Understanding the sensory characteristics of edible insects to promote entomophagy: A projective sensory experience among consumers

Alfonso Piscitelli, Roberto Fasanelli, Elena Cuomo, Ida Galli

1. Introduction

The world population is continuously growing, and with it, the demand for food increases. Processes such as urbanization and globalization are increasingly influencing dietary change for a considerable part of the population. The result is a constant increase in the need for high biological value proteins, the production of which represents a challenge for the future, especially considering that current production techniques (i.e., animal protein farming) not only have a significant environmental impact but also show a low level of efficiency. These techniques produce high levels of carbon dioxide, consume considerable amounts of water, and involve major waste-disposal problems (Amato et al., 2019).

The European Parliament has indicated that the deficit in protein sources is one of Europe's most critical problems: the Old Continent imported about 80% of its protein from other countries. Insects can be a sustainable alternative to this problem, for their efficient metabolism and their ability to transform organic waste into high-quality protein (Materia and Cavallo, 2015). Western countries' interest in insects as a potential source of food has grown considerably in recent years: the high content of high-quality protein and the sustainability of the production process, compared to traditional sources, primarily meat, have contributed to increasing scientific debate on the topic. The progressive inclusion of insect-based ingredients in the human diet has attracted increasing attention as a valid alternative to overcome the major nutrition challenges the world is facing (Schrögel and Wätjen, 2019). However, a diet based on insects (or their components) entails a radical departure from Western societies' current food traditions. Although recent research shows that consuming insects (raw or processed) provides significant benefits in terms of protein content, social acceptance is, on the contrary, very low in Western societies (Verneau et al., 2016; La Barbera et al., 2018; 2020). However, insects and their derivatives in food products are not entirely new even in the West: products such as jams and fruit juices contain traces of them, for an estimated average per capita consumption of 250 gr/year (Materia and Cavallo, 2015; Sogari and Vantomme, 2014), even if a clear awareness of this is still lacking. Scholars conducted several studies to analyze consumer behavior employing insect-based foods; many of these have identified factors that may positively or negatively influence the degree of acceptance.

Our basic hypothesis is that intention to try insect-based dishes is causally dependent on sensory reasons that are relevant to sensation-seeking. To test this hypothesis, we interviewed a convenience sample of consumers to examine the relationships between their intention to try insect-based dishes and their anticipatory gustative sensations regarding "insects as food". The research data were obtained from a web questionnaire completed by a sample of consumers which was held using social media and via e-mail lists.

The paper is organised as follows. After this introduction, Section 2 describes the sample

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survey and introduces the model for data analysis. Then, Section 3 presents the main results of the statistical analysis of the collected data. Finally, Section 4 interprets the data with reference to sensation seeking in connection with the choice of food.

2. Data and methods

2.1 Consumer survey on entomophagy

A fact-finding/exploratory survey was conducted on a small convenience sample of Italian consumers. The inclusion criterion was represented by having at least heard of the introduction of insects into human nutrition. The survey, conducted between July to December 2020, was carried out by means of a web questionnaire filled out by participants who completely satisfied the inclusion criterion and recruited using social media (e.g., Facebook, Twitter, WhatsApp chats) and via e-mail lists (e.g., University of Naples student lists).

The self-administered questionnaire has been structured into 3 sections each of them with a specific aim of collecting data. In the first section, we asked each participant to answer both semi-structured and structured questions made up starting from the following dimensions: previous knowledge of the "insects as food", informative sources, and opinions about it. As a supplement, three additional items were administered to measure the intention to eat insects in general. This section ended with four items added to ask participants for their willingness to eat specific animals (cow, fish, chicken, and pig) fed with insects. All answers were collected using a 7-point scale from "strongly unlikely" to "strongly likely". A specific section was devoted to what we called projective sensory experience (PSE). To identify respondents' anticipatory gustative sensations regarding "insects as food" we used an ad hoc created two-step tool. In particular, (first step) we asked participants to imagine tasting an insect dish and then rate from 1 imperceptible up to 10 very perceptible the following taste-olfactory sensations inspired by the work of Donadini et al. (2008): Sapidity, Bitter tendency, Acidity, Sweet, Spiciness, Aroma, Greasiness-Unctuosity, Succulence, Sweet, Fatness, Persistence. Furthermore (second step), since a representation is always built from a disturbing object (in positive or negative), at the end of the task, we asked our interviewees to indicate, through a specific checklist, which was the most disturbing and least disturbing imagined taste-olfactory sensation. The goal is to know which kind of "sensory anchoring" participants activate in front of an insect's dish.

The questionnaire ended by collecting the respondents' descriptive characteristics (gender, age, education, living area) as well as their eating habits.

2.2 Analytical model

The model for data analysis includes the intention to try insect-based dishes as a dependent variable, Y, a set of possible regressors, $\mathbf{X}$, and a set of control variables, $\mathbf{Z}$. The relationship may be written as

$$Y = f(X_i \mid Z_i) ,$$

where X_i denotes the taste-olfactory sensations. The control variables, which were forced into the model, were gender, age, education, and living area. The Y variable was measured on two levels.

The logistic regression model is written as follows (Agresti, 2002; Bilder and Loughin, 2014):

$$logit(\pi) = \beta_0 + \beta_1 X_1 + \cdots + \beta_p X_p \quad ,$$

where $0 < \pi < 1$ and $logit(\pi) = log[\pi / (1 - \pi)]$, and β_i measures the relation between Y and

X_i when all other variables in the model remain fixed.

$$\pi = \Pr\{Y = 1 \mid X, Z\}$$

where Y = 1 represent the positive intention to try insect-based dishes.
Maximum likelihood estimation is used to estimate the parameters $\beta_0, \ldots, \beta_p$ of the logistic regression model. It will be clear, based on the context, how the probability of success is a function of explanatory variables, being the slope of the logit function hyperplane along each X dependent on the value of the corresponding parameter β.

Statistical analyses were carried out in the *R* environment (R Core Team, 2021). A logistic regression model to a dichotomous response variable was identified by the *glm* function. Moreover, the *step* function was utilised to perform stepwise model selection with criterion *AIC*.

3. Results

The data were gathered from 154 consumers, of these, about 58% of respondents were female, and about 42% were male. The mean age of respondents was 43 years (SD = 14.12), 53% lived in a highly urbanized area, 39% lived in the urban suburbs, and the remaining 8% lived in a rural area. About 28% of respondents has a very high level of education (superior graduate or PhD), 49% has a bachelor's or master's degree, and the remaining 23% has a level of education of secondary school.

Table 1 summarises the results of the regression analysis reporting the estimates of the regression betas obtained and their significance.

Table 1. Beta estimates, and related standard errors, of the regression model with intention to try insect-based dishes as criterion variable (forward stepwise selection of regressors, n = 154; AIC = 181.95; *** $0 < \alpha^{oss} < 0.001$; ** $0.001 < \alpha^{oss} < 0.01$; * $0.01 < \alpha^{oss} < 0.05$; ° $0.05 < \alpha^{oss} < 0.1$; NS= Not significant at 10% threshold; the interactions are labeled by colon between the variables' names)

Regressor	$\widehat{\beta}$	$\mathrm{se}(\widehat{\beta})$	***Signific.***
Intercept	-0.13239	1.40747	NS
Male	0.24661	0.43939	NS
Age	0.01346	0.01762	NS
AreaMedium urbanization area	-0.14526	0.93184	NS
AreaHigh urbanization area	0.41342	0.90084	NS
EduBachelor's degree	-1.99574	1.54414	NS
EduMaster's degree	-1.70110	1.58013	NS
EduSuperior Graduate or PhD	-2.05785	1.49962	NS
Acidity	-1.08717	0.40715	**
Spiciness	0.70918	0.32008	*
Persistence	-0.15071	0.10155	NS
Sweet_tendency	0.18975	0.10348	°
EduBachelor's degree**:**Acidity	1.03092	0.46193	*
EduMaster's degree**:**Acidity	0.80548	0.45596	°
EduSuperior Graduate or PhD**:**Acidity	0.78677	0.43907	°
EduBachelor's degree**:**Spiciness	-0.51565	0.37416	NS
EduMaster's degree**:**Spiciness	-0.42817	0.36845	NS
EduSuperior Graduate or PhD**:**Spiciness	-0.34148	0.35956	NS

Note: Some regressors are not individually significant but are significant wrt AIC criterion.

Our results highlight a dependence of the willingness to try insect-based dishes by the respondent's fondness to Acidity (indirect), Spiciness (direct) and a mediation effect of education degree on the former. The results of the regression analysis support the following claims:

- imagining a taste-olfactory sensation of "extremely perceptible" acidity reduces the willingness to try insect-based dishes;
- imagining a taste-olfactory sensation of "extremely perceptible" spiciness increases the willingness to try insect-based dishes;
- educational level plays a moderating role because the interaction between educational levels and acidity indicates a differentiating among the participants. The bachelor's degree moderates the effect of acidity and increasing the probability to try insect-based dishes, as do the other two levels of education, but gradually;
- imagining a taste-olfactory sensation of "extremely perceptible" sweet tendency increases the willingness to try insect-based dishes.

4. Discussion and conclusion

We have tested whether the consumption of insects is carried out for sensorial reasons by means of the new tool, ad hoc created, the Projective Sensory Experience (PSE).

As Lammers, Ullmann, and Fiebelkorn (2019) demonstrated, in connection with the choice of food, sensation seeking correlates with liking spicy food and the willingness to try unusual foods also showed that people with a high sensation seeking have a lower food neophobia. From our results, we assume that sensations like “spicy” should be positively related to the willingness to consume insects while “acidity” has a negative role.

In summary, this study confirms the results found in other researches on Italian consumers, who are not completely familiar with the topic of entomophagy. In addition, it was shown that overall, only four of ten of our interviewees would try the experience of eating insects, as well as another study (Sogari et al., 2017) showed that 47% of young Italian “foodies” envisaged insect eating. Moreover, it is important to highlight that the willingness of Italian consumers to adopt insects into their diet seems higher than in other countries of Mediterranean Europe (Mancini et al., 2019). Furthermore, this study identified sensation seeking and especially “sensory anchoring” as additional predictors for the willingness to consume insects as food in addition to the already known influential factors such as gender, educational level, previous insect consumption, food neophobia and food technology neophobia. In our case highest level of education mediate the willingness for spicy insect dishes.

These preliminary results allowed us to identify which aspects are worth focusing on while searching for the multidimensional motivations behind this particular food choice, and also to highlight the moderation role played by some kind of cultural factors. After the screening achieved thanks to this pilot stage of the study, it would be interesting, for example, to understand the role played by environmentalist ideology on the choice to regularly include insects in one's diet. The question arises as to whether the ecology-based food really motivates consumers to eat insects. A more in-depth analysis of the motivation of people already consuming insect products might provide further insights on how insects might be integrated into the Italian diets. The findings of this preliminary analysis are encouraging about the idea of exploring by a “projective” approach the sensory experience related to food, and supports us to continue along this path. Nonetheless, in order to reduce the aversion to insects as food, it is necessary to create opportunities for the Italian population to make their own positive taste experiences, probably by giving to these foods precisely the sensory characteristics that our interviewees have already imagined attractive to their palate.

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