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# Acceptance of bars with edible insects by a selected group of students from Tri-City, Poland

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**Abstract:** Although entomophagy as a diet has been known since the dawn of humanity, it is still considered a novelty to the European market and consumers. This study was performed to evaluate the acceptance of a trend promoted by the FAO diet regarding selected young Polish consumers and it presents the results of a survey conducted among them. The primary goal of this study was to assess the acceptance of new edible insect products with mealworms *Tenebrio molitor* L. and house crickets *Acheta domesticus* L. These products were prepared in the form of four different types of bars; one without insects, one with whole mealworms, one with ground mealworms and one with ground crickets. According to consumers, the worst bars were the ones which contained the whole mealworms. Additionally, the main problems with accepting this product were caused by the colour of the ground crickets and visible whole pieces of the insects in the edible bars. The study proved that the acceptance of insect bars as food depends on the tastiness and smell. The acceptance of bars also depends on variants. The basic bar had the highest acceptance rate, while the bar with whole mealworms had the lowest one.

**Keywords:** house crickets; mealworms; new food; young consumers; entomophagy

Entomophagy has been known since the dawn of humanity and has a long history in many parts of the world. For many populations worldwide edible insects are the primary source of nutrients and it is not due to the lack of other food but because of the special taste. What is more, they are treated almost as delicacies (Siriamornpun & Thammapat 2008). The advantages resulting from the consumption of insects are mainly health, environment, and livelihood of people (Van Huis et al. 2013).

For many people in western societies, insects are regarded as pests and entomophagy is often associated with disgust and primitive behaviour. In the future, insects could be food for both humans and livestock (Van Huis et al. 2013). Determinants of consumer acceptance of new sources of food are price and quality advantages, the risk of naturalness, confidence, attitude, culture, and adjusted offer for consumers. The lack of knowledge about entomophagy makes insects seen as "unhygienic", which would mean that they are the source of diseases, bacteria, or infections (Lensvelt & Steenbekkers 2014).

According to Dicke et al. (2014) people will accept eating insects if they look and smell familiar and if they are not served intact. At present, the consumption of edible insects is minimal in developed countries, but people's curiosity is growing. In Europe, edible insects arouse various emotions and, at the same time, huge curiosity.

New food, especially with insects, can cause anxiety and a sense of insecurity because of ignorance,

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the lack of knowledge and experience in dealing with it. As a result, there are internal conflicts and barriers associated with the consumption of new, unknown food. New food may arouse ambivalent attitudes, containing components of both positive and negative approaches. Thus, consumers' prejudice based on visual aspects and their willingness to expand their knowledge about nutrition are contradictions in the attitude towards this food (Shiv & Fedorikhin 1999).

Visual assessment generally takes place before the first assessment carried out by the other senses, and it often determines the acceptance or rejection of the product (Babicz-Zielińska et al. 2009). Consumer research in Europe found that acceptance is higher when insects are hidden in products (Lensvelt & Steenbekkers 2014; Sogari 2015; Tan et al. 2015; Schouteten et al. 2016).

In European consumer research, insects were served in various forms, both in their natural form, in different flavours (Megido et al. 2014; Ruby 2015; Sogari 2015) and in the form of burgers, bars or other dishes known to consumers (Megido et al. 2014; Tan et al. 2015; Hartmann & Siergist 2016; House 2016; Megido et al. 2016; Verneau et al. 2016; Menozzi et al. 2017; Jensen & Lieberoth 2018; Lombardi et al. 2018).

In Europe, there is no cultural impulse to eat insects, given that entomophagy is not practised, but Mancini et al. (2019) indicate a growing interest in edible insects in European countries such as Finland, Germany, Czech Republic, Italy, Belgium, Netherlands, Switzerland, Hungary, Denmark, Ireland and Poland manifesting in the amount of research on their acceptance in these countries.

Therefore, it is important to know the factors currently affecting the acceptance of edible insects in Poland in a selected group of young people. According to Gutkowska et al. (2014) study, Polish consumers are generally positive about changes in the food market and they have the most positive attitude represented by the youth and the middle-aged. Apparently, there is a high degree of acceptance of new foods among young consumers.

Therefore, the main purpose of this study was to evaluate the acceptance of new edible insect products with mealworms *Tenebrio molitor* L. and house cricket**s** *Acheta domesticus* L. starting with a selected group of young consumers in Poland. There are some limitations in the presented study. The selected group of students is not a representative group, and this does not allow generalizing the results for the whole group of young consumers in Poland.

## MATERIAL AND METHODS

**Respondent profile.** The experiment was executed in a laboratory. All consumers participated voluntarily. They were also informed about safety and potential allergenicity of arthropods. The selected group consisted of students because a trend of innovation in the market is observed among young people. It is expressed by an increase of interest in other products with new, unknown flavours. A total of 101 students from one of the colleges in Tri-City (Gdańsk, Sopot and Gdynia) rated the intensity of each sensory descriptor for each sample, using the 10-point unstructured scale labelled on both ends with hedonic or intensity terms, on the left (unacceptable, undetectable) and on the right (acceptable, very intense). The respondents' gender was 74 women (73.3%) and 27 men (26.7%). Respondents made a sensory evaluation of four different types of bars which were prepared. Having been instructed about the way of using the 10-point scale for each descriptor, the respondents were also informed about the possibility of the occurrence of allergy to insects. One of the bars was an insect-free bar, one with (visible) whole mealworms *Tenebrio molitor* L., another with a non-visible powder and a bar with crushed *Acheta domesticus* L. The young consumers rated the intensity of each sensory descriptor for each sample. A 10-point scale in the acceptance test was to evaluate: appearance, overall assessment, tastiness, consistency (0-unacceptable–10-acceptable) and sweet taste, nutty flavour, coconut flavour, sesame flavour, a taste of cranberry, a taste of honey, a taste of sunflower (0-undetectable–10-very intense). After assessing the variants, the consumers identified preferences of these four bars from the worst to the best (0–10).

**Insect preparation.** The mealworms *Tenebrio molitor* L. and crickets *Acheta domesticus* L. used in this study were produced in the Netherlands for Eat Grub Ltd., all insects were from organic farming. The raw material was preserved by freeze-drying, which allowed preserving the original organoleptic properties and full nutritional and biological value. The research material was certified by KBBL Wijhe B.V. (Netherlands). The certificate included microbiological determination of insects as food (*Escherichia coli*, Enterobacteriaceae, *Listeria monocytogenes*, Salmonella, *Staphylococcus aureus*). The packing contained information on the nutrients of products and allergic factors, expiration date, as well as the method of preparation and storage conditions. The samples included oatmeal, sesame seed, cranberry, honey, coconut, sunflower seeds, hazelnuts, and condensed milk. The bars were baked at 130 °C for 1 hour. The sample

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BB was basic (basic bar), BWWM (bar with whole mealworms, addition 7.4%) was with whole mealworms (visible), BWGM (bar with ground mealworms, addition 7.4%) was with flavoured mealworms (not visible to the human eye) and BWGC (bar with ground crickets, addition 7.4%) was with favoured crickets. Whole crickets were not used in the study because their grey-brown colour could negatively affect the acceptance of bars. During the study, the consumers mentioned the negative effect of colour, which led to acceptance in the appearance descriptor of the BWGC bar.

**Statistical analysis.** The obtained data were subjected to statistical analysis in the Statistica PL12 computer program (StatSoft Kraków, Poland), at $P \leq 0.05$. One-way analysis of variance ANOVA was used to compare the variants of the bars. Cluster analysis was also used. A multiple regression analysis was performed for each variant. The dependent variable was acceptance (overall assessment in this study), while the independent variables were appearance, tastiness, smell, consistency, and taste: sweet, nutty, coconut, sesame, cranberry, honey, sunflower (ingredients of bars). The significance estimate was calculated at $P \leq 0.05$.

## RESULTS AND DISCUSSION

Consumers who evaluated the bars had similar preferences to the ones with whole mealworms and ground crickets. The BB bar without mealworms showed similarity in parameters like appearance, tastiness, smell, texture, and taste: sweet, nutty, sesame, cranberry, honey, sunflower to BWGM with invisible insects. The invisible whole mealworms in bars affected many parameters which had an indirect effect on consumers' acceptance. Comparing BWWM and BWGM bars, the lowest values were found in almost all BWWM assessment parameters except coconut preferences and taste, which were the lowest in BWGC. BWWM and BWGC bars were the least preferred by consumers. The sight of whole insects and colour affected consumers' perception. Although the ingredients were the same in all bars, the addition of 7.4% edible insects in BWWM, BWGC and BWGM bars showed that the respondents rated the appearance lower in BWWM and BWGC bars compared to BB (Table 1).

Based on the results obtained, it was found that the acceptance of bars also depends on the type of bar. The relationship is shown in the comparison (acceptance ± SD): Acceptance BB (8.5 ± 1.3) > BWGM (7.7 ± 1.8) > BWGC (5.8 ± 2.7) > BWWH (5.5 ± 2.8). The bars BB, BWGM, BWGC and BWWM are statistically different but BWWM and BWGC are statistically the same. According to the respondents, the BB bar had the highest value of acceptance and it was different from the others. The BWWM and BWGC bars had the lowest acceptance value and showed significant similarity to each other, they were equally accepted by consumers.

Two clusters have been distinguished based on the data. One of them contained BB and BWGM bars, which

Table 1. Mean scores for sensory descriptors on a 10-point scale of fit bars (mean ± SD)

| Descriptors | BB | BWWM | BWGM | BWGC |
|---|---|---|---|---|
| Appearance | 8.5 ± 1.4$^{a}$ | 5.7 ± 2.9$^{b}$ | 8.0 ± 1.8$^{a}$ | 6.9 ± 2.5$^{c}$ |
| Tastiness | 8.0 ± 1.5$^{a}$ | 4.8 ± 2.6$^{bc}$ | 7.7 ± 1.8$^{a}$ | 5.5 ± 2.9$^{c}$ |
| Sweet taste | 6.5 ± 1.7$^{a}$ | 3.5 ± 2.3$^{b}$ | 6.3 ± 2.5$^{a}$ | 5.1 ± 2.8$^{c}$ |
| Nutty flavour | 5.7 ± 2.7$^{ac}$ | 3.9 ± 3.2$^{bd}$ | 6.4 ± 2.4$^{a}$ | 4.7 ± 2.7$^{cd}$ |
| Coconut flavour | 6.3 ± 2.5$^{a}$ | 3.9 ± 2.9$^{bc}$ | 3.3 ± 2.7$^{cd}$ | 2.8 ± 2.6$^{d}$ |
| Sesame flavour | 5.9 ± 2.7$^{a}$ | 3.9 ± 2.9$^{bc}$ | 5.0 ± 2.9$^{abc}$ | 4.4 ± 2.5$^{c}$ |
| Taste of cranberry | 4.6 ± 3.4$^{a}$ | 3.5 ± 3.1$^{a}$ | 4.5 ± 3.4$^{ab}$ | 4.8 ± 3.0$^{b}$ |
| Taste of honey | 4.5 ± 3.0$^{ab}$ | 1.9 ± 1.8$^{b}$ | 4.6 ± 3.1$^{a}$ | 3.1 ± 2.6$^{c}$ |
| Taste of sunflower | 5.1 ± 3.1$^{a}$ | 4.9 ± 2.7$^{a}$ | 5.8 ± 3.0$^{a}$ | 5.3 ± 2.8$^{a}$ |
| Smell | 8.4 ± 2.4$^{a}$ | 6.1 ± 2.8$^{bc}$ | 7.5 ± 2.4$^{a}$ | 6.2 ± 2.4$^{c}$ |
| Consistency | 6.6 ± 2.2$^{a}$ | 6.8 ± 2.2$^{a}$ | 6.7 ± 2.9$^{a}$ | 6.8 ± 2.5$^{a}$ |
| Overall assessment | 8.5 ± 1.3$^{a}$ | 5.5 ± 2.8$^{bd}$ | 7.7 ± 1.8$^{c}$ | 5.8 ± 2.7$^{d}$ |
| Consumer preference | 8.7 ± 1.3$^{a}$ | 4.8 ± 3.0$^{bd}$ | 6.7 ± 2.4$^{c}$ | 4.6 ± 3.0$^{d}$ |

Values in the same row followed by the same letter were not significantly different ($P > 0.05$); BB – basic bar; BWWM – bar with whole mealworms (7.4%, visible); BWGM – bar with ground (flavoured) mealworms (7.4%, not visible); BWGC – bar with ground crickets (7.4%, not visible)

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showed the closest resemblance to each other. In the second cluster there were BWGC and BWWM bars, which showed similarities in relation to each other, but this cluster was different from the first one (Figure 1).

Stock et al. (2016) noted that hiding insects in food "weakens encounters with them". The inclusion of insects as an invisible ingredient can lead to greater readiness to try a particular product, perhaps the lack of a pronounced appearance or taste reduces the positive reasons for choosing an insect-based food product.

The invisible inclusion of insects in the product in this study as well as in others e.g. pizza, lentils, burgers, spring rolls, soup, pasta, bread, cookies, chocolate bars or biscuits with insect flour including the combination of insects with known flavours, i.e. insects covered with pepper or chocolate, seems to cause less aversion than the presentation of visible and distasteful insects (Schösler et al. 2012; Lensvelt & Steenbekkers 2014; Megido et al. 2014; Tan et al. 2016; Lombardi et al. 2018).

Sogari et al. (2018) demonstrated that the sensory attribute perception such as appearance, taste and organoleptic characteristics can change between readily visible and processed insect product. They also suggested that for some "consumer groups" the presence of the whole insect significantly increases taste preference, although the visible aspect of the cricket is still a disgusting factor just like in this study. Texture and appearance of insects are perceived as stronger barriers than the taste attribute. The positive experience of tasting products with both visible and processed insects may lead consumers to reconsider their initial negative expectations and attitudes towards entomophagy. In this study, the visible mealworm and cricket aspects were confirmed in the analysed case in the BWGC and BWWM bars.

Comparing BWWM and BWGC, BWGC bars obtained lower values in descriptors such as consumer's preference and coconut flavour. In other descriptors, BWWM bars obtained lower values. Despite not very encouraging appearance of the BWGC bar, consumers rated it better than a product in which insect pieces were visible. This fact indicates that the consumer should not see the form of an insect at this stage of obtaining products containing insects. This conclusion is in line with the scientific statements set out above. Obtained models of the dependence between acceptance and selected sensory qualities allowed concluding that the level of acceptance of the tested products was conditioned by a significant influence of the quality fac-

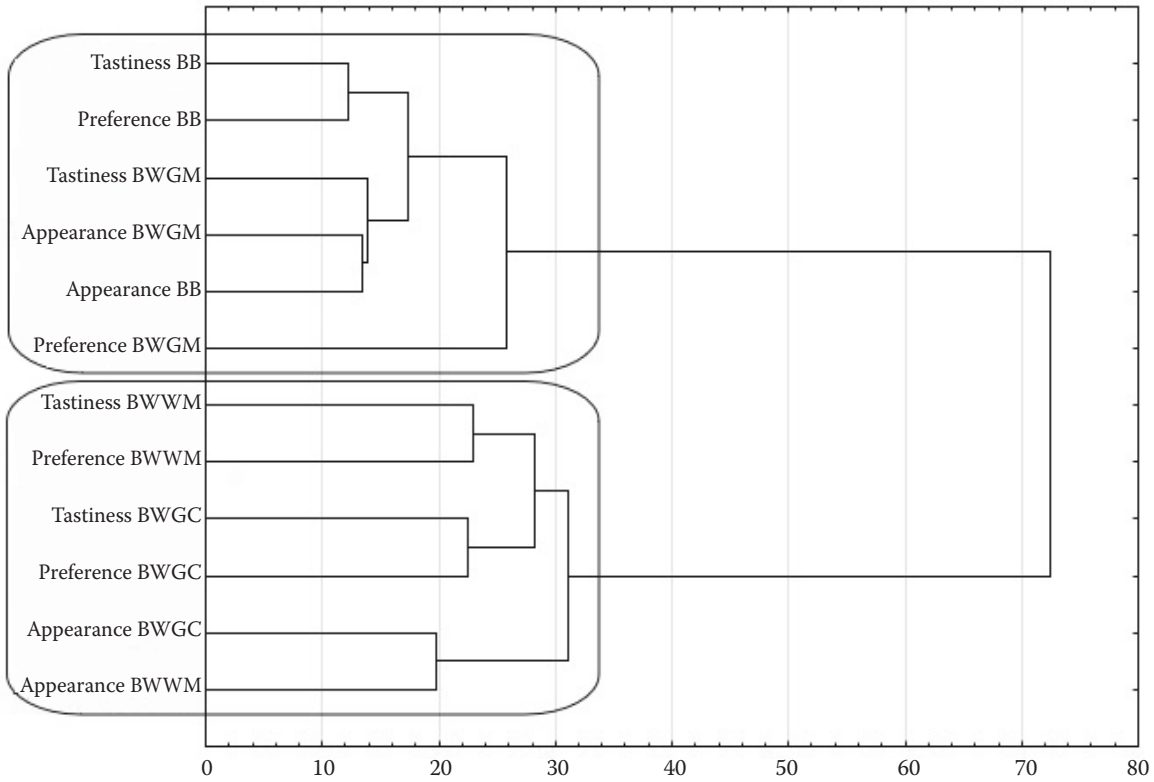


Figure 1. Concentration of four variants of fit bars (Ward's method)

For abbreviations see Table 1

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Table 2. Multiple regression models for all variants of fit bars

| Model | $R^2$ |
|---|---|
| **BB** | |
| Acceptance BB = 0.530 tastiness BB + 0.316 appearance BB + 0.228 consistency BB | 0.381 |
| **BWGM** | |
| Acceptance BWGM = 0.648 tastiness BWGM + 0.350 smell BWGM | 0.719 |
| **BWWM** | |
| Acceptance BWWM = 0.504 smell BWWM + 0.489 tastiness BWWM | 0.618 |
| **BWGC** | |
| Acceptance BWGC = 0.565 smell BWGC + 0.432 tastiness BWGC | 0.768 |

$R^2$ – multiple regression coefficient; for abbreviations see Table 1

tors, which were identified as critical. The indication of selected quality factors as critical parameters resulted from their statistically significant role in shaping the quality of these products expressed in the assessment of their acceptance. Generated multiple regression models are presented together with the values of the multiple regression coefficient $R^2$ in Table 2.

Comparing the values of the coefficients of determination characterizing the multiple regression models describes the impact of selected quality factors on the level of acceptance of individual flavour variants. The highest value was found in the case of BWGC and it amounted to 76.8%, and the lowest value in the case of BB reached 23.2%. Tastiness was a statistically significant factor that occurred in all multiple kinds of regression for all bars. The generated critical parameters may be a hint for further research on products containing edible insects.

Sensory evaluation is a method of testing and comparing different products in terms of the human senses: sight, smell, taste, touch, and hearing. It would seem that taste is the most important determinant of quality in the case of food, however, it is not the only one. Food may taste delicious and its appearance may be unpleasant to the eye (Grunert 2005; Song & Schwarz 2009; Megido et al. 2014; Jensen & Lieberoth 2018) like in the case of BWWM and BWGC bars.

## CONCLUSION

The consumers in this study preferred BB bar without edible insects and BWGM bar with the ground mealworms. They had similar preferences to BWWM and BWGC. According to consumers, the appearance of BWGC was worse than that of BB and BWGM. Based on the obtained results, it was found that the acceptance of insect bars as food will depend on the tastiness, which in each of the examined cases seemed to be the key factor differentiating quality. It is worth noting that the predictor – the smell of the presented bars – was an important statistical quality indicator in 3 out of the 4 cases studied. The acceptance of bars also depends on variants. The highest acceptance was BB and the lowest was BWWM bars. This study shows that the consumer should not see the form of an insect at this stage of obtaining products containing insects. The variety of ingredients used in the preparation of bars was aimed at increasing the acceptance of bars with insects and familiarizing a young Polish consumer with them. This experiment was an attempt to use the well-known oat bar as a base to add edible insects.

## REFERENCES

Babicz-Zielińska E., Rybowska A., Obniska W. (2009): The Sensory Evaluation of Food Quality. 2nd Ed. Wydawnictvo Akademii Morskiej, Gdynia, Poland: 9–72. (In Polish)

Dicke M., Van Huis A., Peters M., Van Grurp H. (2014): The hockey stick pattern in the acceptance of edible insects in the Netherlands. Abstract book at Conference "Insects to Feed the World", Netherlands: 118.

Gutkowska K., Kowalczuk I., Sajdakowska M., Żakowska-Biemans S., Kozłowska A., Olewnik-Mikołajewska A. (2014): Consumers' attitudes towards innovations in the food market. Handel Wewnętrzny, 4: 80–93. (In Polish)

Grunert K.G. (2005): Food quality and safety: Consumer perception and demand. European Review of Agricultural Economics, 32: 369–391.

Hartmann C., Siegrist M. (2016): Becoming an insectivore: Results of an experiment. Food Quality and Preference, 51: 118–122.

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

https://doi.org/10.17221/236/2019-CJFS

Jensen N.H., Lieberoth A. (2018): We will eat disgusting foods together – evidence of the normative basis of Western entomophagy – disgust from an insects tasting. Food Quality and Preference, 72: 2–30.

Lensvelt E.J., Steenbekkers L.P. (2014): Exploring consumer acceptance of entomophagy: A survey and experiment in Australia and the Netherlands. Ecology of Food and Nutrition, 53: 542–561.

Lombardi A., Vecchio R., Borrello M., Caracciolo F., Cembalo L. (2018): Willingness to pay for insect-based food: the role of information and carrier. Food Quality and Preference, 72: 18–27.

Mancini S., Moruzzo R., Riccioli F., Paci G. (2019): European consumers' readiness to adopt insects as food. A review. Food Research International, 1–44.

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

Megido R.C., Sablon L., Geuens M., Brostaux Y., Alabi T., Blecker C., Drugmand D., Haubruge È., Francis F. (2014): Edible insects acceptance by Belgian consumers: Promising attitude for entomophagy development. Journal of Sensory Studies, 29: 14–20.

Menozzi D., Sogari G., Veneziani M., Simoni E., 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.

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

Schouteten J.J., de Steur H., de Pelsmaeker S., Lagast S., Juvinal J.G., et al. (2016): Emotional and sensory profiling of insect-, plant- and meat-based burgers under blind, expected and informed conditions. Food Quality and Preference, 52: 27–31.

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

Shiv B., Fedorikhin A. (1999): Heart and mind in conflict: The interplay of affect and cognition in consumer decision making. Journal of Consumer Research, 26: 278–292.

Siriamornpun S., Thammapat P. (2008): Insects as a delicacy and a nutritious food in Thailand (Chapter 16). In: Robertson G.L., Lupien J.R. (eds): Using Food Science and Technology to Improve Nutrition and Promote National Development. International Union of Food Science & Technology, 1–12.

Sogari G. (2015): Entomophagy and Italian consumers: An exploratory analysis. Progress in Nutrition, 17: 311–316.

Sogari G., Menozzi D., Mora C. (2018): Sensory-liking expectations and perceptions of processed and unprocessed insects product. International Journal on Food System Dynamics, 9: 314–320.

Song H., Schwarz N. (2009): If it's difficult to pronounce, it must be risky fluency, familiarity, and risk perception. Psychological Science, 20: 135–138.

Stock P.V., Phillips C., Campbell H., Murcott A. (2016): Eating the unthinkable: the case of ENTO, eating insects and bioeconomic experimentation. In: Le Heron R., Campbell H., Lewis N., Carolan M. (eds): Biological Economies: Experimentation and the Politics of Agri-food Frontiers, London, UK: 157–169.

Tan H.S.G., Fischer A.R., Tinchan P, Stieger M, Steenbekkers P., 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.

Tan H.S.G., Fischer A.R., van Trijp H.C., Stieger M. (2016): Tasty but nasty? Exploring the role of sensory-liking and food appropriateness in the willingness to eat unusual novel foods like insects. Food Quality and Preference, 48: 293–302.

Van Huis A., van Itterbeeck J., Klunder H., Mertens E., Halloran A., Muir G. Vantome P. (2013): Edible insects: Future prospects for food and feed security. FAO Forestry Paper, UNFAO, Rome, Italy: 1–201.

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

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