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Forum

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Healthy, but Disgusting: An Investigation Into Consumers' Willingness to Try Insect Meat

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Abstract

Consumption of insects has gained interest because it may provide a more sustainable and healthier alternative for conventional meat. However, in Western societies, insect consumption is met with resistance due to negative attitudes based on fear and disgust. To further understand consumers' willingness to try insect meat, a 2 (meat type: bovine vs. insect) × 2 (product type: common vs. uncommon) experiment was conducted (n = 130). Four food choice factors were expected to mediate the effect of meat type and product type on willingness to try: health, sensory appeal, risk perception, and disgust. Results indicate that meat type had no effect on willingness to try. Relative to bovine meat, insect meat was perceived as both healthier and more disgusting, which could explain the absence of a meat type effect. Unexpectedly, use of insects in common products (burgers) as compared to uncommon products (skewers) was met with a lower willingness to try. Also, common products with insect meat was considered to be less healthy and more disgusting, compared to uncommon products with insect meat.

Key words: bovine meat, insect meat, consumer decision-making, food choice motives

For sustainability reasons and in order to foster global food security, there is a tendency to look for alternatives to complement or substitute the production of conventional meat products, including bovine meat (Grunert 2006, Gahukar 2011, De Bakker and Dagevos 2012), which ranks among the most input-intensive meat types (Subak 1999, Hoekstra and Chapagain 2006, Vergé et al. 2008). One approach is to replace animal proteins by alternative protein sources, or to develop hybrid products that are partly based on animal proteins, partly on alternative protein sources (Neville et al. 2017). One possibility is the development of cultured meat, but so far, the prices are very high and consumers have reacted with skepticism (Verbeke et al. 2015). Another possibility aims at the development of marketable insect-based food products. These products have met with increasing attention in the past few years as they can be an efficient, sustainable, and safe source of nutrients (Oonincx et al. 2010, Yates-Doerr 2015). At least 1,900 species are consumed as human food (Van Huis et al. 2013). The consumption of insects is called *entomophagy*, and throughout the world, insects are consumed because of their richness in protein, fat, vitamins and minerals (Janssen et al. 2017, Li et al. 2017). Besides these nutritional features, claims are made that consuming insects provides environmental and economic benefits relative to the conventional meat consumption, since insects produce smaller quantities of greenhouse gases and ammonia than cattle and pigs, and insect production demands less land and water (Van Huis et al. 2013). The picture is actually more complex: Oonincx and Van Huis (2017) reported that a life cycle assessment (LCA) performed on mealworms, house crickets, black soldier flies, and houseflies provide very different results and the rearing conditions can deeply change the sustainability figure.

Despite these claims, entomophagy is far from common practice in many Western societies (Van Huis et al. 2013). Only few Western consumers are willing to eat insects (Deroy et al. 2015), and Western consumers have a negative attitude towards entomophagy due to disgust and unfamiliarity. Insects are associated with safety elements such as dirt, diseases, and death (Deroy et al. 2015, Hamerman 2016). Indeed, studies confirm that many people do not accept insects as protein source (e.g., De Boer et al. 2013), and suggest that acceptance of entomophagy will depend on factors beyond cultural, emotional and rational dimensions such as palatability, availability, and nutritional benefits.

The typology of insect-based products available in the Western countries is rapidly changing. In the pioneer phase, whole insects such as cricket and worms were consumed—desiccated or fried as snack. This was accepted only by few adventurous eaters and in any case not for regular consumption (Tan et al. 2015, 2016). Nowadays, the food industry is exploring possibilities to incorporate invisible insects in familiar food, creating products identical in appearance and taste to more conventional meat products. In these products,

insects are used as ingredients: usually by grinding them into flour, while the use of protein isolates similar to those available from soybean will become possible in the near future. These products offer a viable alternative especially to eco-friendly consumers who are tempted by this new food, but disgusted by the idea of eating visible insects (Tan et al. 2015, 2016).

Against this background, understanding consumers' perception regarding the use of invisible insects in food vis-à-vis conventional meat types like bovine meat is key. Therefore, the aim of the present research is to examine the food choice motives that determine an individual's willingness to try an insect product versus a bovine meat product. This could provide important insights into effective strategies to develop and market novel protein products, such as alternatives to conventional meat, or for instance hybrid meat products, as well as for existing products that will compete with these new products.

Whether or not persons will eat insects vis-a-vis conventional alternatives depends on their intentions to do so. An intention is the most direct and important predictor for behavior (Ajzen 1991), and intentions are relevant to study given the fact that insect products are as of yet not widely available. A way to examine consumers' intentions to try novel foods is assessing their *willingness to try* it. People typically vary in the willingness to try novel foods. While some individuals show strong aversion, other people show enjoyment when eating new foods (Ritchey et al. 2003). Furthermore, *food choice motives* can explain people's reasons for trying food products. In this research, we explore the influence of different motives that are relevant in the context of willingness to try insects: health, sensory appeal, risk perception, and disgust.

A prominent food choice factor is *health*. Health considerations include nutritional value, contents of macronutrients (like fat and carbohydrates) and micronutrients (like minerals and vitamins), essential nutrients (like proteins) and non-essential nutrients (like fiber), and the appraisal of whether a food will be good for the body. People with higher health concerns make more deliberate food choices than those less concerned with health (Steptoe et al. 1995). Therefore, health is a key food choice determinant.

Another motive for food choice is *sensory appeal*: the appearance, the smell, and taste of food. People will favor a certain food if they judge its appearance, mouthfeel, and taste to be pleasant. Rozin (1988) argued that food that is (expected to) taste good, is easily accepted and frequently eaten. Sensory motives are seen as the most important motives of consumer food choice in Europe (Magnusson et al. 2001).

A third motive is *risk perception*. Unlike bovine meat, edible insects are a novel food and most people are unfamiliar with it. The public knows little about the food safety aspects of insect products (Tan et al. 2015), but Western consumers take the safety of industrial food products for granted and frequently reject certain novel foods more for psychological than logical reasons. Due to unfamiliarity in Western countries, the idea of entomophagy may be associated with risk-taking and may raise questions about safety and risks of consumption. In the current context, we understand risk perception as the perceived unsafety of consumption and the potential to cause harm to the body. The idea of insects as unsafe and new, and as a possible hazard to the body, could influence the intention to (not) consume them.

A fourth motive that may play a role is *disgust*. Despite the increasing number of adventurous eaters attracted by the possibility of consuming insects (Latimer et al. 2015) in Western countries, the idea of entomophagy is still largely associated with disgust (Tan et al. 2016): Insects have the 'yuck'-factor, as they are associated with dirt and diseases. Disgust is a basic food-related emotion, associated with the perceived or imagined taste, smell, mouthfeel, or appearance of a food. Furthermore, disgust is a response to something repulsive or unpleasant: it is a strong food rejection as it can be regarded a survival tool to keep oneself from ingesting dangerous and unknown food. Western consumers avoid entomophagy because of this disgust and hygiene concern (Rozin and Fallon 1987). When food is believed to be disgusting, people will likely choose not to eat it. Therefore, disgust of food is a relevant food choice motive to explore.

Method

Participants and Design

Dutch non-vegetarian consumers were invited via (public) social media sites and the personal network of the third author to participate in an online research. Participants were randomly assigned to one of the conditions of the 2 (meat type: bovine vs. insect) × 2 (product type: common vs. uncommon) between-subject design.

Procedure

In order to investigate consumers' willingness to try products of different meat sources and different preparations, participants were presented a picture of the product accompanied by a product description (Fig. 1). Participants took part in one condition of the between-subjects design, so they were presented only one picture of the condition they were allocated to. We used identical pictures and varied the information across different meat type conditions. In this way, we were able to explain possible differences by the fact that the description read by the participants was different for the different meat type conditions, and not because the picture looked different. The photos in the common product type conditions represented a hamburger (the same picture was used in the insect and the bovine meat conditions); in reality, the picture represented a beef patty. The description stated that the burger patty was made out of ground beef (for bovine meat type condition) or ground 'buffalo worms', *Alphitobius diaperinus* (Panzer) (Coleoptera: Tenebrionidae), the lesser mealworm, and locusts (for insect meat type condition); it was mentioned that both are edible insects, was prepared on the grill and flavored with salt, pepper and mustard—all common flavorings to the Dutch consumer. In the uncommon product type conditions a picture of a shish kebab was used (again, the same picture was used in the insect and the bovine meat conditions), a skewer with cubes of ground veal (bovine meat type condition) or cubes of ground buffalo worms and locusts (insect meat type condition; it was mentioned that both are edible insects); in reality, the picture represented a veal skewer. The description stated that it was prepared on the grill and seasoned with Mediterranean spices: turmeric, cardamom, cumin, ginger and chili pepper; these represent relatively less typical ingredients for Dutch standards. No information about nutrition and safety regarding the product was given. To make sure that the respondents paid good attention to the product and the description, they were asked to describe the product they saw on the picture. After the presentation of the product, participants were asked to rate the visibility of the ingredients and how common the products were to them. Then the food choice motives—health, sensory appeal, risk perception, and disgust—were evaluated, and finally participants' willingness to try the product.

Measures

All questionnaire items used were statements to which respondents responded by indicating their agreement on 7-point Likert scales, with response options from 1: 'not at all' to 7: 'to a great extent', unless otherwise stated. Please see the Supp. Appendix for the full list of questionnaire items.

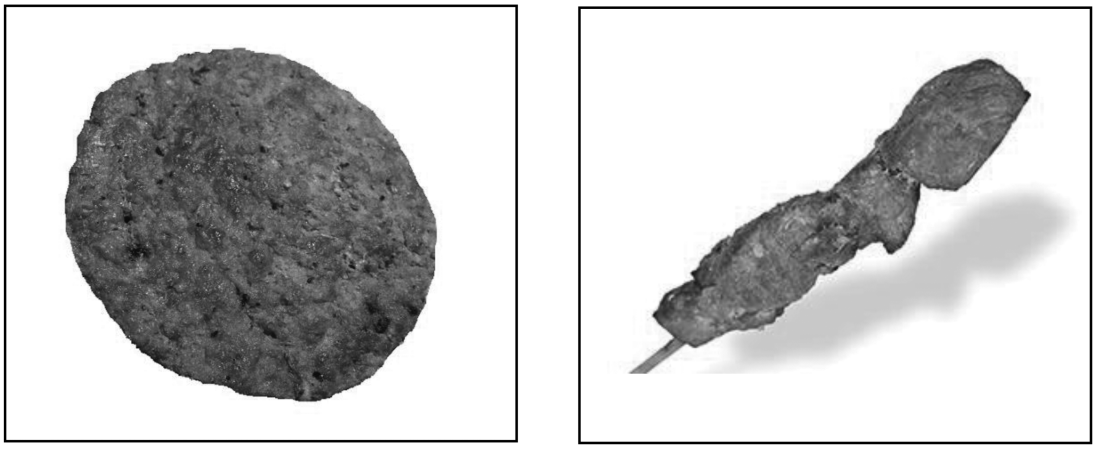

Fig. 1. Experimental stimulus material. The left panel shows the picture used in the two common product type conditions; the right panel the picture used in the two uncommon product type conditions.

Manipulation Checks

Participants were asked to indicate how common the product was to them (5 questionnaire items; α = .77). An example item is 'to what extent is a [burger/shish kebab] a product you usually eat?' We also checked to what extent the ingredients were clearly visible and described to the participants in the experimental manipulation (three questionnaire items; α = .74); sample item: 'how visible were the ingredients of the product in the picture?'

Willingness to Try

If people cannot refer to their habits and past behavior, their future behavior is guided by intention (Danner et al. 2008). For most Dutch consumers, this would also be the case for trying insects. According to the theory of planned behavior, a person's intention is the most proximal driver of actual behavior. Therefore, statements were based on measurements of intention in the theory of planned behavior (Ajzen 1991). Willingness to try was measured with six statements about the product presented in the picture (α = .94); an example of an item is: 'in the near future, I would like to try the product in the picture' (1 = strongly disagree; 7 = strongly agree).

Food Choice Motives

The participants answered nineteen questions concerning four food choice motives (Steptoe et al. 1995, Fandos Herrera and Flavián Blanco 2011): *health* (six questionnaire items; α = .89), *sensory appeal* (six questionnaire items; α = .84), *risk perception* (four questionnaire items; α = .78), and *disgust* (three questionnaire items; α = .83). Representative examples of questionnaire items are: 'do you think the product in the picture contains a lot of vitamins and minerals?' (health); 'do you think the product in the picture will have a pleasant texture?' (sensory appeal); 'do you consider the product in the picture safe to eat?' (risk perception; positively formulated); 'to what extent does the product in the picture repulse you?' (disgust).

Results

Sample

One hundred thirty-four Dutch consumers (89 women) participated in the study; only non-vegetarians participated. The participants represented different age ranges (<18 yr: 3.0%; 18–24: 38.1%; 25–34: 25.4%; 35–44: 10.4%; 45–54: 13.4%; 55–64: 7.5%; >65: 2.2%; four participants were under the age of 18). As we were interested in the perceptions and decision-making of an adult consumer sample, these responses were left out of the analysis). Of the participants, 6.2, 42.3, and 51.5% indicated that they had completed lower, intermediate, or higher education, respectively.

Manipulation Checks

A 2 × 2 univariate analysis of variance (ANOVA) indicated a main effect of the product type manipulation on how common the product was judged: $F(1, 126) = 22.04$, $P < 0.001$. As intended, participants considered the burger products to be more common ($M = 4.02$, SD = 1.26) than the skewer products ($M = 3.20$, SD = 1.28).

Furthermore, in all four conditions, we used pictures of products with ground bovine or insect meat, so it was intended that the ingredients were not identifiable. To check for this, we conducted a 2 × 2 ANOVA on the visibility scale. This analysis yielded no main effects of meat type or product type on visibility, nor a two-way interaction (all Fs < 1.02; *ns*). So, as intended, across conditions participants did not note differences in the visibility of ingredients.

Willingness to Try

The means and SDs of the dependent variable of willingness to try are displayed in Table 1. A 2 × 2 ANOVA on willingness to try indicated a main effect of product type: $F(1, 126) = 8.85$, $P < 0.01$. Participants reported a stronger willingness to try skewers ($M = 4.33$, SD = 1.55) than burger patties ($M = 3.49$, SD = 1.67).

Food Choice Motives

The means and SDs of the explored food choice motives are displayed in Table 1. A 2 × 2 ANOVA on the health scale indicated a main effect of meat type: $F(1, 126) = 29.32$, $P < 0.001$ and a main effect of product type: $F(1, 126) = 9.81$, $P < 0.01$. Insects ($M = 4.27$; SD = 1.29) were considered more healthy than bovine meat ($M = 3.16$; SD = 1.09). In the uncommon product type conditions ($M = 4.05$; SD = 1.17) higher health ratings were reported than in the common product type conditions ($M = 3.40$; SD = 1.37).

A 2 × 2 ANOVA on the sensory appeal scale showed a main effect of product type: $F(1, 126) = 16.21$, $P < 0.001$; the two-way interaction was also significant ($F(1, 126) = 11.56$, $P < 0.001$). Uncommon products (skewers) were considered more appealing ($M = 4.38$; SD = 1.12) than common products (burger patties; $M = 3.59$; SD = 1.19). The interaction effect showed that this difference was bigger for bovine meat than for insects (Table 1).

A 2 × 2 ANOVA on the risk perception scale indicated a main effect of meat type: $F(1, 126) = 8.39$, $P < 0.01$. In the bovine meat conditions ($M = 3.22$; SD = 1.02) higher risk perceptions were reported than in the insect conditions ($M = 2.60$; SD = 1.36).

Finally, a 2 × 2 ANOVA on the disgust scale indicated a main effect of meat type: $F(1, 126) = 4.25$, $P < 0.05$, and a main effect of product type: $F(1, 126) = 10.14$, $P < 0.01$. Insects were considered more disgusting ($M = 2.95$; SD = 1.76) than bovine meat ($M = 2.44$; SD = 1.30). Second, skewers were considered less disgusting ($M = 2.27$; SD = 1.38) than burger patties ($M = 3.09$; SD = 1.62).

Mediation Analysis of Food Choice Motives

To test the mediating roles of the different food choice motives, a bootstrap analysis (Preacher and Hayes 2004) was employed to test the indirect effect between meat type and willingness to try, while controlling for product type. This approach involves computing 95% confidence intervals (CIs; 5,000 bootstrap resamples) around indirect effects; mediation is indicated by CIs that do not contain zero. Importantly, this powerful test allows for the detection of indirect effects in the absence of a direct effect, such as when different underlying indirect effects level out the direct effect on a dependent variable.

The results from the bootstrap analysis for indirect effects are presented in Table 2. The mediation analysis shows that two specific mediators could be identified that describe the indirect relation between meat type and willingness to try—as the value 0 was not included in the respective 95% CIs: health and disgust. The other variables—sensory appeal and risk perception—were not found to contribute to the indirect relationship between meat type and willingness to try.

Discussion

Four food choice motives were expected to underlie people's decision-making for bovine meat versus insect meat: health, sensory appeal, risk perception, and disgust. Relative to bovine meat, insect meat was judged to be healthier but also more disgusting. As health is positively associated with the willingness to try, whereas disgust is negatively so, these opposite motives level each other out. Consequently, bovine meat is regarded relatively less healthy but also less disgusting, while insect meat products are regarded to be healthy but at the same time disgusting, and this explains the tie between the two investigated meat types in terms of willingness to try (i.e., no effect of meat type on willingness to try).

Across two different product types (burgers and skewers) no difference between bovine and insect meat was observed with respect to willingness to try. However, when presented a relatively uncommon product—an insect shish kebab—respondents indicated to be more willing to try it, compared to bovine burgers. This suggests that care should be taken to design insect products that have an exclusive appearance. To further investigate this idea, future research could include measures of openness to product innovation. In contrast to expectations based on literature, common product types resulted in lower sensory appeal expectations, and this effect was even stronger for bovine meat. Additionally, the common product type condition (i.e., the burger) led to lower health expectations, and higher disgust. This could be because a hamburger is considered by these consumers as the stereotype of a junk food product, with related adverse health effects (Oakes 2017). A related explanation for unexpected effects on disgust is that burger patties may be associated by these consumers with mass-production, while skewers signal a more ethnic product because of their Mediterranean origin. Taken together, this implies that for conventional meat, uncommon products have greater market potential than common products.

This also goes for insect meat products. Nowadays, the insect burger is possibly the most well-known insect-based food; however, although it is already 10 yr on the Dutch market, its adoption is very limited. According to the current research, uncommon products could be favored more strongly by Dutch consumers. Producers of hybrid meat-insect products or of insect-based foods should consider

Table 1. Means and SDs of willingness to try and food choice motives as a function of meat type and product type

Meat type	Bovine				Insect			
Product type	Common		Uncommon		Common		Uncommon	
Dependent variable	*M*	SD	*M*	SD	*M*	SD	*M*	SD
Willingness to try	3.32a	1.45	4.52b	1.27	3.67acd	1.87	4.15bd	1.77
Health	2.72a	0.93	3.64b	1.06	4.10bcd	1.41	4.45d	1.15
Sensory appeal	3.28a	1.09	4.73b	0.95	3.91c	1.21	4.04c	1.18
Risk perception	3.46a	0.86	2.96abc	1.13	2.62b	1.43	2.59c	1.30
Disgust	2.97a	1.42	1.85b	0.82	3.22a	1.82	2.68a	1.68

ANOVA post hoc tests were performed to tests for differences between conditions. Means that do not share subscripts differ significantly at $P < 0.05$.

Table 2. Bootstrap analysis of indirect relationships

			95% CI for indirect effect	
Mediator	Indirect effect	SE	Lower	Upper
Health	−0.48	0.17	**−0.8752**	**−0.1937**
Sensory appeal	0.00	0.04	−0.0789	0.0832
Risk perception	−0.08	0.07	−0.2577	0.0190
Disgust	0.27	0.14	**0.0286**	**0.6071**

Mediation of food choice motives between meat type and willingness to try was tested by computing 95% CIs (5,000 bootstrap resamples) around indirect effects (Preacher and Hayes 2004). Mediation is formally indicated by CIs that do not contain zero (in bold).

special foods like Turkish shish kebabs, Greek stuffed vine leaves ('dolmades'), different kinds of meatballs, or perhaps sushi.

It is likely this trend can be similar in most of the Western countries: take advantage from the health and eco-friendly perception of insects and include them as invisible ingredients in foods, which are relatively uncommon in the market. In this way, the trend of ethnic foods can meet the trend towards sustainable food, thus favoring the introduction of insect in products that are consumed on a daily base (Tomic et al. 2018).

Disgust and health explained the indirect effect of meat type on the willingness to try. This is in line with Hamerman (2016), who concluded that disgust determines the willingness to try insects, while Tucker (2014) emphasized the positive responses concerning health benefits of entomophagy. This is consistent with our results as respondents perceived insect-based products healthier than the bovine-based products. Furthermore, although this was not found to play a mediating role, respondents had a lower risk perception for insect products relative to bovine-based products. This is relevant as it may come as no surprise that consumers are more likely to adopt a product when they perceive it with fewer risks.

Finally, it is recommended to consider health aspects of insect products during the phase of marketing strategy development. Marketers could emphasize nutritional characteristics when promoting hybrid bovine-insect products or insect-only products, for instance by informing the consumers about the health benefits of insects: protein type, mineral and vitamin contents, etc.

Conclusion

The aim of this research was to discover the different underlying motives people have for their food choices regarding to insects vis-à-vis bovine meat, and whether particular motives could predict the consumers' willingness to try insects. Uncommon products (i.e., a shish kebab) were preferred over common products (i.e., a burger), but no difference was observed between meat types (bovine meat vs. insect meat). The higher perceived health benefits and disgust related to insect products had opposite effects on the willingness to try the product: this can explain why insect products are not preferred over bovine meat products. Interestingly, this study suggests that health might be an important driver for the adoption of insect consumption. However, this perception can be easily canceled out by any safety concern arising from the suboptimal rearing conditions still adopted in some insect farms, especially those located in developing countries (Oonincx and Van Huis 2017), or expectedly if questions arise on animal welfare conditions in insect rearing. Development of marketing strategies for insect products or bovine-insect hybrids should consider the health features of insects and the way of product presentation.

Supplementary Data

Supplementary data are available at *Journal of Economic Entomology* online.

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