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# Sensory-liking Expectations and Perceptions of Processed and Unprocessed Insect Products

Giovanni Sogari, Davide Menozzi, Cristina Mora

*Department of Food and Drug, University of Parma, Italy  
giovanni.sogari@unipr.it; davide.menozzi@unipr.it; cristina.mora@unipr.it*

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## ABSTRACT

The aim of this study was to investigate how sensory-liking attribute perceptions (appearance, taste and organoleptic characteristics) can change between a readily visible vs a processed insect product before and after tasting. Results indicate that texture and appearance of the insect are perceived as stronger barriers than the taste attribute. Moreover, both unprocessed and processed insect-based products generate more positive perceptions after tasting compared to expectations. The positive experience of tasting products with both visible and processed insect may lead consumers to reconsider their initial negative expectations and attitude towards entomophagy.

**Keywords:** *entomophagy; consumer studies; sensory science; cricket; novel food; Italy*

## 1 Introduction

Entomophagy, the consumption of insects, is a normal component of human diet in Asia, Africa, Central and South America (van Huis et al., 2013; Nadeau et al., 2015), whereas in Western culture it tends to be viewed with disgust and as a practice for times of famine only (DeFoliart, 1997; Sogari and Vantomme, 2014).

The acceptance or rejection of a novel food is influenced by several factors (e.g. culture and society environment and personal traits) (Lensvelt and Steenbekkers, 2014); however the characteristics of the food itself (i.e. sensory properties) play a major role in food choice decisions, mostly because knowledge and appreciation of sensory properties increase with taste exposure (Hartmann and Siegrist, 2016; Tan et al., 2016).

Previous studies have shown how simply informing and making Western consumers aware of the nutritional and environmental benefits of entomophagy is not sufficient to persuade people to include edible insects in a regular diet (Verbeke, 2015; Hartmann and Siegrist, 2016). But taking account of the importance of appearance, taste and texture in the pleasure of eating, recent research has adopted a sensory-driven approach and included tasting sessions of several insect-based products in order to discover whether attitudes towards this novel food can change (Schouteten et al., 2016; Hartmann and Siegrist, 2016; Tan et al., 2016; Sogari, Menozzi and Mora, 2017). Moreover, when there is no real experience or regular consumption of a food, consumer expectations tend to be based on visual appearance and expected taste. Rozin and Fallon (1987) demonstrated that considering insects as food can evoke disgust and the thought of consumption can lead to the expectation and perceptions of bad taste. Therefore, the expected bad taste of edible insects is a potential barrier accepting them as food.

In line with the scope of this special issue "*Credence attributes, consumer trust and sensory expectations in modern food markets: is there a need to redefine their role?*", our work offers insights on how sensory

expectations and perception of a new novel food can change over time with experience as consumers gain familiarity with the food. Through the investigation of consumer's quality judgment of new novel food (edible insects) this study highlights the potential market success of such new food products.

This research aims to investigate whether and how Italian consumers will be willing to try these novel food products and eventually introduce whole and processed insects into their diets.

## 2 Background

After the approval by the European Commission of the new Regulation on Novel Food (Regulation (EC) No 2015/2283), from January 1, 2018 it should be easier to find insect products on the market in all the EU member states. Following intensive on-going research on edible insects in Northern Europe, particularly Belgium and the Netherlands, where some species are already authorized for sale (Caparros Megido et al., 2016), it now becomes important to study the entomophagy trend in the Mediterranean area. For cross-cultural comparison in consuming an insect-based product between North and South European countries see Menozzi et al. (2017a).

Although it is difficult to predict whether edible insects are the "food of the future" (Sogari, 2015), entomophagy sooner or later is set to become a niche market in Mediterranean food culture (Cicatiello et al., 2016; Menozzi et al., 2017b; Sogari et al., 2017).

As suggested by Tan et al. (2016), research on entomophagy should involve actual tasting and measures of perceived sensory properties, which play an important role in food choice decisions (Martins and Pliner, 2005). To date however, sensory perception changes after tasting real insect products have not been closely investigated among Italian consumers. The focus in Italy has been on initial consumer perception of insects as food and feed (Materia and Cavallo, 2015; Balzan et al., 2016; Cicatiello et al., 2016; Laureati et al., 2016; Mancuso, Baldi and Gasco, 2016), and few researchers include a tasting experiment (Sogari, 2015; Verneau et al., 2016; Menozzi et al., 2017b; Sogari et al., 2017). It now becomes of interest to investigate whether and how sensory-liking attribute perceptions (appearance, taste and organoleptic characteristics) can change between a readily visible vs a processed insect product before and after tasting.

Schösler, De Boer and Boersema (2012) also suggest that differences in consumer preferences and acceptability of insects as food might depend on the visibility of the insects. In fact, when the insect is not shown visually in the product and is present only in the list of ingredients, consumers tend to be more open to taste the product (Caparros Megido et al., 2014; Sogari, 2015; Tan et al., 2015).

However, few studies have investigated the sensory attributes (appearance, taste, texture, visibility) of common edible insects, such as the house cricket, in the western countries. However, knowing whether and how these sensory properties are evaluated is essential for businesses which want to start developing insect preparations for the market.

Previous research in the Italian context on consumer perception and tasting insect products showed that interest or curiosity can be a key driver to tasting insects for the first time (Sogari, 2015; Verneau et al., 2016; Sogari et al., 2017). This trigger however does not entail that consumers will be willing to eat insects repeatedly if the product is not considered to be tasty.

Following the study by Rozin & Fallon (1987), in this study a familiar food (a common sweet product) was "contaminated" by an unusual item (house cricket). The aim was to explore the likelihood of success of two insect food products (visible vs invisible insect presence) by measuring the changes in the level of sensory-liking expectations and preferences (appearance and taste) before and after tasting. For brevity, in this paper 'insect jelly' is used to indicate a soft jelly with a whole visible house cricket inside, species *Acheta domesticus* (L.), while "insect-based jelly" indicates the soft jelly containing house cricket flour.

## 3 Methods

This study is part of a wider research project on consumer expectations, neophobia and willingness to try insects among young adults in Italy. In this study, 88 Italian participants (45 females) performed a hedonic and sensory evaluation (sensory-liking) of a processed and unprocessed insect product. Recruitment was carried out at the University of Parma (Italy) among students and Faculty members. Participants were aged 18–40 years and can be considered potential future insect consumers. The study was advertised for participants of Italian nationality and without any types of food allergies. All study subjects gave informed written consent and were informed that the insects tasting was optional. Age, gender and the Italian region of origin of the respondents were reported.

Data were analyzed with descriptive statistics of the sample and a paired t-test of the Likert scale questions. The paired t-test was used to compare consumer expectations and perceptions before and after the tasting (treatment). This test is practicable with small sample.

Before tasting, sensory-liking expectations were evaluated with the question “What are your expectations about taste and the aspect of these products?” (the insects which participants were to taste) and rated on a 7-point Likert scale, from -3 (“extremely negative”) to +3 (“extremely positive”). Then, the two jellies were offered, one with a visible and one with a processed cricket, and participants were made aware that both products contained the same percentage of insect. The tasting session was individual, and no interactions were allowed. After tasting, participants were asked whether they had eaten the jelly insect and/or the jelly-based insect or neither of the products. In cases where participants did not try one or either of the products, they were asked about the reasons for their decision.

In the second part of the questionnaire, participants answered several questions about perceived sensory-liking (appearance and taste) and which of the two products they preferred.

In the descriptive sensory evaluation of the taste (flavors), respondents were asked to list positive and negative attributes in an open section. As in the study by Schouteten et al. (2016), sensory data were treated as check-all-that apply (CATA) by using the frequency of terms. The CATA technique was used to test food product characteristics perceived by consumers (sensory attributes).

Lastly, participants were asked whether they would invite friends and/or family members to try the insect jelly and/or the insect-based jelly, rating on a 7-point Likert scale, from ‘totally disagree’ to ‘totally agree’.

## 4 Results

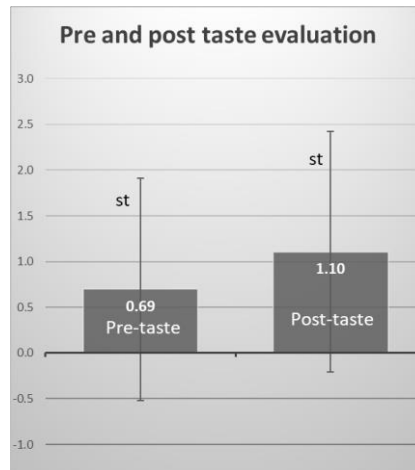
The sample was gender balanced: 43 men (49%) and 45 women participated in the study. All participants were Italian (20% from North-east, 36% North-west, 14% Centre and 30% South and Islands). The majority were students (80%) and the rest Faculty members.

Sixty-six participants (75%) agreed to taste both products, 17 (19%) only the insect-based jelly and five people (6%) did not try either product. In the hedonic evaluation, 38 participants indicated that they preferred the jelly with the whole cricket inside, 20 people preferred the insect-based jelly, only three liked both products, and three stated neither of the two jellies; 19 people did not indicate a preference.

Pre-tasting sensory-liking expectations (mean liking score 0 = neutral) revealed that participants rated the appearance of the insect-based jelly with a slightly positive score (mean value=0.48) which significantly increased (0.92) after the taste exposure ( $t(82)=2.11$ ,  $p<0.05$ ). No significant difference was found in expectations for the appearance of the insect jelly. However after tasting, the level of sensory-liking for the taste attribute of the insect jelly increased significantly from 0.69 (before) to 1.10 ( $t(65)=1.96$ ,  $p<0.05$ ) (Figure 1). The lower taste expectations of the insect jelly did not therefore result in a lower sensory-liking upon tasting. It can be assumed that as knowledge and familiarity with taste increases, appearance will become less important (Tan et al., 2016). Moreover, the gender effect was small but significant: for males the mean value increased from 0.53 to 1.29 after tasting ( $t(37)=2.64$ ,  $p<0.05$ ); whereas for females the taste evaluation decreased slightly after eating the insect. This suggests that this trait plays a key role in determining the sensory appreciation of a whole insect product. These findings conflict with Tan et al. (2016a) who found that taste experience reduced the differences in evaluations between males and females.

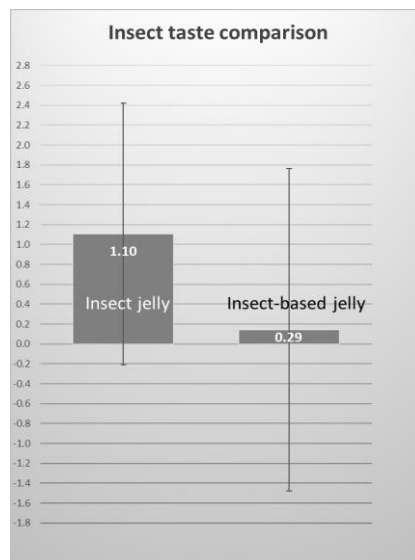
As shown in Figure 2, after the tasting session participants rated the insect jelly taste with a higher score (1.10) than the insect-based jelly (0.29) ( $t(65)=3.32$ ,  $p<0.01$ ) and the male participant values fell significantly from 1.29 to 0.24 ( $t(37)=3.49$ ,  $p<0.01$ ). This confirms the importance of the gender effect. On the other hand, the cricket flour jelly was preferred in appearance to the visible insect product.

Results from the descriptive sensory evaluation reported the main differences in sensory attributes (appearance, texture and taste) across the two products. The frequency of sensory term selection is shown in Tables 1 and 2. Some terms have not been reported because they were not relevant for this study. Significant differences were found between the insect jelly and the insect-based jelly especially regarding negative attributes.



Note: Mean values rated on a 7-point Likert scale, from -3 to + 3 and standard deviation bars

Figure 1



Note: Mean values rated on a 7-point Likert scale, from -3 to + 3 and standard deviation bars

Figure 2

Some sensory attributes (e.g. sweetness) are due to the properties of the products itself (a jelly sweet) and therefore should not be considered specifically for insect characteristics. But terms such as nutty, pet food or woody flavors are specifically related to the cricket flour.

The main results indicate how the whole cricket gives a positive perception of crunchiness (Sogari, 2015), but participants also reported that some parts of the insect (e.g. legs) can become “stuck in the teeth” and this gives a negative feeling. Problems of palatability and low digestibility due to the presence of the exoskeleton, have not as yet been fully investigated in developing insect products (Verbeke et al., 2015).

On the other hand, the presence of the cricket flour did not evoke the disgust factor, but other negative perceptions emerged. First, the texture was perceived as “too granular”, and the taste of flour “too strong”, with negative flavors (e.g. woody, pet food). The smell of the insect-based jelly was also considered less pleasant than the other product.

**Table 1.**  
Frequency terms (in brackets) of the sensory attributes for the insect jelly (n=66)

<b>Attributes</b>	<b>Positive</b>			<b>Negative</b>		
	<b>Appearance</b>	<b>Texture</b>	<b>Taste</b>	<b>Appearance</b>	<b>Texture</b>	<b>Taste</b>
<b>Terms</b>	<i>Pleasant (5)</i>	<i>Crunchy (14)</i>	<i>Sweet (11)</i> <i>Mild taste (3)</i> <i>Tasty (8)</i>	<i>Unpleasant</i>	<i>Cricket legs in the teeth (10)</i> <i>Hard texture of the insect (3)</i>	<i>Too sweet (9)</i> <i>Not tasty (2)</i>

**Table 2.**  
Frequency terms (in brackets) of the sensory attributes for the insect-based jelly (n=83)

<b>Attributes</b>	<b>Positive</b>			<b>Negative</b>		
	<b>Appearance</b>	<b>Texture</b>	<b>Taste</b>	<b>Appearance</b>	<b>Texture</b>	<b>Taste</b>
<b>Terms</b>	<i>Pleasant (6)</i>	<i>Crunchy (2)</i> <i>Good texture (2)</i> <i>Granular (2)</i>	<i>Sweet (12)</i> <i>Tasty (7)</i> <i>Nutty flavor (3)</i> <i>Mild taste (2)</i>	<i>Unpleasant (3)</i>	<i>Too Granular (8)</i>	<i>Too sweet (11)</i> <i>Unpleasant smell (7)</i> <i>Pet food taste (4)</i> <i>Too savory (3)</i> <i>Woody taste (2)</i>

As reported in previous studies (Menozzi et al., 2017b; Sogari et al., 2017), reasons for not tasting any of the two products were mainly “disgust”, “society, family members and friends do not consider insect as food” and more specifically “concern about the sensory properties (especially texture) of the jellies”. Participants who rejected only the insect jelly (n=17) indicated “disgust” and “concern for the texture property” as the strongest barriers, while “society, family members and friends do not consider insect as food” and “fear of taste expectations” are not as important as in the group which tried both products.

Finally, when asked about the likelihood of recommending people “close to you” to taste edible insects, participants rated highly positive both friends (2.14) and slightly lower family members (1.66) ( $t(83)=3.97$ ,  $p<0.05$ ). This result might suggest that people are more worried about promoting eating insects within their families because of possible negative feedbacks from older people, given that food culture in Italy is closely linked to traditional and familiar food habits. No gender effect was significant across the two groups.

## 5 Discussion and Conclusions

The present study provides an exploratory view of the role of sensory-liking expectations before and after tasting a visible and processed house cricket in a familiar food product (jelly).

Although many studies have suggested that presenting an invisible, processed form of insect may be the most effective strategy (Schösler et al., 2012; Caparros Megido et al., 2014; Sogari, 2015; Hartmann and Siegrist, 2016), this work suggests that for some “consumer groups” the presence of the whole insect significantly increases taste preference, although the visible aspect of the cricket is still a repellent factor. In line with other authors (Pliner, 1992; Lensvelt and Steenbekkers, 2014; Menozzi et al., 2017b; Tan et al., 2016), our findings show how a neophobic attitude towards novel foods decreases if individuals’ perceptions of sensory properties change positively after tasting. Taste exposure in fact improved the sensory-liking of these novel foods, and thus the perceived appropriateness of insects as a food. Our results also indicate that texture and appearance of the insect are stronger barriers than the taste.

The commercial potential of unprocessed and processed insect-based products will depend heavily on the sensory-liking attribute opinion both before and after tasting. So stakeholders in this sector should seek to publicize not only the potential benefits of entomophagy, but also consider taste education as an important tool in changing attitude and negative expectations of edible insects.

As noted by Tan et al. (2015), the presence of an invisible insect will not necessarily improve the overall liking compared to the whole insect product. Further studies are required to better identify and cluster different consumer groups.

The positive experience of tasting products with both visible and processed insect can lead consumers to reconsider their initial negative expectations and attitude towards entomophagy, and also encourage others to eat these novel foods. Our results show there is willingness to recommend similar tasting experiences to family members and friends, and thus highlight the importance of organizing insect tasting sessions for potentially interested consumer groups and / or the general public (Sogari, 2015). Moreover, it seems that the indirect approval of other people (e.g. family and friends) may be one of the most important drivers of the introduction and spread of entomophagy in Italian society (Sogari, 2015; Sogari et al., 2017).

Our study is however subject to certain limitations. First, the majority of the sample were University students, who may be more open towards novel foods than the general Italian population. Second, the study focused on two products and it is not possible to generalize the results to other insect novel products.

Future studies will need to take into consideration drivers which might influence repeat consumption intentions after tasting, so that insects become integrated into diet (House, 2016) and will need to consider a range of different food categories that vary in their similarity with Mediterranean cuisine, such as insect-based pasta or pizza products. In fact, in Italy insect tastings have so far been carried out only in tailored-made entomophagy conferences or research experiments where the product is presented unprocessed or as an ingredient in processed food. Moreover, considering that a limit of this study is the specific national/cultural context (Italian consumers), future experiments will need to make cross-cultural comparison. Future research will also need to consider eating contexts (restaurant vs home consumption) and the stage of preparation (raw or ready-to-eat).

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