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Consumer acceptance of insect-based alternative meat products in Western countries

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ABSTRACT

During the past few years, entomophagy has been increasing in significance. As insects are generally high in protein, they are principally considered as meat substitutes. Nevertheless, in Western countries, meat substitute consumption is actually very low, principally due to food neophobia and poor sensory qualities in comparison with meat. In insect particular case, food neophobia is clearly high. To reduce insect food neophobia, previous studies suggest to insert invisible insect in food preparation and/or to associate them with known flavors. In this study, a survey on entomophagy perception and hedonic tests were realized to assess the level of sensory-liking of hybrid insect-based burgers (beef, lentils, mealworms and beef, mealworms and lentils). Participants' overall liking of the four burgers differed between genders and was influenced by burger appearance and taste. Women clearly preferred beef burger appearance, whereas men preferred the appearance of beef and insect-based burgers. Concerning insect-based burger taste, participants (men and women) rated it intermediately, between that of the beef and lentil burger, with a preference for the mealworm and beef burger. Results also showed that people with previous entomophagy experience was limited but that they gave globally higher ratings to all preparations. In conclusion, insect tasting sessions are important to decrease food neophobia, as they encourage people to "take the first step" and become acquainted with entomophagy. Nevertheless, insect integration into Western food culture will involve a transitional phase with minced or powdered insects incorporated into ready-to-eat preparations, as people are not ready to add insects to their diets in "whole form."

1. Introduction

Meat plays an important role in the consumption patterns of most Western consumers (Elzerman, Hoek, van Boekel, & Luning, 2011; Schösler, Boer, & Boersema, 2012). Consumption of animal-based foods has increased throughout the world since the 1960s, due principally to the sensory qualities of meat, increased production efficiency of the meat industry, and rising global average income and standard of living in growing populations characterized by changing food preferences (Elzerman et al., 2011; Reynolds, Buckley, Weinstein, & Boland, 2014; Steinfeld et al., 2006). Meat consumption is not predicted to decline in upcoming years; to the contrary, global meat production is projected to more than double, from 229 million tonnes in 1999/2001 to 465 million tonnes by 2050 (Steinfeld et al., 2006). Unfortunately, meat production is responsible for well-known environmental pressure due to the inefficient conversion of plant protein to meat protein (Aiking, 2011; Pimentel & Pimentel, 2003). A trend of reversal appears to be required, which could be materialized by a reduction in meat portion size ("less is better" strategy), the promotion of "meatless days" or the consumption of meat substitutes (Aiking, 2011; De Boer, Schösler, & Aiking, 2014; De Boer, Schösler, & Boersema, 2013b). Meat substitutes, also referred as meat replacers, meat alternatives, or meat analogs, are protein-containing foods that are primarily vegetable based and that replace the function of meat as a hot meal component (Hoek et al., 2011). These products are principally made of pulses (mainly soy), cereals, or fungus protein, but the utilization of new protein sources, such as insects and seaweed, has been considered (Aiking, 2011; De Boer et al., 2013b; Hoek et al., 2011). Nevertheless, in Western

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countries, the quantity and frequency of meat substitute consumption are actually very low (Elzerman et al., 2011; Hoek et al., 2011, 2013). Food neophobia (i.e., reluctance to try novel foods), primarily the fear of a negative sensory experience, is the most important person-related factor determining meat substitute acceptance (Hoek et al., 2011; Pelchat & Pliner, 1995; Pliner & Hobden, 1992). Information on proper use, positive taste or similarity to familiar food (“tastes like food X”), and exposure over time have been found to facilitate the acceptance of these unfamiliar foods (Cardello, Maller, Masor, Dubose, & Edelman, 1985; Hoek et al., 2013; Pelchat & Pliner, 1995; Tuorila, Meiselman, Cardello, & Lesher, 1998). A first step to reduce food neophobia is to present the substitute in a meal context in due to increase familiarity with the product (Elzerman et al., 2011). Concerning product-related factors, low sensory attractiveness is a key barrier to meat substitute acceptance among non-vegetarian consumers (Hoek et al., 2011). Effectively, the imitation of meat, a high complex product with a well-appreciated, distinctive flavor and texture, remains a technological challenge (Hoek et al., 2013). Finally, occasional consumers of meat substitutes generally recognize ethical (in terms of animal welfare or environmental impact) or nutritional aspects of these products, but this recognition is not sufficient to compensate generally negative attitudes toward and beliefs about them (De Boer, Schösler, & Boersema, 2013a; Hoek et al., 2011; Tucker, 2014). Educational programs, communication, and information provision are valuable to increase consumers’ awareness about the impacts of food choices on themselves and the environment (Vanhonacker, Van Loo, Gellynck, & Verbeke, 2013; Vermeir & Verbeke 2008).

Among the new environmentally friendly sources of protein, insects appear to be valuable candidates (Belluco et al., 2013; FAO, 2009; Gahukar, 2011). Insects have (1) high fecundity rates, with year-round breeding; (2) high conversion rates; (3) low environmental impact, due principally to low greenhouse gas emissions; (4) small breeding space requirements; and (5) in some species, the ability to recycle organic industrial and/or agricultural byproducts to feed livestock or humans (Bednárová, Borkovcová, Mlcek, Rop, & Zeman, 2013; Defoliart, 1995; DeFoliart, 1997; Rumpold & Schlüter, 2013a, 2013b; Van Huis, 2013; van Huis et al., 2013; Yen, 2009; Yi et al., 2013). Alongside these environmental benefits, insects are very nutritious; they are, for example, particularly rich in high-quality protein (Bednářová, Borkovcová, & Komprda, 2014; Rumpold & Schlüter, 2013a; van Huis et al., 2013). Mealworm larvae (*Tenebrio molitor*, L.; Coleoptera: Tenebrionidae) and crickets (*Teleogryllus testaceus*, F.; Orthoptera: Gryllidae) contain up to 50% and 75% protein in dry weight, respectively, which is made of essential amino acids such as phenylalanine, tyrosine, and tryptophan (Bednářová et al., 2014; Caparros Megido et al., 2015; Rumpold & Schlüter, 2013a; Siemianowska et al., 2013). Despite the many benefits of insects as food, insect food neophobia is clearly established, in Western countries, and may be explained by knowledge of the animals’ origins and habitats or by anticipated negative post-ingestional consequences (Caparros Megido et al., 2014; Rozin, Haidt, McCauley, Dunlop, & Ashmore, 1999; Schösler et al., 2012; Verbeke, 2015). Few studies have focused on consumers’ perceptions and readiness to adopt insects as meat substitutes in Western culture (Tan, Fischer, van Trijp, & Stieger, 2016; Verbeke, 2015). Most of the studies have not involved tasting sessions, and their main finding has been a very low degree of willingness to eat edible insects in Western countries (De Boer et al., 2013b; Schösler et al., 2012; Vanhonacker et al., 2013; Verbeke, 2015). To reduce insect neophobia, a first possible solution is to educate consumers on cultural, nutritional, and ecological issues associated with entomophagy; however, several studies have shown that this approach is poorly effective (Lensvelt & Steenbekkers, 2014; Mignon, 2002; Verbeke, 2015). A second solution is to increase the frequency of edible insect exposure and experimental tasting (Caparros Megido et al., 2014). People who have already eaten insects have significantly more positive attitudes toward entomophagy and are more willing to eat and cook insects in the future (Caparros Megido et al., 2014; Lensvelt & Steenbekkers, 2014). Nevertheless, the invisible inclusion of insects in a preparation (i.e., pizza with insect protein or biscuit with insect flour) and the association of insects with known flavors (i.e., insects coated with paprika or chocolate) appear to trigger less aversion than the presentation of visible and unflavored insects (Caparros Megido et al., 2014; Lensvelt & Steenbekkers, 2014; Schösler et al., 2012; Tan et al., 2016).

To decrease the well-known food neophobia related to insects and to meat substitutes, we decided, in this present study, to test the level of sensory-liking of mealworms-based burger patties allowing us to hide insects and to present them in a familiar way. Mealworms were chosen as insect model since it is, between the three edible insect species actually reared and sold in Europe (mealworms, migratory locusts and house crickets) the easiest to rear, the “greenest”, the cheapest and the less neophobic (Caparros Medigo, Alabi, Haubruge, & Francis, 2015; Caparros Megido et al., 2014; Caparros Megido et al., in press; Li, Zhao, & Liu, 2013; Oonincx et al., 2010). Using hedonic testing, this product was compared with fully meat and vegetable burgers, as well as hybrid vegetable burgers (as suggested by De Boer et al. (2013b).

2. Material and methods

2.1. Respondent profile

The experiment was conducted at the Paul Lambin Institute (Woluwe-Saint-Lambert, Belgium). During the study period (15/01/2014–27/02/2014), 159 students from several disciplines (medical biology, dietetics, and chemistry) attended a brief presentation of the testing session (schedule and duration of the tasting session and the potential presence of insects) and had the opportunity to register for it. Seventy-nine (51%) students agreed to participate in the study. The students were aged 18–25 years and were considered to be potential future insect consumers.

After being isolated in a tasting booth, participants were invited to respond to the first part of the questionnaire. This part of the survey solicited sociodemographic information from participants and included the following five questions: (1) have you already heard about entomophagy (yes or not)? (2) If yes, through which channel: television, radio, newspaper, internet or other? (3) What are your preconceptions about eating insects: curiosity, disgust, fear, primitive behavior or nothing (check-all-that-apply question)? (4) Have you already eaten insects or insect products (yes or not)? and (5) If yes, was it a positive experience?

All respondents participated voluntarily, were recruited in the Paul Lambin Institute by email and received no monetary compensation for their participation. Potentially allergic subjects to crustaceans or mites were not invited to participate. Ethical approval was granted and all participants gave written consent.

2.2. Sample preparation

Mealworms (*Tenebrio molitor* L.) reared in our laboratory on wheat flour, brewer’s yeast, and wheat bran were used in this study. The insects were fasted for 24 h before they were killed by freezing, to ensure that they have excreted all feces. This procedure allowed us to reduce the bacterial load in the insect gut and to offer a safe product for human consumption. Nevertheless, microbiological tests were conducted to ensure the harmlessness of insect preparations to respondents.

Four different burger patties were prepared using three main ingredients: unflavored ground beef, green lentils, and mealworms