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How information affects consumers' purchase intention and willingness to pay for poultry farmed with insect-based meal and live insects

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2 **Title**

3 How information affects consumers' purchase intention and willingness to pay for poultry
4 farmed with insect-based meal and live insects

5

6 **Short title:**

7 Consumers' perception of meat from poultry fed on insects

8

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22

23 **Abstract**

24 The opportunity to use insects as protein sources for poultry has many environmental
25 advantages. Moreover, the administration of insects to poultry can provide animal welfare and
26 health benefits, allowing the expression of their natural behaviour, reducing aggression, and
27 supplying nutrients. However, there is limited research on consumer's acceptance of farmed
28 animals fed with insects. Our study aims to understand consumers' attitude towards, intention
29 to purchase, and willingness to pay (WTP) for meat obtained from a farmed duck fed on (1) an
30 insect-based meal, and (2) live insect diet. We conduct an online survey of 565 Italian meat
31 consumers, including an information treatment regarding the sustainability and nutrition
32 benefits of using insects as feed. Our results demonstrate that providing more information about
33 the positive effects of using insects in feed production may motivate those more interested in
34 environmental issues to purchase insect-fed duck meat products. Compared to the control
35 group, the purchase intention of consumers in the treatment group is also affected by their
36 attitude towards animal welfare. Their WTP for such products is directly affected by their
37 previous entomophagy experience. Attitude and intention to purchase an insect-fed duck are
38 the main predictors of consumers' WTP for a duck fed with both insect-meal and live insects.
39 This study provides insights for policymakers and the private sector. We suggest that increasing
40 consumers' awareness by communicating the positive environmental impact of the use of insect
41 as feed can potentially differentiate meat products for consumers and influence their purchase
42 preferences.

43 **Keywords**

44 duck meat, animal welfare, sustainability, consumer behaviour, attitude

45 **Conflict of interest:** The authors declare no conflict of interest.

1. Introduction

The increase in world population and the changes in dietary habits will necessitate an increase in food production in the near future (HLPE, 2017). However, it is particularly challenging to increase food production without degrading natural resources, limiting the emissions of greenhouse gases, and consequently, the impacts due to climate change (FAO, 2017; Poore and Nemecek, 2018). Nowadays, livestock feed production is using 80% of agricultural land worldwide. Moreover, soybean cultivation for animal feed is constantly growing over the years, with 53% of the total soy production being used in poultry feed (Dalgaard *et al.*, 2007; Fraanje and Garnett, 2020). The poultry sector is showing the greatest increases among the farmed animals; poultry meat production is estimated to be 136.8 million tons in 2020, a 7.5% increase compared to 2018 (FAO, 2020). Poultry sector includes different avian species, such as chicken, duck, turkey, and geese. The second most reared poultry species for meat production, in terms of number of heads produced worldwide, is duck (FAOSTAT, 2020). Recently, duck meat is being considered more by diet-conscious consumers because of its muscle fibre composition and its fat quality (Ali *et al.*, 2007; Chartrin *et al.*, 2005; Schiavone *et al.*, 2004, 2007). Specifically, duck breast meat has more red muscle fibres compared to chicken breast. Furthermore, it has also a great amount of polyunsaturated fatty acids, helping reduce the risks of cardiovascular disease, obesity, and cancer (Jakobsen, 1999). In 2018, the global production of duck meat reached 4.46 million tons, with Asia being the main producer (83% in 2018) (Castillo *et al.*, 2020). Europe is the second largest producer, at 11.7%, in 2018 (Castillo *et al.*, 2020). In Italy, however, duck meat production is marginal and declining compared to other poultry products (80,000 birds slaughtered in 2019, a 45% decrease compared to 2019) (ISTAT, 2020).

The reduced availability of natural resources, together with the increasing cost of raw materials (such as soybean meal), will require innovative and sustainable feed input to support animal growth while alleviating the negative impacts on the environment (Gasco *et al.*, 2020a; Mancuso *et al.*, 2020). Recently, researchers are focusing on the use of insects as livestock feed, particularly for monogastric species such as poultry (Biasato *et al.*, 2018; Dabbou *et al.*, 2017; Gariglio *et al.*, 2019a, 2019b; Gasco *et al.*, 2020c). The opportunity to use insects as protein sources for poultry has many environmental advantages. First, insects can efficiently process food industry by-products, converting organic wastes into raw material rich in nutrients. Moreover, if waste or otherwise non-utilised side-streams are used as insect rearing substrate, the environmental impact of insects' rearing is further reduced. This also contributes to the circular economy principle (Fowles and Nansen, 2020; Gasco *et al.*, 2020b). The lower soil and water requirements of rearing insects, together with their lower greenhouse gas and ammonia emissions, make them competitive against the conventional vegetable raw materials used in poultry feeding (Smetana *et al.*, 2016).

The legal framework on the use of insects and insect-derived products as feed differ across countries. Due to the feed ban legislation, laid down as a preventive measure against Transmissible Spongiform Encephalopathy, insect-derived proteins are only authorised for aquaculture feeds in the European Union (EU) (Sogari, Amato, *et al.*, 2019). However, recently, on the 13th of April 2021, EU Member States voted positively on a draft regulation aimed at enabling the use of insect processed animal proteins in poultry and pig nutrition. This proposal is expected to enter into force at the end of the 2021. It will be a big step forward toward the authorisation of the use of insect meals for livestock feeding in Europe. Currently, in the EU, whole dried or frozen insects cannot be used for feed purposes except for pet. However, the use of live insects does not fall within the definition of processed animal proteins, and therefore, the feed ban is not applicable [(EC) 999/2001]. Thus, live insects may be used for fish, poultry, and pigs (Sogari, Amato, *et al.*, 2019). However, certain EU Member States, including Italy,

95 still do not authorise their use before obtaining clearer information on safety issues (Ministero
96 della Salute, 2017). Market permission is the first step for the insect industry development,
97 followed by a strict collaboration between private sector, researchers, governmental
98 organisations, and public society (van Huis, 2020). In this context, consumer's increasing
99 attention to animal welfare is an important aspect to be considered (Kendall *et al.*, 2006). Insects
100 are commonly consumed by wild birds and free-range poultry species, improving their welfare
101 by expressing their natural behaviour (Rodenburg *et al.*, 2005). Live insect larvae
102 administration to poultry could provide animal welfare and health benefits, allowing the
103 expression of their natural behaviour, reducing aggression, and supplying nutrients (Star *et al.*,
104 2020). For example, Veldkamp and Niekerk (2019) observed positive effects, in terms of
105 reduced feather pecking, in young turkey poults. Similarly, Star *et al.* (2020) noted better feather
106 conditions in lying hens fed with live insect larvae compared to hens fed with commercial diet.

107 Despite the increasing interest in using insects (whole or processed) in animal feed, for
108 successful development of a market for insect-based feed, it is crucial to investigate consumers'
109 response to this new production method. To the best of our knowledge, only few studies have
110 investigated consumers' acceptance of meat and meat-based products obtained from animals
111 fed with insects (Popoff *et al.*, 2017; Verbeke *et al.*, 2015). One of the first consumer perception
112 surveys was undertaken by PROteINSECT in 2014 and 2015 with a sample of over 2,400
113 responses in several EU countries. The results found a high level of support for insects as a
114 protein source in animal feed. Indeed, 70% of the respondents accepted the use insects as
115 protein sources for farmed animals. 73% would be willing to eat fish, chicken, or pork meat
116 from animals fed diet containing insect proteins. Two-thirds of people surveyed expressed no
117 or low health risks of eating farmed animals that had been fed insect protein. They also
118 expressed a need for more information on the topic (PROteINSECT, 2016). Verbeke *et al.*
119 (2015) reported the results of a small survey involving 82 consumers visiting Agriflanders 2015
120 (which is a bi-annual public fair for and by Flemish agriculture); the results found favourable
121 attitudes of participants towards the use of insects in animal feed, where more than two-thirds
122 of the study participants accepted this idea, while only 6% definitely rejected it. This positive
123 attitude and the general consumers' acceptance of insects used as feed in fish farming was also
124 found for trout among French (Bazoche and Poret, 2020) and German consumers (Ankamah-
125 Yeboah *et al.*, 2018), and for salmon among Scottish (Popoff *et al.*, 2017) and Italian consumers
126 (Mancuso *et al.*, 2016). This general wide acceptance is driven by the fact that fish eat insects
127 when they are reared in natural environments.

128 However, few studies have been conducted on consumer's acceptance of poultry animals fed
129 with insects. Altmann *et al.* (2019) evaluated respondents' opinion about chicken breast
130 produced with insect meal over other types of feed. Onwezen *et al.* (2019) focused on
131 consumers' acceptance of a burger made from chicken fed with insect-based feed (Onwezen *et al.*,
132 2019). Spartano and Grasso (2021a, 2021b) investigated consumers' attitudes, perceptions,
133 and willingness to try and pay towards eggs from insect-fed hen in the UK. Few studies have
134 focused on the comparison between different farmed animals. For instance, Kostecka *et al.*
135 (2017) used a Polish sample and Domingues *et al.* (2020) used Brazilian consumers for carrying
136 out studies on the willingness to accept the use of insects to feed poultry, cattle, pigs, and fish.
137 Our study aims to understand consumers' attitude towards, intention to purchase, and
138 willingness to pay (WTP) for meat obtained from a farmed duck fed both on an insect-based
139 meal and/or live insect diets. We conducted an online survey of 565 Italian meat consumers.
140 The effects of individual and psycho-social characteristics, such as previous experience with
141 entomophagy, attitude towards animal welfare, interest in sustainability issues, as well as socio-
142 demographic variables, were also investigated. Previous studies focusing on the Italian
143 consumers' acceptance of insects as food (Mancini *et al.*, 2019; Verneau *et al.*, 2016) have

144 shown how information positively influenced attitude towards eating insects (i.e. lower disgust
145 and distaste). Therefore, we included an information treatment regarding the sustainability and
146 nutrition benefits of using insects as feed, assuming that the purchase intention and WTP for
147 animals fed insects is affected by information provided to consumers, as suggested by others
148 (e.g. Bazoche and Poret, 2020). Since it is still unclear how information about insect-based feed
149 may positively influence consumers (Ankamah *et al.*, 2018), we also attempt to address this
150 gap.

151 **2. Materials and Methods**

152

153 Cross-sectional data collection was conducted in Italy during December 2019 and January 2020
154 using an online survey. A total number of 583 responses were collected. Participants were
155 excluded from the survey if they reported to be minors and/or vegetarians and/or vegans. After
156 a quality check, a final sample of 565 participants (53.1% female) was included in the data
157 analyses. The age range was 18–80 years, with a mean age of 38.8 years (SD = 13.9).
158 Approximately 73.6% participants were from Northern Italy, while the rest were from Central
159 and South Italy. About one-third (33.5%) indicated coming from ‘small sized urban area (<
160 5,000 population < 50,000)’, 47.8% from ‘Large urban area (population \geq 50,000)’, and the
161 rest from ‘Rural area (population < 5,000)’.

162 The questions were developed based on previous literature on consumer studies on insect as
163 feed (Mancuso *et al.*, 2016; Popoff *et al.*, 2017; Verbeke *et al.*, 2015). The survey instrument
164 was web-programmed in Qualtrics[®], an online survey platform, and distributed among a
165 convenient sample of Italian food primary shoppers and meat consumers. After a pilot test to
166 determine the length and overall understanding of the questions, the survey was revised prior
167 to administration. The questionnaire was developed in English and translated into Italian by a
168 professional translator.

169 The final survey consisted of five main sections. All questionnaire items are available in the
170 electronic Supplementary Material (Table S1). The first part addressed meat eating and
171 purchasing habits, including duck meat. The second section asked, using a single item, the
172 participant’s interest in the environment and the motivation to process sustainable information
173 (Sogari *et al.*, 2020). Then, we included an information treatment using a message about the
174 sustainability benefits of including insects as feed raw material (Table 1). The sample was
175 randomised and half of the participants (n = 286) received the information, while the rest (n =
176 279) did not.

177 The third section focused more on the use of insects as feed for animal/duck farming. Here, we
178 included questions regarding the attitude to eat and the intention to purchase meat-based
179 products obtained from animals fed with insects. The WTP for a duck meat product was also
180 assessed using a hypothetical scenario. Participants were asked to imagine purchasing a duck
181 leg fed, first, with insects-based meal and then with live insect diet, instead of vegetable meal.
182 A mock-up packaging image was displayed before the question to create a more realistic and
183 credible situation. The standard price, expressed in € per kg, was based on market inventory
184 conducted in different grocery stores in several Italian cities to ascertain the average retail price
185 for a duck leg (8.95€/kg). Respondents were asked to indicate how much would they be willing
186 to pay, considering the three alternatives ‘I would pay a lower price’, ‘I would pay the same
187 price’, and ‘I would pay a higher price’. If they were willing to pay a lower or higher price, they
188 had to state what price they would have paid, in a monetary interval of 10 ranges from 10% to
189 100% below or above the average price of 8.95€/kg (also, see Riccioli *et al.*, 2020).

190 The fourth section included an open question about the potential reasons for eating a farmed-
191 duck fed on an insect-based diet (Popoff *et al.*, 2017), the attitude towards animal welfare
192 (Marescotti *et al.*, 2019), and familiarity and previous experience with entomophagy (Kostecka

193 *et al.*, 2017). Finally, socio-demographic questions such as gender, age, region of origin, and
194 geographical area were recorded in the last section.

195 Informed consent was asked before starting the survey. Upon review of the human subject
196 protocol, this study was approved by the Research Ethics Committee of the University of Turin
197 (Protocol ID: 122601).

198 The analysis was performed using SPSS and AMOS statistical software (v26.0, IBM
199 Corporation, Armonk, NY, USA). We performed two structural equation models (SEM), one
200 for the questions related to ‘insect-meal’ and the other one to ‘live insects’, to test for the effect
201 of exogenous variables (e.g. previous experience with entomophagy) on purchase intention and
202 WTP (endogenous variables). SEM allows for the specification of models with both latent (e.g.
203 attitude towards eating a duck fed with insect-based meal) and observed variables (e.g. previous
204 entomophagy experience) (Kline, 2016). A multi-group analysis was also conducted for each
205 product to test for differences between control and information treatment groups. We used the
206 Bayesian estimation routine recommended in presence of categorical variables. The goodness-
207 of-fit of the models was assessed with the following indices: χ^2 and their degrees of freedom
208 (df), Tucker-Lewis Index (TLI), comparative fit index (CFI), root mean square error of
209 approximation (RMSEA) with its 90% confidence interval, and standardised root mean square
210 residual (SRMR).

211

212 **Table 1. Text shown to the participants in the information treatment:**

The world population is increasing as well as the demand for food, consequently the concern for food reserves is growing. Insects are increasingly recognized as an alternative source of protein for use as animal feed. In fact, many insect species are highly nutritious, and their production has a lower environmental impact compared to other feed protein sources, such as soy. Therefore, it has been recently proposed that the protein part of traditional feed (composed only of vegetable ingredients) used in farmed animals (e.g. ducks) could be partially replaced with products derived from insects. In addition, insects are eaten in nature by many animals such as fish, pigs, poultry, including chickens and ducks, and can therefore be considered a natural food. Furthermore, no type of sensory alteration has been identified on the final products.

(Adapted by Altmann, Risius, and Anders, 2019; Laureati *et al.*, 2016; Popoff *et al.*, 2017)

213

214 **3. Results**

215

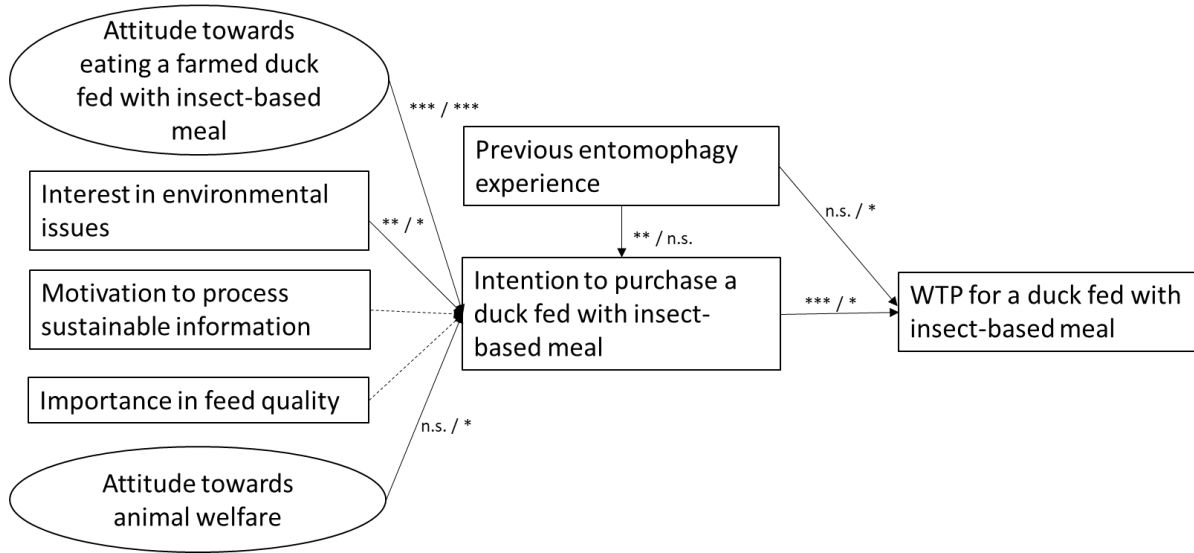
216 We tested the path model represented in Figure 1 for predicting the intention to purchase and
217 the WTP for a farmed duck fed with (a) insect-based meal, and (b) live insects. A multi-group
218 analysis was applied to test the difference between control and information treatment groups.

219 In the first model predicting the intention and WTP for a farmed duck fed with insect-based
220 meal (Figure 1a, Table 2), the main predictor of intention is consumers’ attitude towards eating
221 a duck fed with insects in both control ($\beta = 0.617^{***}$) and information treatment groups ($\beta =$
222 0.633^{***}). In the control group, intention is also affected by having previous experience with
223 entomophagy ($\beta = 0.127^{**}$) and consumers’ interest in environmental topics ($\beta = 0.128^{**}$).
224 Interest in environmental topics ($\beta = 0.095^*$) and attitude towards animal welfare ($\beta = 0.104^*$)
225 are also relevant for explaining the intention to purchase a farmed duck when information is
226 provided.

227 Figure 1a and Table 2 show that consumers' WTP for a duck product fed with insect-based
 228 meal is positively affected by the intention ($\beta = 0.245^{***}$) in the control group. When
 229 information is provided to consumers, intention becomes less significant ($\beta = 0.126^*$), while
 230 the previous experience with entomophagy becomes relatively more important in explaining
 231 consumers' WTP ($\beta = 0.138^*$).

232

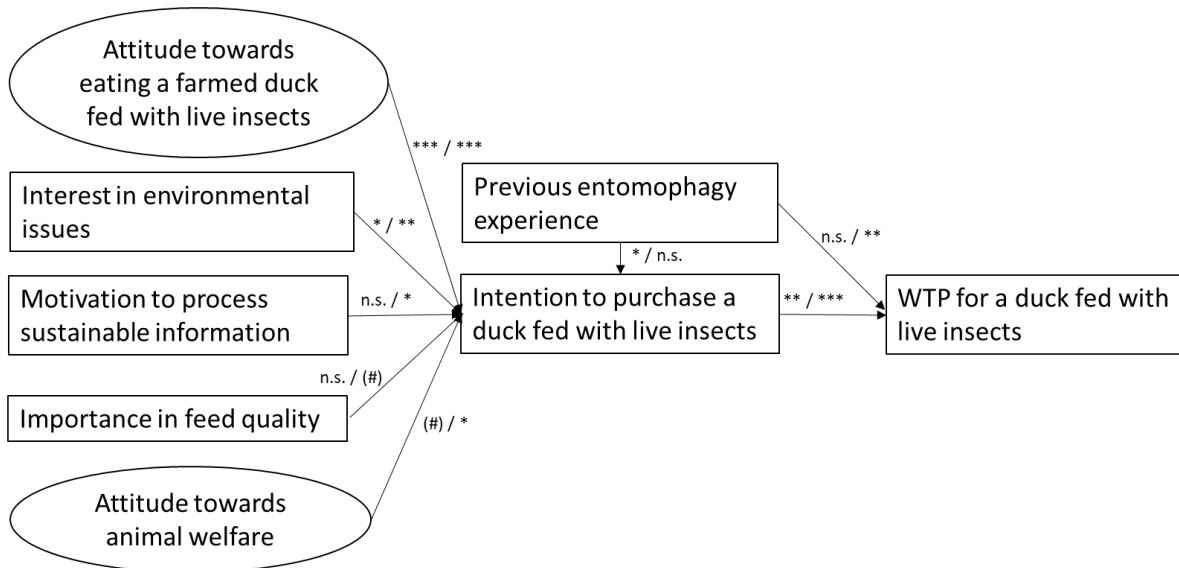
233 **a) Insect-based meal (control / information), n = 565**



234

235

236 **b) Model live insects (control / information), n = 565**



237

238 **Figure 1: Path model predicting the intention to purchase and the WTP for a farmed duck fed with a) insect-**
 239 **based meal and b) live insects, in control (n = 279) and information treatment groups (n = 286).**

240 Note: For simplicity, the correlations among variables are not displayed, but are available in the electronic
 241 Supplementary Material (Table S2). Rectangles indicate observed (measured) variables, whereas ellipses surround
 242 latent (unmeasured) variables. Sign: ***: $p < 0.001$; **: $p < 0.01$; *: $p < 0.05$; #: $p < 0.10$; values in brackets are
 243 negative parameters; dashed line: parameter not estimated.

244

245 In the second model predicting the intention and WTP for a farmed duck fed with live insects
246 (Figure 1b, Table 2), the main predictor of intention is still attitude towards eating a duck fed
247 with insects in both control ($\beta = 0.728^{***}$) and information treatment groups ($\beta = 0.698^{***}$).
248 Therefore, in both cases, consumer's attitude is the most important determinant of intentions,
249 confirming several psycho-social theoretical frames (Fishbein and Ajzen, 2011). In the control
250 group, intention is again affected by consumers' interest in the environmental topics ($\beta =$
251 0.122^*) and previous experience with entomophagy ($\beta = 0.093^*$). When information is
252 provided, the consumers' motivation to process sustainable information ($\beta = 0.141^*$), and
253 interest in environmental topics ($\beta = 0.149^{**}$), as well as attitude towards animal welfare ($\beta =$
254 0.111^*), are all relevant in explaining the intention to purchase a farmed duck fed with live
255 insects.

256 Figure 1b and Table 2 show that the WTP for a farmed duck fed with live insects is driven by
257 the intention, both in control ($\beta = 0.189^{**}$) and information treatment groups ($\beta = 0.210^{***}$),
258 confirming the ability of intentions in predicting behaviour (Fishbein and Ajzen, 2011).
259 Previous experience with entomophagy is significantly predicting respondents' WTP once they
260 have been provided with information ($\beta = 0.154^{**}$).

261 The analysis of the covariates among the model variables shows several strong correlations of
262 the motivation to process sustainable information, interest in environmental issues, importance
263 in feed quality, and attitude towards animal welfare (Supplementary Material, Table S2).

264

265 4. Discussion

266

267 Studies demonstrate that, technically, a partial or total replacement of conventional protein
268 sources by insect proteins is feasible with minimal impact on the sensorial and quality
269 characteristics of animal food products (Gasco *et al.*, 2019). Some argue that consumers' low
270 motivations to accept insects as food (i.e. due to food cultural unfamiliarity) are strong barriers
271 for the development of this industry in Western countries (Dagevos, 2021), including Italy (Toti
272 *et al.*, 2020). However, the use of insects as feed may be better accepted than insect food
273 designed for human consumption (Onwezen *et al.*, 2019; Spartano and Grasso, 2021b; Verbeke
274 *et al.*, 2015). This study contributes to the discussion on the factors influencing consumers'
275 purchase motivations and WTP for meat products from poultry fed with (a) insect-meal and (b)
276 live insect. One strength of this study is measuring the effects of these drivers for a specific
277 poultry animal (i.e. duck meat) instead of a more general willingness to accept the use of insects
278 in feed for poultry (Domingues *et al.*, 2020; Kostecka *et al.*, 2017).

279 As shown in previous studies about entomophagy (Mancini *et al.*, 2019; Menozzi *et al.*, 2017),
280 our results indicate that attitude towards insects as novel source is the main predictor of the
281 behavioural intention of purchasing an animal fed with insects. This is true for both products,
282 that is, meat obtained by animals fed with either insect-meal and live insect, and in both
283 information treatments. Unsurprisingly, interest in environmental issues positively influences
284 the intention to purchase both types of meat products, regardless of the information treatment,
285 although with a lower magnitude than attitude. Instead, the motivation to process sustainability-
286 related information has a significant impact on consumers' purchase intention only for the duck
287 products fed with live insects, and only when additional information is available for consumers.
288 Therefore, this demonstrates that providing more information about the positive effects of using
289 insects in feed production may motivate those more interested in environmental issues to
290 purchase meat products of animals fed with insects. In turn, intention to purchase a duck fed
291 with insects is the main predictor of consumers' WTP for such meat products. That is, we show
292 that consumers' motivation to purchase is the main driver of their WTP for meat products
293 obtained by animals fed with both insect-based meal and live insects.

294
295

Table 2: Insect-based meal and live insect models: path coefficients (unstandardised beta, standard errors, standardised beta, and p-values) in control (n = 279) and information treatment groups (n = 286).

Path coefficients	Control (n = 279)				Information (n = 286)			
	beta	S.E.	Std β	p	beta	S.E.	Std β	p
Insect-based meal model								
<i>Predicting Intention to purchase</i>								
Importance in feed quality	-	-	-	-	-	-	-	-
Interest in environmental issues	0.207	0.079	0.128	0.009	0.132	0.066	0.095	0.047
Motivation to process sustainable information	-	-	-	-	-	-	-	-
Attitude animal welfare	-0.092	0.068	-0.067	0.180	0.154	0.076	0.104	0.041
Previous entomophagy experience	0.340	0.124	0.127	0.006	0.068	0.105	0.030	0.517
Attitude toward eating a duck fed with insects	1.014	0.099	0.617	<0.001	1.235	0.132	0.633	<0.001
<i>Predict WTP</i>								
Intention to purchase	0.287	0.070	0.245	<0.001	0.128	0.060	0.126	0.032
Previous entomophagy experience	0.001	0.187	0.000	0.997	0.314	0.134	0.138	0.019
Live insects model								
<i>Predicting Intention to purchase</i>								
Importance in feed quality	0.034	0.060	0.025	0.576	-0.110	0.061	-0.084	0.073
Interest in environmental issues	0.225	0.088	0.122	0.011	0.219	0.085	0.149	0.009
Motivation to process sustainable information	0.030	0.072	0.021	0.675	0.177	0.077	0.141	0.022
Attitude animal welfare	-0.137	0.078	-0.082	0.079	0.193	0.088	0.111	0.028
Previous entomophagy experience	0.282	0.123	0.093	0.022	0.123	0.101	0.052	0.225
Attitude toward eating a duck fed with insects	0.785	0.046	0.728	<0.001	0.785	0.053	0.698	<0.001
<i>Predict WTP</i>								
Intention to purchase	0.192	0.061	0.189	0.002	0.236	0.065	0.210	<0.001
Previous entomophagy experience	0.230	0.186	0.074	0.217	0.413	0.155	0.154	0.008

296 Fit measures Insect-based meal model: $\chi^2(df) = 255.482 (186)$; CFI = 0.983; TLI = 0.978; RMSEA (90% CI) = 0.026 (0.017-0.033); SRMR = 0.055

297 Fit measures Live insects model: $\chi^2(df) = 288.122 (184)$; CFI = 0.979; TLI = 0.972; RMSEA (90% CI) = 0.032(0.024-0.039); SRMR = 0.051

298 We have assumed, as suggested by Ankamah *et al.* (2018), Popoff *et al.* (2017), and Spartano
299 and Grasso (2021a), that increasing consumers' awareness of the positive environmental impact
300 of the use of insect as feed through communication on the package (i.e. the information
301 treatment) can potentially differentiate meat products for consumers and influence their
302 purchase preferences. We do find that providing information on the sustainability and nutrition
303 benefits of using insects as feed compared to traditional sources may modify the predictors of
304 intention to purchase and WTP for the animals fed with both live insects and insect-based meal.
305 Compared to the control group, when consumers are provided with information, their purchase
306 intention is also affected by their attitude towards animal welfare. Meanwhile, their WTP for
307 such products is directly affected by their previous entomophagy experience. In the control
308 group, the effect of consumers' previous entomophagy experience on WTP is only mediated by
309 intention. Therefore, we find a more direct effect on consumers' WTP of previously
310 entomophagy experience in those who have received more information about the benefits of
311 using insects in animal farming.

312 Our results are in line with Spartano and Grasso, (2021b), who found that previous tasting
313 experiences with insects as food affected consumers' WTP for eggs from insect-fed hens in the
314 UK. This is particularly relevant for companies aiming at using insect-based feed given a likely
315 increase, in the near future, of individuals being exposed to edible insects; these consumers, if
316 provided with more information about animal feeding with insects, may have a higher WTP for
317 these products. A possible explanation for these results is that the fear of a negative sensory
318 experience is reduced. As shown by Mancuso *et al.* (2016), distaste is one of the strongest
319 barriers to the willingness to purchase and eat farmed animals fed on insect meals. Furthermore,
320 Menozzi *et al.*, (2021) showed that providing information about insects' benefits reduced the
321 disgust emotion associated with eating animal fed with insects. The authors suggested that
322 communicating about the insects as being a natural feed for poultry animals and that the final
323 meat taste is unchanged are important factors to increase acceptance.

324 Therefore, to decrease consumer's distaste, we recommend providing information that
325 reassures the consumer that the taste of these products is not negatively influenced. Moreover,
326 our finding of previous entomophagy experience decreasing consumers' neophobia to
327 acceptance animals fed with a novelty feed is in line with many studies on the importance of
328 past experiences for increasing insect acceptance (for a complete review see Sogari, Menozzi,
329 *et al.*, 2019). This assumption is partially in contrast with the findings by La Barbera *et al.*,
330 (2020), who suggested a negative correlation between acceptance of 'indirect entomophagy'
331 (insect as feed) and 'direct entomophagy' (insect as food) among Western consumers. Future
332 studies should thoroughly investigate whether the acceptance of insect-based feeds may be
333 negatively correlated with individuals' attitude towards direct entomophagy.

334 The information treatment also increased the effect of consumers' attitude towards animal
335 welfare on the intention to purchase a duck fed with both insect meal and live insects. As
336 reported by Vecchio and Annunziata (2012), the quality of animals' feed is one of the most
337 important welfare aspects for Italian consumers. Thus, we may assume that consumers like it
338 more that poultry are fed with insects, similar to their natural living environment (Verbeke *et al.*,
339 2015).

340 These results have several policy and business implications. Our findings suggest that the
341 purchase intent and WTP for poultry meat can be influenced through information campaigns to
342 consumers on the negative impact of traditional feeding practices, and the potential nutritional
343 and environmental benefits of insect as feed. Moreover, we believe that communicating that the
344 final sensory quality of the meat would not be negative influenced (i.e. the taste remains the
345 same) is crucial to avoid any disgust reaction. Furthermore, our results show that the main
346 drivers of consumers' motivations to purchase and WTP are the same regardless of the type of
347 insect feed used, that is, insect-meal or live insect. As reported in the introduction, in the EU,

348 live insects are currently authorised for use in fish, poultry, and pigs. Live insects' larvae
349 provision in poultry can improve birds' welfare, in terms of a more stimulating environment,
350 thereby reducing stress and allowing the expression of their natural behaviours. A more
351 respectful rearing system of the animals (in terms of the possibility to express specific
352 behaviours) can be positively associated to the increasing consumer interest in animal welfare.
353 This is relevant in policy terms too. As pointed out by Altmann *et al.* (2019) and Menozzi *et*
354 *al.*, (2021), the importance of information (i.e. a label 'insect feed') in influencing consumers'
355 product choice decisions raises the question whether the legislator should consider a mandatory
356 labelling in meat and meat-based products.

357 Although these findings present implications for practitioners, the study has some limitations.
358 First, a convenience sampling method in the distribution of the questionnaires was used. This
359 implies that the results are difficult to be generalised to the whole Italian population. Another
360 limitation may be due to the specific products included in the study (i.e. duck fed with insects).
361 We noticed that respondents were not so familiar with duck meat. Moreover, as the product
362 under study (i.e. insect-fed duck) is not yet on the market, it may be difficult for the respondents
363 to imagine the purchase situation.

364 Even though past studies indicated that any defects, off-flavour, nor aroma negatively
365 influenced meat obtained from poultry fed with insect meal (Gasco *et al.*, 2019), a first avenue
366 for future research should integrate a multidisciplinary approach that includes both consumer
367 and sensory sciences with non-hypothetical scenarios (Altmann *et al.*, 2019; Sogari, Amato, *et*
368 *al.*, 2019). Future studies should also investigate the trade-off between the type of feed (i.e.
369 insects) and other product attributes (e.g. origin, farming method), and how this may affect
370 consumers' purchase decisions. Finally, an in-depth investigation should focus on key
371 stakeholders such as feed and poultry producers, and retailers to identify potential barriers and
372 drivers of insects' inclusion as commercial animal feeds.

373

374 **5. Conclusions**

375

376 Understanding which factors could affect consumers' purchase intention and WTP for meat
377 products from animals fed with insects plays a key role in establishing tailored policy and
378 marketing interventions towards the emerging sector of insect feed. We found that attitude
379 towards insects as novel source is the main predictor of the behavioural intention of purchasing
380 an animal fed with insects; in turn, intention is the main predictor of consumers' WTP for such
381 meat products. We also discussed the effects of consumers' interest in environmental issues,
382 attitude towards animal welfare, and previous entomophagy exposure on intention and WTP,
383 along with the effects of information treatment.

384 This study is one of the first attempts to understand how information on the use of insects as
385 feed can influence consumer behaviour towards a poultry meat product. In contrast with the
386 movement of entomophagy, which has received a substantial and growing global media
387 attention in the past few years (Payne *et al.*, 2019), the topic of insects as feedstuff has not
388 received wide media coverage yet. Thus, most people are still unaware about the potential
389 benefits of this alternative protein source for farmed animals (Spartano and Grasso, 2021b).
390 Therefore, we believe that providing information will raise awareness. Insects as feed can
391 potentially become an important branding opportunity for poultry farmed animals. We suggest
392 that poultry producers and distributors should consider identifying the feed type used on duck
393 meat produced with insect meal, especially if information on the benefits will be provided to
394 consumers (e.g. on the product package). Even though these are prominent results for the
395 private sector interested in this alternative feed source, a link between reported intention to
396 purchase animals fed with edible insect and actual future consumption cannot be stated.

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401

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