



How will better products improve the sensory-liking and willingness to buy insect-based foods?



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ABSTRACT

Insects have been established to be a more sustainable alternative source of protein in comparison to conventional meats, but have little appeal to those who are unfamiliar with their taste. Yet little attention has been given to understanding how more appealing products could be developed, and whether that is sufficient to encourage consumption of a culturally unusual food. By evaluating appropriate (i.e. meatball) and inappropriate (i.e. dairy drink) mealworm products along with the original mealworm-free products, this study provided new insights into how the product influences sensory-liking and willingness to buy insect-based foods for trial and regular consumption. Willing ($n = 135$) and unwilling tasters ($n = 79$) were recruited to explore differences between individuals who differ in their intentions to eat insects. An appropriate product context improved the expected sensory-liking and willingness to buy mealworm products once and regularly. However, consumers should first be motivated to eat insects for a better product to improve consumption intentions. Descriptive sensory profiling revealed that mealworm products were expected and experienced to taste very different from the original mealworm-free products, but were generally preferred to taste similar to the original, albeit with some unique attributes. Using a familiar and liked product preparation could help to increase trial intentions, but the product should also be appropriate and taste good if it is to be regularly consumed. We conclude that even with high interest and good products, willing consumers still hesitate to consume insect-based foods regularly due to other practical and socio-cultural factors. We recommend that future research should not only give emphasis to increasing initial motivations to try, but should address the barriers to buying and preparing insects for regular consumption, where issues relating to availability, pricing, knowledge and the social environment inhibit the uptake of this culturally new food.

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1. Introduction

Western interest in insects as food has escalated tremendously in recent years due to its nutritional and environmental advantages over conventional sources of protein (Boland et al., 2013; van Huis, 2013). Yet insects have little sensory appeal to most Western consumers (Deroy, Reade, & Spence, 2015) and even the most motivated eaters remain unwilling to consume them on a regular basis after tasting the products (Tan et al., 2015; Tucker, 2014). The low sensory appeal of insect-based foods poses difficulties for consumer acceptance as taste is an important driver of food choice (Steptoe, Pollard, & Wardle, 1995). Few consumers are willing to compromise on taste for other desired benefits like health and sustainability, which offer less immediate and tangible benefits (Horgen & Brownell, 2002; Tuorila & Cardello, 2002;

van Trijp & Fischer, 2011). Improving the sensory experience of insect-based products is thus of critical importance if insects are to be eaten regularly. Studies on the consumer acceptance of insects as food in the West have so far given much attention to the psychological factors (e.g. food neophobia, risk perceptions) (Baker, Shin, & Kim, 2016; Hartmann, Shi, Giusto, & Siegrist, 2015), but the role of the product preparation and its sensory qualities remains relatively unexplored. While it is known that a food's preparation could change its desirability by influencing its hedonic qualities and perceived appropriateness (Cardello & Maller, 1982; Mela, 2001), the cultural unfamiliarity and inappropriateness of insects as food (Deroy et al., 2015; Tan, Fischer, van Trijp, & Stieger, 2016) raises new questions regarding what consumers perceive to be appealing, and whether making better products could encourage regular consumption of this culturally unusual food.

Product-based strategies for improving the willingness to eat novel foods usually emphasize the use of familiar and liked flavours or preparations (Prescott, Young, Zhang, & Cummings, 2004; Tuorila, Andersson, Martikainen, & Salovaara, 1998). This helps by presenting the novel food

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in a way that looks and tastes familiar to consumers in order to create more positive expectations (Tuorila, Meiselman, Cardello, & Leshner, 1998; Wansink, 2002). However, applying a liked flavour or preparation does not always increase the liking of a novel food (Pliner & Stallberg-White, 2000; Stallberg-White & Pliner, 1999). A usually liked food could also be disliked when presented in an inappropriate context or situation (Cardello, Schutz, Snow, & Leshner, 2000; Schutz & Martens, 2001). According to Schutz and Martens (2001), appropriateness is a measure of food acceptance that brings in the contextual aspects that are important to food acceptance, therefore enabling a better understanding and prediction of food behaviours.

Perceived appropriateness is often discussed in terms of the usage context (Cardello et al., 2000; Schutz & Martens, 2001), which refers to whether the food product matches the situation or context of consumption. For instance, a delicious stew may not appeal at breakfast, or an insect-based food that is intended as a meat substitute may not be attractive as dessert (Tan et al., 2015). This is based on the premise that consumers perceive products in terms of benefits, using them as a means to an end (Ratneshwar & Shocker, 1991). The satisfaction delivered by a food product thus depends not only on the hedonic qualities of the food but also on the match between product category and usage situation. Perceived appropriateness could also refer to the food combination (Elzerman, Hoek, van Boekel, & Luning, 2011; Stallberg-White & Pliner, 1999), in which case flavour principles are in check. For instance, using chocolate with grasshoppers may be seen to be an inappropriate combination with clashing flavours and textures (Tan et al., 2015). In the present paper, we refer to the perceived appropriateness of the product preparation as 'product appropriateness'.

What is an appropriate way to prepare and use a food is, however, very much influenced by individual experiences and cultural norms (Rozin, 2006; Tan et al., 2015) where satisfactory past experiences are likely to influence what consumers deem to be appropriate (Giacalone & Jaeger, 2016). For novel foods like insects that are culturally unfamiliar and never eaten by most Western consumers, expectations concerning how a food is appropriately used are likely to be less defined. At the moment, insects can be found in a wide variety of food applications in Western cookbooks (e.g. van Huis, van Gurp, and Dicke (2012)), where insects seem to be used more for its protein rather than sensory value. Thai consumers of insects, on the other hand, speak of specific ways of preparing and consuming various insect species, and are able to discuss extensively about the distinctive sensory qualities of each species and how they enhance the recipes they are combined with (Tan et al., 2015). But even though culturally-defined rules may be lacking in Western cultures, savoury insect products are still perceived to be more appropriate than sweet products (Tan, van den Berg, & Stieger, 2016) due to the primary positioning of insects as a meat alternative (Shelomi, 2015; Tan et al., 2015). It follows that consumers expect savoury insect products to taste better and are more willing to buy and try them (Tan, van den Berg, et al., 2016). However, it remains to be seen if products are also liked when they are tasted.

Given the unfamiliarity with insects as food, Western consumers tend to overlook their taste qualities (Deroy et al., 2015). There is a strong presumption that incorporating ground insects invisibly within food products would increase the acceptance of insect-based foods (Caparros Megido et al., 2016; Gmuer, Guth, Hartmann, & Siegrist, 2016). However, it is possible that the insect-based foods are perceived instead to be inferior versions of the original products (Tan, Fischer, et al., 2016), although the sensory-liking (i.e. hedonic appraisal of the sensory properties) has yet to be examined in detail. This study takes a closer look at what underlies the sensory-liking of insect-based products by examining the expected, experienced and ideal sensory properties of insect-based and insect-free products. Sensory research on a wide range of foods have shown that larger deviations of a food's sensory properties from the reported ideal properties negatively influences sensory-liking (Conner, 1994; Worch & Punter, 2015). Yet for culturally unusual foods like insects, the perceived food appropriateness also plays an

important role in acceptance and is strongly related to the sensory-liking of novel foods (Tan, Fischer, et al., 2016). Rozin and Fallon (1987) define 'items that are not considered by a culture to be fit for consumption' to be inappropriate. For such foods the mere belief of its presence could already result in rejection (Rozin & Fallon, 1987; Tan, Fischer, et al., 2016), which could mean that certain consumers may dislike and decline to eat insects regardless of its product preparation and sensory qualities. To make a distinction from 'product appropriateness' that pertains to the product context, in this paper we refer to the perceived fitness of insects for human consumption as 'food appropriateness'.

The novelty and inappropriateness of insects as food adds further complexity to understanding its acceptance as food, especially in view of encouraging dietary change. First, consumers who are willing to try insects are not similarly willing to buy it (Tan, van den Berg, et al., 2016) or to use it as food on a regular basis (Tan et al., 2015; Tucker, 2014; Verbeke, 2015). Motivations for trial and regular consumption of insect-based foods are evidently very different, where repeated consumption is driven by more conventional considerations regarding food choice (e.g. taste, price) (House, 2016). Second, people differ in their willingness to adopt insects as food due to traits such as food neophobia and gender (Hartmann et al., 2015; Verbeke, 2015), but when specific products are evaluated, these individual factors seem to play a minor role in determining the acceptability of insect-based foods (Tan, Fischer, et al., 2016; Tan, van den Berg, et al., 2016). The present study takes a closer look at these dimensions by exploring how willing and unwilling consumers differ in their evaluations and rationales regarding their willingness to buy insect-based foods for trial and regular consumption.

This study aims to gain a better understanding of how an appropriate product could influence the acceptance of a novel food like insects. Mealworms (*Tenebrio molitor* larvae) were selected for this study due to its recent availability as food in the Netherlands, such that findings have direct applications to the Dutch context. Using appropriate (i.e. meatball) and inappropriate (i.e. dairy drink) mealworm products, product influences on sensory-liking and willingness to buy mealworm products for trial and regular consumption were investigated. In addition, by comparing the evaluations and rationales given by willing and unwilling tasters, this study further explores the interplay between product and individual factors in the acceptance of a novel food. Implications of the study outcomes on product development and consumer acceptance of culturally novel foods with low sensory appeal are discussed.

2. Materials and methods

2.1. Participants

Participants were recruited from a previous survey-based study on Dutch consumers (n = 1057) (Tan, van den Berg, et al., 2016) during which they were invited to participate in a taste study involving mealworm products. A total of 596 positive responses and 296 negative responses were received, whereas the rest cited reasons of inconvenience and disinterest. Positive responders (n = 596) received a screening survey. Those who were between 18 and 65 years of age, had no allergies or dietary restrictions, and were available during study period were invited to participate in a sensory study. Negative responders (n = 296) were invited to participate in an online survey-based study that used the sensory questionnaire without the part that involved tasting products. A total of 135 willing tasters (33.0 ± 16.7 years, 80% female, 90.4% completed tertiary education) participated in the sensory study and 79 unwilling tasters (50.9 ± 21.2 years, 65.8% female, 68.4% tertiary education) participated in the online study. A Wageningen University ethics committee granted ethical approval. Participants of the sensory study signed an informed consent form at the start of the study and received 10 euros reward upon

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