 2008). In addition, the comparative fit index is 0.996, above  
368 the recommended value of 0.900. The results show the behavioral intention in the first period to  
369 be positively associated with the reported behavior measured in the follow-up question (*coefficient*  
370 = 0.500,  $p = 0.000$ ), indicating that consumer behavioral intention toward the blended burger  
371 appears to be a good predictor of actual future consumption behavior.

## 372 **6. Discussion**

373 Many practitioners, policy makers, and academics have participated in the ongoing debate  
374 on how to reduce meat consumption in order to address the potential impact related to health,  
375 society, and environment (Apostolidis & McLeay, 2016). As a consequence, consumers are  
376 increasingly interested in shifting to diets with occasional inclusion of animal products  
377 (flexitarian). Reducing the consumption of meat is an easier practice to adopt than the complete  
378 exclusion of meat, i.e., a complete shift to strict vegetarianism or veganism (Sogari et al., 2021).  
379 Therefore, past studies (Arnaudova et al., 2022; Grasso & Jaworska, 2020) have suggested that, in  
380 order to create an effective dietary change, the new eating habits should be familiar to consumers,  
381 especially the consumers who are very attached to meat. Research on how marketers and food  
382 service operators can encourage consumers to include blended meat and plant-based ingredients  
383 in their traditional meat products are lacking. Our results show that the introduction of a meat-  
384 mushroom burger among university students represents a robust applicable strategy to  
385 simultaneously increase vegetable consumption and reduce red meat consumption and sodium  
386 intake. Moreover, this strategy does not include compromising the original taste of the burger and  
387 does not limit the number of food choices available at the school cafeteria.

388 As suggested by Balcombe et al. (2016), provision of nutritional information did not sway  
389 the target population, while an appropriately targeted environmental message may be more  
390 effective in reducing meat consumption. Thus, a foodservice operation’s commitment to include  
391 more meat and plant-based options in its menu will be enhanced by investing in education related

392 to the sustainability and environmental impacts of food (Lee et al., 2014; Willett et al., 2019).

393         Although previous studies have identified how evocative and indulgent names and  
394 descriptions of foods can result in higher hedonic valuation (Turnwald et al., 2017; Yeomans et  
395 al., 2001), our findings did not find any significant relationships. This can be explained by the  
396 content of the message based on the umami properties that may not be commonly known and  
397 understood. This perhaps suggests that marketing strategies should focus more on the sensory  
398 appeal of the overall product (Bublitz & Peracchio, 2015), i.e., the taste of the burger, rather than  
399 the singular flavor ingredient of mushrooms.

400         High level of expectations and desire to eat the product have a positive association with  
401 the acceptance of food, whereas a lack of correspondence between the expected and actual liking  
402 may lead to a negative relationship between the perception of a product's quality and the appeal  
403 and desire to eat. For instance, Spencer, Cienfuegos, & Guinard (2018) reported that the  
404 acceptability of a dish using legumes as a meat replacement decreases if the expectations are not  
405 being met. Our results confirm that the overall liking of this new vegetable-meat recipe was rated  
406 higher when the eating experience matched the expectations. This implies that these new products  
407 still need to meet sensory quality expectations to be accepted because positive messaging alone  
408 will not compensate for low level of satisfaction. Nevertheless, in order to reduce the risk of  
409 product failure in the marketplace, the providers of meat-mushroom blended burgers need to  
410 communicate the attributes of the product (e.g., sustainability benefits of mushroom production)  
411 to increase burger acceptance, which would in turn positively increase the overall eating  
412 experience.

413         It is common in food research to investigate consumer acceptability to predict the  
414 consumption or purchasing of food products in future occasions (Cardello et al., 2000). Our  
415 findings emphasize the role of combined perceived and expected overall liking experiences to  
416 explain most of the attitude and behavioral intention to try this new product in the future.  
417 Consistent with previous studies (Menozzi et al., 2017; Ricci et al., 2018), the results confirm the  
418 importance of attitude in predicting the intention to consume. Finally, in line with the TPB model,  
419 our findings confirm that the ability of intention to predict behavior is higher when the behavior  
420 in question is more accessible and context-specific to perform (i.e., availability of the product at  
421 the dining hall) (De Cannièrè et al., 2009).

422         While previous research shows that openness to trying novel foods can be explained by

423 social influence and pressure (Mancini et al., 2019; Ruby & Heine, 2012), our results suggest food  
424 acceptance to also be a determinant in increasing the positive attitude toward this new blended  
425 burger. Since consumers are drawn to make choices based on the familiarity, the habits, and the  
426 taste of foods (Arnaudova et al., 2022; Bublitz & Peracchio, 2015), it is desirable to guarantee a  
427 positive reaction to the sensory appeal of these mixed meat and plant-based products. In fact, one  
428 of the main obstacles to the acceptance of these new novel products is the limited expected sensory  
429 appeal perceived by many consumers, which can create skepticism about the final quality.  
430 Therefore, new product development of meat alternatives (Arnaudova et al., 2022) and culinary  
431 strategies in the food service (Sogari et al., 2021) should consider the desired and expected sensory  
432 characteristics. The success of these products could encourage consumers to shift their traditional  
433 eating habits toward more sustainable options like “plant forward” menus (Culinary Institute of  
434 America, 2016; Spencer & Guinard, 2018). In particular, for heavy meat eaters, familiarity with  
435 the product is crucial to increase their intention to try reduced-meat alternatives.

436         Despite our encouraging findings, several limitations occur. First, generalizing our results  
437 to the general public might be problematic considering that our sample consists primarily of  
438 college students. University-educated individuals may be more receptive to information and in  
439 general be more open to switch to a diet with less meat intake than non-university students  
440 (Arnaudova et al., 2022). Future research should consider a broader and diversified sample, i.e.,  
441 older consumer groups and other nationalities.

442         While our study provides valuable insights on the consumer acceptability of the meat-  
443 mushroom burger, this work does not consider the other critical aspects that may influence the  
444 success of this type of product in other market contexts. Future research should explore the costs,  
445 the consumer willingness to pay, and the preferences across different types of meat alternatives,  
446 including 100% plant-based versus hybrid meat products. New directions for research in this area  
447 should focus on the consumer behavior in other eating contexts and purchasing situations such as  
448 restaurants and grocery stores. Moreover, further studies should include sensory analysis measures  
449 to investigate the profile of products under blind and informed conditions to evaluate the role of  
450 information.

## 451 **7. Conclusions**

452         This research has looked at the possible pathways to reshape the current tradition of heavy  
453 meat consumption with a more environmentally sustainable and healthier “plant-forward” diet. In



454 order to examine this pathway, we investigated whether students were ready to replace traditional  
455 burgers with a hybrid meat-mushroom burger in college dining venues. This is grounded in the  
456 principle that it may be more plausible to reduce the intake of meat in our daily diet routines than  
457 to completely eliminate meat consumption.

458 Our findings suggest that higher familiarity with hybrid meat and plant-based products,  
459 i.e., consumer tasting experience, increase the likelihood of a repeated purchase in the near future.  
460 Moreover, information on the sustainability benefits (e.g., lower carbon and water footprint  
461 impact) influences the acceptability of the blended burger. Thus, it is necessary to develop effective  
462 campaigns to communicate the benefits of these new foods to create market acceptance.

463 The strategy used for the blended burger can be replicated with other traditional US food  
464 items to partially replace meat with plant-based ingredients. We believe that our contribution to  
465 the current literature and body of knowledge on meat reduction strategies and eating behavior of  
466 hybrid meat products among students could lead to further discussion and insights, which may in  
467 turn inspire new initiatives and studies to investigate healthier and more sustainable diets.

#### 468 **Footnote**

469 <sup>1</sup>For the sake of transparency, the National Mushroom Council was involved in this study just as  
470 an external expertise. It did not take part in data collection or analysis, and neither did it finance  
471 the study.

472 **Declaration of competing interest:** None.

#### 473 **Acknowledgement of financial support of research**

474 **This study is part of a wider project called “CONSUMEHealth. Using consumer science to**  
475 **improve healthy eating habits” and has received funding from the European Union’s**  
476 **Horizon 2020 research and Innovation programme under the Marie Skłodowska-Curie**  
477 **grant agreement No 749514.****Acknowledgments**

478 The authors express thanks to all the staff of the Cornell Dining venues for their collaboration and  
479 help in carrying out this study. Additionally, the authors thank The National Mushroom Council  
480 for providing vital support to carry out this investigation.

481

#### 482 **Ethical Statement**

483 All study procedures were deemed exempt by the Institutional Review Board (IRB) of the Office  
484 of Research Integrity and Assurance of Cornell University (Protocol ID#: 1808008184).  
485 All participants in the study gave informed consent before taking part in the study.

486

#### 487 **Author Contributions**

488 **Giovanni Sogari**: Conceptualization, Methodology, Data curation, Formal analysis, Project  
489 administration, Supervision, Writing - original draft. **Jie Li**: Data curation, Formal analysis,  
490 Writing - original draft. **Qian Wang**: Data curation, Formal analysis. **Michele Lefebvre**:  
491 Methodology, Writing - review & editing. **Shihua Huang**: Data curation. **Cristina Mora**: Writing  
492 - review & editing, Project administration. **Miguel I. Gómez**: Writing - review & editing, Project  
493 administration, Supervision. All authors have approved the final article.

494

#### 495 **Appendix**

496

497 *Insert here Table A1. Preliminary questionnaire items, before eating the burger*

498

499 *Insert here Table A2. Primary questionnaire, after eating the burger*

500

501

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