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

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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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1. Introduction

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

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

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

7

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).

4. Materials and Methods

4.1 Participants

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

[Insert Table 1]

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

4.2 Design with information treatment

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

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

It is essential that any type of information provided to encourage consumption is appropriately presented at the point of purchase/selection, otherwise, it will not be salient to the 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/)[1].

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 α 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

12

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 Cannière et al., 2009).

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

14

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

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

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

7. Conclusions

This research has looked at the possible pathways to reshape the current tradition of heavy 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 [1]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.

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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