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Insects or not Insects? Dilemmas or Attraction for Young Generations: A Case in Italy

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ABSTRACT

The production of proteins from insects is the next big challenge for Western countries. Although several benefits have been highlighted, mainly regarding their high environmental, social and economic sustainability, the use of insect-based ingredients is a radical break with tradition and encounters a very low acceptance among consumers. In this study, we present an exploratory analysis on a sample of Italian Millennials to test whether some product attributes can represent a barrier or a driver to such consumption. Results suggest that acceptance is far to be obtained, although the most powerful driver to insect consumption can be the invisibility of the insect shape.

Keywords: Insects as food; Millennials; Consumers' acceptance

JEL codes: D12; L66;

1 Introduction

Food demand is increasing with the constant growth of the population. Urbanization and globalization push towards a change in the diets at a worldwide level: new sources of high value proteins are desirable to meet the need of safe and secure food (Vantomme et al., 2014). Producing new proteins represents still a challenge for the future though: the current production process - the meat production is an example - is characterized by a high environmental impact and a low efficiency level, which calls for the need of new sources of proteins (van Huis and Vantomme, 2014). The lack of sources of proteins has been acknowledge also by the European Parliament, which has recently stated that 80% of the proteins used for the European consumption is actually imported from other non-EU countries, rather than being produced in Europe, with a high risk of the possible presence of GMOs in some of the imported products (for example, soy products) (van Huis et al., 2013). In this framework, insects represent a viable alternative to the current process of proteins production for several reasons (Borrello, et al., 2016; Celi and Rudkin, 2016; La Barbera et al., 2018). Their efficient metabolism, for instance, allows them to transform the organic waste they are fed with into high quality proteins, that, in turn, can be used also as feed (Vantomme et al., 2014).

The relevant amount of high quality proteins insects contain and the high sustainability of their production processes have recently contributed not only to the scientific debate on the appropriateness of their consumption (Fischer and Steenbekkers, 2018; Tan et al., 2015), but also to the increase of public interest on the topic even in Western societies (Schlup and Brunner, 2018). A scenario in which entomophagy becomes part of the diet-habits for Europe is not completely a utopia nor a taboo anymore: it may represent, in fact, an answer to the nutrition challenge that the world is facing (van Huis, 2013;

Verbeke, 2015). Recent studies have analyzed several reasons (cultural, economic, ecologic, technologic and legal reasons) beyond the great potential of ingredients such as insects to give a solution to the current food security issues (Dobermann et al., 2017; van Huis, 2013; van Huis et al., 2013).

However, a diet that includes insects-based ingredients certainly represents a radical break with nutritional traditions for European consumers. Although research has shown that benefits derive from the consumption of insects, or parts of them (Halloran et al., 2015; Kouřimská and Adámková, 2016; Rumpold and Schlüter, 2013; van Huis, 2013), the social acceptance is still very low in Europe (De Boer et al., 2011; DeFoliart, 1999; Hartmann et al., 2015; Sogari et al., 2017). The presence of insects in food is not totally new for Western societies, though: some products - jams and juices - already contain insects in traces and recent analyses show that there is an average consumption per capita of insects of about 250gr/year (Sogari and Vantomme, 2014). Consumers are completely unaware about this, which makes their acceptance level even lower.

The aim of the study is to verify the willingness to buy and consume insects as food of a specific part of society, the young generations, which might be triggered by specific attributes of these innovative ingredients. The case study is set in Italy. The insights deriving from these analyses might contribute to extend the set of drivers and barriers to the consumption of such foods and set an agenda for implementing a change in awareness starting from the youngest generations. How the attributes of the product influence the consumers' acceptance is therefore our main research question. Furthermore, since the introduction of insect-based snacks to the market will seemingly be realistic only in few years in Italy, we decided to base our study on young consumers, categorized as "Millennials", namely people that will effectively encounter this innovation in the near future (Cavaliere and Ventura, 2018). The case study of this research is represented by a snack food, being a familiar product for the targeted group of consumers and being not particularly linked to culinary preparation or cooking. To our knowledge, this study represents the first attempt in investigating the opinion of young consumers, simulating a point-of-purchase decision, in the case of insects-based food.

In this context, the present study aims, therefore, first at systematizing the existing literature in order to identify: (i) barriers to the consumption of insects-based ingredients in Europe (section 2), and (ii) drivers to possible changes in eating habits (section 3). Subsequently, in order to extend the knowledge about the factors that increase or lower the consumers' acceptability of insects as food, this study proposes an exploratory analysis, which makes use of a contingent experiment (section 4). Finally, the results of the exploratory study are presented (section 5), discussion and overall conclusions follow (section 6).

2 Barriers to insects as food

Although insects represent a source of food in several developing countries, in Western society there are still barriers that limit their production, acceptance and consumption. On top of this, a widespread concern for safety issues and the lack of laws regulating this matter along the whole supply chain (Rumpold and Schlüter, 2013) certainly do not facilitate the entrepreneurial activity of companies interested in opportunities in the field of insects as food. In an attempt to systematize the current literature on the topic, in this section we divide barriers to insects as food into general barriers for all insect-based products, and barriers depending upon the specific product characteristics. The attributes of the products that are recognized as influencing elements in consumers' perceptions will be subsequently tested in an empirical study.

2.1 Regulation of insects as food

The regulation of insects as food represents a field in which the legal framework is still quite complex. Laws regulate food that is historically considered as such. To enter this category, insects have firstly to be recognized as novel food; this already happened in Europe, as Belgium has been the first country considering insects as a possible source of food in December 2013, followed by the Netherlands later on and by Switzerland in 2017. The new Regulation on Novel Food[*] will allow to register insect-based food in the next future in Europe; Italy is still in a phase in which insects are not allowed yet to be used as food until European authorization.

[*] Regulation (EU) 2015/2283

The role of legislation is important, as it has an impact on the possibility for farms to innovate, develop new technologies, organize the commerce and marketing of the final product on the market (Porter and Van der Linde, 1995). Consequences are important also for supply chains relations (Boons and Lüdeke-Freund, 2013). We can, then, predict that several changes will occur in near future when laws will be clearer.

Religious food laws represent another issue for acceptability of insects. Islam has not clear rules about them, but interpretations of laws state that insects are neutral but not proper as food (Regenstein et al., 2003). While the situation is different for Kosher laws, in fact most of the insects are not allowed as food (this rule concerns also insects commonly used as pigments in food). Moreover, insects considered as "impure" in touch with food have the power of making impure the food in contact (Isman and Cohen, 1995). However, there are no bans and not suggestions about the use of such food from Catholic religion (Scopel, 2016).

2.2 Cultural barriers: consumers' perceptions and risk

A strong cultural barrier is represented by disgust as the main reaction of consumers when facing the possibility of eating insects: they are not considered as food (DeFoliart, 1992; Hartmann and Siegrist, 2018; Yen, 2009), they are rather vectors of diseases and pests (Tan et al., 2015). Disgust can be defined as "aversion to incorporate an offending substance" (Rozin and Fallon, 1987). The "law of contagion" states that objects or persons can influence each other with the contact (Morales and Fitzsimons, 2007). Rozin et al. (1986) offer with their study a demonstration of the effectiveness of this principle in explaining dynamics linked to the case of insects: in their empirical approach to the "law of contagion", the Authors used a drink that in contact with a sterilized cockroach becomes not appropriate for consumption according to the participants to the study. The effect is asymmetric: the direction of the contagion cannot be reversed; it is persistent with the time and it can influence consumer choices (Morales and Fitzsimons, 2007).

In addition, there is a shared general idea of insects as triggering food-borne diseases (Hartmann and Siegrist, 2018). According to several studies, this is however only a *perception* of the consumer: on the one hand, the products that enter the market undergo severe safety checks, and this will be certainly valid also for the insects-based food when legal limits will be available (Kouřimská and Adámková, 2016). It is however proven that the perception of consumers can deviate from the reality in case of (general) risks (Yeung and Morris, 2001). Theory states that risk perception is influenced by the uncertainty of the consumer: the fact that insects represent "novel foods", as recently recognized by the main institutions, can be a reason for changing consumers' behavior (Bauer and Cox, 1967; Menozzi et al., 2017). On the other hand, insects like caterpillars and grasshoppers actually feed themselves mostly with fresh vegetables, which makes them "healthier and cleaner" than other products commonly thought as being a high value food items for consumers (shellfish, for example, is generally considered as *luxury* food, however they can be fed with different types of waste[†]; still, this does not prevent consumers from eating them). Studies have furthermore demonstrated that the actual microbial risks carried by insects are the same presented by other meat sources, which still meet the interest and acceptance of the consumers (EFSA, 2015); although this justifies the need to still adopt proper good practice standards (e.g. blanching) when insects are grown in order to extracts components which will be used as for human consumption, no differences in microbial risks should be enough to enhance the acceptance of insects on the same level of meat sources (Caparros Megido et al., 2017; Dobermann et al., 2017).

The scarce acceptance of insects as food is due also to allergy issues that are raised by the presence of chitin and by the development of new allergies due to their consumption. Chitin can often be not digested by humans. The long-term effects of chitin ingestion are not known yet, however the information collected so far about the effects of chitin derivative suggest that even positive effects can be obtained on human health (Koide, 1998). When it comes to allergies, although there is room to suppose that the allergies deriving from the consumption of insects-based foods might be similar to those deriving from the consumption of crustaceans (with whom insects share some properties), it is still possible that new ones will emerge after concrete diffusion and consumption of insect as food (Dobermann et al., 2017; Ribeiro et al., 2017).

2.3 Lack of information

Besides consumers' perceptions based on the (nutritional) risks associated to the potential consumption of insects as food, the lack of information about the production, processing, safety and availability of this type of food represents a barrier that contributes to the negative attitude towards eating insects

[†] (Furedy, et al., 1999)

(Kouřimská and Adámková, 2016; Tan, et al., 2015). In general, the knowledge about the nature or the origin of food has a crucial role in the acceptance or avoidance of it (Martins and Pliner, 2006). In fact, in Eastern Asian countries, generally, insects are wild caught and then sold to the public (Morris, et al., 1991); while a product suitable for European consumers derives from insects that are properly raised, taking into account all the elements aimed at bringing a safe product on the market.

A wide literature dealing with psychological and cultural issues linked to the consumption of insects (especially in western societies) has so far devoted efforts in explaining these mechanisms (Gmuer et al., 2016; Looy et al., 2014; Sogari et al., 2017; Tan et al., 2015). Empirical evidence demonstrated that psychological and demographic variables together with cultural exposure can mediate for the acceptance of insects as food (Payne et al., 2016; Vanhonacker et al., 2013).

The rejection expressed by consumers towards new or unfamiliar food is commonly defined as *neophobia* (Barrena and Sánchez, 2013): an aversion or tendency to avoid food that is new (Pliner and Hobden, 1992) or food that is not traditional according to the individual's culture (Barrena and Sánchez, 2013; Tuorila et al., 1994). This is addressed as being one of the main barriers to the consumption of insects-based food (Hartmann et al., 2015). Neophobia appears to be an individual trait, however there are some trends in age groups. For example, neophobia is at the highest level in children and teenagers and appears to decrease in adults (Pliner and Hobden, 1992). However, among adults it increases with age (Choe and Cho, 2011; Tuorila et al., 2001).

2.4 Attributes of the products

Some barriers are represented by product-specific attributes. In fact, some studies have recently demonstrated that visibility and recognizability of insects can play a crucial role in shaping the preferences and altering the consumers' acceptability levels towards this radical innovative food (Gmuer et al., 2016; Schösler et al., 2012). However, so far, only a few number of studies has analyzed which specific factor triggers the sense of disgust toward insects, among which the shape, type, color, visibility or novelty of the insects when used for novel food production (Dobermann et al., 2017; Sogari et al., 2017; Verneau et al., 2016).

The novelty of this type of food can be understood also in relation to the difficulty to insert a new type of food in the already established food routine of European consumers (Gmuer et al., 2016). Since it is a product with no tradition in its use, the lack of familiarity with the product influences the consumers' actual behavior (Cavallo and Piqueras-Fiszman, 2017). For Eastern societies and some developing countries though, insects are in fact part of traditional diets and sometimes they are considered as culinary specialties (Hanboonsong, 2010; Ramos-Elorduy, 1997).

Summarizing, missing regulations represents the main barrier to production and consumption of insect-based food, while disgust and anticipated danger have a decisive impact on the intentions to consume such type of food that is not familiar in general. Anticipated danger is referred to reactions to food based on the anticipated consequences of eating it, rather than on the actual action and experience of eating it, as in the case of microbial and allergy risk that is not real. Sometimes, avoidance can be based upon judgments of not appropriateness of the product based on the lack of exposure of the consumer or on the missing insect-food culture in the society that does not provide both general information about the products and information about the possible culinary preparations. Another barrier can be represented by individual traits as the level of neophobia or the adherence to a religion. At the same time, some barriers are represented by product-specific attributes, the recognizability of the shape of the insects or the problem of inserting this food in the eating routine of consumers.

3 Drivers to the acceptance of insects as food

3.1 Low environmental impact of insects' production

Insects can live in different environmental conditions, they have a fast reproduction process, they show high growth rates, high feed conversion rates and they have a low ecologic footprint for their whole life cycle (van Huis, 2013). This entails that the environmental sustainability of this production is far higher compared to the current alternatives to produce protein sources (De Boer et al., 2011). These features make the group of consumers that is most likely to adopt insects as food, the ones concerned about ethical aspects of food, also due to the absence of pain sensation in insects (Caparros Megido et al., 2016; Ruby et al., 2015; Vanhonacker et al., 2013; Verbeke, 2015).

3.2 Cultural context

The cultural context represents an important factor determining the attitude of consumers towards radical innovations, especially in the food sector. Insects represent for non-European cultures an important traditional and cultural element (Christensen et al., 2006). For societies with an already existing entomophagy tradition, insects represent a value, a sort of link with rural life nostalgia (van Huis, 2013). Building such a reputation to insect-based products might potentially favor the attention towards insects also in cultures not yet ready to accept similar radical innovations (DeFoliart, 1992).

An important cultural factor that is able to shape the perceptions of consumers is represented by exposure. A long exposure to food appears to have some effects on its acceptability (Sogari et al., 2017). Although several psychological and biological factors regulate food preferences and "aversions", experience is certainly the first channel to acquire knowledge and "sense" for the food (Tan et al., 2015). In the case of insects, there are actually no evidences about an innate consumer aversion (Bodenheimer, 1951): this last seems to be rather an element that is learned with experience and it is due to cultural reasons (Tan et al., 2015). Some studies have already tried to introduce insects in Western diets making use of experiments, although on a small scale (Sogari et al., 2017; Tan et al., 2015). The main challenge is to induce consumers in making "the first try": after this, consumers can recognize in the insects taste some familiar sensory notes, as it can be the common nut taste (Caparros Megido et al., 2016; Sogari et al., 2017). The practice of growing insects is already existent in some parts of the world: their introduction in some ecosystems has proved to contribute to the integrated pest management; the use of insects on a large scale as an ingredient for feed has proved to be technically feasible and it is also already put in practice by some successful innovative companies (House, 2016; van Huis, 2013). This can set a precedent that stimulates the use of insects also for human nutrition.

3.3 Preparation method

The appropriateness of the preparation method, defined as the perception consumers have of the combination of both insects as food ingredients and culinary style, is in literature a potential driver in determining the openness of consumers towards radical food innovations (Caparros Megido et al., 2016). It has been proved that consumers are way more willing to try insects if they are prepared with common ingredients and if the preparation method is considered appropriate (Tan et al., 2015). Another element that can enhance acceptability is using an appropriate and evocative name to insects recipes, to attract the attention and generate a good expectation from the consumer (Piqueras-Fiszman and Spence, 2015).

3.4 Products' attributes

Certification of production of high environmentally sustainable animal proteins through insects represents a product-specific attribute that can serve as driver for consumers' acceptance (Halloran et al., 2016; Vanhonacker et al., 2013). The high biological value of proteins contained in some species of insects is also a product-specific driver that can enhance the acceptance (Christensen et al., 2006; Fischer and Steenbekkers, 2018). Consumers that are particularly focused on the health profile of their diet might see certifications of sustainability as a relevant driver of their choice to consume them (Fernqvist and Ekelund, 2014).

3.5 Communication

Underlining the reduced environmental impact that derives from insects' consumption can certainly positively affect the attitudes of consumers (Borrello et al., 2017; DeFoliart, 1992; House, 2016; Verneau et al., 2016); the same can be for the disclosure of the other benefits, as the nutritional ones, of which the consumers can be still not aware of. In detail, Verneau et al. (2016) investigated which type of communication would be more effective in providing information about this novel food: communicating the societal benefits of their consumption seems to be the most efficient in meeting the acceptance. In general, a broader communication would enhance the familiarity with the product and be, thus, an acceptance driver for consumption (Lensvelt and Steenbekkers, 2014).

As visibility of the original shape has been previously pointed out as a barrier, in turn, using insects flour can be thought as a driver (van Huis, 2013): this can certainly lower the disgust the visibility of the insects shape might generate. This aspect is also able to reduce the attention towards the appropriateness of their preparation (Gmuer et al., 2016; Tan et al., 2015).

4 The consumer survey

In order to investigate the role that product attributes can have in driving the perceptions of consumers of insect-based products and provide a base to increase consumers' acceptability, an experiment has been set up. The survey was provided in an online environment using Qualtrics and the sample (*n*=135) has been obtained through snowball sampling through the main social media (see Table 1). The study was based in Italy, therefore all the respondents were resident in Italy. The convenience sample has been selected with a specific focus on the younger part of the population: they are usually defined as "Millennials" (Bucic et al., 2012). They are defined as people born between 1980 and 2000 (Eastman et al., 2014), their purchase behavior is different from other categories as their set of personal values and traits play a central role in their food decisions (Lerro et al., 2018a). This choice has been made in order to best represent what is the opinion of consumers that are more likely to come across such an innovative product on the market in a near future (44.5% between the age of 18 and 24, 55.5% between the age of 25 and 35). Moreover, being the reluctance of European consumers particularly strong, it seemed plausible to investigate an age group with, on average, minimum levels of neophobia compared to the rest of the population (Cavaliere and Ventura, 2018; Tuorila et al., 2001).

Table 1.
Summary statistics of the sample

	Sample (n=135)
Gender	
Female	46%
Male	54%
Age	
18-24	44.50%
25-35	55.50%
Household size	
Mean	3.17
Education	
High-school degree	48%
Lower degree	30%
Post-degree	22%
Neophobia (1-5)	
Mean	3.06
St. dev.	0.33

The core of the experiment has been a contingent rating method (Bateman et al., 2002; Cicia et al., 2016; Hanley et al., 2001). In detail, a series of products cards have been shown to consumers describing the products for which they were asked to express their opinion. When each product card has been shown, the participants have been asked "*According to you, how likely is it for you to buy the product hereby described?*" the answer being on a scale from 1 (certainly not) to 6 (absolutely certain) (Siegrist et al., 2008). At the end of this task, the Food Neophobia Scale followed (Pliner and Hobden, 1992). Some demographic questions have concluded the analysis and have supported the definition of the characteristics of the sample of respondents.

4.1 The model

In order to understand the consumers' opinion about an insect-based snack, a contingent experiment has been then applied. Interviewed had expressed rating scores that were recoded into rank-ordered

preferences (Bond, et al., 2011). The outcome of the contingent rating experiment of the *i*-th respondent per each *j*-th product profile can be rewritten as $Y_{i,j} = m$, $j \in J$ alternatives (the 8 profiles) and *m* the rating that goes from 1 ("I will certainly not buy") to 6 ("absolutely certain that I will buy"). From a utility perspective, the use of ordinal preferences implies that, for the *i*-th respondent's perceived utility associated to the *j*-th product, $U_{i,j}$ is greater (lower) than to $U_{i,k}$ when $Y_{i,j} > Y_{i,k}$ ($Y_{i,j} < Y_{i,k}$) and $U_{i,j}$ is equal to $U_{i,k}$ when $Y_{i,j} = Y_{i,k}$ with the alternative $k \in J$ and $k \neq j$. The data from the ranking task and the covariates have been analyzed using a Rank-ordered Logit. Assuming that consumers do not always choose what they prefer, according to the Random Utility Maximization Model (McFadden, 1974), the utility function is made by a deterministic part and an error term. In this case, the deterministic part is made by the assumption that the outcome is a preference ordering of utilities (*U*) corresponding to each profile (ξ):

$$U\xi_j^1 \geq U\xi_j^2 \geq \cdots \geq U\xi_j^J$$

that depends on a taste parameter (β_h) multiplied by each attribute ($x_{j,h,n}$) represented by a row vector x (Cicia et al., 2002). The maximum-likelihood method provides consistent and efficient estimates of the taste-parameters vector β. Those values indicate, indeed, how much each attribute contributes to the total utility.

The model also had controlled for covariates, namely elements, other than levels and attributes, that are able to explain part of the data variability. To this purpose, interactions between covariates and independent variables have been included in the model. We had tested therefore for all the possible interactions, and through a stepwise procedure, we have selected the one with the highest statistical significance.

We had excluded price from the set of attributes: this choice has been motivated by the pioneering feature of this study. In fact, at this early stage of diffusion of this category of products, we aimed to investigate the basics of acceptance, therefore, excluding the trade-off that the consumer makes between attributes and price, that is subsequent to the prior willingness to buy the product.

4.2 The variables

The product used as a stimulus was a snack. The choice of this category of product was motivated by the high familiarity of the targeted group with already-prepared meals and particularly with snacks (Hamilton et al., 2000). Furthermore, there was a need of investigating the acceptance of insect-based food without the influence of pairing with other food in other meals of the day (Gmuer et al., 2016).

The independent variables were chosen according to the attributes that have been selected by consumers in a previous qualitative study (Materia and Cavallo, 2015) and according to what the literature has considered as relevant in influencing the decisions of consumers (see the previous sections). In detail, the selected explanatory variables were:

- Flour/ whole insect: the visibility of the shape of insects can be a major driver of disgust, but, at the same time, it can trigger curiosity in consumers (Sogari et al., 2017). For these reasons, snacks are proposed into two different shapes: snacks with the shape of insect versus snacks made with insect flour;
- Opaque packaging: since the visibility of the insect is an important element, the type of packaging can influence the perception of consumers. Usually products with a transparent packaging are preferred as they convey a natural image of food (Cavallo and Piqueras-Fiszman, 2017). In the peculiar case of insect-based food, the presence of this effect needs to be tested;
- Cacao flavor: the presence of cacao can be appealing to consumers as it represents a hedonistic consumption and can help to overcome the barrier represented by the presence of insects (Masi et al., 2016; Varela et al., 2014);
- High protein content (30% of protein content): peculiar nutritional information can have some effects in driving decisions of consumers, in fact, previous researches state that it can generate expectations about superior nutritional content (Brunsø et al., 2002). In this case we used a claim about a high content in protein, since the efficient production of protein-dense food is one of the peculiarities of insect-based food (Hartmann and Siegrist, 2017);

- Environmental Certification: insect-based food finds its reasons in the sustainability of processes; therefore, we test the effect that the presence of an environmental certification can play on consumers' decisions (Caswell and Mojduszka, 1996). In detail, we used an already existing certification that responds to the environmental friendly characteristics of insects-based food, namely the ISO 14040 certification[‡].

In each survey, eight labels were shown, combining the levels and attributes following an orthogonal design developed through the Orthoplan procedure with the software SPSS, as shown in Table 2. The orthogonal design allows to analyze the effects of the attributes without using the full profile set, still allowing robust results (Green and Srinivasan, 1990; Hanley et al., 2001).

Table 2.
Attributes and levels corresponding to each profile

Profile	Insects	Pack	Cacao	High-protein content	Environmental Certification
1	Flour	Opaque	No	No	Yes
2	Whole	Opaque	Yes	No	Yes
3	Whole	Trasparent	No	No	No
4	Whole	Trasparent	Yes	Yes	Yes
5	Whole	Opaque	No	Yes	No
6	Flour	Trasparent	Yes	No	No
7	Flour	Opaque	Yes	Yes	No
8	Flour	Trasparent	No	Yes	Yes

5 Results

The willingness to buy was analyzed through a rank-ordered logistic regression through the software Stata 14. In our case, the dependent variable was the rating assigned to the likelihood of buying each of the profiles of snack containing insects-based ingredients. The β parameters represented the magnitude associated to each independent variable and explained how strongly the variable affected the choice of the consumers whether to buy or not. Table 3 shows the coefficients of the model. The results suggest that the willingness to buy an insect-based snack is affected by the attributes of the product, but there is some heterogeneity among groups of respondents.

On average, all the respondents reacted more positively to products made out of insect flour compared to the ones made with whole insects (+1.45). This means that the invisibility of the original shape of the insect is supposed to add acceptability to this category of products. In addition, there is no sharp difference between opaque and transparent packaging for those food products, being the coefficient of opaque packaging attribute not statistically significant. The effect of cacao flavor, on average, is not statistically significant, except for the respondents with higher neophobia: this category of consumers seems in fact to prefer cacao flavored products over control snacks (+1.87). The high-protein claim seems not to be particularly appealing to consumers, the coefficient is negative (-0.41): this means that consumers tend to avoid products with this claim. Finally, the effect of the environmental certification appears to be not important in this particular food decision, being the coefficient not statistically significant; however, there is an exception for respondents with higher education (university degree or more), who show an important preference towards this attribute (+1.75).

Other indications on the increasing acceptance towards these types of ingredients can be drawn from the fact that, in the whole experiment, 64% of the times respondents stated that they were willing to buy the products for a reasonable price.

[‡] This certification evaluates the environmental impact of productions through LCA procedure, that considers the environmental impact of a product through its entire life cycle ("ISO 14040: Environmental Management – Life Cycle Assessment – Principles and Framework," 2006; Caracciolo et al., 2017).

Table 3.
Estimated parameters with a rank-ordered logistic regression

	Coef.	Std. Err.	Sign.
Flour	**1.45**	0.193	***
Opaque	0.10	0.178	
Cacao	-1.00	1.077	
High_protein	**-0.41**	0.179	**
Certification	-0.97	0.932	
Cacao*neophobia	**1.87**	1.096	*
Certification*education	**1.75**	0.952	*

#obs 1080
*Note: * ;** and *** correspond, respectively to 0.1; 0.5 and 0.01 significance levels*

6 Discussion and conclusions

The present study represented a first attempt to investigate, through a systematization of the literature and an empirical analysis, main barriers and drivers for the consumers' acceptance of insects as food. A particular focus has been devoted to test whether product attributes can play a role in stimulating the young consumers' intention to buy. Testing the willingness to buy, the paper has tried to give a first indication about the current state of acceptance and the next future possibilities. Furthermore, an indication has been obtained about which product attributes can represent a driver towards the acceptance of an insect-based food, namely a snack.

From the literature it emerges that a combination of socio-cultural barriers contributes to a lower acceptability of insects as food source in Western societies. Disgust, aversion, anticipated danger and neophobia are the main factors influencing negatively the perceptions of consumers when it comes to accept insects as food. However, it is especially the invisibility of their shape that plays a relevant role in favoring the acceptance of insects as food: the use of flour instead of the whole insect seems to be more desirable. Exposure, cultural context and environmental sustainability play a role as drivers instead. In fact, growing insects is undoubtedly more sustainable compared to other sources of proteins (as cattle) and this aspect, although not particularly salient in the mind of consumers, can be used as leverage to raise their acceptance towards insects.

From the empirical analysis, namely the contingent experiment, it emerges that, on average, the young respondents appeared to be willing to buy the product, so the acceptance of the product, once it will actually be on the market can be anticipated, at least for the young part of population. Then, considering product-specific features, elements such as an invisible shape of the insect and the cacao flavor can have an effect in increasing the consumers' acceptance, as in line with previous studies (Sogari et al., 2017; Verneau, et al., 2016); they can, then, represent further drivers to insects consumption. The effect played by the cacao attribute is visible only on consumers with higher neophobia: this could be attributable to the hedonistic purpose added to the snack consumption by the presence of chocolate (Masi et al., 2016; Varela et al., 2014). Practical indications for producers can stem from these results; in fact, when insect-based foods will be actually on the market, it is desirable that they do not show the original shape of the insect and that they are prepared with familiar and appealing ingredients in order to get the favor of Italian consumers.

Despite the fact that environmental sustainability represents one of the main benefits of this type of food production, this certification seems not to be effective on average in fostering consumers' intentions, as shown also in previous studies (Laureati et al., 2016). In our study, we found however an exception for respondents with a higher education, who showed interest toward the presence of such certification. This is in line with previous studies on products with environmental friendly attributes (Husted et al., 2014; Lerro et al., 2018b), but it can also be attributable to the higher ability of this segment of population in understanding and processing information about food products (Verbeke, 2005). From a managerial point of view, planning proper marketing campaigns is supposed to reinforce the association between protection of the environment and insect-based food in the mind of the totality of consumers.

Finally, even if protein production is considered as the main feature for producing insect-based food, a high-protein content does not seem to be an appealing attribute for the consumers of our sample. This is in line with previous studies that highlighted that the general interest of consumers toward protein-enriched food is low, as they tend to eat more protein-rich conventional foods, should they need to increase their protein intake (van der Zanden et al., 2015).

Albeit, on average, the respondents appeared not totally reluctant to the possibility of buying insect-based snack foods, we can draw other conclusions from the general low statistical power of the attributes in the model: a high acceptance from consumers' side is far to be obtained, as only one attribute (the use of insect flour) appeared to be a substantial driver for acceptance according to the whole sample. Due to the effect played by exposure in lowering the avoidance toward new food products, it would be desirable to plan occasions in which consumers are encouraged to try insect-based food for the first time, in order to overcome the first psychological barrier and build a culture environment in which eating insect-based food is not totally unfamiliar.

Although this study presents some clear limitations in the limited and overly specific sample adopted, it surely adds some new evidence to the current debate on this topic. A further improvement of the paper would consider extending the sample with comparison among different countries, where different regulations also play a crucial role in stimulating the development of innovative foods using non-conventional sources of proteins. In addition, investigating the role of price in mediating the effect of the attributes on the acceptance of consumers would support the understanding of factors potentially contributing to the success of the introduction of insect-based food on the Italian market.

References

Barrena, R., Sánchez, M. (2013). Neophobia, personal consumer values and novel food acceptance. *Food Quality and Preference* **27** (1): 72-84.

Bateman, I. J., Carson, R. T., Day, B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., and Özdemiroglu, E. (2002). Economic valuation with stated preference techniques: a manual. *Economic valuation with stated preference techniques: a manual*.

Bauer, R. A., Cox, D. F. (1967). Risk taking and information handling in consumer behavior. Boston: Harvard University, pp 469-486.

Bodenheimer, F. S. (1951). Insects as Human Food. In: Bodenheimer, F.S. (ed.). Insects as Human Food. Springer, Netherlands, pp 7-38.

Bond, C. A., Hoag, D. L., and Kipperberg, G. (2011). Agricultural producers and the environment: A stated preference analysis of Colorado corn producers. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie* **59** (1): 127-144.

Boons, F., Lüdeke-Freund, F. (2013). Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. *Journal of Cleaner Production* **45**: 9-19.

Borrello, M., Caracciolo, F., Lombardi, A., Pascucci, S., and Cembalo, L. (2017). Consumers' Perspective on Circular Economy Strategy for Reducing Food Waste. *Sustainability* **9** (1): 141.

Borrello, M., Lombardi, A., Pascucci, S., and Cembalo, L. (2016). The seven challenges for transitioning into a bio-based circular economy in the agri-food sector. *Recent patents on food, nutrition and agriculture* **8** (1): 39-47.

Brunsø, K., Fjord, T. A., and Grunert, K. G. (2002). Consumers' food choice and quality perception. MAPP Working Papers.

Bucic, T., Harris, J., and Arli, D. (2012). Ethical Consumers Among the Millennials: A Cross-National Study. *Journal of Business Ethics* **110** (1): 113-131.

Caparros Megido, R., Desmedt, S., Blecker, C., Béra, F., Haubruge, É., Alabi, T., and Francis, F. (2017). Microbiological load of edible insects found in Belgium. *Insects* **8** (1): 12.

Caparros Megido, R., Gierts, C., Blecker, C., Brostaux, Y., Haubruge, É., Alabi, T., and Francis, F. (2016). Consumer acceptance of insect-based alternative meat products in Western countries. *Food Quality and Preference* **52**: 237-243.

Caracciolo, F., Amani, P., Cavallo, C., Cembalo, L., D'Amico, M., Del Giudice, T., Freda, R., Fritz, M., Lombardi, P., and Mennella, L. (2017). The environmental benefits of changing logistics structures for fresh vegetables. *International Journal of Sustainable Transportation* **12** (4): 233-240.

Caswell, J., Mojduszka, E. M. (1996). Using Informational Labeling to Influence the Market for Quality in Food Products. *American Journal of Agricultural Economics* **78** (5): 1248-1253.

Cavaliere, A., Ventura, V. (2018). Mismatch between food sustainability and consumer acceptance toward innovation technologies among Millennial students: The case of Shelf Life Extension. *Journal of Cleaner Production* **175**: 641-650.

Cavallo, C., Piqueras-Fiszman, B. (2017). Visual elements of packaging shaping healthiness evaluations of consumers: The case of olive oil. *Journal of Sensory Studies* **32** (1): e12246.

Celi, M., Rudkin, J. (2016). Drawing food trends: Design potential in shaping food future. *Futures* **83**: 112-121.

Choe, J. Y., Cho, M. S. (2011). Food neophobia and willingness to try non-traditional foods for Koreans. *Food Quality and Preference* **22** (7): 671-677.

Christensen, D. L., Orech, F. O., Mungai, M. N., Larsen, T., Friis, H., and Aagaard-Hansen, J. (2006). Entomophagy among the Luo of Kenya: a potential mineral source? *International Journal of Food Sciences and Nutrition* **57** (3-4): 198-203.

Cicia, G., Caracciolo, F., Cembalo, L., Del Giudice, T., Grunert, K. G., Krystallis, A., Lombardi, P., and Zhou, Y. (2016). Food safety concerns in urban China: Consumer preferences for pig process attributes. *Food Control* **60**: 166-173.

Cicia, G., Del Giudice, T., and Scarpa, R. (2002). Consumers' perception of quality in organic food: A random utility model under preference heterogeneity and choice correlation from rank-orderings. *British food journal* **104** (3/4/5): 200-213.

De Boer, I. J. M., Cederberg, C., Eady, S., Gollnow, S., Kristensen, T., Macleod, M., Meul, M., Nemecek, T., Phong, L. T., and Thoma, G. (2011). Greenhouse gas mitigation in animal production: towards an integrated life cycle sustainability assessment. *Current Opinion in Environmental Sustainability* **3** (5): 423-431.

DeFoliart, G. R. (1992). Insects as human food: Gene DeFoliart discusses some nutritional and economic aspects. *Crop protection* **11** (5): 395-399.

DeFoliart, G. R. (1999). Insects as food: why the western attitude is important. *Annual Review of Entomology* **44** (1): 21-50.

Dobermann, D., Swift, J., and Field, L. (2017). Opportunities and hurdles of edible insects for food and feed. *Nutrition Bulletin* **42** (4): 293-308.

Eastman, J. K., Iyer, R., Liao-Troth, S., Williams, D. F., and Griffin, M. (2014). The Role of Involvement on Millennials' Mobile Technology Behaviors: The Moderating Impact of Status Consumption, Innovation, and Opinion Leadership. *Journal of Marketing Theory and Practice* **22** (4): 455-470.

EFSA. (2015). Risk profile related to production and consumption of insects as food and feed. *EFSA Journal* **13** (10): 4257.

Fernqvist, F., Ekelund, L. (2014). Credence and the effect on consumer liking of food – A review. *Food Quality and Preference* **32**: 340-353.

Fischer, A. R., Steenbekkers, B. (2018). All insects are equal, but some insects are more equal than others. *British food journal* (just-accepted): 00-00.

Furedy, C., Maclaren, V., and Whitney, J. (1999). Reuse of waste for food production in Asian cities: health and economic perspectives. In Koc, McRae, Mougeot, and Welsh (ed.). For Hunger-Proof Cities. Sustainable Urban Food Systems: Ottawa, International Development Research Center, pp 144-154.

Gmuer, A., Guth, J. N., Hartmann, C., and Siegrist, M. (2016). Effects of the degree of processing of insect ingredients in snacks on expected emotional experiences and willingness to eat. *Food Quality and Preference* **54**: 117-127.

Green, P. E., Srinivasan, V. (1990). Conjoint Analysis in Marketing: New Developments with Implications for Research and Practice. *Journal of Marketing* **54** (4): 3-19.

Halloran, A., Münke, C., Vantomme, P., Reade, B., and Evans, J. D. (2015). Broadening insect gastronomy. In *Routledge Handbook of Sustainable Food and Gastronomy*: Routledge.

Halloran, A., Roos, N., Eilenberg, J., Cerutti, A., and Bruun, S. (2016). Life cycle assessment of edible insects for food protein: a review. *Agronomy for Sustainable Development* **36** (4): 57.

Hamilton, J., McIlveen, H., and Strugnell, C. (2000). Educating young consumers – a food choice model. *Journal of Consumer Studies and Home Economics* **24** (2): 113-123.

Hanboonsong, Y. (2010). Edible insects and associated food habits in Thailand. In Durst, Johnson, Leslie, and Shon (ed.). Forest insects as food: humans bite back. Bangkok, FAO, pp 65-84.

Hanley, N., Mourato, S., and Wright, R. E. (2001). Choice Modelling Approaches: A Superior Alternative for Environmental Valuatioin? *Journal of economic surveys* **15** (3): 435-462.

Hartmann, C., Shi, J., Giusto, A., and Siegrist, M. (2015). The psychology of eating insects: A cross-cultural comparison between Germany and China. *Food Quality and Preference* **44**: 148-156.

Hartmann, C., Siegrist, M. (2017). Consumer perception and behaviour regarding sustainable protein consumption: A systematic review. *Trends in Food Science and Technology* **61**: 11-25.

Hartmann, C., Siegrist, M. (2018). Development and validation of the Food Disgust Scale. *Food Quality and Preference* **63**: 38-50.

House, J. (2016). Consumer acceptance of insect-based foods in the Netherlands: academic and commercial implications. *Appetite* **107**: 47-58.

Husted, B. W., Russo, M. V., Meza, C. E. B., and Tilleman, S. G. (2014). An exploratory study of environmental attitudes and the willingness to pay for environmental certification in Mexico. *Journal of Business Research* **67** (5): 891-899.

Isman, M. B., Cohen, M. S. (1995). Kosher insects. *American Entomologist* **41** (2): 100-103.

ISO 14040 (2006). Environmental Management – Life Cycle Assessment – Principles and Framework.

Koide, S. (1998). Chitin-chitosan: properties, benefits and risks. *Nutrition research* **18** (6): 1091-1101.

Kouřimská, L., Adámková, A. (2016). Nutritional and sensory quality of edible insects. *NFS Journal* **4**: 22-26.

La Barbera, F., Verneau, F., Amato, M., and Grunert, K. (2018). Understanding Westerners' disgust for the eating of insects: The role of food neophobia and implicit associations. *Food Quality and Preference* **64:** 120-125.

Laureati, M., Proserpio, C., Jucker, C., and Savoldelli, S. (2016). New sustainable protein sources: consumers' willingness to adopt insects as feed and food *Italian Journal of Food Science* **28** (4): 652-668.

Lensvelt, E. J., Steenbekkers, L. (2014). Exploring consumer acceptance of entomophagy: a survey and experiment in Australia and the Netherlands. *Ecology of food and nutrition* **53** (5): 543-561.

Lerro, M., Caracciolo, F., Vecchio, R., and Cembalo, L. (2018a). Consumer's Side of Corporate Social Responsibility: A Nonhypothetical Study. *Journal of Consumer Affairs*. doi: 10.1111/joca.12182.

Lerro, M., Vecchio, R., Caracciolo, F., Pascucci, S., and Cembalo, L. (2018b). Consumers' heterogeneous preferences for corporate social responsibility in the food industry. *Corporate Social Responsibility and Environmental Management*. doi: 10.1002/csr.1519.

Looy, H., Dunkel, F. V., and Wood, J. R. (2014). How then shall we eat? Insect-eating attitudes and sustainable foodways. *Agriculture and human values* **31** (1): 131-141.

Martins, Y., Pliner, P. (2006). "Ugh! That's disgusting!": Identification of the characteristics of foods underlying rejections based on disgust. *Appetite* **46** (1): 75-85.

Masi, C., Dinnella, C., Pirastu, N., Prescott, J., and Monteleone, E. (2016). Caffeine metabolism rate influences coffee perception, preferences and intake. *Food Quality and Preference* **53**: 97-104.

Materia, V. C., Cavallo, C. (2015). Insetti per l'alimentazione umana: barriere e drivers per l'accettazione da parte dei consumatori. *Rivista di Economia Agraria* **LXX** (2): 139-161.

McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. *Frontiers in econometrics,* New York, Wiley, pp 105-142.

Menozzi, D., Sogari, G., Veneziani, M., Simoni, E., and Mora, C. (2017). Eating novel foods: An application of the Theory of Planned Behaviour to predict the consumption of an insect-based product. *Food Quality and Preference* **59**: 27-34.

Morales, A. C., Fitzsimons, G. J. (2007). Product contagion: Changing consumer evaluations through physical contact with "disgusting" products. *Journal of Marketing Research* **44** (2): 272-283.

Morris, M., Collins, N., Vane-Wright, R., and Waage, J. (1991). The utilization and value of non-domesticated insects. In Collins (ed.). The conservation of insects and their habitats. London, Academic Press, pp 319-349.

Payne, C. L., Dobermann, D., Forkes, A., House, J., Josephs, J., McBride, A., Müller, A., Quilliam, R., and Soares, S. (2016). Insects as food and feed: European perspectives on recent research and future priorities. *Journal of Insects as Food and Feed* **2** (4): 269-276.

Piqueras-Fiszman, B., Spence, C. (2015). Sensory expectations based on product-extrinsic food cues: an interdisciplinary review of the empirical evidence and theoretical accounts. *Food Quality and Preference* **40**: 165-179.

Pliner, P., Hobden, K. (1992). Development of a scale to measure the trait of food neophobia in humans. *Appetite* **19** (2): 105-120.

Porter, M. E., Van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *The journal of economic perspectives* **9** (4): 97-118.

Ramos-Elorduy, B. J. (1997). The importance of edible insects in the nutrition and economy of people of the rural areas of Mexico. *Ecology of food and nutrition* **36** (5): 347-366.

Regenstein, J., Chaudry, M., and Regenstein, C. (2003). The kosher and halal food laws. *Comprehensive Reviews in Food Science and Food Safety* **2** (3): 111-127.

Ribeiro, J. C., Cunha, L. M., Sousa-Pinto, B., and Fonseca, J. (2017). Allergic risks of consuming edible insects: A systematic review. *Molecular Nutrition and Food Research* **62** (1): 1700030.

Rozin, P., Fallon, A. E. (1987). A perspective on disgust. *Psychological review* **94** (1): 23-41.

Rozin, P., Millman, L., and Nemeroff, C. (1986). Operation of the laws of sympathetic magic in disgust and other domains. *Journal of personality and social psychology* **50** (4): 703-712.

Ruby, M. B., Rozin, P., and Chan, C. (2015). Determinants of willingness to eat insects in the USA and India. *Journal of Insects as Food and Feed* **1** (3): 215-225.

Rumpold, B. A., Schlüter, O. K. (2013). Potential and challenges of insects as an innovative source for food and feed production. *Innovative Food Science and Emerging Technologies* **17:** 1-11.

Schlup, Y., Brunner, T. (2018). Prospects for insects as food in Switzerland: A tobit regression. *Food Quality and Preference* **64**: 37-46.

Schösler, H., De Boer, J., and Boersema, J. J. (2012). Can we cut out the meat of the dish? Constructing consumer-oriented pathways towards meat substitution. *Appetite* **58** (1): 39-47.

Scopel, L. (2016). *Le prescrizioni alimentari di carattere religioso*. Trieste: EUT Edizioni Università Trieste.

Siegrist, M., Stampfli, N., and Kastenholz, H. (2008). Consumers' willingness to buy functional foods. The influence of carrier, benefit and trust. *Appetite* **51** (3): 526-529.

Sogari, G., Menozzi, D., and Mora, C. (2017). Exploring young foodies' knowledge and attitude regarding entomophagy: A qualitative study in Italy. *International Journal of Gastronomy and Food Science* **7:** 16-19.

Sogari, G., Vantomme, P. (2014). A tavola con gli insetti. Fidenza, Mattioli 1885.

Tan, H. S. G., Fischer, A. R., Tinchan, P., Stieger, M., Steenbekkers, L., and van Trijp, H. C. (2015). Insects as food: Exploring cultural exposure and individual experience as determinants of acceptance. *Food Quality and Preference* **42**: 78-89.

Tuorila, H., Lähteenmäki, L., Pohjalainen, L., and Lotti, L. (2001). Food neophobia among the Finns and related responses to familiar and unfamiliar foods. *Food Quality and Preference* **12** (1): 29-37.

Tuorila, H., Meiselman, H. L., Bell, R., Cardello, A. V., and Johnson, W. (1994). Role of sensory and cognitive information in the enhancement of certainty and linking for novel and familiar foods. *Appetite* **23** (3): 231-246.

van der Zanden, L. D. T., van Kleef, E., de Wijk, R. A., and van Trijp, H. C. M. (2015). Examining heterogeneity in elderly consumers' acceptance of carriers for protein-enriched food: A segmentation study. *Food Quality and Preference* **42**: 130-138.

van Huis, A. (2013). Potential of insects as food and feed in assuring food security. *Annual Review of Entomology* **58**: 563-583.

van Huis, A., Van Itterbeeck, J., Klunder, H., Mertens, E., Halloran, A., Muir, G., and Vantomme, P. (2013). Edible Insects: Future prospects for food and feed security. In: Food and agriculture organization of the United Nations (FAO), Foresty paper 171.

van Huis, A., Vantomme, P. (2014). Conference report: Insects to Feed the World. *Food Chain* **4** (2): 184-192.

Vanhonacker, F., Van Loo, E. J., Gellynck, X., and Verbeke, W. (2013). Flemish consumer attitudes towards more sustainable food choices. *Appetite* **62**: 7-16.

Vantomme, P., Münke, C., van Huis, A., van Itterbeeck, J., and Hakman, A. (2014). Insects to feed the world. Ede, The Netherlands: FAO/WUR.

Varela, P., Beltrán, J., and Fiszman, S. (2014). An alternative way to uncover drivers of coffee liking: Preference mapping based on consumers' preference ranking and open comments. *Food Quality and Preference* **32**: 152-159.

Verbeke, W. (2005). Agriculture and the food industry in the information age. *European Review Of Agricultural Economics* **32** (3): 347-368.

Verbeke, W. (2015). Profiling consumers who are ready to adopt insects as a meat substitute in a Western society. *Food Quality and Preference* **39:** 147-155.

Verneau, F., La Barbera, F., Kolle, S., Amato, M., Del Giudice, T., and Grunert, K. (2016). The effect of communication and implicit associations on consuming insects: An experiment in Denmark and Italy. *Appetite* **106**: 30-36.

Yen, A. L. (2009). Edible insects: Traditional knowledge or western phobia? *Entomological Research* **39** (5): 289-298.

Yeung, R. M., and Morris, J. (2001). Food safety risk: Consumer perception and purchase behaviour. *British food journal* **103** (3): 170-187.