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

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Title

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

Short title:

Consumers' perception of meat from poultry fed on insects

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Abstract

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

Keywords

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

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 particular challenging to increase food production without degrading natural resources, limiting the emissions of greenhouse gasses, 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,

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

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

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

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

2. Materials and Methods

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

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

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

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

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

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

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

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

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)

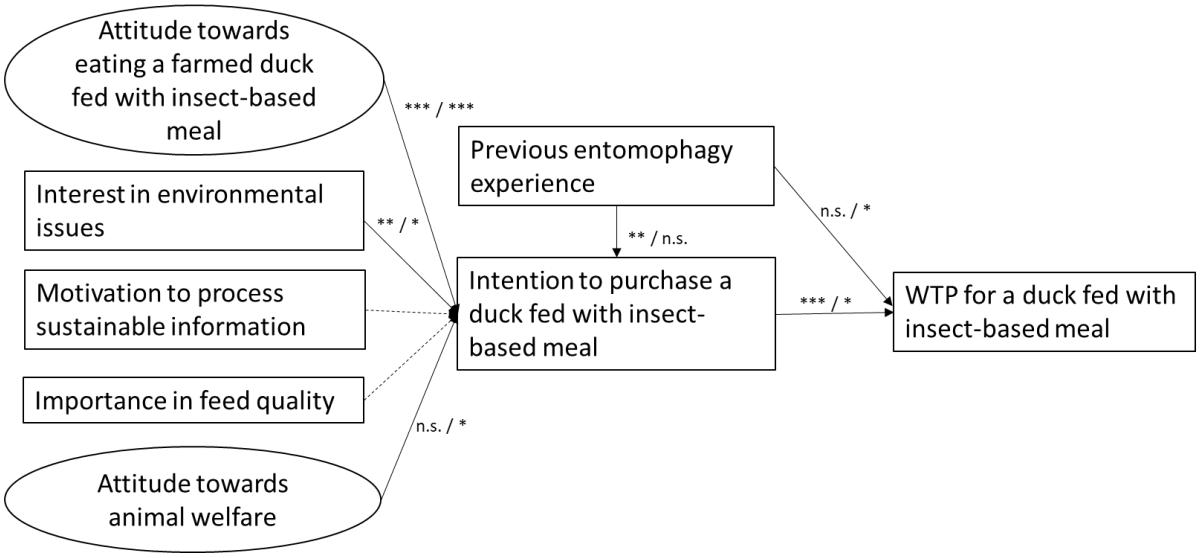
3. Results

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

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

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

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



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

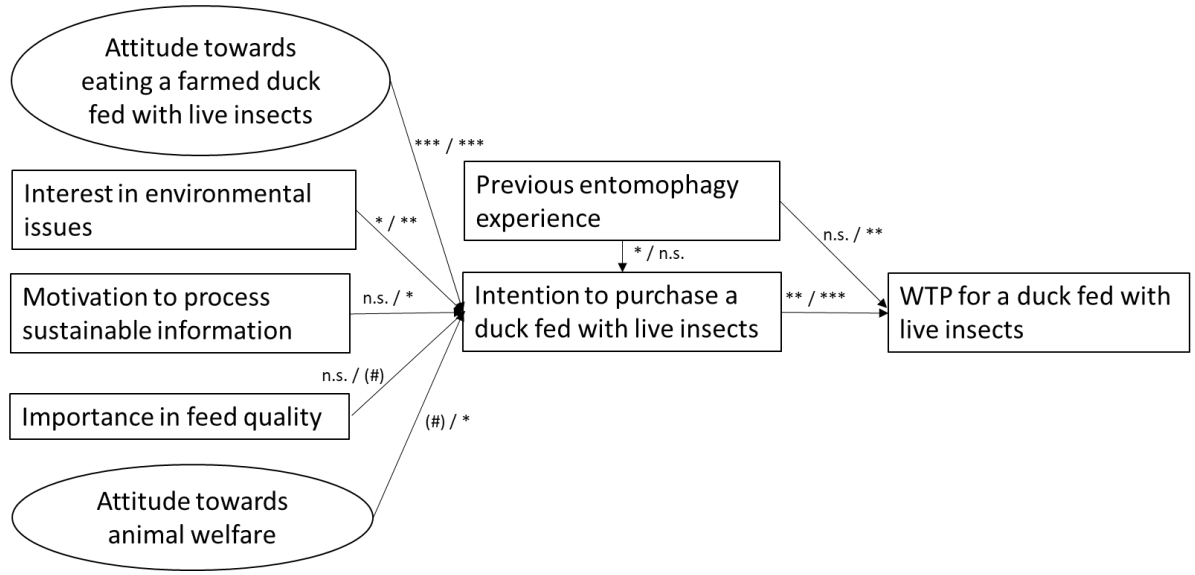


Figure 1: Path model predicting the intention to purchase and the WTP for a farmed duck fed with a) insect-based meal and b) live insects, in control (n = 279) and information treatment groups (n = 286).

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

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

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

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

4. Discussion

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

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

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).

	Control (n = 279)				Information (n = 286)			
Path coefficients	beta	**S.E.**	**Std β**	**p**	**beta**	**S.E.**	**Std β**	**p**
Insect-based meal model								
Predicting Intention to purchase								
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
Predict WTP								
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								
Predicting Intention to purchase								
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
Predict WTP								
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

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

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

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

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

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

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

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

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

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

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

5. Conclusions

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

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

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